

MAGNETOSPHERIC CONSCIOUSNESS

Matti Pitkänen

Köydenpunojankatu D 11, 10900, Hanko, Finland

Preface

This book belongs to a series of online books summarizing the recent state Topological Geometrodynamics (TGD) and its applications. TGD can be regarded as a unified theory of fundamental interactions but is not the kind of unified theory as so called GUTs constructed by graduate students at seventies and eighties using detailed recipes for how to reduce everything to group theory. Nowadays this activity has been completely computerized and it probably takes only a few hours to print out the predictions of this kind of unified theory as an article in the desired format. TGD is something different and I am not ashamed to confess that I have devoted the last 32 years of my life to this enterprise and am still unable to write The Rules.

I got the basic idea of Topological Geometrodynamics (TGD) during autumn 1978, perhaps it was October. What I realized was that the representability of physical space-times as 4-dimensional surfaces of some higher-dimensional space-time obtained by replacing the points of Minkowski space with some very small compact internal space could resolve the conceptual difficulties of general relativity related to the definition of the notion of energy. This belief was too optimistic and only with the advent of what I call zero energy ontology the understanding of the notion of Poincare invariance has become satisfactory.

It soon became clear that the approach leads to a generalization of the notion of space-time with particles being represented by space-time surfaces with finite size so that TGD could be also seen as a generalization of the string model. Much later it became clear that this generalization is consistent with conformal invariance only if space-time is 4-dimensional and the Minkowski space factor of imbedding space is 4-dimensional.

It took some time to discover that also the geometrization of also gauge interactions and elementary particle quantum numbers could be possible in this framework: it took two years to find the unique internal space providing this geometrization involving also the realization that family replication phenomenon for fermions has a natural topological explanation in TGD framework and that the symmetries of the standard model symmetries are much more profound than pragmatic TOE builders have believed them to be. If TGD is correct, main stream particle physics chose the wrong track leading to the recent deep crisis when people decided that quarks and leptons belong to same multiplet of the gauge group implying instability of proton.

There have been also longstanding problems.

- Gravitational energy is well-defined in cosmological models but is not conserved. Hence the conservation of the inertial energy does not seem to be consistent with the Equivalence Principle. Furthermore, the imbeddings of Robertson-Walker cosmologies turned out to be vacuum extremals with respect to the inertial energy. About 25 years was needed to realize that the sign of the inertial energy can be also negative and in cosmological scales the density of inertial energy vanishes: physically acceptable universes are creatable from vacuum. Eventually this led to the notion of zero energy ontology which deviates dramatically from the standard ontology being however consistent with the crossing symmetry of quantum field theories. In this framework the quantum numbers are assigned with zero energy states located at the boundaries of so called causal diamonds defined as intersections of future and past directed light-cones. The notion of energy-momentum becomes length scale dependent since one has a scale hierarchy for causal diamonds. This allows to understand the non-conservation of energy as apparent. Equivalence Principle generalizes and has a formulation in terms of coset representations of Super-Virasoro algebras providing also a justification for p-adic thermodynamics.
- From the beginning it was clear that the theory predicts the presence of long ranged classical electro-weak and color gauge fields and that these fields necessarily accompany classical electromagnetic fields. It took about 26 years to gain the maturity to admit the obvious: these fields are classical correlates for long range color and weak interactions assignable to dark matter. The only possible conclusion is that TGD physics is a fractal consisting of an entire hierarchy of fractal copies of standard model physics. Also the understanding of electro-weak massivation and screening of weak charges has been a long standing problem, and 32 years was needed to discover that what I call weak form of electric-magnetic duality gives a satisfactory solution of the problem and provides also surprisingly powerful insights to the mathematical structure of quantum TGD.

I started the serious attempts to construct quantum TGD after my thesis around 1982. The original optimistic hope was that path integral formalism or canonical quantization might be enough to construct the quantum theory but the first discovery made already during first year of TGD was that these formalisms might be useless due to the extreme non-linearity and enormous vacuum degeneracy of the theory. This turned out to be the case.

- It took some years to discover that the only working approach is based on the generalization of Einstein's program. Quantum physics involves the geometrization of the infinite-dimensional "world of classical worlds" (WCW) identified as 3-dimensional surfaces. Still few years had to pass before I understood that general coordinate invariance leads to a more or less unique solution of the problem and implies that space-time surfaces are analogous to Bohr orbits. Still a couple of years and I discovered that quantum states of the Universe can be identified as classical spinor fields in WCW. Only quantum jump remains the genuinely quantal aspect of quantum physics.
- During these years TGD led to a rather profound generalization of the space-time concept. Quite general properties of the theory led to the notion of many-sheeted space-time with sheets representing physical subsystems of various sizes. At the beginning of 90s I became dimly aware of the importance of p-adic number fields and soon ended up with the idea that p-adic thermodynamics for a conformally invariant system allows to understand elementary particle massivation with amazingly few input assumptions. The attempts to understand p-adicity from basic principles led gradually to the vision about physics as a generalized number theory as an approach complementary to the physics as an infinite-dimensional spinor geometry of WCW approach. One of its elements was a generalization of the number concept obtained by fusing real numbers and various p-adic numbers along common rationals. The number theoretical trinity involves besides p-adic number fields also quaternions and octonions and the notion of infinite prime.
- TGD inspired theory of consciousness entered the scheme after 1995 as I started to write a book about consciousness. Gradually it became difficult to say where physics ends and consciousness theory begins since consciousness theory could be seen as a generalization of quantum measurement theory by identifying quantum jump as a moment of consciousness and by replacing the observer with the notion of self identified as a system which is conscious as long as it can avoid entanglement with environment. "Everything is conscious and consciousness can be only lost" summarizes the basic philosophy neatly. The idea about p-adic physics as physics of cognition and intentionality emerged also rather naturally and implies perhaps the most dramatic generalization of the space-time concept in which most points of p-adic space-time sheets are infinite in real sense and the projection to the real imbedding space consists of discrete set of points. One of the most fascinating outcomes was the observation that the entropy based on p-adic norm can be negative. This observation led to the vision that life can be regarded as something in the intersection of real and p-adic worlds. Negentropic entanglement has interpretation as a correlate for various positively colored aspects of conscious experience and means also the possibility of strongly correlated states stable under state function reduction and different from the conventional bound states and perhaps playing key role in the energy metabolism of living matter.
- One of the latest threads in the evolution of ideas is only slightly more than six years old. Learning about the paper of Laurent Nottale about the possibility to identify planetary orbits as Bohr orbits with a gigantic value of gravitational Planck constant made once again possible to see the obvious. Dynamical quantized Planck constant is strongly suggested by quantum classical correspondence and the fact that space-time sheets identifiable as quantum coherence regions can have arbitrarily large sizes. During summer 2010 several new insights about the mathematical structure and interpretation of TGD emerged. One of these insights was the realization that the postulated hierarchy of Planck constants might follow from the basic structure of quantum TGD. The point is that due to the extreme non-linearity of the classical action principle the correspondence between canonical momentum densities and time derivatives of the imbedding space coordinates is one-to-many and the natural description of the situation is in terms of local singular covering spaces of the imbedding space. One could speak about effective value of Planck

constant coming as a multiple of its minimal value. The implications of the hierarchy of Planck constants are extremely far reaching so that the significance of the reduction of this hierarchy to the basic mathematical structure distinguishing between TGD and competing theories cannot be under-estimated.

From the point of view of particle physics the ultimate goal is of course a practical construction recipe for the S-matrix of the theory. I have myself regarded this dream as quite too ambitious taking into account how far reaching re-structuring and generalization of the basic mathematical structure of quantum physics is required. It has indeed turned out that the dream about explicit formula is unrealistic before one has understood what happens in quantum jump. Symmetries and general physical principles have turned out to be the proper guide line here. To give some impressions about what is required some highlights are in order.

- With the emergence of zero energy ontology the notion of S-matrix was replaced with M-matrix which can be interpreted as a complex square root of density matrix representable as a diagonal and positive square root of density matrix and unitary S-matrix so that quantum theory in zero energy ontology can be said to define a square root of thermodynamics at least formally.
- A decisive step was the strengthening of the General Coordinate Invariance to the requirement that the formulations of the theory in terms of light-like 3-surfaces identified as 3-surfaces at which the induced metric of space-time surfaces changes its signature and in terms of space-like 3-surfaces are equivalent. This means effective 2-dimensionality in the sense that partonic 2-surfaces defined as intersections of these two kinds of surfaces plus 4-D tangent space data at partonic 2-surfaces code for the physics. Quantum classical correspondence requires the coding of the quantum numbers characterizing quantum states assigned to the partonic 2-surfaces to the geometry of space-time surface. This is achieved by adding to the modified Dirac action a measurement interaction term assigned with light-like 3-surfaces.
- The replacement of strings with light-like 3-surfaces equivalent to space-like 3-surfaces means enormous generalization of the super conformal symmetries of string models. A further generalization of these symmetries to non-local Yangian symmetries generalizing the recently discovered Yangian symmetry of $\mathcal{N} = 4$ supersymmetric Yang-Mills theories is highly suggestive. Here the replacement of point like particles with partonic 2-surfaces means the replacement of conformal symmetry of Minkowski space with infinite-dimensional super-conformal algebras. Yangian symmetry provides also a further refinement to the notion of conserved quantum numbers allowing to define them for bound states using non-local energy conserved currents.
- A further attractive idea is that quantum TGD reduces to almost topological quantum field theory. This is possible if the Kähler action for the preferred extremals defining WCW Kähler function reduces to a 3-D boundary term. This takes place if the conserved currents are so called Beltrami fields with the defining property that the coordinates associated with flow lines extend to single global coordinate variable. This ansatz together with the weak form of electric-magnetic duality reduces the Kähler action to Chern-Simons term with the condition that the 3-surfaces are extremals of Chern-Simons action subject to the constraint force defined by the weak form of electric magnetic duality. It is the latter constraint which prevents the trivialization of the theory to a topological quantum field theory. Also the identification of the Kähler function of WCW as Dirac determinant finds support as well as the description of the scattering amplitudes in terms of braids with interpretation in terms of finite measurement resolution coded to the basic structure of the solutions of field equations.
- In standard QFT Feynman diagrams provide the description of scattering amplitudes. The beauty of Feynman diagrams is that they realize unitarity automatically via the so called Cutkosky rules. In contrast to Feynman's original beliefs, Feynman diagrams and virtual particles are taken only as a convenient mathematical tool in quantum field theories. QFT approach is however plagued by UV and IR divergences and one must keep mind open for the possibility that a genuine progress might mean opening of the black box of the virtual particle.

In TGD framework this generalization of Feynman diagrams indeed emerges unavoidably. Light-like 3-surfaces replace the lines of Feynman diagrams and vertices are replaced by 2-D partonic

2-surfaces. Zero energy ontology and the interpretation of parton orbits as light-like "wormhole throats" suggests that virtual particles do not differ from on mass shell particles only in that the four- and three- momenta of wormhole throats fail to be parallel. The two throats of the wormhole defining virtual particle would contact carry on mass shell quantum numbers but for virtual particles the four-momenta need not be parallel and can also have opposite signs of energy. Modified Dirac equation suggests a number theoretical quantization of the masses of the virtual particles. The kinematic constraints on the virtual momenta are extremely restrictive and reduce the dimension of the sub-space of virtual momenta and if massless particles are not allowed (IR cutoff provided by zero energy ontology naturally), the number of Feynman diagrams contributing to a particular kind of scattering amplitude is finite and manifestly UV and IR finite and satisfies unitarity constraint in terms of Cutkosky rules. What is remarkable that fermionic propagators are massless propagators but for on mass shell four-momenta. This gives a connection with the twistor approach and inspires the generalization of the Yangian symmetry to infinite-dimensional super-conformal algebras.

What I have said above is strongly biased view about the recent situation in quantum TGD and I have left all about applications to the introductions of the books whose purpose is to provide a bird's eye of view about TGD as it is now. This vision is single man's view and doomed to contain unrealistic elements as I know from experience. My dream is that young critical readers could take this vision seriously enough to try to demonstrate that some of its basic premises are wrong or to develop an alternative based on these or better premises. I must be however honest and tell that 32 years of TGD is a really vast bundle of thoughts and quite a challenge for anyone who is not able to cheat himself by taking the attitude of a blind believer or a light-hearted debunker trusting on the power of easy rhetoric tricks.

Matti Pitkänen

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During last decade Tapio Tammi has helped me quite concretely by providing the necessary computer facilities and being one of the few persons in Finland with whom to discuss about my work. I have had also stimulating discussions with Samuli Penttinen who has also helped to get through the economical situations in which there seemed to be no hope. The continual updating of fifteen online books means quite a heavy bureaucracy at the level of bits and without a systemization one ends up with endless copying and pasting and internal consistency is soon lost. Pekka Rapinoja has offered his help in this respect and I am especially grateful for him for my Python skills. Also Matti Vallinkoski has helped me in computer related problems.

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In the situation in which the conventional scientific communication channels are strictly closed it is important to have some loop hole through which the information about the work done can at

least in principle leak to the publicity through the iron wall of the academic censorship. Without any exaggeration I can say that without the world wide web I would not have survived as a scientist nor as individual. Homepage and blog are however not enough since only the formally published result is a result in recent day science. Publishing is however impossible without a direct support from power holders- even in archives like arXiv.org.

Situation changed for five years ago as Andrew Adamatsky proposed the writing of a book about TGD when I had already got used to the thought that my work would not be published during my life time. The Prespacetime Journal and two other journals related to quantum biology and consciousness - all of them founded by Huping Hu - have provided this kind of loop holes. In particular, Dainis Zeps, Phil Gibbs, and Arkadiusz Jadczyk deserve my gratitude for their kind help in the preparation of an article series about TGD catalyzing a considerable progress in the understanding of quantum TGD. Also the viXra archive founded by Phil Gibbs and its predecessor Archive Freedom have been of great help: Victor Christianto deserves special thanks for doing the hard work needed to run Archive Freedom. Also the Neuroquantology Journal founded by Sultan Tarlaci deserves a special mention for its publication policy. And last but not least: there are people who experience as a fascinating intellectual challenge to spoil the practical working conditions of a person working with something which might be called unified theory: I am grateful for the people who have helped me to survive through the virus attacks, an activity which has taken roughly one month per year during the last half decade and given a strong hue of grey to my hair.

For a person approaching his sixty year birthday it is somewhat easier to overcome the hard feelings due to the loss of academic human rights than for an inpatient youngster. Unfortunately the economic situation has become increasingly difficult during the twenty years after the economic depression in Finland which in practice meant that Finland ceased to be a constitutional state in the strong sense of the word. It became possible to depose people like me from the society without fear about public reactions and the classification as dropout became a convenient tool of ridicule to circumvent the ethical issues. During last few years when the right wing has held the political power this trend has been steadily strengthening. In this kind of situation the concrete help from individuals has been and will be of utmost importance. Against this background it becomes obvious that this kind of work is not possible without the support from outside and I apologize for not being able to mention all the people who have helped me during these years.

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Chapter 1

Introduction

1.1 Background

T(opological) G(eometro)D(ynamics) is one of the many attempts to find a unified description of basic interactions. The development of the basic ideas of TGD to a relatively stable form took time of about half decade [27]. The great challenge is to construct a mathematical theory around these physically very attractive ideas and I have devoted the last twenty-three years for the realization of this dream and this has resulted in seven online books [1, 2, 3, 5, 4, 6, 7] about TGD and eight online books about TGD inspired theory of consciousness and of quantum biology [8, 9, 10, 11, 12, 13, 14, 14].

Quantum T(opological)D(ynamics) as a classical spinor geometry for infinite-dimensional configuration space, p-adic numbers and quantum TGD, and TGD inspired theory of consciousness have been for last decade of the second millenium the basic three strongly interacting threads in the tapestry of quantum TGD.

For few yeas ago the discussions with Tony Smith generated a fourth thread which deserves the name 'TGD as a generalized number theory'. The work with Riemann hypothesis made time ripe for realization that the notion of infinite primes could provide, not only a reformulation, but a deep generalization of quantum TGD. This led to a thorough and extremely fruitful revision of the basic views about what the final form and physical content of quantum TGD might be.

The fifth thread came with the realization that by quantum classical correspondence TGD predicts an infinite hierarchy of macroscopic quantum systems with increasing sizes, that it is not at all clear whether standard quantum mechanics can accommodate this hierarchy, and that a dynamical quantized Planck constant might be necessary and certainly possible in TGD framework. The identification of hierarchy of Planck constants whose values TGD "predicts" in terms of dark matter hierarchy would be natural. This also led to a solution of a long standing puzzle: what is the proper interpretation of the predicted fractal hierarchy of long ranged classical electro-weak and color gauge fields. Quantum classical correspondences allows only single answer: there is infinite hierarchy of p-adically scaled up variants of standard model physics and for each of them also dark hierarchy. Thus TGD Universe would be fractal in very abstract and deep sense.

TGD forces the generalization of physics to a quantum theory of consciousness, and represent TGD as a generalized number theory vision leads naturally to the emergence of p-adic physics as physics of cognitive representations. The seven online books [1, 2, 3, 5, 4, 6, 7] about TGD and eight online books about TGD inspired theory of consciousness and of quantum biology [8, 9, 10, 11, 12, 13, 14, 14] are warmly recommended to the interested reader.

1.2 Basic Ideas of TGD

The basic physical picture behind TGD was formed as a fusion of two rather disparate approaches: namely TGD is as a Poincare invariant theory of gravitation and TGD as a generalization of the old-fashioned string model.

1.2.1 TGD as a Poincare invariant theory of gravitation

The first approach was born as an attempt to construct a Poincare invariant theory of gravitation. Space-time, rather than being an abstract manifold endowed with a pseudo-Riemannian structure, is regarded as a surface in the 8-dimensional space $H = M_+^4 \times CP_2$, where M_+^4 denotes the interior of the future light cone of the Minkowski space (to be referred as light cone in the sequel) and $CP_2 = SU(3)/U(2)$ is the complex projective space of two complex dimensions [16, 31, 34, 19]. The identification of the space-time as a submanifold [33, 30] of $M^4 \times CP_2$ leads to an exact Poincare invariance and solves the conceptual difficulties related to the definition of the energy-momentum in General Relativity [Misner-Thorne-Wheeler, Logunov *et al*]. The actual choice $H = M_+^4 \times CP_2$ implies the breaking of the Poincare invariance in the cosmological scales but only at the quantum level. It soon however turned out that submanifold geometry, being considerably richer in structure than the abstract manifold geometry, leads to a geometrization of all basic interactions. First, the geometrization of the elementary particle quantum numbers is achieved. The geometry of CP_2 explains electro-weak and color quantum numbers. The different H-chiralities of H -spinors correspond to the conserved baryon and lepton numbers. Secondly, the geometrization of the field concept results. The projections of the CP_2 spinor connection, Killing vector fields of CP_2 and of H -metric to four-surface define classical electro-weak, color gauge fields and metric in X^4 .

1.2.2 TGD as a generalization of the hadronic string model

The second approach was based on the generalization of the mesonic string model describing mesons as strings with quarks attached to the ends of the string. In the 3-dimensional generalization 3-surfaces correspond to free particles and the boundaries of the 3- surface correspond to partons in the sense that the quantum numbers of the elementary particles reside on the boundaries. Various boundary topologies (number of handles) correspond to various fermion families so that one obtains an explanation for the known elementary particle quantum numbers. This approach leads also to a natural topological description of the particle reactions as topology changes: for instance, two-particle decay corresponds to a decay of a 3-surface to two disjoint 3-surfaces.

1.2.3 Fusion of the two approaches via a generalization of the space-time concept

The problem is that the two approaches seem to be mutually exclusive since the orbit of a particle like 3-surface defines 4-dimensional surface, which differs drastically from the topologically trivial macroscopic space-time of General Relativity. The unification of these approaches forces a considerable generalization of the conventional space-time concept. First, the topologically trivial 3-space of General Relativity is replaced with a "topological condensate" containing matter as particle like 3-surfaces "glued" to the topologically trivial background 3-space by connected sum operation. Secondly, the assumption about connectedness of the 3-space is given up. Besides the "topological condensate" there is "vapor phase" that is a "gas" of particle like 3-surfaces (counterpart of the "baby universes" of GRT) and the nonconservation of energy in GRT corresponds to the transfer of energy between the topological condensate and vapor phase.

1.3 The five threads in the development of quantum TGD

The development of TGD has involved four strongly interacting threads: physics as infinite-dimensional geometry; p-adic physics; TGD inspired theory of consciousness and TGD as a generalized number theory. In the following these five threads are briefly described.

1.3.1 Quantum TGD as configuration space spinor geometry

A turning point in the attempts to formulate a mathematical theory was reached after seven years from the birth of TGD. The great insight was "Do not quantize". The basic ingredients to the new approach have served as the basic philosophy for the attempt to construct Quantum TGD since then and are the following ones:

a) Quantum theory for extended particles is free(!), classical(!) field theory for a generalized Schrödinger amplitude in the configuration space CH consisting of all possible 3-surfaces in H . "All possible" means that surfaces with arbitrary many disjoint components and with arbitrary internal topology and also singular surfaces topologically intermediate between two different manifold topologies are included. Particle reactions are identified as topology changes [35, 32, 29]. For instance, the decay of a 3-surface to two 3-surfaces corresponds to the decay $A \rightarrow B + C$. Classically this corresponds to a path of configuration space leading from 1-particle sector to 2-particle sector. At quantum level this corresponds to the dispersion of the generalized Schrödinger amplitude localized to 1-particle sector to two-particle sector. All coupling constants should result as predictions of the theory since no nonlinearities are introduced.

b) Configuration space is endowed with the metric and spinor structure so that one can define various metric related differential operators, say Dirac operator, appearing in the field equations of the theory.

1.3.2 p-Adic TGD

The p-adic thread emerged for roughly ten years ago as a dim hunch that p-adic numbers might be important for TGD. Experimentation with p-adic numbers led to the notion of canonical identification mapping reals to p-adics and vice versa. The breakthrough came with the successful p-adic mass calculations using p-adic thermodynamics for Super-Virasoro representations with the super-Kac-Moody algebra associated with a Lie-group containing standard model gauge group. Although the details of the calculations have varied from year to year, it was clear that p-adic physics reduces not only the ratio of proton and Planck mass, the great mystery number of physics, but all elementary particle mass scales, to number theory if one assumes that primes near prime powers of two are in a physically favored position. Why this is the case, became one of the key puzzlers and led to a number of arguments with a common gist: evolution is present already at the elementary particle level and the primes allowed by the p-adic length scale hypothesis are the fittest ones.

It became very soon clear that p-adic topology is not something emerging in Planck length scale as often believed, but that there is an infinite hierarchy of p-adic physics characterized by p-adic length scales varying to even cosmological length scales. The idea about the connection of p-adics with cognition motivated already the first attempts to understand the role of the p-adics and inspired 'Universe as Computer' vision but time was not ripe to develop this idea to anything concrete (p-adic numbers are however in a central role in TGD inspired theory of consciousness). It became however obvious that the p-adic length scale hierarchy somehow corresponds to a hierarchy of intelligences and that p-adic prime serves as a kind of intelligence quotient. Ironically, the almost obvious idea about p-adic regions as cognitive regions of space-time providing cognitive representations for real regions had to wait for almost a decade for the access into my consciousness.

There were many interpretational and technical questions crying for a definite answer. What is the relationship of p-adic non-determinism to the classical non-determinism of the basic field equations of TGD? Are the p-adic space-time region genuinely p-adic or does p-adic topology only serve as an effective topology? If p-adic physics is direct image of real physics, how the mapping relating them is constructed so that it respects various symmetries? Is the basic physics p-adic or real (also real TGD seems to be free of divergences) or both? If it is both, how should one glue the physics in different number field together to get *The Physics*? Should one perform p-adicization also at the level of the configuration space of 3-surfaces? Certainly the p-adicization at the level of super-conformal representation is necessary for the p-adic mass calculations. Perhaps the most basic and most irritating technical problem was how to precisely define p-adic definite integral which is a crucial element of any variational principle based formulation of the field equations. Here the frustration was not due to the lack of solution but due to the too large number of solutions to the problem, a clear symptom for the sad fact that clever inventions rather than real discoveries might be in question.

Despite these frustrating uncertainties, the number of the applications of the poorly defined p-adic physics grew steadily and the applications turned out to be relatively stable so that it was clear that the solution to these problems must exist. It became only gradually clear that the solution of the problems might require going down to a deeper level than that represented by reals and p-adics.

1.3.3 TGD as a generalization of physics to a theory consciousness

General coordinate invariance forces the identification of quantum jump as quantum jump between entire deterministic quantum histories rather than time=constant snapshots of single history. The new view about quantum jump forces a generalization of quantum measurement theory such that observer becomes part of the physical system. Thus a general theory of consciousness is unavoidable outcome. This theory is developed in detail in the books [8, 9, 10, 11, 12, 13, 14, 14].

Quantum jump as a moment of consciousness

The identification of quantum jump between deterministic quantum histories (configuration space spinor fields) as a moment of consciousness defines microscopic theory of consciousness. Quantum jump involves the steps

$$\Psi_i \rightarrow U\Psi_i \rightarrow \Psi_f ,$$

where U is informational "time development" operator, which is unitary like the S-matrix characterizing the unitary time evolution of quantum mechanics. U is however only formally analogous to Schrödinger time evolution of infinite duration although there is *no* real time evolution involved. It is not however clear whether one should regard U-matrix and S-matrix as two different things or not: U -matrix is a completely universal object characterizing the dynamics of evolution by self-organization whereas S-matrix is a highly context dependent concept in wave mechanics and in quantum field theories where it at least formally represents unitary time translation operator at the limit of an infinitely long interaction time. The S-matrix understood in the spirit of superstring models is however something very different and could correspond to U-matrix.

The requirement that quantum jump corresponds to a measurement in the sense of quantum field theories implies that each quantum jump involves localization in zero modes which parameterize also the possible choices of the quantization axes. Thus the selection of the quantization axes performed by the Cartesian outsider becomes now a part of quantum theory. Together these requirements imply that the final states of quantum jump correspond to quantum superpositions of space-time surfaces which are macroscopically equivalent. Hence the world of conscious experience looks classical. At least formally quantum jump can be interpreted also as a quantum computation in which matrix U represents unitary quantum computation which is however not identifiable as unitary translation in time direction and cannot be 'engineered'.

The notion of self

The concept of self is absolutely essential for the understanding of the macroscopic and macro-temporal aspects of consciousness. Self corresponds to a subsystem able to remain un-entangled under the sequential informational 'time evolutions' U . Exactly vanishing entanglement is practically impossible in ordinary quantum mechanics and it might be that 'vanishing entanglement' in the condition for self-property should be replaced with 'subcritical entanglement'. On the other hand, if space-time decomposes into p-adic and real regions, and if entanglement between regions representing physics in different number fields vanishes, space-time indeed decomposes into selves in a natural manner.

It is assumed that the experiences of the self after the last 'wake-up' sum up to single average experience. This means that subjective memory is identifiable as conscious, immediate short term memory. Selves form an infinite hierarchy with the entire Universe at the top. Self can be also interpreted as mental images: our mental images are selves having mental images and also we represent mental images of a higher level self. A natural hypothesis is that self S experiences the experiences of its subselves as kind of abstracted experience: the experiences of subselves S_i are not experienced as such but represent kind of averages $\langle S_{ij} \rangle$ of sub-subselves S_{ij} . Entanglement between selves, most naturally realized by the formation of join along boundaries bonds between cognitive or material space-time sheets, provides a possible a mechanism for the fusion of selves to larger selves (for instance, the fusion of the mental images representing separate right and left visual fields to single visual field) and forms wholes from parts at the level of mental images.

Relationship to quantum measurement theory

The third basic element relates TGD inspired theory of consciousness to quantum measurement theory. The assumption that localization occurs in zero modes in each quantum jump implies that the world of conscious experience looks classical. It also implies the state function reduction of the standard quantum measurement theory as the following arguments demonstrate (it took incredibly long time to realize this almost obvious fact!).

a) The standard quantum measurement theory a la von Neumann involves the interaction of brain with the measurement apparatus. If this interaction corresponds to entanglement between microscopic degrees of freedom m with the macroscopic effectively classical degrees of freedom M characterizing the reading of the measurement apparatus coded to brain state, then the reduction of this entanglement in quantum jump reproduces standard quantum measurement theory provide the unitary time evolution operator U acts as flow in zero mode degrees of freedom and correlates completely some orthonormal basis of configuration space spinor fields in non-zero modes with the values of the zero modes. The flow property guarantees that the localization is consistent with unitarity: it also means 1-1 mapping of quantum state basis to classical variables (say, spin direction of the electron to its orbit in the external magnetic field).

b) Since zero modes represent classical information about the geometry of space-time surface (shape, size, classical Kähler field,...), they have interpretation as effectively classical degrees of freedom and are the TGD counterpart of the degrees of freedom M representing the reading of the measurement apparatus. The entanglement between quantum fluctuating non-zero modes and zero modes is the TGD counterpart for the $m - M$ entanglement. Therefore the localization in zero modes is equivalent with a quantum jump leading to a final state where the measurement apparatus gives a definite reading.

This simple prediction is of utmost theoretical importance since the black box of the quantum measurement theory is reduced to a fundamental quantum theory. This reduction is implied by the replacement of the notion of a point like particle with particle as a 3-surface. Also the infinite-dimensionality of the zero mode sector of the configuration space of 3-surfaces is absolutely essential. Therefore the reduction is a triumph for quantum TGD and favors TGD against string models.

Standard quantum measurement theory involves also the notion of state preparation which reduces to the notion of self measurement. Each localization in zero modes is followed by a cascade of self measurements leading to a product state. This process is obviously equivalent with the state preparation process. Self measurement is governed by the so called Negentropy Maximization Principle (NMP) stating that the information content of conscious experience is maximized. In the self measurement the density matrix of some subsystem of a given self localized in zero modes (after ordinary quantum measurement) is measured. The self measurement takes place for that subsystem of self for which the reduction of the entanglement entropy is maximal in the measurement. In p-adic context NMP can be regarded as the variational principle defining the dynamics of cognition. In real context self measurement could be seen as a repair mechanism allowing the system to fight against quantum thermalization by reducing the entanglement for the subsystem for which it is largest (fill the largest hole first in a leaking boat).

Selves self-organize

The fourth basic element is quantum theory of self-organization based on the identification of quantum jump as the basic step of self-organization [39]. Quantum entanglement gives rise to the generation of long range order and the emergence of longer p-adic length scales corresponds to the emergence of larger and larger coherent dynamical units and generation of a slaving hierarchy. Energy (and quantum entanglement) feed implying entropy feed is a necessary prerequisite for quantum self-organization. Zero modes represent fundamental order parameters and localization in zero modes implies that the sequence of quantum jumps can be regarded as hopping in the zero modes so that Haken's classical theory of self organization applies almost as such. Spin glass analogy is a further important element: self-organization of self leads to some characteristic pattern selected by dissipation as some valley of the "energy" landscape.

Dissipation can be regarded as the ultimate Darwinian selector of both memes and genes. The mathematically ugly irreversible dissipative dynamics obtained by adding phenomenological dissipation terms to the reversible fundamental dynamical equations derivable from an action principle can be

understood as a phenomenological description replacing in a well defined sense the series of reversible quantum histories with its envelope.

Classical non-determinism of Kähler action

The fifth basic element are the concepts of association sequence and cognitive space-time sheet. The huge vacuum degeneracy of the Kähler action suggests strongly that the absolute minimum space-time is not always unique. For instance, a sequence of bifurcations can occur so that a given space-time branch can be fixed only by selecting a finite number of 3-surfaces with time like(!) separations on the orbit of 3-surface. Quantum classical correspondence suggest an alternative formulation. Space-time surface decomposes into maximal deterministic regions and their temporal sequences have interpretation a space-time correlate for a sequence of quantum states defined by the initial (or final) states of quantum jumps. This is consistent with the fact that the variational principle selects preferred extremals of Kähler action as generalized Bohr orbits.

In the case that non-determinism is located to a finite time interval and is microscopic, this sequence of 3-surfaces has interpretation as a simulation of a classical history, a geometric correlate for contents of consciousness. When non-determinism has long lasting and macroscopic effect one can identify it as volitional non-determinism associated with our choices. Association sequences relate closely with the cognitive space-time sheets defined as space-time sheets having finite time duration and psychological time can be identified as a temporal center of mass coordinate of the cognitive space-time sheet. The gradual drift of the cognitive space-time sheets to the direction of future force by the geometry of the future light cone explains the arrow of psychological time.

p-Adic physics as physics of cognition and intentionality

The sixth basic element adds a physical theory of cognition to this vision. TGD space-time decomposes into regions obeying real and p-adic topologies labelled by primes $p = 2, 3, 5, \dots$. p-Adic regions obey the same field equations as the real regions but are characterized by p-adic non-determinism since the functions having vanishing p-adic derivative are pseudo constants which are piecewise constant functions. Pseudo constants depend on a finite number of positive binary digits of arguments just like numerical predictions of any theory always involve decimal cutoff. This means that p-adic space-time regions are obtained by gluing together regions for which integration constants are genuine constants. The natural interpretation of the p-adic regions is as cognitive representations of real physics. The freedom of imagination is due to the p-adic non-determinism. p-Adic regions perform mimicry and make possible for the Universe to form cognitive representations about itself. p-Adic physics space-time sheets serve also as correlates for intentional action.

A more more precise formulation of this vision requires a generalization of the number concept obtained by fusing reals and p-adic number fields along common rationals (in the case of algebraic extensions among common algebraic numbers). This picture is discussed in [20]. The application this notion at the level of the imbedding space implies that imbedding space has a book like structure with various variants of the imbedding space glued together along common rationals (algebraics). The implication is that genuinely p-adic numbers (non-rationals) are strictly infinite as real numbers so that most points of p-adic space-time sheets are at real infinity, outside the cosmos, and that the projection to the real imbedding space is discrete set of rationals (algebraics). Hence cognition and intentionality are almost completely outside the real cosmos and touch it at a discrete set of points only.

This view implies also that purely local p-adic physics codes for the p-adic fractality characterizing long range real physics and provides an explanation for p-adic length scale hypothesis stating that the primes $p \simeq 2^k$, k integer are especially interesting. It also explains the long range correlations and short term chaos characterizing intentional behavior and explains why the physical realizations of cognition are always discrete (say in the case of numerical computations). Furthermore, a concrete quantum model for how intentions are transformed to actions emerges.

The discrete real projections of p-adic space-time sheets serve also space-time correlate for a logical thought. It is very natural to assign to p-adic binary digits a p -valued logic but as such this kind of logic does not have any reasonable identification. p-Adic length scale hypothesis suggest that the $p = 2^k - n$ binary digits represent a Boolean logic B^k with k elementary statements (the points of the

k -element set in the set theoretic realization) with n taboos which are constrained to be identically true.

1.3.4 TGD as a generalized number theory

Quantum T(opological)D(ynamics) as a classical spinor geometry for infinite-dimensional configuration space, p-adic numbers and quantum TGD, and TGD inspired theory of consciousness, have been for last ten years the basic three strongly interacting threads in the tapestry of quantum TGD. For few years ago the discussions with Tony Smith generated a fourth thread which deserves the name 'TGD as a generalized number theory'. It relies on the notion of number theoretic compactification stating that space-time surfaces can be regarded either as hyper-quaternionic, and thus maximally associative, 4-surfaces in M^8 identifiable as space of hyper-octonions or as surfaces in $M^4 \times CP_2$ [16].

The discovery of the hierarchy of infinite primes and their correspondence with a hierarchy defined by a repeatedly second quantized arithmetic quantum field theory gave a further boost for the speculations about TGD as a generalized number theory. The work with Riemann hypothesis led to further ideas.

After the realization that infinite primes can be mapped to polynomials representable as surfaces geometrically, it was clear how TGD might be formulated as a generalized number theory with infinite primes forming the bridge between classical and quantum such that real numbers, p-adic numbers, and various generalizations of p-adics emerge dynamically from algebraic physics as various completions of the algebraic extensions of rational (hyper-)quaternions and (hyper-)octonions. Complete algebraic, topological and dimensional democracy would characterize the theory.

What is especially satisfying is that p-adic and real regions of the space-time surface could emerge automatically as solutions of the field equations. In the space-time regions where the solutions of field equations give rise to in-admissible complex values of the imbedding space coordinates, p-adic solution can exist for some values of the p-adic prime. The characteristic non-determinism of the p-adic differential equations suggests strongly that p-adic regions correspond to 'mind stuff', the regions of space-time where cognitive representations reside. This interpretation implies that p-adic physics is physics of cognition. Since Nature is probably extremely brilliant simulator of Nature, the natural idea is to study the p-adic physics of the cognitive representations to derive information about the real physics. This view encouraged by TGD inspired theory of consciousness clarifies difficult interpretational issues and provides a clear interpretation for the predictions of p-adic physics.

1.3.5 Dynamical quantized Planck constant and dark matter hierarchy

By quantum classical correspondence space-time sheets can be identified as quantum coherence regions. Hence the fact that they have all possible size scales more or less unavoidably implies that Planck constant must be quantized and have arbitrarily large values. If one accepts this then also the idea about dark matter as a macroscopic quantum phase characterized by an arbitrarily large value of Planck constant emerges naturally as does also the interpretation for the long ranged classical electro-weak and color fields predicted by TGD. Rather seldom the evolution of ideas follows simple linear logic, and this was the case also now. In any case, this vision represents the fifth, relatively new thread in the evolution of TGD and the ideas involved are still evolving.

Dark matter as large \hbar phase

D. Da Rocha and Laurent Nottale [37] have proposed that Schrödinger equation with Planck constant \hbar replaced with what might be called gravitational Planck constant $\hbar_{gr} = \frac{GmM}{v_0}$ ($\hbar = c = 1$). v_0 is a velocity parameter having the value $v_0 = 144.7 \pm .7$ km/s giving $v_0/c = 4.6 \times 10^{-4}$. This is rather near to the peak orbital velocity of stars in galactic halos. Also subharmonics and harmonics of v_0 seem to appear. The support for the hypothesis coming from empirical data is impressive.

Nottale and Da Rocha believe that their Schrödinger equation results from a fractal hydrodynamics. Many-sheeted space-time however suggests astrophysical systems are not only quantum systems at larger space-time sheets but correspond to a gigantic value of gravitational Planck constant. The gravitational (ordinary) Schrödinger equation would provide a solution of the black hole collapse (IR catastrophe) problem encountered at the classical level. The resolution of the problem inspired by

TGD inspired theory of living matter is that it is the dark matter at larger space-time sheets which is quantum coherent in the required time scale [21].

Already before learning about Nottale's paper I had proposed the possibility that Planck constant is quantized [25] and the spectrum is given in terms of logarithms of Beraha numbers: the lowest Beraha number B_3 is completely exceptional in that it predicts infinite value of Planck constant. The inverse of the gravitational Planck constant could correspond a gravitational perturbation of this as $1/\hbar_{gr} = v_0/GMm$. The general philosophy would be that when the quantum system would become non-perturbative, a phase transition increasing the value of \hbar occurs to preserve the perturbative character and at the transition $n = 4 \rightarrow 3$ only the small perturbative correction to $1/\hbar(3) = 0$ remains. This would apply to QCD and to atoms with $Z > 137$ as well.

TGD predicts correctly the value of the parameter v_0 assuming that cosmic strings and their decay remnants are responsible for the dark matter. The harmonics of v_0 can be understood as corresponding to perturbations replacing cosmic strings with their n -branched coverings so that tension becomes n^2 -fold: much like the replacement of a closed orbit with an orbit closing only after n turns. $1/n$ -sub-harmonic would result when a magnetic flux tube split into n disjoint magnetic flux tubes. Also a model for the formation of planetary system as a condensation of ordinary matter around quantum coherent dark matter emerges [21].

Dark matter as a source of long ranged weak and color fields

Long ranged classical electro-weak and color gauge fields are unavoidable in TGD framework. The smallness of the parity breaking effects in hadronic, nuclear, and atomic length scales does not however seem to allow long ranged electro-weak gauge fields. The problem disappears if long range classical electro-weak gauge fields are identified as space-time correlates for massless gauge fields created by dark matter. Also scaled up variants of ordinary electro-weak particle spectra are possible. The identification explains chiral selection in living matter and unbroken $U(2)_{ew}$ invariance and free color in bio length scales become characteristics of living matter and of bio-chemistry and bio-nuclear physics. An attractive solution of the matter antimatter asymmetry is based on the identification of also antimatter as dark matter.

p-Adic and dark matter hierarchies and hierarchy of moments of consciousness

Dark matter hierarchy assigned to a spectrum of Planck constant having arbitrarily large values brings additional elements to the TGD inspired theory of consciousness.

a) Macroscopic quantum coherence can be understood since a particle with a given mass can in principle appear as arbitrarily large scaled up copies (Compton length scales as \hbar). The phase transition to this kind of phase implies that space-time sheets of particles overlap and this makes possible macroscopic quantum coherence.

b) The space-time sheets with large Planck constant can be in thermal equilibrium with ordinary ones without the loss of quantum coherence. For instance, the cyclotron energy scale associated with EEG turns out to be above thermal energy at room temperature for the level of dark matter hierarchy corresponding to magnetic flux quanta of the Earth's magnetic field with the size scale of Earth and a successful quantitative model for EEG results [20].

Dark matter hierarchy leads to detailed quantitative view about quantum biology with several testable predictions [20]. The applications to living matter suggests that the basic hierarchy corresponds to a hierarchy of Planck constants coming as $\hbar(k) = \lambda^k(p)\hbar_0$, $\lambda \simeq 2^{11}$ for $p = 2^{127-1}$, $k = 0, 1, 2, \dots$ [20]. Also integer valued sub-harmonics and integer valued sub-harmonics of λ might be possible. Each p-adic length scale corresponds to this kind of hierarchy and number theoretical arguments suggest a general formula for the allowed values of Planck constant λ depending logarithmically on p-adic prime [19]. Also the value of \hbar_0 has spectrum characterized by Beraha numbers $B_n = 4\cos^2(\pi/n)$, $n \geq 3$, varying by a factor in the range $n > 3$ [19]. It must be however emphasized that the relation of this picture to the model of quantized gravitational Planck constant \hbar_{gr} appearing in Nottale's model is not yet completely understood.

The general prediction is that Universe is a kind of inverted Mandelbrot fractal for which each bird's eye of view reveals new structures in long length and time scales representing scaled down copies of standard physics and their dark variants. These structures would correspond to higher levels in self

hierarchy. This prediction is consistent with the belief that 75 per cent of matter in the universe is dark.

1. *Living matter and dark matter*

Living matter as ordinary matter quantum controlled by the dark matter hierarchy has turned out to be a particularly successful idea. The hypothesis has led to models for EEG predicting correctly the band structure and even individual resonance bands and also generalizing the notion of EEG [20]. Also a generalization of the notion of genetic code emerges resolving the paradoxes related to the standard dogma [21, 20]. A particularly fascinating implication is the possibility to identify great leaps in evolution as phase transitions in which new higher level of dark matter emerges [20].

It seems safe to conclude that the dark matter hierarchy with levels labelled by the values of Planck constants explains the macroscopic and macro-temporal quantum coherence naturally. That this explanation is consistent with the explanation based on spin glass degeneracy is suggested by following observations. First, the argument supporting spin glass degeneracy as an explanation of the macro-temporal quantum coherence does not involve the value of \hbar at all. Secondly, the failure of the perturbation theory assumed to lead to the increase of Planck constant and formation of macroscopic quantum phases could be precisely due to the emergence of a large number of new degrees of freedom due to spin glass degeneracy. Thirdly, the phase transition increasing Planck constant has concrete topological interpretation in terms of many-sheeted space-time consistent with the spin glass degeneracy.

2. *Dark matter hierarchy and the notion of self*

The vision about dark matter hierarchy leads to a more refined view about self hierarchy and hierarchy of moments of consciousness [16, 20]. The larger the value of Planck constant, the longer the subjectively experienced duration and the average geometric duration $T(k) \propto \lambda^k$ of the quantum jump.

Quantum jumps form also a hierarchy with respect to p-adic and dark hierarchies and the geometric durations of quantum jumps scale like \hbar . Dark matter hierarchy suggests also a slight modification of the notion of self. Each self involves a hierarchy of dark matter levels, and one is led to ask whether the highest level in this hierarchy corresponds to single quantum jump rather than a sequence of quantum jumps. The averaging of conscious experience over quantum jumps would occur only for sub-selves at lower levels of dark matter hierarchy and these mental images would be ordered, and single moment of consciousness would be experienced as a history of events. The quantum parallel dissipation at the lower levels would give rise to the experience of flow of time. For instance, hadron as a macro-temporal quantum system in the characteristic time scale of hadron is a dissipating system at quark and gluon level corresponding to shorter p-adic time scales. One can ask whether even entire life cycle could be regarded as a single quantum jump at the highest level so that consciousness would not be completely lost even during deep sleep. This would allow to understand why we seem to know directly that this biological body of mine existed yesterday.

The fact that we can remember phone numbers with 5 to 9 digits supports the view that self corresponds at the highest dark matter level to single moment of consciousness. Self would experience the average over the sequence of moments of consciousness associated with each sub-self but there would be no averaging over the separate mental images of this kind, be their parallel or serial. These mental images correspond to sub-selves having shorter wake-up periods than self and would be experienced as being time ordered. Hence the digits in the phone number are experienced as separate mental images and ordered with respect to experienced time.

3. *The time span of long term memories as signature for the level of dark matter hierarchy*

The simplest dimensional estimate gives for the average increment τ of geometric time in quantum jump $\tau \sim 10^4 CP_2$ times so that $2^{127} - 1 \sim 10^{38}$ quantum jumps are experienced during secondary p-adic time scale $T_2(k = 127) \simeq 0.1$ seconds which is the duration of physiological moment and predicted to be fundamental time scale of human consciousness [30]. A more refined guess is that $\tau_p = \sqrt{p}\tau$ gives the dependence of the duration of quantum jump on p-adic prime p . By multi-p-fractality predicted by TGD and explaining p-adic length scale hypothesis, one expects that at least $p = 2$ -adic level is also always present. For the higher levels of dark matter hierarchy τ_p is scaled up by \hbar/\hbar_0 . One can understand evolutionary leaps as the emergence of higher levels at the level of individual organism making possible intentionality and memory in the time scale defined τ [21].

Higher levels of dark matter hierarchy provide a neat quantitative view about self hierarchy and its evolution. For instance, EEG time scales corresponds to $k = 4$ level of hierarchy and a time scale of .1 seconds [16], and EEG frequencies correspond at this level dark photon energies above the thermal threshold so that thermal noise is not a problem anymore. Various levels of dark matter hierarchy would naturally correspond to higher levels in the hierarchy of consciousness and the typical duration of life cycle would give an idea about the level in question.

The level would determine also the time span of long term memories as discussed in [20]. $k = 7$ would correspond to a duration of moment of conscious of order human lifetime which suggests that $k = 7$ corresponds to the highest dark matter level relevant to our consciousness whereas higher levels would in general correspond to transpersonal consciousness. $k = 5$ would correspond to time scale of short term memories measured in minutes and $k = 6$ to a time scale of memories measured in days.

The emergence of these levels must have meant evolutionary leap since long term memory is also accompanied by ability to anticipate future in the same time scale. This picture would suggest that the basic difference between us and our cousins is not at the level of genome as it is usually understood but at the level of the hierarchy of magnetic bodies [21, 20]. In fact, higher levels of dark matter hierarchy motivate the introduction of the notions of super-genome and hyper-genome. The genomes of entire organ can join to form super-genome expressing genes coherently. Hyper-genomes would result from the fusion of genomes of different organisms and collective levels of consciousness would express themselves via hyper-genome and make possible social rules and moral.

1.4 Bird's eye of view about the topics of the book

The basic them of this book is the notion of magnetic body which is one of the most radical new notions of TGD inspired theory of consciousness and quantum biology.

1. The concept derives from the topological quantization of fields implying also the notion of topological light ray ("massless extremal", ME) and quantization of electric flux. The notion means that, in contrast to Maxwell's ED, TGD allows to assign to a given material system also field identity. Magnetic body as the intentional agent controlling biological body thus comes the basic hypothesis of TGD inspired quantum theory of living systems.
2. TGD Universe is fractal containing fractal copies of standard model physics at various space-time sheets and labeled by the collection of p-adic primes assignable to elementary particles and by the level of dark matter hierarchy characterized partially by the rational value of Planck constant labeling the pages of the book like structure formed by singular covering spaces of the imbedding space $M^4 \times CP_2$ glued together along a four-dimensional back. Particles at different pages are dark relative to each other since purely local interactions defined in terms of the vertices of Feynman diagram involve only particles at the same page. p-Adic length scale hypothesis and the assignment of dark matter with macroscopic quantum phases characterized by a hierarchy of Planck constants allows to quantify the notion of magnetic body. One can identify dark magnetic flux quanta relevant to biology as 4-surfaces at pages of the book for which Planck constant is large.
3. All rational multiples of basic value $\hbar = \hbar_0$ of Planck constant are in principle allowed. The multiples which corresponds to ratios of integers defining ruler and compass polygons are favored by their number theoretical simplicity. There are indications that Planck constants comings as 2^{11k_d} - multiples of the standard Planck constant are in a special role in biology (this might relate to proton electron mass ratio and to the fact that 2^{11} appears as fundamental constant in TGD Universe, as well as to the fact that the phases $\exp(i2\pi 2^{-k_d})$ are number theoretically simple). For instance, in $B_{end} = 2B_E/5 = .2$ Gauss cyclotron energy is above thermal threshold at room temperature for $k_d \geq 4$.
4. The notion of personal magnetic body (actually onion-like fractal hierarchy of them) is essential for the TGD inspired model of living matter and predicts a hierarchy of generalized EEGs associated with the magnetic bodies and responsible for the communications from biological body or its part to the corresponding magnetic body. Since the size scale of magnetic flux quanta at $k_d = 4$ level of hierarchy is of order of Earth size, there is no reason to assume that

only personal magnetic bodies of living systems are relevant. Rather, the view about entire magnetosphere as a conscious system controlling the behavior of biosphere emerges naturally. In this book this vision is developed.

A brief summary about the contents of the book is in order.

1. In the first part of the book the first chapter is devoted to the idea about magnetosphere as a conscious system perhaps defining in some respects a fractally scaled up version of biological body and brain. At the first look this idea sounds completely crazy but in TGD Universe p-adic fractality and the fractality associated with dark matter hierarchy make it look rather natural. Second chapter represents a vision about evolution in many-sheeted space-time.
2. The second part of the book contains two chapters about the notion of semitrance. Semitrance is based on quantum entanglement of subself of self, say subsystem of brain, with a remote system. The idea that sub-systems of two unentangled systems can entangle and in this manner give rise to a sharing and fusion of mental images (stereo vision would be the basic example) makes sense only in many-sheeted space. A rigorous justification for the sharing of mental images comes from the notion of finite measurement resolution - one of the fundamental notions of quantum TGD.

The proposal is that semitrance could have been basic control and communication tool of collective levels of consciousness during the period of human consciousness which Jaynes calls bicamerality. Schizophrenics could be seen as modern bicamerals.

The idea that human consciousness might have had totally different character for only few millenia ago, finds additional support from the notions of super- and hyper genome implicated naturally by the dark matter hierarchy and the notion of magnetic body. Super genome could be seen as as a book having magnetic flux sheets as pages. Text lines would be defined by genomes for sequences of nuclei. This would make possible coherent gene expression at the level of organs. The text lines of hyper genome would consist of super genomes of different organisms, not necessarily of same species. Hyper genome would make possible coherent gene expression at the level of social group and society and give rise also to social rules. The identification of memes as hyper genes looks rather attractive. The evolution of hyper genome could be seen as the basic driver of the explosive evolution of human civilizations during last two millenia and would also distinguish us from our cousins.

3. The two chapters of the third part of the book entitled "Crazy Stuff" are devoted to a model of crop circles: it is left to the reader to decide whether the chapters should be taken as miserable crack-pottery, mental gymnastics with tongue in cheek, or as a fruit of a new brave vision about us and the Universe. In the first chapter it is proposed that crop circles are due to intentional action of magnetospheric higher level self or a higher level self using magnetosphere as a tool to build them. In second chapter two special crop circles, Chilbolton and Crabwood crop circles, are discussed in detail and the proposal that they provide information about the genomes of the life forms responsible for the crop circles. Some candidates for these life forms are discussed: the most science fictive identification allowed by TGD would be ourselves in distant geometric future using time mirror mechanism to affect geometric past.

Most of the material of this book has been written much before the dark matter revolution and formulation of the zero energy ontology and that I have only later added comments to the existing text. I hope that I can later add new material in which the implications of the dark matter hierarchy are discussed in more detail.

The seven online books about TGD [1, 2, 3, 5, 4, 6, 7] and eight online books about TGD inspired theory of consciousness and quantum biology [8, 9, 10, 11, 12, 13, 14, 14] are warmly recommended for the reader willing to get overall view about what is involved.

1.5 The contents of the book

1.5.1 PART I: MOTHER GAIA HYPOTHESIS IN TGD UNIVERSE

Magnetospheric Sensory Representations

One can imagine two basic candidates for how *our* sensory and motor control are realized: the representations at the personal magnetic sensory body and the representations on the magnetic flux tubes structures of Earth, the magnetic body of Mother Gaia. Quite a long time I saw the problem as the question 'Which of these options is correct?'

If our sensory and motor representations were realized using magnetospheric representations alone, the consciousness of astronauts would differ in a dramatic manner from the ordinary wake-up consciousness. This is not the case so that personal magnetic bodies must give the basic contribution to our personal sensory representations and motor control if the basic approach is correct. Because of the sharing of mental images also the sensory and motor areas of the magnetic Mother Gaia making possible higher collective levels of consciousness are however important for us and are perhaps responsible for memory and imagination. Therefore is of importance to try to understand also the magnetospheric representations.

a) The basic element hypothesis is that some kind of resonance mechanism is involved. The simplest possibility is that projector MEs ('massless extremals', topological counterparts of light rays) to the sensory canvas have length equal to the wavelength defined by the magnetic transition frequency. Also the TGD counterpart of Alfvén resonance (magnetic flux tube as string) might be involved. In the simplest situation the length of the projector ME would be equal to the distance to the activated point of the magnetic flux tube structure involved. Also the intersections of the projector ME with magnetic flux tubes of Earth and some cavity resonance at larger space-time sheet, such as Schumann resonance, could help to amplify the signal. Representations which do not satisfy this condition could of course contribute to our consciousness but the contribution should be weak and masked by resonant contributions.

b) 'Personal' sensory and motor representations are realized at the personal magnetic flux tube structures by place coding: if the thickness of the magnetic flux tube increases linearly with the length coordinate of the flux tube resonance condition is satisfied all along it. A similar dependence is implied also by the homeopathic findings [68] (see the chapter "Homeopathy in Many-sheeted Space-time") and by the requirement that magnetic energy density per unit length is constant.

c) Magnetospheric sensory and motor representations are realized at the magnetic body of Earth and correspond the personal consciousness of Mother Gaia. Also we can share part of her experience by fusion of the mental images. Magnetospheric representations could be responsible for the transpersonal and third person components of our consciousness, and also for memories and even imagination. The weakening of Earth's magnetic field provides the fundamental distance coding via cyclotron frequency scale, which scales with distance as $1/r^3$ in the dipole approximation holding for small distances but differs radically from this behavior at large distances, in particular inside magnetic tail. In magnetospheric case resonance condition gives strong conditions on the representation and can be satisfied only inside plasma sphere.

d) There seems to be no upper bound for the size of the super-conducting magnetic web providing the realization for the self hierarchy, and one can build precise quantitative models for this hierarchy. For a Buddhist this vision does not come as a surprise but challenges all cherished beliefs of brain scientist.

In this chapter this vision is developed quantitatively. The vision about magnetosphere as a living organism allows to develop the view about sensory representations to a rather detailed level. The intriguing observation that brain dynamics and iono- and magnetospheric physics seem to have common characteristic time scales, can be understood in this framework and even the mysterious 5 second time scale associated with Comorosan effect finds a possible explanation.

A TGD based view about magnetosphere results as a by product and allows to topologize the phenomenological but overall important notions of magnetohydrodynamics. In magnetohydrodynamics magnetic field lines are treated as effective super-conductors: in TGD Universe magnetic flux tubes *are* super-conductors. Also Alfvén waves cease to be a phenomenological concept, and the super-conducting geodynamo model is free of the difficulties of the standard model.

Evolution in Many-Sheeted Space-Time

The topics of the chapter has been restricted to those, which seem to represent the most well-established ideas. There are many other, more speculative, ideas such as the strong form of the hypothesis that plasmoid like life forms molecular life forms has evolved in "Mother Gaia's womb", maybe even in the hot environment defined by the boundary of mantle and core.

1. Basic facts about and TGD based model for pre-biotic evolution are discussed.
2. A model for the ATP-ADP process based on DNA as topological quantum computer vision, the identification of universal metabolic energy quanta in terms of zero point kinetic energies, and the notion of remote metabolism is discussed.
3. A model for the evolution of the recent genetic code (3-codons) as a fusion of codes for which codons are nucleotides (1-codons) and di-nucleotides (2-codons) is discussed. The symmetries of the genetic code, the observation that tRNA can be seen as a fusion of two hairpin like DNA molecules, and the finding that the first nucleotides of 3-codon code for the reaction path leading from a precursors of the aminoacid to aminoacids for hydrophobic/hydrophilic dichotomy, serve as motivations of the model. 1- and 2-codes corresponding to the two forms of RNA (the exotic 2' – 5' RNA and the usual 3' – 5' RNA) would have prevailed in RNA world. Aminoacids would have served as catalysts for the copying of RNA on one hand, and RNA molecules would have catalyzed the formation of aminoacids from their precursors on one hand, meaning the presence of a positive feedback loop. In the transition to DNA-aminoacid era RNA began to be translated to aminoacid sequences.
4. Cambrian explosion represents a rather mysterious period in biology: new highly developed phylas emerged out of nowhere. A second strange finding is that continents would fit together to form single super-continent covering entire Earth's surface at time of Cambrian explosion if the radius of Earth would have been one half of its recent value. This finding has inspired Expanding Earth theories but it has not been possible to identify the mechanism causing the expansion. The success of the standard tectonic plate theory requires that possible expansion must have occurred in relatively short geological time scale. The hierarchy of Planck constants implies that cosmic expansion has occurred in quantum leaps increasing the value of \hbar and thus of quantum scales by factors which tend to be powers of 2. Cosmic expansion would have occurred as jerks even in the case of planets. In the proposed model Cambrian explosion would have accompanied the expansion of the Earth's radius by a factor of 2: during this period an outburst of highly developed life forms from underground seas to the surface of Earth would have taken place.
5. The last section of the chapter compares TGD based view about the evolution of genetic code to the views of McFadden. This section is a little bit out of date. For instance, the hypothesis that magnetic body of DNA could induce mutations purposefully is not discussed. This hypothesis is natural if one believes that magnetic flux tubes connecting bio-molecules play a key role in bio-catalysis. This idea is discussed in the chapter devoted to protein folding.
6. A vision about biological evolution and evolution of brain is discussed on basis of the wisdom gained from the construction of the models of sensory receptor and generalized EEG.

1.5.2 PART II: MOTHER GAIA HYPOTHESIS AND HUMAN CONSCIOUSNESS

Semi-trance, Mental Illness, and Altered States of Consciousness

The book "The origin of consciousness in the breakdown of the bicameral mind" of Julian Jaynes provides, not only a fascinating scenario about the evolution of modern consciousness from the consciousness of bicameral stone age man, but also a holistic view about schizophrenic consciousness. In fact, Jaynes regards schizophrenic as a bicameral man receiving commands of 'God' as auditory and visual hallucinations.

Jaynes sees 'Gods' as the right brain of the bicameral man. In TGD framework 'Gods' represent higher levels of the self-hierarchy. To put it in nutshell, TGD view about the relationship of human

consciousness to higher levels of self-hierarchy relies on the notion of semi-trance. During semi-trance parts of brain entangle with some higher level, say the self associated with the social group, and are in trance and therefore unconscious. The remaining parts of brain are however conscious and receive communications from the collective consciousness via the entangled region of brain as sensory hallucinations, emotions and thoughts. Semi-trance is absolutely essential for the self-narrative: without it our consciousness would consist of memory fragments lasting only few seconds: higher level selves tell us where we come from and where we are going. Bicameral man received the commands and advices of the collective consciousness as auditory and visual hallucinations via regions of the right brain hemisphere wherefrom they were communicated to the left hemisphere whereas modern man receives these communications as thoughts ('internal speech') in left brain semi-trance and emotions in right brain semi-trance.

According to this view, schizophrenic spends in the bicameral state larger fraction of time than normal person and receives communications of the higher levels selves more often as sensory hallucinations than as thoughts and emotions. Thus schizophrenia can be seen as cognitive and emotional abnormality and becomes illness in modern society relying crucially on cognitive and emotional self-narrative which is much more refined than the self-narrative based on sensory hallucinations. In normal consciousness left brain hemisphere inhibits the messages from right hemisphere, left and right hemispheres are totally entangled a considerable fraction of time and the entanglement with higher level selves can also involve the entanglement of entire brain leading to short periods of total trance. In this view negative periods of schizophrenia correspond to the phases when right brain hemisphere is not entangled with higher level selves and positive, psychotic periods to the phase when this entanglement occurs often. This vision generalizes also to manic-depressive and anxiety disorders and one can see mental illness as disorder of communication between human brain and higher levels of self hierarchy.

Semi-trance mechanism provides also more detailed understanding about various altered states of consciousness and extrasensory perception (hypnotic state, telepathy, clairvoyance, some meditative states, identification experiences). Semi-trance mechanism provides considerable insights to 'Stephan's case', which originally stimulated serious attempts to understand the communications between various levels of the self hierarchy. I also apply semi-trance mechanism to model my personal altered states of consciousness.

Semitrance, Language, and Development of Civilization

The book "The origin of consciousness in the breakdown of the bicameral mind" of Jaynes provides a highly original vision about the evolution of modern consciousness from the consciousness of bicameral stone age man. TGD version about the cosmology of human consciousness relies on the notion of semi-trance. During semitrance parts brain entangle with some higher level, say the self associated with the social group, and are in trance and therefore unconscious. The remaining parts of brain are however conscious and receive communications from the collective consciousness via the entangled region of brain as sensory hallucinations, emotions and thoughts. Semitrance is absolutely essential for self narrative and establishment of long term goals: without semitrance our consciousness would consist of memory fragments lasting only few seconds. Higher level selves tell us where we come from and where we are going.

The basic differences between Jaynes's and TGD based version about evolution of civilization relate to the interpretation of bicamerality and what really happened in the evolution of individual.

a) In TGD framework one could see bicameral man as a cognitive and emotional child characterized by the effective cognitive and emotional ages at which the cognitive and emotional self-organizations of her left brain hemisphere stopped in the absence of external stimuli necessary for self-organization (it is impossible to learn to write if civilization has not discovered written language). Of course, there are several parameters differentiating between modern man and bicameral man (sensitivity for semitrance, profile of semitrance, time fraction spent in semitrance, right-left brain inhibition,..) and the identification of bicameral as a cognitive and emotional child as we understand child is unnecessarily strong.

b) The ability to fall in semitrance was not lost during evolution but was transformed to a new form. Not only linguistic but also sensory regions of the right brain hemisphere of bicameral man entangled with higher level selves and the communications from right to left brain hemisphere were not inhibited as they are in the brain of modern man. As left brain hemisphere differentiated and

memetic code gradually established itself, the guiding voice of God was transformed to internal speech and emotions. Higher level selves began to express their will via emotions, moods, planning and long term goals.

c) The differences between EEG:s of normal person and schizophrenic suggest that the fraction of time spend by average modern man in semitrance is much shorter. A more general criterion of bicamerality might be based on the fraction of time spend in semitrance state, be it sensory, cognitive or emotional. It is plausible that thoughts (not all of course!) are communicated to modern man via left brain hemisphere. If this is indeed the case, some regions of left brain hemisphere of modern man should allow standing EEG waves.

The development of the language is an absolutely essential part of the development of civilization. The syntactic structures of language emerged in parallel with the development of civilization. In TGD framework the development of language can be seen as a gradual establishment of genetic and memetic codes at new level and the emergence of symbol function. This could be also seen as an establishment of a symbiosis between two life-forms: biological life and 'culture' having as a physical correlate electromagnetic life represented as topological quanta of em ELF fields and providing realization of the memetic code.

Semitrance mechanism provides an extremely general communication mechanism between the levels of the self hierarchy and could explain why ant nests, beehives, flocks of birds, packs of wolves, cell societies, nuclei of brain, etc.. can behave as single organism and still consist of apparently randomly behaving individuals. Indeed, relevant biological structures (DNA double strand, double lipid layer forming cell membrane, epithelial sheets) have binary structure analogous to two brain lobes and are ideal candidates for 'bicameral' structures.

The vision about the development of civilization generalizes to cell level. p-Adic fractality plus the fact that the number of quantum jumps performed by selves is huge even at cellular and elementary particle levels, inspires the hypothesis that various societies ranging from human civilization to cell societies and protein-DNA societies are characterized by universal asymptotic self-organization patterns. This provides important insights to the structure of the biological self-hierarchy and its relation to the structure and functioning of organism and about how semitrance might allow bio-systems to control and coordinate their behavior. Cell as a protein-DNA society together with parallel between memetic and genetic codes provides a predictive vision about how genetic code might have established itself and semitrance suggests that new kind of control and communication mechanisms based on semitrance mechanism are at work.

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1.5.3 PART III: CRAZY STUFF

Crop Circles and Life at Parallel Space-Time Sheets: Part I

Crop circles as a hoax is one of the illusions of century created by the market economy media. That this cannot be the case has been known for a long time. For instance, microwave induced explosions in growth nodes of crops are regularly involved. Also meteoric material is often associated with the crop formations but not to the region exterior to them: this is absolutely impossible if the formations were made by human artists. Routine laboratory tests allow to judge whether the formation is man-made.

Models involving plasma flows from the ionosphere to the crop field formation have been developed. The regions where the soil has a high content of calcium carbonate (chalk) helping to charge it electrically are the places where the circles appear predictably from year to year. There is also evidence suggesting that this interaction exists during the entire growth period so that there would be a continual connection to the ionosphere.

Simplest crop circles have a form similar to plasma self-organization patterns. Small plasma balls have been observed in the fields both before and after the appearance of the crop formation. There are also irregular, 'non-geometric', patterns of downing which must have been created by same mechanism as crop circles involving the interaction with the ionosphere. These are ideal bits of data for developing in detail hypothesis that any living system, even plants and plant populations, has a magnetic body, and that also magnetosphere is a conscious and intelligent entity receiving information from and controlling the bio-sphere.

Dark matter hierarchy leads to a quantitative vision about how magnetic body controls biological body and receives sensory input from it, and this vision can be applied to crop circles interpreted as an outcome of generalized motor actions of magnetic body. The resulting model supports the view about crop circles as an attempt of (geo-, planeto-, helio-, or some other) magnetospheric conscious entities to tell about their existence to us.

Crop Circles and Life at Parallel Space-Time Sheets: Part II

There are two especially fascinating crop circle formations: Chilbolton and Crabwood. Both formations suggests very strongly the interpretation as a message from an intelligent civilization perhaps living at parallel space-time sheets in our solar system.

1. Genetic codes of aliens

The interpretation of the Crabwood message as a representation for the genetic codes of alien life forms is suggestive. If this interpretation is accepted, the crop circles allow to deduce a lot of information about the genetic code and other bio-codes associated with these life-forms.

a) The message suggests strongly the existence of also doublet code besides two triplet codes and this inspires a simple model for our genetic code allowing to see the code as resulting from much simpler product code by a small symmetry breaking due to the interaction between singlets and doublets. Also various alien codes results in the same manner. This has deep implications for the theories how the life at the molecular level has involved.

b) The model suggests strongly that DNA triplets have resulted as a fusion of DNA singlets and doublets defining simpler genetic codes. My bio-chemical knowledge does not allow to test this hypothesis. It turns out that one can deduce surprisingly detailed information about the alien genetic codes. In fact, almost unique codes result if one accepts the proposed model of the genetic code having symmetries obeyed also by our genetic code.

c) The Chilbolton message tells that also silicon is of fundamental importance for this life-form at DNA level. Crabwood message contains a variant of genetic code for which the simplest interpretation is that DNA doublets of form XA are effectively doubled: perhaps doublets of form XA_S besides XA , where A_S denotes a compound of A and silicon, have emerged. This increases the number of DNA triplets from 64 to 80 and thus also the information content of the genetic code. Same could have occurred to one member of the 7-plet composing aminoacids and increased the number of amino-acid like molecules by three: this in turn would increase the expressive power of the genetic code. The difference between man and ape is enormous although genetic codes are almost identical. It is impossible to even imagine the level of intelligence of these creatures as compared to that of us. The silicon insertions to the DNA and amino-acids bring in mind symbiosis with a silicon-based nano-computers.

d) Chilbolton message contains two different DNA strands. This could have several interpretations. DNA could indeed be asymmetric. Alternatively, there could be two genetic codes for the same life-form: the 80 DNA-23 amino-acid code would involve silicon and could perhaps give rise to a living arithmetic processor. The third option is that there are two separate life-forms involved. 64-DNA code would be associated with the plasmoidic life-forms. The fact that the Sun, whose convective zone contains a magnetic field of order Tesla making it an ideal environment for this life-form, is described to be smaller than in Arecibo message, suggests that this life-form populates also solar magnetosphere. The plasmoidic life-forms could serve as kind of less intelligent medium like messengers, quantum entanglers, making possible a telepathic sharing of mental images between members of different civilizations. The light balls observed near crop formations would represent this life-form. Also UFOs could be identified as plasmoidic life-forms inducing telepathic encounters with the alien life-forms. The biology of the more intelligent life-form would be based on 80 DNA-23 amino acid code, which could live even outside the solar system.

The very general symmetries deduced from our own genetic code fix the identification of the alien codes highly uniquely. All these codes result by the same universal mechanism, and are characterized by the same imbedding of the aminoacid space to the DNA space implying that a considerable part of the code is universal. The symmetries are the exact A-G permutation symmetry and the almost exact T-C permutation symmetry for the last base of the DNA triplet, and the approximate decomposition to a product of codes associated with DNA doublets (the first two bases of triplet) and singlets (the third base of triplet). The success of this model inspires the view that molecular life first evolved to form DNA singlets and doublets coding for 2-plet *resp.* 10-plet of 'pre-aminoacids'. After that DNA doublets and singlets fused to triplets coding for the ordinary aminoacids, which are perhaps an outcome from the fusion of the two kinds of "pre-aminoacids". 2×10 dichotomy might relate to the hydrophilic-hydrophobic dichotomy for the aminoacids.

2. Where do the messages arrive from?

The messages responsible for the crop circles should come from our solar system, perhaps from terrestrial magnetosphere or solar magnetosphere. Time mirror mechanism allows to consider also the possibility (suggested by the time interval of year and one day between the messages) that the messages arrive from a distant geometric future and tell about the genetic codes of future civilizations living in the solar system.

3. Where do the life forms assignable to the genetic codes live?

One can consider several identifications of the biological life forms assignable to the codes using Chilbolton message as a hint. These life forms could live in Earth, Mars, Jupiter, perhaps as intra-planetaries, say intra-terrestrials at various boundaries such as mantle-core and core-inner core boundary. Even the photosphere of Sun could be populated.

The notions inspired by the dark matter hierarchy, in particular the notion of N -molecule, allow to consider seriously the existence of biological life forms able to cope in high temperature environments, and one can build rough view about what high- T life should look like. The experimental signature of N -molecules are spectral lines of corresponding ordinary molecules in environments where they are not thermally stable. In the solar photosphere the spectral lines of water and solid calcium ferrite have been indeed observed. To sum up, without exaggerating one can say that the systematic search of these spectral lines might revolutionize our world view.

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Part I

**MOTHER GAIA HYPOTHESIS
IN TGD UNIVERSE**

Chapter 2

Magnetospheric Sensory Representations

2.1 Introduction

The general view about sensory and motor representations has been rather heuristic hitherto. By some additional thought one can however build a more detailed picture about sensory and motor representations.

2.1.1 Are sensory representations at the personal magnetic body or at the magnetic body of the Earth's magnetic field?

One can imagine two basic candidates for how *our* sensory and motor control are realized: the representations at the personal magnetic sensory body and the representations on the magnetic flux tube structures of Earth, the magnetic body of Mother Gaia. Quite a long time I saw the problem as the question 'Which of these options is correct?'

If our sensory and motor representations were realized using magnetospheric representations alone, the consciousness of astronauts would differ in a dramatic manner from the ordinary wake-up consciousness. This is not the case so that personal magnetic bodies must give the basic contribution to our personal sensory representations and motor control if the basic approach is correct. Because of the sharing of mental images also the sensory and motor areas of the magnetic Mother Gaia making possible higher collective levels of consciousness are however important for us and are perhaps partially responsible for memory and imagination and third person aspect of our consciousness. Therefore it is of importance to try to define and understand also the magnetospheric representations.

1. The basic hypothesis is that some kind of resonance mechanism is involved. The simplest possibility is that projector MEs ('massless extremals', topological counterparts of light rays) to the sensory canvas have length equal to the wavelength defined by the magnetic transition frequency. Also the TGD counterpart of Alfvén resonance (magnetic flux tube as string) might be involved. In the simplest situation the length of the projector ME would be equal to the distance to the activated point of the magnetic flux tube structure involved. Also the intersections of the projector ME with magnetic flux tubes of Earth and some cavity resonance at larger space-time sheet, such as Schumann resonance, could help to amplify the signal. Representations which do not satisfy this condition could of course contribute to our consciousness but the contribution should be weak and masked by resonant contributions.
2. What might be called personal sensory and motor representations are realized at the personal magnetic flux tube structures by place coding: if the transversal area of the magnetic flux tube increases linearly with the length coordinate of the flux tube, the resonance condition is satisfied all along it. A similar dependence is implied also by the homeopathic findings [68] discussed in [18] and by the requirement that magnetic energy density per unit length is constant.
3. Magnetospheric sensory and motor representations are realized at the magnetic body of Earth and correspond to the personal consciousness of Mother Gaia. Also we can share part of her

experience by fusion of the mental images and magnetospheric representations could be responsible for the transpersonal and third person components of our consciousness, and also involved with our memories and imagination. The weakening of Earth's magnetic field provides the fundamental distance coding via cyclotron frequency scale, which scales with distance as $1/r^3$ in the dipole approximation holding for small distances but differs radically from this behavior at large distances, in particular inside magnetic tail. In the magnetospheric case resonance condition gives strong conditions on the representation.

4. There seems to be no upper bound for the size of the super-conducting magnetic web providing the realization for the self hierarchy and one can build precise quantitative models for this hierarchy. For Buddhist this vision does not come as a surprise but challenges the cherished beliefs of brain scientist.

2.1.2 The relationship between Earth's magnetic field and personal magnetic body

A dramatic clarification to the relationship between personal magnetic body and Earth's magnetic field came through a rather frustrating experience. For years I erratically believed that the magnitude of the magnetic field assignable to the biological body is $B_E = .5$ Gauss, the nominal value of the Earth's magnetic field. Probably I had made the calculational error at very early stage when taking Ca^{++} cyclotron frequency as a standard. I am grateful for Bulgarian physicist Rossen Kolarov for pointing to me that the precise magnitude of the magnetic field implying the observed 15 Hz cyclotron frequency for Ca^{++} is .2 Gauss and thus slightly smaller than the minimum value .3 Gauss of B_E . This value must be assigned to the magnetic body carrying dark matter rather than to the flux quanta of the Earth's magnetic field. This field value corresponds roughly to the magnitude of B_E at distance $1.4R$, R the radius of Earth.

The understanding of the dark matter hierarchy leads to a detailed quantitative view about quantum biology with several testable predictions [20]. The applications to living matter suggests that the basic hierarchy corresponds to a hierarchy of Planck constants coming as $\hbar(k) = \lambda^k(p)\hbar_0$, $\lambda \simeq 2^{11}$ for $p = 2^{127-1}$, $k = 0, 1, 2, \dots$ [20]. Also integer valued sub-harmonics and integer valued sub-harmonics of λ might be possible. Each p-adic length scale corresponds to this kind of hierarchy.

Number theoretical arguments suggest a general formula for the allowed values of λ [16] as $\lambda = n$ where n characterizes the quantum phase $q = \exp(i\pi/n)$ characterizing Jones inclusion [19]. The values of n for which quantum phase is expressible in terms of squared roots are number theoretically preferred and correspond to integers n expressible as $n = 2^k \prod_n F_{s_n}$, where $F_s = 2^{2^s} + 1$ is Fermat prime and each of them can appear only once. $n = 2^{11}$ obviously satisfies this condition. The lowest Fermat primes are $F_0 = 3, F_1 = 5, F_2 = 17$. The prediction is that also n-multiples of p-adic length scales are possible as preferred length scales. The unit of magnetic flux scales up as $h_0 \rightarrow h = nh_0$ in the transition increasing Planck constant: this is achieved by scalings $L(k) \rightarrow nL(k)$ and $B \rightarrow B/n$.

$B = .2$ Gauss would corresponds to a flux tube radius $L = \sqrt{5/2} \times L(169) \simeq 1.58L(169)$, which does not correspond to any p-adic length scale as such. $k = 168 = 2^3 \times 3 \times 7$ with $n = 5$ would predict the field strength correctly as $B_{end} = 2B_E/5$ and predict the radius of the flux tube to be $r = 18 \mu\text{m}$, size of a large neuron. However, $k = 169$ with flux $2h_5$ would be must more attractive option since it would give a direct connection with Earth's magnetic field. Furthermore, the model for EEG forces to assume that also a field $B_{end}/2$ must be assumed and this gives the minimal flux h_5 . Note that $n = 5$ is the minimal value of n making possible universal topological quantum computation with Beraha number $B_n = 4\cos^2(\pi/n)$ equal to Golden Mean [25].

This picture inspires several questions. Is the Earth's magnetic field at $k = 169$ flux sheets accompanied by $n = 5$ dark variant at which macroscopic quantum phases responsible for many properties of living matter reside. How strongly the behavior of B_{end} correlates with that of B_E ? For instance, do perturbations of B_E induce those of B_{end} and is the average ratio B_{end}/B_E constant? Unfortunately, I did not have a slightest idea about these questions when I wrote the first version of this chapter and the implications of the new view about B_{end} and its relationship to B_E are not discussed in the sequel.

2.1.3 Topics of the chapter

In this chapter the transpersonal, magnetospheric sensory and motor representations are the principal objects of interest.

1. The basic vision inspired by fractality of consciousness is that the entire solar system is a gigantic magnetic organism having planetary magnetospheres as sub-organisms. Magnetospheres represent collective levels of consciousness and receive sensory input from biosphere and perform also very high level bio-control. Like brain, also magnetosphere decomposes to two kinds of regions. Relatively stable regions are optimal for the sensory representations. Unstable and self-organizing transition regions are optimal for imagination and for a generalized motor control in the planetary scale. Motor control could mean higher control at biochemistry level but also social behavior could reflect the presence of this kind of control since we are in a well defined sense cells (or perhaps neurons) of the magnetic Mother Gaia.
2. The structure of the magnetosphere predicts a hierarchy of magnetospheric selves bringing in mind the chakra hierarchy of Eastern philosophies of consciousness. This hierarchy has counterpart at the level of brain and corresponds to the 5-levelled hierarchy of cortex plus midbrain and brain stem.
3. The resonance condition $f_m = c/L$ relating magnetic frequency to the length of the projector ME, is very natural for the magnetospheric sensory representations. The condition can be satisfied only within the plasma sphere and for EEG frequencies above 8.6 Hz. Also cavity resonances associated with various space-time sheets (inner core of Earth, the cavity below ionosphere, magnetosphere,) could give could be behind resonance frequencies. The predictions are consistent with the basic facts about EEG.
4. The mysterious $\tau_C = 5$ second time scale associated with the Comorosan effect (the enhancing effect of the laser light irradiation on the catalyst activity when irradiation time is a multiple of 5 seconds) corresponds to several magnetic transition frequencies in ~ 10 nT magnetic field prevailing at plasma sheet. This kind of magnetic field is created also by magnetic particles in lungs. This inspires the speculation that very high level electromagnetic bio-control from, say plasma sheet and magnetic lobes is present.

A TGD based view about magnetosphere results as a by product and allows to topologize the phenomenological but overall important notions of magnetohydrodynamics. In magnetohydrodynamics magnetic field lines are treated as effective super-conductors: in TGD framework magnetic field lines are replaced by magnetic flux tubes which could be genuine super-conductors (here the value of Planck constant is expected to play the key role). Also Alfvén waves cease to be a phenomenological concept, and the super-conducting geodynamo model is free of the difficulties of the standard model.

What makes the proposed speculative picture so fascinating is its generality. Even meteors have magnetospheres so that the generation of conscious life would be completely universal phenomenon unavoidable for any magnetized objects in the vicinity of any star producing ionic wind! The crucial prediction is that magnetospheres are living, self-organizing systems. There is indeed empirical support for this prediction.

2.2 The structure of magnetic field of Earth and variation of cyclotron frequency scales

It is interesting to try to relate the model for sensory representations to the structure of Earth's magnetosphere. To achieve this, I will provide a brief novice's overview about the structure of magnetosphere. I will use partially TGD based language in which magnetic field lines are replaced by magnetic flux tubes and the formation of the plasma corresponds to the leakage of the supra currents from the magnetic flux tubes. I will also briefly consider TGD based qualitative models for the phenomena, many of which are not well understood in Maxwellian theory. Examples of such phenomena are Alfvén waves which are not proven to result from Maxwellian theory, and magnetic dynamo of Earth whose working mechanism is not really understood. Also the mechanism of auroras becomes very concrete when field lines are replaced with flux tubes [27].

2.2.1 Magnetosphere

Solar wind [61, 53, 65] determines the large scale structure of the magnetic field of Earth to a high extent. The basic structural components are transition regions and regions between them.

1. At the bow shock the solar wind arriving at a supersonic velocity of 500 km/s encounters Earth's magnetic field and is transformed to a subsonic flow and dissipates energy inside magnetosheath where the plasma is denser and hotter than in the solar wind. The distance of the bow shock is roughly 12-14 R (R denotes Earth's radius).
2. The shocked solar wind cannot penetrate Earth's magnetic field and a cavity called magnetosphere is formed. Interplanetary magnetic field and magnetosphere is separated by a transition region called magneto-pause, which is accompanied by a plasma mantle. At the day side magneto-pause is at distance of about 10 R but when solar wind is particularly strong in can move down to 6-7 R . At the night side magnetosphere is stretched into long cylindrical magneto-tail of length about 1000 R and radius about 20 R .

Magnetosphere consists of clearly separated regions with widely different densities and temperatures. The main division is into inner and outer magnetosphere. In the inner magnetosphere magnetic field lines are co-rotating with the Earth: in the outer magnetosphere they are stationary. Magneto-pause contains an ionic current determined by the discontinuity of the magnetic field and orthogonal to it.

Magnetic lobes

The outer magnetosphere at the night side, magneto-tail, consist of northern and southern magnetic lobes which are cavities having very low ionic density of about .01 ions per cubic cm. The low density can be understood as resulting from the absence of the solar wind in this region. By Maxwell's equations magnetic field is approximately constant in the region where the flow lines are parallel (if sources can be neglected). According to [68] the value of the magnetic field is about 30 nT in the interior of the lobes. The relatively strong magnetic field inside lobes serves as a magnetic energy battery feeding energy to the plasma sheet.

Magneto-tail is a cylindrical structure with radius of order $R_m = 20R$. Magnetic lobes extend up to $r \sim 1000R$. The magnetic field lines remain actually closed. In TGD framework this means the existence of a closed supra-current circuitry formed by the magnetic flux tubes.

Plasma sheet and magneto-pauses

Magnetic lobes are separated by a plasma sheet in the equatorial plane consisting of hot (5×10^6 K), low density plasma (.3-.5 ions/cm³ as opposed to .01 ions/cm³ inside lobes) with magnetic field ~ 10 nT. Plasma sheet extends from $8R$ to about $60R$ and has thickness of order few R , and gets thinner with increasing distance. Plasma sheet disappears at so called neutral point, where magnetic field vanishes. In the plasma sheet the magnetic flux from southern lobe flows to the northern lobe. Near the Earth plasma sheet reaches the high latitude auroral ionosphere. The value of the magnetic field immediately above the magnetic sheet is 20 nT.

In TGD framework the plasma sheet can be seen as resulting from the leakage of the supra currents from the magnetic flux tubes of Earth's magnetic field to a larger space-time sheet. This supra-current leakage is caused by the inertia of the ions and electrons in the region where the magnetic flux tubes are highly curved. The leakage occurs also in the magneto-pause, where the tangential component of the magnetic field is discontinuous and a surface current orthogonal to B generating the discontinuity flows. In the magneto-pause the magnetic flux tubes of the inner and outer region are parallel. The reconnection of the parallel flux tubes of the magnetic fields of Earth and Sun allows the transfer of the ions of the solar wind to the magnetosphere. Magneto-pause is accompanied by a plasma mantle, which could be partially due to the leakage of ions to larger space-time sheet accompanying the reconnection process.

There is a convective flow of ions towards the plasma sphere along the plasma sheet. In TGD framework this motion must take place at a larger space-time sheet or involve a hopping between magnetic flux tubes: in both cases a breaking of super-conductivity is implied.

Plasma sheet has also a boundary layer in which the tangential component of the magnetic field is discontinuous. This requires a surface current orthogonal to the axis of the sheet. This current results when the ions from the magnetic flux tubes leak out from flux tubes to a larger space-time sheet by their inertia in the highly curved portion of the flux tube caused by the tangential discontinuity.

Cusps

Southern and northern cusps are funnel-shaped regions which on the day side consist of closed highly compressed flux tubes of dipole field and on the night side of almost open flux tubes stretched deep into the magnetospheric tail. In this funnel magnetic field is orthogonal to the magneto-pause and the magnetic flux tubes of the solar magnetic field can penetrate the magnetosphere. This implies that solar plasma contained in the solar magnetic field lines penetrates deeply into the magneto-tail by reconnecting with the field lines of Earth's magnetic field near poles. This gives rise to auroras [52].

Reconnection can be seen as resulting from the penetration of the solar magnetic flux tubes at the upper boundary of the magneto-pause along the plasma sheet to a highly stretched flux tubes along the boundary of the plasma sheet. The transformation to open flux tubes can happen only if the solar flux tubes reconnect with the flux tubes of the solar magnetic field penetrated into the plasma sphere. Thus auroras can be seen as a phenomenon involved with the boundary between plasma sheet and lobes.

Cusps, and to some extent also plasma mantle, serve as a channel along which the solar wind feeds 'magnetometabolic' energy to the magnetosphere needed to run the geodynamo system [70] (the notion of super-conducting geodynamo will be introduced later). The dipole field generated solely by the convective currents in Earth interior would die out in few thousands of years. The field inside lobes serves as a storage of magnetic energy and is recharged by the energy of the solar ions leaking into the magnetic tail in the reconnection process. One could see the cusps also as a communication channel between solar and Earth's magnetic structures, kind of magnetic 'ears' of magnetic Mother Gaia.

Inner magnetosphere

Inner magnetosphere is a toruslike structure whose extension varies between $4R$ (day side) and $8R$ (night side). In the inner magnetosphere the typical density is about 1 ion per cubic centimeter. Inner magnetosphere is bounded by a transition layer of thickness of $\sim R$ (magneto-pause). In this region the density of the ions drops rapidly.

Inner magnetosphere contains plasma sphere whose radius varies in the range $2R-4R$ at day side and $2R-6R$ at night side. Plasma has a ionospheric origin. The density of the cold plasma consisting mainly of protons ($T \sim 1$ eV) sphere varies in the range $10 - 10^3$ ions/cm³, whereas the temperature is $\sim 5 \times 10^3$ K. The cold, dense plasma of plasma sphere is frozen around magnetic flux lines which co-rotate with Earth. In TGD framework this means that flux tubes co-rotate and thus change shape. In the equatorial plane the density of the plasma sphere drops sharply down to ~ 1 ion/cm³ at $r = 4R$. This transition region is known as a plasma pause. During magnetic storms the outer radius decreases since the pressure of the solar wind compresses the plasma sphere. The day-night variation of the shape of the plasma sphere is rather small. Within this region the magnetic field has in a reasonable approximation dipole shape with radiation belts forming an exception.

Radiation belts and ring currents

Plasma sphere contains the inner and outer van Allen radiation belts [55] (extending from $2R$ to $4R$ at the day side and from $2R$ to $9R$ at the night side). Both the inner and outer belts extend up to latitude of 60 degrees. The boundaries of the belts follow magnetic field lines except in at the Northern and Southern tips. This region contains ring currents.

One of the functions of the radiation belts is to prevent the penetration of the biologically harmful high energy cosmic rays to the ionosphere. In fact, the inner protonic belt results by the decay of the cosmic ray neutrons to protons. Second function (in TGD universe!) is to act as a part of a controlled dynamo system giving rise to the magnetosphere of Earth (for the standard theory of geodynamo see [70]).

It has been found that the energies of the ions in the radiation belts are much higher than one might expect [58]. This might be understood if part of the ions runs as supra currents along the magnetic flux tubes. Super-conductivity is broken only by the leakage of the supra currents from the magnetic flux tubes. This could explain the success of magnetohydrodynamics based on the assumption of effective super conductivity.

1. Inner radiation belts

There are actually two separate inner radiation belts: the one containing protons and the one containing electrons. Protons in the inner belt have energies in 10-100 MeV range and readily penetrate space crafts. The inner radiation belts are concentrated around equator in the range $(1.1 - 3.3)R$ (these numbers depend on the conventions used and should not be taken too literally). In the protonic belt the maximum of the flux density is at $2R$: in electronic belt the maximum flux density is at about $1.4R$. The inner belts are relatively stable and there is no night-day difference. The inner belts feel magnetic storms and vary with the 11 year period of solar activity.

What is interesting is that the inner belts are also sensitive to human technology. The inner belt has lowered above the East Coast of US from 300 km to 10 km [68]: this process is associated with power transmission along magnetic field line and the usage of the ionosphere-resonance frequency 60 Hz as the frequency of household current.

During the last decade two new belts have formed inside inner belts [68, 61]. The new electronic belt has maximum electron flux at $r \sim 2R$ (earlier flux maximum was at $r \sim 1.4R$). The second newcomer consists mostly of O^+ ions but containing also He^+ . This process has been seen as a part of magnetic re-self-organization process occurring in the scale of the entire helio-magnetosphere implying rapid changes of planetary magnetospheres [68].

2. Outer radiation belt

Outer belt contains mainly electrons with energies up to 10 MeV and is produced by the injection of charged particles during geomagnetic storms. This makes outer belt much more dynamical than the inner one. The cross section of the outer radiation belt is banana shaped. The outer belt ranges from $3R$ to $6R$ (at night side). The maximum for the density of electrons above MeV energy occurs at $4R$.

3. Ring currents

Radiation belts contain ring currents. Electronic ring current rotates in the same direction as Earth whereas protonic current runs to the opposite direction. In the outer belt only electronic current is present. Quiet time ring current in the inner electronic *resp.* protonic belts consists mainly of hydrogen ions *resp.* electrons but during magnetic storms also O^+ ions are present (note however the presence of the new O^+ belt). Ring current has the effect that magnetic field gets stronger at the outer side of given belt and weaker at the inner side.

Super-conducting geodynamo?

The standard theory for Earth's magnetic field assumes that the convective currents in the liquid outer core of Earth generate the magnetic field [70]. It has been found that also planets which do not possess liquid core can have magnetic field: this means a failure of the standard geodynamo theory. Furthermore, planetary magnetospheres have very similar structure [56], and solar magnetosphere has 'memory' [38]. This suggests that magnetospheres are self-organizing systems having only few asymptotic patterns. There is evidence that the changes of Earth's magnetic field can be quite too fast (several degrees per day!) to be caused by convective currents in the outer liquid core [69]. Also the different orientations of the magnetic and rotational axis is not what one would make as the first guess. This forces to think that standard dynamo theory might be somehow wrong.

The vision about solar and planetary magnetospheres as self-organizing systems inspires the idea that the rotational electric field and ring currents could be an essential part of the dynamo system generating, and perhaps even controlling, Earth's magnetic field. Solar wind would provide the energy needed for this purpose. This vision gets support from the findings of the last decades about dramatic changes in the magnetospheres of some planets [68] (auroras in Saturn, polar shifts of Uranus and Neptune, the doubling of the field intensity of Jupiter, rapid pole shifts of the geomagnetic field suggesting the possibility of a geomagnetic field inversion in progress, significant growth of the recognized

geomagnetic anomalies). That solar magnetic activity has been also especially strong during this time supports the view that solar wind controls these events to some extent.

1. *Super-conducting geodynamo model*

The notion of many-sheeted space-time leads to a modification of the dynamo theory.

1. The simplest TGD based model for a rotating astrophysical object predicts dynamo system replacing black hole type solutions with singularity free space-time surfaces [21]. The basic characteristic of the models is the presence of the orthogonal magnetic and electric fields (this follows from the assumption that CP_2 projection of the space-time surface is 2-dimensional).
2. The fields in question can be either magnetic or Z^0 magnetic. In the TGD framework ring currents consist of the ions 'dropped' from the magnetic flux tubes to a larger space-time sheet. The dropped ions drift in an electric field whose field lines circle around the axis of the magnetic field. Ring currents generate a weak magnetic field in a direction orthogonal to the plane of the ring currents. This field, if sufficiently strong, could serve as a seed inducing a spontaneous magnetization inside Earth's outer or inner core. In standard physics this is not possible since Earth's core is very hot so that conductive currents as a source of the magnetic field are the only possibility.
3. In TGD the situation is different. The interior of Earth contains besides atomic space-time sheet also super-conducting space-time sheets at very low temperature. In particular, the flux tubes of the magnetic fields generated by the ring currents are present. Since the temperature is extremely low, electrons could bind to Cooper pairs with net spin $J = 2$ (ions would possess relative angular momentum) as in high T_c super-conductors [28, 27]. Bosonic ions could form Bose-Einstein condensates. Exchange interaction favors magnetization parallel to the seed field. This generates additional magnetic field in the direction of the magnetic field inside flux tubes and leads to spontaneous magnetization and the amplification of the seed field. The same trick could be applied also by living organisms to achieve magnetic homeostasis.
4. The energy needed to maintain the magnetic field would be much smaller than in the conventional dynamo model since dissipative effects are small. The direction of the magnetic field could also vary rapidly for the same reason. To some degree the direction of the magnetic field could be controlled by the solar wind since it affects ring currents. An interesting question is whether the solar wind could feed electrons to the Earth's interior: first to the magnetic flux tubes of Earth's magnetic field in a reconnection process, and then to Earth's core along flux tubes in the outer radiation belt dipping near to the polar caps.
5. Only the magnetic flux tube structure containing the super-conducting matter rotates around the magnetic axis. The small amount of super-conducting matter means that the change of the direction for the magnetic field does not require huge energy and angular momentum transfers. The rotation axis of the space-time sheet representing entire Earth could be different. There could be similar dynamo also at this larger space-time sheet. In the simplest model this dynamo would be Z^0 -magnetic.
6. The mechanism inducing the reversals of the magnetic field is at the topological level the same as in the standard model of geodynamo (for an early TGD inspired model of the solar sunspot cycle see [21]). Magnetic flux tubes get strongly entangled during differential rotation and sooner or later this leads to a reconnection process. Super-conductivity makes possible very rapid reversals.
7. What distinguishes TGD model from geodynamo model is that the super-conducting magnetic flux tubes are the primary dynamical system rather than the convective currents. This allows to view the anomalies of the geomagnetic field as additional magnetic flux tube bundles (there are four anomalous regions: Canadian, East Siberian, Brazilian, and Antarctic) having some role in the control of the magnetodynamics. For instance, the feed of super-conducting electronic or ionic Cooper pairs to the Earth interior would allow to intensify magnetization inside flux tubes. Self-organization would explain why the magnetic field patterns are similar for all planets possessing a detectable magnetic field. Self-organization would also explain the 'memory' of the solar magnetic field [38].

2. Dark matter as a hierarchy of phases with large values of Planck constant

In the original model it was assumed that space-time sheets carrying various Bose-Einstein condensates are at a very low temperature so that cyclotron energy scale is above thermal energy and spontaneous magnetization as a source of magnetic field becomes possible instead of electric currents.

The hypothesis that dark matter corresponds to a hierarchy of phases with a large value of Planck constant [16] brings a new element to the model since magnetic interaction energies scale as \hbar and for large enough value of \hbar can be above thermal threshold. Also dissipation rates are expected to behave like $1/\hbar$ and would thus be very small for large values of Planck constant.

Therefore macroscopically quantum coherent dark matter can generate spontaneous magnetization even of magnetic flux sheets are at the same temperature as the visible matter. The TGD inspired model of EEG [20] relies on a hierarchy for favored values of Planck constant given by $\hbar(k) = \lambda^k \hbar_0$, $\lambda = 2^{11}$. $\lambda = 2^{11}$ corresponds to a fundamental constant in TGD Universe [21]. For $k \geq 4$ cyclotron energy for ions is above the thermal threshold at room temperature. For electrons this is true already for $k \geq 3$. At least the values of k satisfying $k \leq 7$ are favored by the model for EEG predicting a fractal hierarchy of EEGs.

3. Application to planetary magnetospheres

Consider now how the proposed model survives qualitative tests.

1. Five planets (Earth, Jupiter, Saturn, Neptune, and Uranus) have detectable magnetic fields. The rings of Saturn are an excellent candidate for the seed of the magnetic field. Also Jupiter has a dense ring of condensed plasma rotating at its radiation belts.
2. Mercury is smallest of the terrestrial planets and rotates slowly (rotation period is 58.6 days) but has weak magnetic field contrary to what the standard dynamo theory predicts [56]. Mercury is also the planet nearest to the sun and solar wind is strong at this distance. This could mean that the ring currents are sufficiently intense to generate the critical seed field inducing the spontaneous magnetization.
3. Mars has extremely weak magnetic field. Magnetic field is crucial for life in TGD framework and there is evidence that Mars has possessed life in past. It would be interesting to find whether Mars has had magnetic field in the past. Earth's magnetic field should vanish during two millenia if it continues to decay with the recent rate. Those who like doomsday scenarios could of course wonder whether the life in Earth might suffer the Martian fate and how much time our species still has?
4. Also Venus has very tiny magnetic field. It has almost same radius as Earth and is also hot. The rotation period is however very long (243 days) and in the standard model this is taken as an explanation for the smallness of the magnetic field. In TGD framework one must assume that the rotation velocities of the ions of the ring currents are proportional to the rotation velocity implying that the seed magnetic field is below the critical value.

Magnetic transition frequencies in magnetic lobes and plasma sheet

The values of important magnetic transitions frequencies in various regions of the magnetosphere are crucial if one wants to construct a general vision about sensory and motor representations at the magnetic sensory canvas. In the inner magnetosphere dipole approximation allows to estimate the spatial dependence magnetic transition frequencies.

In magnetosheet and magnetolobes the average values of the magnetic field are 10 nT and 30 nT respectively. Immediately above the magnetosheet the value of the magnetic field is 20 nT. Magnetosheet could thus allow place coding by the magnetic transition frequency scale whereas magnetolobes are not tailor made for this purpose. Note that the thickness of the magnetic flux tubes in the field of 10 nT = $2^{-9} B_e$, $B_e = 5 \times 10^4$ nT is from the quantization of magnetic flux equal to about 55 μm and thus corresponds to a biological length scale. This length scale corresponds to the p-adic length scale $L(11, 16)$ ($L_p(n) = p^{(n-1)/2} L_p$). Already this encourages to think that plasma sheet might be involved with bio-control.

The strength of the interplanetary magnetic field depends on the intensity of solar wind and varies between .2 – 80 nT and has average of 6 nT. Interestingly, the maximum value 80 nT corresponds to the p-adic length scale $L(173) = 20 \mu\text{m}$.

1. *Proton*

In the case of proton there are three especially interesting frequencies to be considered: cyclotron frequency $f_c = eB/2\pi m_p$, spin flip frequency and the frequency of combined spin flip and $\Delta n = 1$ transitions. The frequencies of these transitions in magnetic field of $.5 \times 10^{-4}$ T are $f_c = 300$ Hz, $f_{flip} = 838$ Hz, $f_1 = 532$ Hz and $f_2 = 1138$ Hz. In a field of 10 nT the values of the transition periods $T = 1/f$ are $T_c = 16.7$ sec, $T_{flip} = 6$ sec, $\tau_1 = 9.3$ sec, and $\tau_2 = 4.4$ sec. For a field of 30 nT the values are obtained by dividing by three. Plasma sheet contains also He^{++} and He^+ ions and for these the cyclotron times are 2τ and 4τ . For O^+ ion which is also present cyclotron time varies between 1 min 20 s and 4 minutes. All these time scales are typical time scales of human consciousness. For the interplanetary magnetic field protonic cyclotron times are 13.9 min, 27.8 sec, and 2.1 sec for the minimum, average, and maximum respectively.

2. *Electron*

For electrons the cyclotron frequency is 282 Hz for 10 nT so that electronic cyclotron transitions cannot represent ionic cyclotron transitions in brain (if they occur at the flux tubes of Earth’s magnetic field!). Spin flip combined with cyclotron transition represents however an important exception. In this case the non-vanishing transition frequency is due to the anomalous magnetic moment of electron and the frequency in the reference field of $.5 \times 10^{-4}$ T is 2255 Hz. This gives $T(e) = 2.24$ sec. Note that also $n = 3$ protonic cyclotron transition gives rise to nearly the same period.

It is interesting to notice that these time scales are important time scales of human consciousness and that both protonic spin flip time scale and $T(e)$ nearly half of the 5 second time scale associated with the Comorosan effect [84, 83] discussed in [27]. If Earth’s magnetic field is accompanied by dark flux sheets in entire magnetosphere carrying field $B_{end} = 2B_E/5$, then the value of $T(e)$ would become $T(e) = 5$ seconds for $B_E = 11.2$ nT.

To sum up:

1. the average magnetic field in plasma sheet corresponds to a definite p-adic length scale;
2. the mysterious time scale of the Comorosan effect pops up as a basic magnetic transition time in magnetic lobes and plasma sheet and is related to bio-control by enhancing catalytic rates: it is however essential that the "dark" counterpart $B_{end} = 2B_E/5$ of B_E associated with living matter is in question;
3. plasma sheet is found to be a complex self-organizing system with the velocity distribution of ions representing complex features (such as 'eyes' and 'wings'!) [51].

These findings force to seriously consider the possibility that plasma sheet and magneto-pause and perhaps even magnetic lobes might perform high level bio-control utilizing MEs and supra-currents along magnetic flux tubes forming the extension of the endogenous magnetic circulation to the entire magnetosphere.

2.2.2 Z^0 magnetosphere

Classical Z^0 fields are in a key role in TGD based model of living matter and chiral selection in the living matter is one of the anomalous phenomena explained by the presence of classical Z^0 fields. Therefore one expects that also Z^0 magnetosphere of Earth is crucial for the realization of sensory representations and/or of motor control.

Clarification of basic notions

The original erratic view was that it is possible to speak about space-time sheets carrying only em or Z^0 fields: hence the term of Z^0 magnetosphere. The notion of induced gauge field combined with field equations however predicts strong constraints between various classical fields and it is not possible to have a situation in which either em -, Z^0 -, or gluon field alone would be present as a classical field.

Hence it is quite possible that same space-time sheets define both magnetosphere, Z^0 magnetosphere, and color magnetosphere.

For instance, for vacuum extremals with vanishing induced Kähler form classical em field γ and Z^0 field satisfy

$$\gamma = -\frac{\sin^2(\theta_W)}{2} Z^0 \simeq -\frac{Z^0}{8}$$

for $\sin^2(\theta_W) = .23$. Note that classical γ and Z^0 fields are defined by vector potentials defined as eA_{em} and $g_Z A_Z$. For space-time sheets for which CP_2 projection is $r = \infty$ homologically non-trivial geodesic sphere of CP_2 (see the appendix of the book) one has

$$\gamma = \left(\frac{3}{4} - \frac{\sin^2(\theta_W)}{2}\right) Z^0 \simeq \frac{5}{8} Z^0 .$$

The induced W fields vanish in this case and they vanish also for all geodesic sphere obtained by $SU(3)$ rotation. For homologically trivial geodesic sphere a standard representative is obtained by using for the phase angles of standard complex CP_2 coordinates constant values. In this case induced em, Z^0 , and Kähler fields vanish but induced W fields are non-vanishing. One can say that for non-vacuum extremals with 2-D CP_2 projection color rotations and weak symmetries commute. Note that neutral and W MEs play a key role in the TGD based model of living systems.

What is true that ordinary particles at space-time sheets behave as if they had vanishing weak charges with respect to long range gauge fields. TGD however predicts an entire hierarchy of scaled up variants of standard model physics for which particles have scaled down mass spectrum. Also dark matter hierarchy is predicted: in this case masses remain invariant in the scaling $\hbar \rightarrow \lambda \hbar$, with $\lambda \simeq 2^{11}$ in the physically most interesting situation, but Compton lengths and time and thus sizes of particle space-time sheets are scaled up since they are proportional to \hbar . This makes possible macroscopic quantum phases with light particles carrying weak and color charges. Even ordinary nuclei can carry anomalous weak and thus also em charges. It seems that these exotic weak and em charges could be central for the proper understanding of even ordinary condensed matter physics and in living matter this exotic new physics would be of crucial importance.

Z^0 magnetic field of Earth

Consider first Z^0 magnetic field accompanying the Earth's magnetic field.

1. If non-vacuum extremals with 2-D CP_2 projection are involved the Z^0 field strength satisfies

$$g_Z B_Z = \frac{1}{\frac{3}{4} - \frac{\sin^2(\theta_W)}{2}} eB \simeq \frac{8}{5} \times eB .$$

For $B =_B E Z^0$ magnetic cyclotron frequency scale would be nearly the same as the magnetic one with alpha band map scaled to ~ 16 Hz so that the cyclotron spectrum of exotically ionized nuclei would be in EEG range.

In this case the question arises, whether em or Z^0 flux quantization fixes the area of flux tubes. For a rational value of $\sin^2(\theta_W)$ it is possible to satisfy both flux quantization conditions if the integers characterizing the flux quanta satisfy

$$\frac{n_\gamma}{n_Z} = \frac{Z_\gamma}{Z_Z} \times \left(\frac{3}{4} - \frac{\sin^2(\theta_W)}{2}\right) .$$

2. If vacuum extremals with 2-D CP_2 projection or small perturbations of them are in question the Z^0 field strength satisfies

$$g_Z B_Z = -\frac{2}{\sin^2(\theta_W)} \times eB \simeq 8 \times eB ,$$

so that Z^0 magnetic field would dominate and one might think that Z^0 magnetic flux tubes corresponds to almost vacuum extremals. Also in this case both flux quantization conditions can be applied.

An interesting question is whether the Z^0 magnetic field forced by the CP_2 geometry alone should have as its source rotating exotic particles carrying Z^0 charge. Exotically ionized nuclei are a natural candidate in this respect.

Symmetry considerations favor the assumption that the overall topology of Z^0 magnetic field is essentially the same as that of magnetic field. If some fraction of atomic nuclei are Z^0 ions they can create Z^0 magnetic field, and it is plausible that Earth's Z^0 magnetic field receives a large contribution from the rotational motion of these nuclei so that the Z^0 -magnetic axis would most naturally be the same as the rotation axis of Earth and not same as the axis of magnetic field so that different space-time sheets would be in question. $L(k = 173)$ next to $L(169)$ associated with the Earth's magnetic field is the first guess for the p-adic length scale characterized Z^0 magnetic field of Earth. If almost vacuum extremals are in question, Z^0 cyclotron frequency scale is by a factor $2/16\sin^2(\theta_W) \simeq 1/2$ smaller than the magnetic one.

Are Z^0 magnetic van Allen belts there?

The symmetry between magnetism and Z^0 magnetism would suggest that the Z^0 counterparts of van Allen belts and ring currents are also there and form a controlling part of the Z^0 super-conducting dynamo generating Earth's Z^0 magnetic field. Exotically ionize ordinary ions and atoms would contribute to the Z^0 ring currents. 4He ions are abundant in solar wind and exotically ionized 4He nuclei are of special interest. In particular, tetra-neutron [48, 47] could be interpreted as an exotically ionized He_4^{2+} nucleus carrying two units of Z^0 and em charge in $d\bar{u}$ type color bonds between nucleons [17]. The lifetime of tetra-neutron is about 10^{-7} seconds. A continual ionization of 4He nuclei by dark W MEs would make possible for tetra-neutrons to serve as a source of dark Z^0 magnetic field. The interaction with biosphere could be responsible for the ionization if ring current flows along space-time sheet serving as a magnetic body controlling biosphere.

Also dark variants of elementary particles carrying weak charges could contribute to the ring current. Note that the protonic radiation belt is believed to result through the decay of highly energetic cosmic ray neutrons to protons. Also Sun should have both magnetic and Z^0 magnetic belts controlling to some extent the solar Z^0 magnetic dynamo. As already noticed, the TGD based model for rotating astrophysical objects automatically predicts dynamolike structures. Planetary orbits could carry the ring currents controlling solar magnetic and Z^0 magnetic fields and thus providing a feedback mechanism. Indeed, in the model of the tritium beta decay anomaly one is forced to assume that also Earth's orbit is surrounded by a dark neutrino belt [17].

2.2.3 Observations making bells ringing

Below I summarize some findings which turned out to be very useful in the attempts to understand whether and how magnetosphere could be a self-organizing living system possibly performing also bio-control.

Magnetospheres as self-organizing systems

The view that magnetospheres are self-organizing systems is supported by the observations accumulated about the magnetic self-organization of the solar system during last decades reviewed in [68]. According to this report we are living a period of transition basically due to a penetration of highly charged material from the interstellar space into the interplanetary space from an interstellar plasma structure containing various kinds of magnetic structures.

This energy feed is inducing various kinds of processes affecting not only the atmo-, iono-, and magnetospheres of Earth but also solar and other planetary magnetospheres. Also interplanetary transmitting properties are affected. The Schumacher-Levy comet, which for few years ago collided with Jupiter and among other things a induced plasmoid train and had dramatic effects on Jupiter's magnetosphere, is referred to as a "Comet" SL-9 in [68]. I am not sure whether "Comet" was meant to suggest that SL-9 was actually a plasma magnetic structure from the interstellar space. There is also evidence that we are moving to a similar temperature instability that occurred for 10.000 years ago and which might have initiated the development of the bicameral society in turn leading to the modern society much later.

This process could be also seen as a re-self-organization and evolution of consciousness in solar length scale as a reaction to the encounter of heliospheric and interstellar magnetic intelligences. The penetration of interstellar plasmoid like structures to the interplanetary space through the solar magneto-pause could be interpreted as a failure of the magneto-immune system of the heliomagneto-sphere. The interaction of the planetary magnetospheres with these intelligent (benevolent?) plasmoid like structures would in turn induce the re-self-organization. Needless to say, the interaction of the two intelligences might have far-reaching consequences for the evolution of the ordinary life.

Connection with the Comorosan effect

Comorosan effect means that the irradiation of living manner by visible light over a period which is a multiple of $\tau_C = 5$ seconds implies enhanced catalytic activity [84, 83]. According to private communication, this effect is not restricted to living or even organic matter. TGD explains the effect [27] but the deeper explanation of the time scale of $\tau_C = 5$ seconds has remained a longstanding challenge.

The 5 second time scale associated with Comorosan effect is the spin flip time scale associated with proton's $\Delta n = 1$ cyclotron transition in the field of $B_{end} = 13.32$ nT (which could correspond to the value of $B_E = 5B_{end}/2 = 33.3$ nT in magnetic lobes). τ_C is also associated with proton's $\Delta n = 3$ cyclotron transition and the electronic cyclotron spin flip in the field of $B_{end} = 2/5B_E = 11.2$ nT (plasma sheet).

Lungs contain magnetic particles giving rise to ~ 10 nT magnetic field and thus for $B_{end} = 2B_E/5$ to $n = 3$ protonic cyclotron transitions and electronic cyclotron spin flips in 5.5 second scale, which is very near to τ_C . Perhaps Comorosan effect is used by the outer magnetosphere to affect the behavior of living matter and lungs are involved with this process.

Plasma sheet as a 'microchip'

Plasma sheet should be a seat for magnetospheric sensory representations in theta and delta bands and among other things provide a model of magnetospheric self. If plasma sheet has this kind of role, it should manifest itself in its properties. Plasma sheet should be self-organizing, complex structure rather than system near thermal equilibrium. Plasma sheet is also expected to perform bio-control.

There is a fascinating finding about the 'memory chip' character of the organization of the ionic velocity distribution in the plasma sheet [51]. The belief was that the distribution is a Maxwellian thermal distribution but an complex organization of the number of ions as a function of speed and direction relative to the direction of the local magnetic field has been detected [51]. By coloring the bins representing small volumes of the velocity space, one finds that 3-dimensional features like 'eyes' and 'wings' appear! The proposed interpretation is that these features codes the history of ionic currents. One cannot exclude the possibility that these ionic currents could reflect even our sensory experiences. The prediction is that also other transition regions (in particular magneto-pause) should exhibit similar complex self-organization patterns. The simplest possibility is that the velocity patterns of ordinary electrons reflect the underlying pattern of dark matter at the dark magnetic flux tubes forming perhaps some kind of sensory representations.

2.3 General assumptions about sensory and motor representations

If one believes that magnetosphere is a living organism, the first thing one can do to concretize this belief, is an attempt to generalize the general wisdom about living organisms in the biosphere to the new context. Thus the notions of metabolism, sensory representations, and motor control should have magnetospheric counterparts. This might provide also new views about the physics of magnetosphere. The physics of magnetosphere could also allow to develop new ideas about TGD inspired quantum biology. The fact that also endogenous magnetic fields are of crucial importance for the understanding of ordinary life in TGD framework, means that the basic distinctions might be due to difference between scales.

2.3.1 Magnetosphere as a living organism

Consider now the analogy between biological organisms and magnetosphere in more detail.

1. In the living matter magnetic flux tubes and corresponding supra currents define what might be called magnetic circulation, kind of analog of the blood circulation, along which information and energy is carried by the supra currents. At the quantum level the spatial variation of the phase of the complex order parameter is a correlate for the supra current and the net phase changes around closed loops (say loop around leg) coming as multiples of 2π characterize these currents. One of the earliest TGD inspired ideas about bio-systems was that these almost topological quantum numbers are ideal for the representation of biologically relevant information. Phenomena supporting strongly the existence of this kind of topological quantum numbers are known [45].

Also in the case of magnetosphere similar magnetic circulation should be present and the phase increments around closed loops should represent 'magnetobiological' information. For instance, supra currents could circulate around the plasma sheet and magneto-pause. Since plasma sheet is a self-organizing structure with very complex fractal structure, huge amounts of magnetobiological information could be stored to these supra currents.

2. Magneto-pause would be kind of a magnetic skin insulating the magnetic organism from the interplanetary magnetic field supra currents. Perhaps a similar insulation occurs also in the skin of the biological organisms and prevents the penetration of harmful magnetic fields to the organism. This would mean the flow of supra currents along skin. Typically the current would rotate around, say, leg and there is indeed evidence for the selection rules implied by the topological quantum numbers associated with these kind of supra currents [45]. The recombination of the flux tubes of solar magnetic field with those of Earth at the magneto-pause could give rise to a 'sensory input' from the magnetic skin: certainly solar supra currents carry a lot of negentropy. Polar cusps and caps would play the role of the parts of body which feed in the metabolic input and feed out the metabolic waste.
3. Magnetic Mother Gaia has besides magnetic skin also a material skin, biosphere. Individual organisms would act as sensory receptors. The notion of magnetospheric tactile senses mapping entire biosphere to the magnetosphere seems very natural in the conceptual framework of TGD inspired theory of consciousness.

2.3.2 Magnetospheric nervous system

One could also try to find whether the magnetospheric counterpart of the nervous system might make sense. Of course, one must be very cautious in making this kind of associations. The first thing to notice is that nervous system corresponds to the self-organizing and strongly dissipating parts of organism. In magnetosphere the plasma rich regions certainly satisfy this criterion. The most one can hope is that there is direct mapping between brain structures and magnetosphere such that dominating EEG MEs in brain area project to the corresponding regions of the magnetosphere and define magnetospheric sensory representations there.

1. One function of the nervous system is to build a sensory map of the material world. Thus also the magnetospheric nervous system should process 'sensory' information about biosphere. This fixes naturally the order of the hierarchical structure: the larger the distance from Earth's center, the higher the hierarchy level. This also conforms with the fact that lower frequencies must correspond to the higher levels of self hierarchy.
2. The interpretation for the magnetosphere would be as brains of Mother Gaia receiving sensory input from biosphere with various organisms serving as sensory receptors. Outer magnetosphere would correspond to the highest and most abstract level of information processing contributing also to the brain consciousness via the sharing of mental images. Corresponding magnetic time scales indeed correspond to brain time scales. Self-organization is maximal inside magneto-pause and plasma sheets. Perhaps the identification as the counterpart of the cortex for either or both of these structures is appropriate. Magnetic lobes, analogous to the brain cavities, certainly serve as stores of magnetic energy. The low density of ions and approximate spatial constancy

of the magnetic field means that magnetic lobes are not tailor made for the sensory representations. Day and night sides of the magnetosphere are good candidates for the magnetospheric counterparts of posterior (hind brain) and anterior (frontal lobes) parts of the cortex. It will be found that resonant magnetospheric sensory representations come in two basic types depending on whether the projector MEs from brain project to the same or the opposite side of the globe: the asymmetries between these representations resemble the asymmetries between left and right brain.

3. One can continue with the structural analogies. The inner magnetosphere could correspond to the subcortical regions. The scales for the magnetic transition frequencies suggest that protonic inner belts would perhaps be the counterparts of thalamus and hippocampus: representation of our long term memories could be in question. Electronic inner belt might correspond to cerebellum characterized by higher EEG frequencies. The outer electronic belt could correspond to basal ganglia and limbic brains (note the toruslike topology) and be involved with our imagination and planning of motor actions and also with speech production. Ionosphere, where also the representations based on heavier ions are possible, would correspond to brain stem, spinal chord, and the neuronal level. p-Adic length scale hypothesis and $v = Lf$ scaling law [23] give a rather precise meaning for this correspondence.

Individual organisms could be seen as sensory receptors of Mother Gaia and would be accompanied by their personal sensory magnetic canvases for which magnetic field strengths could be much weaker, and perhaps directed along the direction of the local magnetic field and penetrating to the interplanetary space. The simplest assumption is that the projector MEs to the personal magnetic canvas intersect the flux tubes of Earth's magnetic field and in this manner generate magnetospheric sensory representations which might serve as memory representations.

The analogy with nervous system suggests that there is two-directional information transfer between magnetosphere and ordinary living organisms. Magnetospheric sensory representations and magnetospheric 'motor control' would correspond to this bi-directional information transfer.

2.3.3 Magnetospheric metabolism

Living systems are self-organizing systems in which highly negentropic energy flow enters the system, delivers its negentropy, and leaves the system. Usually only the negentropy of the solar radiation is considered as important. If magnetosphere is a living organism, also the negentropy feed by the ionic supra-currents flowing along the magnetic flux tubes of the solar magnetic field should play a key role.

Plants get their ordered energy directly from solar radiation via photosynthesis. Magnetosphere would in turn receive its energy and negentropy by breathing solar wind. The flow of ordered energy would enter via the polar cusps and magneto-pause via the leakage of the magnetic flux tubes of solar magnetic field to the magnetic lobes followed by a recombination with the flux tubes of Earth's magnetic field. Magnetic lobes might be seen as reservoirs of magnetic energy and information resulting from the 'sensory' input from solar wind and from Earth.

Magnetic storms transfer this energy along the plasma sheet down to radiation belts during magnetic storms and sub-storms. The incoming ionic flux should flow out back to the interplanetary space somewhere. A good guess is that inertia forces the leakage of the supra current to a larger space-time sheet at the highly curved tips of the outer radiation belts dipped towards the polar caps, and the ions leak out to the interplanetary space along larger space-time sheet as Ohmic currents. The radiation observed instrumentally at the polar caps could result in this process. The energy vacuum zero point energy liberated in the process is about $E_0 = \pi^2/md^2$, where d is the thickness of the magnetic flux tube determined by the flux quantization. This corresponds to energy of about 2×10^{-9} eV which is very small as compared to the energy of the ion.

The energy feed is utilized to pay the energy bills of the dissipative ionic flow along the plasma sheet towards radiation belts and of the dissipative ring currents participating to the control of Earth's magnetic field by super-conducting dynamo mechanism. Also the ionic current flowing along circular flux tubes of the magneto-pause needed to build the magnetic field inside magneto-tail uses the energy of the solar wind. These circulating currents could be supra currents flowing along magnetic flux tubes which correspond to some other, presumably longer p-adic length scale so that that the magnetic field would be weaker.

2.3.4 General ideas about sensory representations

Consider first what the minimal assumptions relating to the sensory representations might be.

Two basic types of representations

The crucial assumption is that neither ionosphere nor Earth's surface can serve as a Faraday cage for the MEs nor for the magnetic flux tubes possibly involved. This is as it should be if the notion of many-sheeted space-time concept makes sense. If this assumption fails, a person in Faraday cage would lose most of the contents of consciousness. This prediction is testable and there are claims that the ELF radiation in alpha band can penetrate Faraday cage (the work of Dr. Andre Puharich): unfortunately, it is not clear to me whether these stories are only modern city folklore or not.

1. Personal representations

The magnetic body consisting of vertical magnetic flux tubes associated with brain and body could serve as a personal magnetic sensory and motor canvas. Since the flux tubes of Earth's magnetic field emerge from the surface of Earth almost vertically, vertical flux tube structures could emerge as structures locally parallel to local Earth's magnetic field from the brain and body. These structures cannot however coincide with the field structures or Earth and flux tubes carrying magnetic field much weaker than Earth's magnetic field could be involved. For instance, eye contains static field of about 10 pT and the magnetic particles of lungs give rise to magnetic fields of order 10 nT. Also brain contains magnetic particles and they presumably give rise to net static magnetic field besides taking care that sensory projectors are oriented parallel to magnetic field and thus define a fixed coordinate frame for the sensory representations.

Ordinary magnetic fields with these typical intensities could be accompanied by dark magnetic fields satisfying $B_{end} = 2B/5$ and corresponding to $n = 5$ length of dark matter having flux tube radii scaled up by factor $n = 5$ and perhaps making possible topological quantum computation in some sense [25].

The transversal surface area (thickness) of the magnetic flux tube would code for the distance of the perceptive field or, more generally, some geometric property of a feature. The magnetic structures associated with pyramidal cells and red blood cells could anchor the coordinate frame for the sensory representations to the coordinate frame defined by the directions of Earth's magnetic and gravitational fields. Somehow the orientation of the ME projectors must be anchored to this frame and vertical flux tube structures might allow to achieve this anchoring. The cellular magnetic dipoles should be parallel to the local Earth's magnetic field which suggests that vertical magnetic fields might have different origin.

2. Magnetospheric representations

Is the notion of personal magnetic sensory canvas necessary? One could consider also the possibility that everything is represented on the flux tubes structures of Earth's magnetic (and Z^0 magnetic) field.

1. If only the magnetic flux tube structures are used so that sensory representations mean sharing of the brainy mental image with the mental image of Mother Gaia about position, one ends up with problems relating to space traveller consciousness. For instance, the nearby magnetic field around the moon traveller should differ dramatically from that at the surface of Earth so that contents of consciousness should change dramatically. This is not the case. Thus it seems that personal sensory magnetic canvas is there and codes at least for the sensory experience. Magnetic Mother Gaia could however contribute to various third person aspects of consciousness and also to memory.
2. TGD based explanation of near death experiences supports the notion of magnetic body remaining after the 'physical death' and this body could correspond to the vertical magnetic flux tube structure or part of the magnetospheric sensory canvas.
3. Vertical magnetic flux tubes would also make possible a direct interaction between brain and Earth's magnetic field. Sharing and fusion of our mental images and the mental images of Mother Gaia becomes possible. In particular, supra currents could flow between magnetic sensory canvas of Mother Gaia and brain and allow the control of organisms.

Thus it would seem that it is best to be as general as possible. Personal magnetic canvases should be there but also Mother Gaia is interested about what happens in our brain and contributes to our consciousness by the sharing of mental images.

Place coding

Place coding is one of the key ideas of TGD based theory of sensory and motor representations. Place coding relies on the observation that the local strength of the magnetic field determines which em frequency induces magnetic transitions of the super-conducting particles residing at a given distance along the magnetic flux tube having a varying thickness. Therefore it becomes possible to code geometric information to frequency and translate it to a distance along the magnetic flux tube. Thus the requirement that endogenous frequency equals to the magnetic transition frequency determines a two-dimensional surface of the magnetosphere and in the case of personal sensory canvas point of the magnetic flux tube.

Endogenous cyclotron frequency f_c corresponds to ME with length which is multiple of the minimal length $L = c/f_c$, $f_c = qB/2\pi m$, where q and m are the charge and mass of the charge carrier. If this length equals to the distance from brain to the point of the sensory canvas, ME acts as a waveguide amplifying the signal. This condition is very stringent and in the case of magnetosphere allows only one-dimensional curves as its solution. In the case of the personal sensory canvas $S \propto L$ condition for the transversal area S of the magnetic flux tube as function of its length L guarantees resonance condition. In the case of magnetic mirrors, a further amplification results from the TGD counterparts of Alfvén waves representing oscillations of the magnetic flux tube and satisfying the dispersion relation $f_n = nc/2L$.

One must however notice the possibility that ME (and corresponding parallel magnetic flux tube in the case of a magnetic mirror) only intersects Earth's magnetic flux tube rather than ending to it. In the case of ULF frequencies associated as magnetic transition frequencies with the magnetic lobes carrying very weak magnetic fields one must indeed assume that MEs can be much longer than the distance from Earth to the activated point of the sensory canvas. Meteor sounds provide support for the existence for MEs having length $\lambda = c/f$, $f \sim 40$ Hz.

1. Place coding for features inside brain

The presence of endogenous magnetic fields giving rise to a magnetic circulation analogous to blood circulation is assumed. The strength of the endogenous magnetic field must be near to that of Earth's magnetic field. Endogenous place coding of the features by magnetic flux tube thickness is assumed and there is evidence for this [87]. The genetically coded magnetic crystals inside pyramidal neurons and haemoglobin molecules could serve as sources of magnetic fields. If endogenous magnetic fields result from the self-organization of Earth's magnetic field, one can understand why the flux quanta of the complex endogenous magnetic fields have approximately the same thickness as those of Earth's magnetic field.

2. Place coding at the personal magnetic sensory canvas

The simplest hypothesis is that personal magnetic canvas consists of a magnetic flux tube bundle defining an almost vertical cone and that each straight flux tube is accompanied by a parallel ME. This structure will be referred to as magnetic mirror with the understanding that the ends of ME intersecting the magnetic flux tube define the mirrors. A ME of length L acts naturally as a wave guide amplifying frequencies, which come as harmonics of the fundamental frequency $f = c/L$ (whether also $f = c/2L$ might be considered: this depends on the boundary conditions).

ME could intersect the flux tube at any point of the tube. Alfvén waves [60] correspond in TGD framework to oscillations of magnetic flux tubes and have spectrum $f_n = nc/2L$ for fluxtube length L . More general types of Alfvén waves result if the magnetic flux tube has some kind discontinuity or sharp gradient in which Alfvén waves are reflected. The intersection of ME with flux tube (this is the optimal situation) or a highly curved portion of the magnetic flux tube could serve as this kind of discontinuity. Alfvén waves or reflected Alfvén waves can resonantly amplify the wave propagating inside ME.

Since magnetic flux is quantized, the average intensity of the magnetic field inside the flux tube is proportional to its transverse area S . Place coding by magnetic transition frequencies is achieved if the transverse area S of the flux tube is proportional to the distance L along the tube: $S \propto L$.

This law can obviously hold true only above some threshold distance L_{min} . An explicit form of the resonance condition reads as

$$\begin{aligned} f &= \frac{c}{L} = f_m = \frac{keB}{m} = f_m^{max} \frac{S_{min}}{S} \quad , \\ f_m^{max} &= \frac{keB_{max}}{m} \quad . \end{aligned} \quad (2.3.1)$$

Here k is a numerical constant characterizing the particular magnetic transition frequency and f_m^{max} is the maximum value of the endogenous frequency and S_{min} corresponding flux tube thickness. This implies

$$L = \frac{c}{f_m^{max}} \frac{S}{S_e} = \frac{m}{keB_{max}} \frac{S}{S_{min}} \quad . \quad (2.3.2)$$

For $L > L_{min}$ the surface of the flux tube is paraboloid. Note that there is separate flux tube for each kind of magnetic transition frequency, in particular for each ion. Harmonics of a given cyclotron frequency can be however coded by the harmonics of the fundamental frequency ME.

Certain findings about the imprinting of water frequencies [68] can be understood if the endogenous magnetic flux tubes satisfy the $L \propto S$ law [18]. Among other things this law also implies that the energy density of the magnetic field per unit length is constant: this is very natural in equilibrium situation.

MEs need not be straight cylinder like structures: the general solution ansatz allows also curved MEs but it is not clear whether any curved magnetic flux tube could form a magnetic mirror with a parallel ME. The magnetic flux tubes associated with the personal magnetic canvas need not be (only) those of Earth's magnetic field and the entire p-adic length scale hierarchy might be involved. For instance, the static magnetic field associated with eye is about 10 pT and corresponds to electronic cyclotron period about 8.87 seconds. If head is accompanied by a magnetic flux tube of thickness of order 8 cm, flux quantization implies that the corresponding electronic cyclotron time is of order 30 minutes.

3. Place coding for magnetospheric representations

In the case of magnetospheric representations analogous place coding can be assumed for the distances of the objects of the perceptive field and translates the distance to a cyclotron frequency scale defined by Earth's magnetic field. The thickness for the magnetic flux tube of Earth's magnetic field, varying as $(r/R)^{3/2}$ in dipole approximation, provides the place coding for the the distance of an object of perceptive field. EEG ME with ionic cyclotron frequency generates cyclotron transition at the magnetic flux tube of Earth and is assumed to create sensory self representing experienced position ('feeling of existence') entangled with various sub-selves of brain representing 'features'. This can be also interpreted as a sharing and fusion of mental images: one of them possessed by the 'magnetic Mother Gaia' and the second one by the organism.

In the simplest model EEG MEs generate magnetic transitions at magnetic flux tubes amplified to quantum phase transitions at and in this manner give rise to the sensory and other representations.

4. How projector EEG MEs are generated?

EEG MEs are generated by the dropping of ions from the atomic (or some larger) space-time sheets to the magnetic flux tubes of endogenous magnetic fields having roughly the same strength as Earth's magnetic field. The dropping ion enters into a cyclotron state with a high value of magnetic quantum number n , and this state decays by emitting ELF radiation at multiples of the cyclotron frequency. These ELF photons or ELF em fields in turn can induce magnetic transitions at the magnetic flux tubes of the appropriate magnetic structure.

This mechanism need not be realized only at the level of brain. Also the plasma rich transition regions of the magnetosphere having interpretation as magnetospheric counterparts of brain structures could communicate with other similar regions by the same mechanism. What is needed is that the plasma ions return to high n cyclotron state at the magnetic flux tube, which then decays by emitting cyclotron radiation having MEs are topological correlate. Magneto-pause, plasma sheet, the transition region between inner and outer magnetospheres, and radiation belts are especially natural candidates for regions communicating in this manner.

Hierarchy and modularity of representations

An entire hierarchy of sensory representations is predicted. Scaling law states that there is a mapping of brainy p-adic length scales L to much longer p-adic length scales $L_{EEG} = \lambda_{EEG} = (c/v) \times L$, where v is the typical conduction velocity for nerve pulses [23]. The interpretation is that there is a physical mechanism transforming of EEG frequencies to much higher endogenous frequencies

$$f_h = c/L = (c/v)f_{EEG} \quad , \quad (2.3.3)$$

and vice versa [32].

Quantum entanglement between different levels of the hierarchy makes possible modularity. The features assigned by quantum entanglement to a given point of the sensory canvas at given level can be representations realized at some lower level canvas. For instance, simple geometric features like triangles and circles could be represented at lower level canvas and associated with a point of higher level sensory canvas by quantum entanglement.

Similar hierarchical structure and modularity is expected to hold true for the representations at the magnetospheric sensory canvas. This applies also to the motor representations. This means modulation hierarchy. The lower level in the hierarchy adds kind of a ripple to the long wave length representation at the higher level. This applies also in the temporal domain. Thus rough control commands from higher level are gradually detailed at the lower levels (motor action as carving of 4-dimensional statue by adding gradually increasingly finer details).

Also Z^0 magnetospheric representations could be there

Z^0 magnetic fields are crucial in the model of hearing and the memetic code believed to be behind the spoken language [32]. Cognitive neutrinos pairs could provide one realization of the memetic code [32]. Most importantly, classical Z^0 force could be strong in the biologically most relevant length scales. Indeed, the p-adic length scales corresponding to $k = 151, 157, 163, 167$ are in the range 10-2500 nm. These primes correspond to Gaussian Mersennes $(1+i)^k - 1$ and are excellent candidates for defining p-adic lengths scales associated with scaled down fractal copies of standard model physics. The reason is that the known smaller Mersennes and Gaussian Mersennes correspond to physically important length scales in the hitherto studied energy range (below TeV energies).

The work of Shnoll [46] demonstrates a correlation between fluctuations of radioactive and biological rates and astrophysical periods. This encourages to think that quantum communications *resp.* control based on Z^0 *resp.* W MEs could be present also at the level of solar system and even longer length scales. The interpretation would be in terms of dark variants of weak bosons having very low masses.

2.3.5 What brain structure and fractality teaches about magnetospheric motor control?

The first bundle of questions relates to the idea that brain structure and fractality could teach something about magnetospheric motor control (and perhaps also vice versa!).

Can one identify magnetospheric motor and sensory areas?

The mapping of the brain structure to that of magnetosphere to be discussed later in detail leads to the conclusion that day side outer magnetosphere very naturally corresponds to hind brain containing associated sensory areas whereas night side outer magnetosphere would correspond to frontal brain containing associative motor areas and association regions for high level planning. For the inner magnetosphere the only sensible option is that the representations at the same side of the globe correspond to sensory areas (otherwise one cannot realize 40 Hz sensory representations): those at the opposite side of the globe could, but need, not to correspond to motor areas. Right and left brain hemisphere in turn correspond to northern and southern magnetohemispheres.

The example of brain suggests that the lowest motor and sensory areas are relatively hard wired. The higher areas responsible for the imagination and planning of the motor action should be less hard wired. Thus the areas responsible for planning imagination should be initial value sensitive and near

to criticality. This would suggest that in the case of magnetosphere transition regions are the regions which are most natural candidates for sensory and motor areas. Bow shock, magneto-pause, plasma sheet, the transition region between inner and outer magnetosphere, and inner and outer radiation belts are good candidates for this kind of regions. Inner and outer radiation belts and the transition region between inner and outer magnetosphere could correspond to primary, secondary and tertiary sensory and motor areas whereas magneto-pause would correspond to sensory and motor associative regions. Even bow shock might be involved.

The magnetosphere of Earth is part of the solar magnetosphere and if helio-magnetosphere controls the behavior of the planetary magnetospheres, it must use those parts of the planetary magnetospheres which it can affect. Note that the effect of the solar spot activity on the human sensory consciousness (complex hallucinations) could be understood as being partially due to the effect of the solar wind on the day side magneto-pause, which is the counterpart of the sensory associative areas.

How do the magnetospheric structures communicate?

Ionic supra currents are the most obvious means of communication and would be counterpart for the corresponding communications at the level of brain a la TGD. Also Ohmic ionic currents in plasma rich regions (the current along plasma sheet down to ionosphere, ring currents,...).

The topology of Earth's magnetic field provides a good overall view about the 'neural circuitry' of Mother Gaia. There are ionic supra currents flowing along magnetic flux tubes around magnetosphere, both inner and outer. In the case of magnetic lobe, which seems to extend to the distance $10^3 R$ these currents are also present. Radiation belts contain besides ring currents also ionic supra currents running back and forth along magnetic flux tubes. Josephson junctions between magnetic flux tubes might be an overall important aspect of the communications.

There are also currents associated with the transition regions where the tangential component of the magnetic field changes (magneto-pause, transition region between inner and outer magnetosphere, the boundary of the plasma sheet,...) running along the transition surface and orthogonal to the discontinuity of the magnetic field. These currents might be also supra currents and make possible horizontal communications inside these structures (magneto-pause would be the counterpart of associative regions) analogous to the horizontal neural communications inside regions of brain.

The regions of magnetosphere could communicate also by ME projectors. Also resonance is possible. For instance, the day side magneto-pause (associative sensory regions) and night side magneto-pause (associative motor regions) could communicate by projector MEs associated with the protonic cyclotron transitions and electronic spin flip transition.

What is the counterpart of the thalamocortical circuitry?

One can also make questions about the counterpart of the thalamocortical resonance circuitry.

1. Inner and outer radiation belts turn out to be the magnetospheric counterparts of the primary and secondary sensory (same side of the globe) and motor (opposite side of the globe) areas in the mapping of the brain structures to magnetospheric structures. If the magnetic flux tubes of Earth emanate also from brains as they should do, a direct interaction with brain with the mediation of the supra currents becomes possible. Second form of control is based on ME projectors, in particular Z^0 MEs.
2. Radiation belts do not only serve as radiation shield but would control the super-conducting dynamo generating magnetosphere. Since radiation belts are strongly affected by cosmic rays and solar wind, they indeed serve as kind of motor organ in very general sense. During solar storms the ionic supra currents running back and forth in radiation belts can leak from the magnetic bottle and end up to the the super-conducting dynamo in Earth interior and thus modify the strength of magnetic field. This control would be the magnetospheric counterpart of long term control of brain upon itself changing the very structure of brain.
3. Earth's inner core takes the role of thalamus in the mapping between brain and magnetospheric structures. This would suggest that Earth's inner core serves as a relay station through which the ionic supra currents run between regions of magnetospheric brain. Thalamocortical feedback suggests a strong feedback from radiation belts to magnetospheric thalamus and the dipole

structure of the magnetic field guarantees this. This would however require that the superconducting ions can leak from the magnetic bottle formed by the increasing strength of the magnetic field inside magnetic tube toward northern and southern latitudes. Classically this is achieved if the longitudinal kinetic energy of the charged particle is high enough so that it is not completely transformed to the energy of the transversal motion before entering into the core. It is known that the ions can have much higher energies than expected [58].

2.3.6 Do the structures of nervous system and magnetosphere correspond to each other fractally?

Control levels corresponding to magnetic and Z^0 magnetic transition frequencies varying up to the time scale of life cycle might be present and correspond to a hierarchy of motor canvases. If this is the case, the hierarchy would continue to the length scale of light life. Z^0 magnetic structures more or less resembling magnetic ones could be responsible for the hierarchy of motor canvases whereas magnetic structures could represent sensory canvases. The resonance condition $f = c/L$ fixes the representational hierarchy practically completely by telling the distance at which given frequency is representable resonantly.

The correspondence between sensory areas and the periods of the periodic table follows from the p-adic length scale hypothesis and $v = Lf$ scaling law [32]. The model for the magnetospheric sensory canvas gives hopes of understanding this hierarchy at a deeper level, and leads to a general vision about how sensory experience, memory, and imagination correlate with the structure of the magnetosphere.

It must be emphasized that sensory representations of magnetic Mother Gaia are in question: these representations might however be behind our memories and imagination. These representations could result as a by-product of the representations at personal sensory canvas and magnetosphere. The best one can hope that there is a detailed correspondence between brain structures and those of magnetosphere induced by the projector MEs associated with the personal sensory canvas.

Representations in the ionosphere

For the representations in the lower ionosphere the transition frequencies would not differ appreciably from those at the surface of Earth and the representing ion could be same as the endogenous ion. 10 per cent variation for the endogenous transition frequency would mean variation of 3.3 per cent for distance so that the representations using same ions would make sense up from $1.01R$ to $1.04R$ which means the height interval 80-190 km (note that the lower boundary of ionosphere is at about 80 km). Endogenous magnetic field should be at least about 1 percent lower than the external magnetic field to guarantee that representation is above 80 km. Distance condition cannot be satisfied for these representations if one assumes that MEs have length equal to the distance from the representation point.

These representations would correspond to the lowest level representations associated with neurons, spine, and brain stem, which have emerged first during the evolution and should emerge first also during the development of individual. Also features could be represented using these low level sensory canvases and entangled to the points of the higher level sensory canvases.

At higher heights the representations with $A_I < A$ are in principle possible and could form a hierarchy. At $r = 2R$ representing the upper boundary of ionosphere protonic cyclotron frequency is 37.5 Hz. ${}^4\text{He}^+$ ion would have cyclotron frequency about 12 Hz at this height. Rather remarkably, thalamocortical resonance frequency corresponds to the protonic radiation belt where the density of ions is high and representation should be intense.

Inner magnetosphere does not allow representations in theta and delta bands

The resonance condition $f = c/L$ stating that ME acts as a resonant wave, when applied at the boundaries of the inner magnetosphere ($4R$ at day side and $6R$ at night side), implies the lower bound 12.5 Hz *resp* 8.1 Hz for the frequencies representable at day side *resp* night side. The conclusion is that in day side only beta and gamma bands are representable whereas night side allows also alpha band. This representation independent prediction is of utmost importance since at least our sensory and cognitive consciousness involves mostly beta and gamma bands and during sleep and meditative states theta and delta bands dominate.

One could also wonder whether the first person aspect of consciousness corresponds to the inner magnetosphere rotating with Earth and whether transpersonal consciousness (me experienced from third person perspective as in OBE experiences) could correspond to the outer magnetosphere (which does not rotate with Earth) plus plasma sheet. The frequencies near Schumann frequency would be at the boundary of these two modes of consciousness. During hypnagogy which is between these two modes, Schumann frequency indeed dominates EEG.

Protonic cyclotron transitions represent resonantly in the range 12.5 – 100 Hz (note that the upper bound corresponds to the highest EEG frequencies) and maximum protonic flux in the protonic radiation belt corresponds to frequencies around 40 Hz thalamocortical resonance band. The representation at the same side of the globe would be responsible for immediate sensory memories and the representation at the opposite side of the globe for symbolic, more long term memories. Also electronic spin flip represents: the maximum of the electron density in the outer radiation belt corresponds roughly to 12.5 Hz frequency. The deviation of the magnetic field from the exact dipole form modifies this prediction somewhat. Electronic Z^0 spin flip frequency varies in the range 9.4 – 25.0 Hz and could represent symbolically motor skills (opposite side of the globe and alpha band) and motor imagination occurring in a shorter time scale (the same side of the globe and beta band).

Plasma sheet and magneto-pause and consciousness in theta and delta bands

Because of their highly unstable character, both plasma sheet and magneto-pause accompanied by plasma mantle might be seats of the magnetospheric imagination and very high level bio-control realized using protons and electrons. Plasma sheet might also receive sensory input from the magneto-pause.

Ionic density is a direct measure for the intensity of the contribution to the conscious experience coming from given region of space and this is a natural criterion when one tries to understand the possible roles of various magnetospheric structures for consciousness. Plasma sheet [62] indeed contains a high density of ions and thus could act as a layer of effectively two-dimensional computer screens of thickness of order R . In this region the intensity of magnetic field transforms from 10 nT to about 20 nT inside lobe immediately above plasma sheet. According to some sources the value of the magnetic field is 30 nT inside the lobe: this might hold true in nearby region. The structure suggests a sensory or a motor representation in which the vertical distance from the sheet represents the distance for the object of perceptible field.

The resonance condition $f = c/L$ (higher harmonics of fundamental frequency for ME are not allowed) implies that only frequencies from 8.1 Hz down to .8 Hz, that is theta and delta band, can be represented in plasma sheet whereas alpha, beta and gamma bands would be represented in the inner magnetosphere at the night side. At the day side only beta and gamma bands are representable. The higher harmonics of protonic cyclotron frequencies make it possible to satisfy this condition in the plasma sheet (the distance of the representing surface varies as $r/R \propto 1/n$). Various cyclotron harmonics would be nicely ordered along the plasma sheet. Similar conclusion holds true in the case of magneto-pause. Also electronic cyclotron spin flip frequency provides single representation.

The harmonics of the electronic Z^0 cyclotron frequency provide representations in this region. The time scale is very slow: roughly Z^0 representation could be responsible for high level motor control, perhaps for learned motor skills.

The electronic cyclotron spin flip frequency would be of order 1 cycle per 5 seconds whereas protonic cyclotron frequency would be 1 cycle per 15 seconds. 5 second time scale is involved with Comorosan effect. Furthermore, a 5 second delay that has been observed between the onset of a 1 to 2 mT magnetic field (about 40 times stronger than Earth's magnetic field) and the first bursts of brain activity responding to the magnetic field (Science 260 (11 June 1993),1590). A further fascinating observation to be discussed later is that plasma sheet is a highly self-organizing structure containing 'features' like 'eyes' and 'wings' [51].

For 10 nT magnetic field the cyclotron time scale is 16.7 seconds for protonic cyclotron transitions and 8.9 ms (112 Hz) for electronic cyclotron transitions. For the latter time scale resonant amplification is not possible. For Z^0 magnetic lobes cyclotron time scales are scaled up by a factor 800 to 3.7 hours and 7.1 seconds for proton and electron respectively. For electron higher harmonics allow to satisfy the resonance condition.

For endogenous Z^0 magnetic field the transition frequencies are around 10 Hz for all atoms and molecules except hydrogen atom and much higher than Z^0 cyclotron frequencies in the magneto-

pause and plasma sheet. Z^0 motor control from the magneto-pause is possible if Z^0 MEs generate endogenous sound waves by Z^0 piezoelectric effect, which in turn are transformed to electromagnetic oscillations via the ordinary piezoelectric effect.

In light of these arguments, the idea that plasma sheet and magneto-pause could contribute to our consciousness via the sharing of mental images might make sense. More detailed developments inspire a very concrete mapping between brain structures and magnetospheric structures and plasma sheet corresponds in this mapping to the magnetospheric self model located in insula whereas day side and night side magneto-pauses correspond to sensory and motor association regions. By the sharing of mental images also our self models are represented at plasma sheet.

Are magnetic lobes, magnetosheath, and solar magnetosphere involved?

The density in magnetic lobes is about .01 ions per cubic centimeter so that these regions are analogous to the brain cavities containing white matter. Thus one might think they do not give a significant contribution to our everyday consciousness. In TGD framework however also blood cells are excellent candidates for defining sensory representations and this contribution to consciousness would correspond to the bodily 'what it feels' consciousness (proprioception) whereas neuronal consciousness would represent the world as experienced from outside (seen and heard). Magnetic lobes and more generally, all regions of the magnetosphere outside the transition regions, are good candidates for this kind of sensory and motor representations.

According to [54] the asymptotic value of magnetic field (outside plasma sheet, $r \geq 100R$) in lobes is 9.2 nT. Second reference [68] reports 30 nT magnetic field in magnetic fields and presumably refers to region $r < 60R$. The scale of frequencies is same as in plasma sheet and magneto-pause so that the conclusions of the previous section apply.

Despite the low density of protons, the representations based on the harmonics of the cyclotron frequency are in principle possible also inside lobes and the low intensity of experience might explain why proprioception is an almost unconscious sense. The harmonics of the protonic cyclotron frequency define a sequence of representation surfaces inside lobes. These representations result naturally if the projector MEs associated with the personal sensory canvases intersect the magnetic flux tubes. The endogenous magnetic transition frequencies would be associated with heavier molecules with mass numbers around $A \sim 1500$. If magnetic lobes contribute to our consciousness, they contribute most probably to consciousness in meditative states. In certain sense 'cosmic' consciousness would be in question. The control from this level could be bio-control rather than control of the behavior of an individual organism at conscious level.

In magnetosheath and solar magnetosphere the density of the ions is few ions per cubic centimeter and thus much higher than inside magnetic lobes so that they are better candidates for the seats of sensory representations. Possible are also the representations at the flux tubes of the interplanetary magnetic field, where the density of ions is few ions per cubic centimeter and thus much higher than inside magnetic lobes.

2.4 Resonant representations

In this section magnetospheric representations satisfying some kind of resonance condition are studied. One can imagine several resonance mechanisms.

1. The first representation is based on the requirement that ME has length equal to the wavelength corresponding to the magnetic transition frequency so that ME acts as a wave cavity.
2. In the case of magnetic mirror Alfvén waves associated with the magnetic flux tube parallel to ME could provide an additional resonant amplification.
3. The second representation utilizes cavity resonances (in particular Schumann resonances). Even the representations at personal magnetic canvas could utilize this mechanism if personal projector MEs intersect the magnetic flux tubes of Earth's magnetic field.
4. Also spherics associated with lightnings might act as amplifiers.

2.4.1 Hierarchy of sensory representations at magnetic Mother Gaia

In principle the cyclotron transitions of a given ion with mass number A in brain could be represented as transitions of any lighter ion with mass number A_I carried by magnetic flux tubes of Earth's magnetic field. Thus one obtains a hierarchy of representations labelled by the pairs (A, A_I) , $A_I \leq A$.

1. The magnetic sensory canvas defined by Earth's magnetic field contains certainly protons. The requirement that the ionic cyclotron frequency f_p/A in brain equals to the protonic cyclotron frequency f_p at the magnetic flux tube of Earth's magnetic field at distance r gives in dipole approximation (implying $1/r^3$ behavior) the constraint

$$\begin{aligned} \frac{r}{R} &= KF(\Theta, \theta) , \\ F &= \left[\frac{\sqrt{1 - 6\cos(\Theta) + 9\cos^2(\Theta)}}{\sqrt{1 - 6\cos(\theta) + 9\cos^2(\theta)}} \right]^{1/3} , \\ K &= A^{1/3} . \end{aligned} \tag{2.4.1}$$

The angle dependent factor $F(\Theta, \theta)$, where θ denotes the polar angle for brain and Θ for the point of magnetosphere, comes from polar angle dependence of the magnetic field. $F(\theta, \Theta)$ varies in the range $[1/2, 2]$. The sensory canvases associated with heavier ions are farther away. For $\theta = \Theta$ (vertical projection) one has $r/R = A^{1/3}$ and $A = 20$ gives $r/R \simeq 2.1$ and $A = 100$ gives $r/R \sim 4.6$.

2. The magnetic flux tubes containing electrons provide second very natural sensory representation. The formula for the distance reads now as

$$K = (m_p/me)^{1/3} A^{1/3} . \tag{2.4.2}$$

3. Any ion can serve as a representative ion at the sensory canvas and the distance is in general case given by given by

$$K = (A/A_I)^{1/3} . \tag{2.4.3}$$

The higher the mass number of representing ion at the canvas, the shorter is the distance to the canvas. The increase of the mass of the 'brainy' ion means the increase of the distance of the representation.

4. The endogenous variation of flux tube thickness and the deviation of Earth's magnetic field from the exact dipole form implies the generalization of the formula

$$\frac{r}{R} = K \times (B_e/B(r, \Theta))^{1/3} . \tag{2.4.4}$$

Here $B_e \sim .5$ Gauss denotes the endogenous value of the Earth's magnetic field whose variation is essential for the frequency coding. $B(r, \Theta)$ denotes the value of the Earth's magnetic field at given point of magnetic flux tube. B_e must be distinguished from dark magnetic field $B_{end} = 2B_E/5 = .2$ Gauss used to explain the findings of Blackman and others. The simplest assumption is that the condition $B_{end}/B_E = 2/5$ is satisfied quite generally in magnetosphere.

5. Even the ions of macromolecules could drop on the magnetic flux tubes of the endogenous magnetic field so that one could have an onion like hierarchy of sensory canvases labelled by the atomic weight A of the ion. Cellular size is certainly the upper bound for the size of the ionized structure and for water density this would give the upper bound $r/R < 10^4 \times R \sim 10^{10}$ meters in protonic case, and $r/R < 10^{11}$ meters in electronic case, approximately the size of the solar system. Small variations of the ionic cyclotron frequency in brain correspond to the small variations of radial distance at the magnetic sensory magnetic canvas.
6. If one does not allow overlap of the regions of magnetic sensory canvases associated with different ions in brain (mass number A) one must have

$$\frac{B_{min}}{B_0} \geq \frac{A}{A+1} \quad \text{or} \quad \frac{B_0}{B_{max}} \geq \frac{A}{A+1} \quad . \quad (2.4.5)$$

For large values of $A \sim 100$ this allows one percent variation of cyclotron frequency scale. Actually larger variation is possible since only biologically important ions are involved with the sensory representations.

2.4.2 Endogenous frequency fixes the representation sphere

The elegance of the place coding by magnetic transition frequency is that the excitation of the frequency corresponding to a given distance automatically stimulates magnetic transition at a correct distance at the sensory canvas. There is only weak dependence on the position of the observer at the surface of Earth even when some fixed structure, say magnetosphere is used to realize the sensory representations. Given frequency determines for given brain a two-dimensional surface (kind of computer screen) of magnetosphere, actually two of them corresponding to different sides of Earth. In some cases the number of this kind of surfaces might be larger.

A given endogenous cyclotron frequency

$$f_m = k \frac{eB_{end}}{m} \quad , \quad (2.4.6)$$

where k is a numerical constant, in turn defines a 2-dimensional surface. The harmonics of endogenous cyclotron frequency define a sequence of surfaces with increasing sizes. In the dipole approximation

$$\bar{B} = B(R, \phi = \pi/2) \times \frac{R^3}{r^3} (\bar{e}_z - 3\cos(\Theta)\bar{e}_r) \quad , \quad (2.4.7)$$

the harmonics of the cyclotron frequency this sequence is given by

$$\frac{ke}{m} B(R, \pi/2) \times \frac{R^3}{r^3} \times \sqrt{1 - 6\cos(\Theta) + 9\cos^2(\Theta)} = f_{end} = n f_m \quad , \quad (2.4.8)$$

which are obtained by the scaling $r \rightarrow n^{-1/3}r$ from $n = n_{min}$ surface. This scaling property holds quite generally and for transitions involving spin flip the scaling factor changes from $n^{-1/3}$ to $(n + \Delta)^{-1/3}$. The distance between subsequent surfaces behaves as $1/n^{4/3}$ and becomes small for large values of n . Note however that finite range $[n_{min}, n_{max}]$ of values for n is possible By varying the endogenous magnetic field the scale of the cyclotron frequency can be varied.

In magnetic lobes and plasma sheet the dipole approximation fails badly. Inside plasma sheet the representing surfaces are in a good approximation sheets parallel to plasma sheet. Magnetic field strength varies B_E from ~ 10 nT to ~ 20 nT from the interior of sheet to the exterior of sheet so that one octave of frequencies is still representable also for B_{end} by the basic assumptions. These sheets appear as northern-southern degenerate pairs. This brings in mind the left-right degeneracy of the sensory representations at the level of brain. The hypothesis that left and right brain hemispheres project to opposite magneto-hemispheres is at least worth of studying. Resonance at the fundamental

frequency of the projector ME is possible only if the representation is realized at very long distance: for an electronic cyclotron spin flip the resonance distance would be $272R$ and for proton cyclotron resonance $817R$.

Note that also the representations below Earth's surface must be considered since projector MEs should be able to penetrate the Faraday cage defined by Earth's surface (the cage is associated with atomic space-time sheets only). These high frequency representations might be also relevant.

2.4.3 Projector MEs as wave cavities

EEG contains several resonances frequencies and the most natural explanation for them is as resonances in a wave cavity defined by ME having length equal to the resonance wavelength defined by the endogenous magnetic transition frequency. The nice aspect of this representation is the possibility of resonant amplification of the EEG signal.

Resonance conditions

Projector MEs could be reflected from the flux tubes of Earth's magnetic field at distance L , which at resonance of n :th order is integer multiple nL_m of the magnetic transition length $L_m = c/f_m$, where f_m represents a variable endogenous magnetic transition frequency:

$$L = nL_m = \frac{c}{f_m} . \quad (2.4.9)$$

Thus the sensory canvas for a given frequency is a subset of a brain centered sphere of radius L_m

$$|\bar{r} - \bar{r}_{brain}| = L = nL_m . \quad (2.4.10)$$

The intersection of this surface with the sphere surrounding the brain defines 1-dimensional curve where the resonance occurs. For large values of $L = nL_m$ the conditions do not have any solutions at all. This is clear from the fact that L behaves like r^3 whereas $|\bar{r} - \bar{r}_{brain}|$ behaves as r and grows much slower. Thus solutions can be found only for sufficiently high endogenous frequencies representable as high harmonics of the cyclotron frequencies at the magnetic canvas.

1. The situation in which longitudinal momentum increment vanishes

If the magnetic transition is such that one can neglect the increment of the longitudinal momentum of the representing particle, one obtains a set of one-dimensional curves labelled by the pairs (n_c, n) of integers. Each harmonic n_c of the cyclotron frequency gives rise to closely spaced one-dimensional curves on the corresponding sphere. The variation of the endogenous cyclotron frequency scale implies that a set of two-dimensional surfaces close to each other is obtained. For large values of n this gives quite good representation for the sensory canvas although the quantization of 3-dimensional volume to 2-dimensional surfaces is unavoidable. From the point of view of information processing this compression of information is desirable.

For a given cyclotron harmonic n_c one can get a good grasp about the situation by solving n_c from the resonance condition when projector ME is vertical:

$$n_c = \frac{2\pi f_s}{f_c(r = R, \theta)} \frac{x^3}{x + \epsilon} \rightarrow \frac{2\pi f_s}{f_c(r = R, \theta)} x^2 , x \rightarrow \infty . \quad (2.4.11)$$

$\epsilon = \pm 1$ refers to the representation at the same/opposite side of the globe. For large values of x one has $n_c \propto x^2$ so that the distance behaves like the radius of a Bohr orbit for a quantized harmonic oscillator.

In the plasma sheet the time averaged magnetic field is constant equal to $B_E \sim 10$ nT. The harmonics of a given cyclotron frequency $f_c = qB/2\pi m$ define a series of octave wide representations at the plasma sheet. The distance r associated with a given cyclotron frequency is given by the resonance condition as

$$x \equiv \frac{r}{R} = -\epsilon + \frac{k}{n_c} , \quad k \equiv \frac{2\pi f_s}{f_c} , \quad (2.4.12)$$

where $f_s = c/2\pi R = 7.8$ Hz is Schumann frequency. $\epsilon = \pm 1$ corresponds to the representations at the same/opposite side of the globe. The condition $8 \leq x \leq 60$ gives the bounds $k/(60+\epsilon) \leq n_c \leq k/(8+\epsilon)$ for n_c . For instance, for proton the allowed range of harmonics is $13 \leq n_c \leq 90$.

2. Taking into account the increment of longitudinal momentum

The previous discussion is oversimplified in that it does not take into account the increment of the longitudinal momentum of the representing particle. The ions at the magnetic flux tubes have also kinetic energy $E = k^2/2m$, $\hbar = 1$ associated with the longitudinal motion (this is indeed the case for the magnetic flux tubes of Earth's magnetic field). The possibility that the longitudinal kinetic energy of large number of ions changes in the magnetic quantum phase transition simultaneously brings in an additional degree of freedom, which replaces the discrete curve associated with a given endogenous frequency with a set of curves.

In this case the formula for n_c (assuming that the projector is in the vertical direction) generalizes to

$$n_c = \left[2\pi f_s \frac{1}{x + \epsilon} - \frac{\Delta k^2}{4\pi m} \right] \frac{x^3}{f_c(r = R, \theta)} . \quad (2.4.13)$$

Clearly the variation of k allows variation of x characterizing the length of ME.

The effective continuity of the new degree of freedom is not guaranteed since the value of the momentum k is quantized to the multiple of $k_0 = \pi/l$, where l is the length of the magnetic flux tube, just as in the case of the Alfvén waves so that one might expect a coupling of super-conducting particles to Alfvén waves to be present. The representation with a given endogenous frequency becomes effectively continuous and thus two-dimensional if the condition

$$\frac{\Delta k^2}{2m} \simeq \frac{2k\Delta k}{m} \ll n f_c \quad (2.4.14)$$

holds true. This implies that the representation obtained by varying the endogenous frequency becomes effectively 3-dimensional.

The quantization of the longitudinal momentum implies that the condition is not trivially satisfied and requires

$$E_{||} \ll \pi n_c f_c . \quad (2.4.15)$$

For energetic ions and electrons the new degree of freedom is still more discrete than that associated with cyclotron frequency (recall that cyclotron energy scale is extremely low).

For highly relativistic particles (say electronic Cooper pairs in outer radiation belt with energies up to 10 MeV) with energy higher than the rest mass, the longitudinal kinetic energy is in a good approximation given by $E_{||} = n_{||}\pi c/l$ and in this case the effective condition reduces to $l \gg L$, which is satisfied in a reasonable approximation. Thus electronic radiation belts could give rise to effectively 2-dimensional representations whereas nearby representations in the ionosphere and protonic representations would be one-dimensional. In particular, 40 Hz protonic representations would be one-dimensional.

Can one understand basic facts about sensory representations?

The basic prediction is that resonance representations are effectively three-dimensional if the increment of the longitudinal kinetic energy of the ions is small in the magnetic transition and if the endogenous frequency varies. If the increment of the longitudinal energy is not possible, the representations are 2-dimensional and reduce to 1-dimensional if endogenous frequency does not vary. In general case

one obtains actually a sequence of representation surfaces with effectively quantize three-space to a collection of 2-dimensional surfaces.

Brain indeed contains two-dimensional representations: consider only the somatosensory maps of skin. Also the visual information from retina is two-dimensional and the objects of the visual field are represented as two-dimensional surfaces. The 3-dimensional visual field could result as a high level construct but it is not at all obvious whether genuinely three-dimensional representations are really needed. The compression of information implied by discretization might be more useful than faithful 3-dimensional representation.

Many fundamental features (such as edges, lines, triangles, circles) in the sensory representations of brain seem to be one-dimensional. Quantum entanglement between various levels in the hierarchy of sensory representations allows modularity so that an object of a lower level representation can be assigned to a point of a higher level sensory canvas. Low level representations, say 40 Hz representation at primary sensory areas are two- or one-dimensional depending on whether the endogenous frequency varies or not. By quantum entanglement these one- or two-dimensional features might be associated with higher level representations which might be non-resonant and thus genuinely two or three-dimensional representation for the positions of the perceptive field.

Could also Alfvén waves be involved?

A further interesting point is related to the Alfvén waves. Alfvén waves are a somewhat phenomenological concept based on the notion of field line resonance (FLR). The idea is to treat field line as a system analogous to a violin string so that the frequencies of the modes are given by $\omega = nk_{\parallel}$, $k_{\parallel} = n\pi/L$, where L is the length of the field line. Whether Maxwell's equations really allow FLR concept has been questioned [59].

Amusingly, it seems that Alfvén's intuition might have gone far beyond Maxwell's theory. In TGD framework FLR modes correspond to the oscillation modes of the magnetic flux tubes and are very similar to the massless modes associated with strings (see the appendix). For straight flux tubes parallel MEs with same length as the magnetic flux tube would couple to the FLR modes resonantly and the ends of the magnetic flux tube would act as a pair of mirrors. This resonance mechanism might be crucial for the representations at the personal magnetic sensory canvas.

Also curvilinear MEs are possible but it is not clear whether the general solution ansatz for MEs allows also curvilinear MEs so that any flux tube would couple resonantly to parallel MEs. In this case the resonance condition would state that the length from brain along the magnetic flux tube to the representation point equals to the wavelength associated with the magnetic frequency at the representation point. This would allow to widen the representational repertoire to lower frequencies.

2.4.4 Sensory representations appear as night-day conjugate pairs

MEs should penetrate the Faraday cages defined, not only by the low boundary of ionosphere, but also by Earth itself. This means that it is possible to have sensory representations at the other side of the globe. As found, resonance conditions for the representation points at the same side of the globe do not have solutions for too low values of the magnetic transition frequency since the sphere associated with the observer is so large that it does not intersect the magnetic transition frequency = constant surface. One can however improve the situation by allowing the representation at the other side of globe. Thus representations come as pairs: a high frequency representation at the same side of Earth as the observer and a conjugate low frequency representation at the other side of the globe.

One can derive the lower bound for the resonance frequencies by simply noticing that the degenerate cases for the sensory representations correspond to a situation in which the the vector \vec{r} of the point of the sensory canvas and the vector $\vec{r} - R\vec{e}$ from the brain to the point of the sensory canvas are parallel. In this case representation point is vertically above the brain and the length of the ME determined by the endogenous transition frequency equals to the magnetic transition frequency in Earth's magnetic field. These two extremes define the frequency range which is representable for a given representative ion with atomic weight A_I and represented ion A .

In order to gain insight it is useful to study a simplified example idealizing Earth's magnetic field strength behaves strictly as $1/r^3$. If one requires that the length of the projector ME is same as the distance of the activated magnetic flux tube from the surface of Earth, one obtains a condition for the ratio A/A_I . The vertical distance d from the surface of Earth to the flux tube would be given by

$$d = R((A/A_I)^{1/3} - \epsilon) , \quad (2.4.16)$$

whereas the length of ME is under simplest assumption cyclotron wavelength $\lambda_c = A/f_p$. $\epsilon = 1/-1$ holds true for the representation point at the same/opposite side of the globe.

This gives the conditions

$$\frac{[(A/A_I)^{1/3} - \epsilon]}{A} \times \frac{f_p}{2\pi f_s} = 1 . \quad (2.4.17)$$

Here $\epsilon = 1$ corresponds to the representations at same side of globe and $\epsilon = -1$ to the representations at the opposite side of the globe. $f_p/2\pi f_s \simeq 6.1$ holds true for $B = .5$ Gauss. The condition selects proton ($A_I = 1$) as optimal for the sensory representations.

Protonic and atomic cyclotron transitions

The numerical study of the condition of Eq. 2.4.17 in the case of proton demonstrates that the protonically representable frequency range is 12.5 – 100 Hz and thus contains beta and gamma bands but not the lower bands. This conforms with the fact that only these bands seem to correlate directly with our sensory and cognitive consciousness (note that these representations presumably correspond to our memories). Na ($A = 13$) corresponds to the lower end of the spectrum and tritium ($A = 3$) to the upper end of the spectrum. Li ($A = 7$) and possibly O^{--} ($A/Z = 8$) correspond to 40 Hz resonance band. Of course, these considerations are only order of magnitude considerations and the weak directional dependence of the magnetic field strength has been neglected. The homeostasis of the endogenous magnetic field does not help to satisfy the condition since the replacement $B \rightarrow xB$ only means the replacement $A \rightarrow A/x$ in the formula above.

Higher harmonics of the proton cyclotron frequency suggest a possibility to widen the representational repertoire to include alpha band perhaps even theta band. $n = 3$ cyclotron transition allows the range (7.0 – 12.5) Hz ranging from Ca to Mg. In this case however the distances are of order $r = 6R$ so that dipole approximation fails and the conclusion about the representability of alpha band are somewhat questionable.

${}^4He^{++}$ ($A_I/Z = 2$) ion provides a second candidate for sensory representation. This representation allows ions with $A \leq 19$ (F) and cyclotron frequencies above 15.8 Hz. ${}^4He^+$ ($A_I/Z = 4$) ion provides a third candidate for sensory representation in this case oxygen ($A=16$) with cyclotron frequency 17.8 Hz is the heaviest representable molecule. It is obvious that when A_I increases the molecular weight of the heaviest representable molecule decreases.

Electronic transitions

Electronic cyclotron spin flip transition provides a second natural candidate for sensory representation. Since the frequency is 902 Hz it corresponds to $n = 3$ cyclotron transition for proton and effectively to $A_I = 1/3$. In this case the representable frequency range is (8.6 – 18.8) Hz and contains also alpha band. The lower end of the spectrum corresponds to Cl^- ($A = 35$) and the upper end to O^+ ($A = 16$), which are thus only marginally representable. The representable frequency range corresponds to frequencies above 18.8 Hz.

For the electronic cyclotron transitions for which one effectively has $A_I = m_e/m_p$, the distance from the point of the magnetic sensory canvas is in general much longer than the minimal length of ME so that ME frequencies must correspond to higher harmonics of the fundamental frequency c/L . The frequencies are above 2.7 kHz for $r < 6R$ in dipole approximation. Electronic cyclotron transitions could provide a representation of audible frequencies above kHz whereas cyclotron spin flip frequencies would represent audible frequencies below 1 kHz.

One could consider also the possibility of a sensory representation based on magnetic flux tubes of the interplanetary magnetic field. The strength of magnetic field varies in the range .2 – 80 nT with average value around 6 nT. For electronic cyclotron transition the corresponding frequency range is 2.4-960 Hz with the length of projector ME varying in the range 20.4 – .05R. 6 nT corresponds to 7.2 Hz corresponding to length 6.8R of projector ME. Thus also theta and delta band are included. Since the

the average solar magnetic field is constant it should be possible to find a point outside magnetosphere for which the resonance condition is satisfied. For protonic representations the frequency scales are scaled down by a factor 2^{-11} and could be also realized but now the distance range is scaled up by a factor 2^{11} and this means that distances are at east of order 100R. During sunspot maxima this contribution to consciousness should be maximal but also shifted to frequencies higher than 7.2 Hz.

Thalamocortical resonance band and magnetospheric sensory representations

The sounds produced by meteors are in the thalamocortical resonance range 37.5 – 43.0 Hz instead of the expected range $20 - 2 \times 10^4$ Hz for sferics and much stronger than expected and strongly dependent on position and the direction of meteor [67]. This encourages the explanation in terms of resonances associated with the projector MEs at 40 Hz band emerging from brain and also from inorganic matter (sounds were recorded also electronically) and acting as amplifying wave guides [27]).

In light of this thalamocortical resonance band which is excellent candidate for the cyclotron frequencies associated with the magnetospheric sensory representations at primary sensory areas. The resonance range is indeed bounded by $A = 8$ and $A = 7$ cyclotron frequencies (37.5 Hz and 42.9 Hz). There are two options.

1. Thalamocortical representation could be associated with Cooper pairs of Li^+ ions having $A = 7$. Endogenous magnetic fields would vary in the range $(7/8, 1) \times B_0$, $B_0 = .5$ Gauss, for this representation. The predicted 12.5 per cent variation is consistent with the general ~ 10 per cent relative variation of EEG frequencies. That lithium acts as an antidepressant might relate to its role in generating sensory representations.
2. O^{--} ions or doubly ionized water molecules ($A/Z = 8$), perhaps resulting when the OH bonds of a water molecule split, are second option. Note that doubly ionized oxygen is boson as is also Ca^{++} ion. In this case endogenous magnetic fields would vary in the range $(1, 8/7) \times B_0$, which means 14 per cent relative variation of the cyclotron frequency.

Both Li^+ and O^{--} could be involved and be related to the sensory representations of the interior milieu (world as it feels) and external world (world as experienced in the third person perspective). In [32] it is suggested that these two representations are separated by blood-brain barrier and are realized by sensory projectors emanating from red blood cells and pyramidal cells respectively (both cells contain magnetic structures). O^{--} would be associated with red blood cells whereas Li^+ would relate to the pyramidal cells.

2.4.5 Representations based on cavity resonances

Various resonances associated with the magnetosphere might help to amplify the cyclotron frequencies represented by MEs. There is indeed a rich repertoire of various oscillation modes associated with the magnetosphere. Being not a specialist, I can mention only the most obvious examples. Various structures defined by Earth and magnetosphere define a hierarchy of space-time sheets and the cavity resonances of the classical fields associated with are the most obvious candidates for amplification purposes. Cavity resonance frequencies could be same or very nearly same for both classical em and Z^0 fields. This is certainly the case if large space-time sheets can carry both electromagnetic and Z^0 fields simultaneously.

In many-sheeted space-time framework also the cavity resonances associated with the space-time sheets of Earth and Earth's inner and outer core plus possible other substructures such as ionospheric cavity and the thin cavities defined by boundary layers must be considered since the matter is at the atomic space-time sheets and the space-time sheets in question are practically empty of particles and could be super-conducting. Effective surface resonances have higher overall frequency scale (by the classical counterpart of Uncertainty Principle) than interior cavity resonances. Schumann resonances (for a detailed treatment see the appendix) are almost surface resonances because the surface layer involved is so thin. Also a well-defined dimensional reduction can occur. For Schumann cavity the lowest frequency is 10.6 Hz, which is essentially the frequency of the alpha peak and quite near to the basic frequency of the memetic code.

The hierarchy of space-time sheets would thus correspond to the hierarchy of potential resonance frequencies in EEG corresponding to the radii of Earth's inner core and outer cores, Earth's radius, ionosphere, the size of the magnetosphere, the sizes of the structures in the magneto-tail, etc...

Schumann resonances and resonances associated with inner and outer core of Earth

Schumann resonances are usually identified as cavity resonances associated with the cavity between Earth's conducting surface and the lower boundary of ionosphere. Also in TGD cavity resonances should be very much like the resonances for the ordinary Maxwell fields. Coupling of MEs with Schumann resonances provides a possible manner to achieve amplification even when the length of ME does not satisfy the resonance condition.

The nominal values of the Schumann resonance frequencies are 7.8, 14, ...39, 45, ... Hz and many of these frequencies are important resonant frequencies of EEG which suggests that this amplification mechanism is indeed utilized. Numerical estimates demonstrate that radiation belts containing the ring currents are especially interesting seats of representations amplified (also) by Schumann resonance. Dipole approximation for the magnetic field should be reasonable at the distance corresponding to the maximum of the ring current. Flux maxima are also good candidates for seats of sensory representation.

1. The flux maximum for the protons in the inner belt is at $2R$. The cyclotron frequency of proton is 37.5 Hz at this distance and corresponds to the lower limit of 40 Hz thalamocortical resonance band and is quite near to Schumann frequency 39 Hz. Note that in this case the resonance condition based on the length of ME can be also satisfied.
2. At the outer electronic belt extending to $6R$ electronic ring current dominates and is maximum at $4R$: the cyclotron spin flip frequency for electron scales which is 902 Hz for $B = .5$ Gauss scales down to 14 Hz, which corresponds to sleeping spindles, sensorimotor resonance frequency, and to the second Schumann resonance, and is also near to the endogenous Na^+ cyclotron frequency 13 Hz. In the electronic case the distance condition is not possible to satisfy unless the representation is realized at the other side of the globe. Note that sleeping spindles could also correspond to control action (now lullaby!) exercised from the outer radiation belt.
3. Also the endogenous cyclotron frequencies sufficiently near 7.8 Hz could be represented as protonic cyclotron transition using Schumann resonance. The lowest Schumann resonance is probably relevant for hypnagogic states. Personally I sometimes experience during hypnagogic periods what it is to be quite another person. If Schumann resonance is in question, the interpretation would be that magnetic Mother Gaia experiencing us as sub-selves and sharing of mental image is in question. T

The distance for 7.8 Hz protonic cyclotron frequency is $3.4R$ in dipole approximation whereas the length of ME would be $6.3R$. For the representation at the opposite side the distance would be below $5.4R$ so that Schumann resonance is the only possible manner to achieve the amplification. For the third harmonic of the protonic cyclotron frequency the lower bound for the resonant amplification by ME is 8.6 Hz and rather near to the lowest Schumann resonance. The absence of the resonant amplification by projector ME wave cavity could explain why hypnagogy is unmasked only when the sensory input is absent. Note that the biologically important ions K and Cl have cyclotron frequencies near the lowest Schumann resonance.

In many-sheeted space-time also the the cavity resonances associated with Earth's inner and outer core could be important. For the inner solid core of Earth having radius of 1200 km the counterpart of the lowest Schumann frequency is 41.4 Hz. The outer liquid core has radius 2900 km and in this case the lowest Schumann frequency is scaled up to 14.3 Hz, which is near to the sensorimotor resonance frequency and sleeping spindle frequency. Both of these frequencies are important resonance frequencies in EEG (and should be so in ZEG) and almost coincide with Schumann frequencies. Even more, the mantle above the outer core divides into two parts. The boundary is at the depth of 1000 km: the corresponding cavity frequency is 9.25 Hz and in the accuracy used equal to the lower bound of Z^0 cyclotron frequency varying in the range 9.3 – 11.4 Hz.

Cavity resonances in the magnetic lobe

Various oscillation modes associated with cavities like the inner magnetosphere and entire magnetosphere could also serve as resonant amplifiers of the signals carried by the projector MEs involved with sensory representations.

In particular, lobe cavity with length $L \sim 10^3 R$ gives rise to electromagnetic oscillation modes in the direction of the lobes with the spectrum of frequencies having fundamental frequency of about $f = c/L = c/10^3 R \sim 49$ mHz. A repeated reflection between magneto-pause and magneto-tail ($r \sim 20R$) would give resonance frequency 2.45 Hz whereas the repeated reflection between the opposite sides of magneto-pause ($r \sim 40R$) would give 1.23 Hz resonance frequency. These are of course only rough order of magnitude estimates. These modes might be involved with the amplification of the frequencies in delta band.

The frequencies of the night side auroral Pc5 pulsations are quantized as multiples of 0.9, 1.3, 1.95, 2.6, and 3.3 mHz [57]. They have been interpreted as field line excitations (FLR) excited by quantized compressional modes. TGD inspired explanation for the Pc5 pulsations would be following. The reconnection process excites the Alfvén waves associated with the flux tubes of the solar magnetic field. The distance to the Sun is $L = 8$ light minutes, that is $L = 2.9 \times 10^{11} R$. The fundamental frequency is $f = c/L = 1.1$ mHz and indeed of the same order of magnitude as the frequencies assigned with the compressional modes. If compressional waves are there, they could excite the FLR excitations of the solar magnetic field or vice versa. If solar magnetosphere is conscious self it could control Earth magnetosphere by exciting these modes (solar magnetosphere is known to have 'memory': the complex magnetic structure return to the original one after 11 year sunspot period [38]).

Delta band cavity resonances and epilepsy

Sferics are electromagnetic excitations associated with lightnings. Some authors define the frequency spectrum of sferics roughly $20 - 2 \times 10^4$ Hz, which corresponds to the range of audible frequencies (this is perhaps not an accident). Some authors define sferics as the frequency range $0 - 2 \times 10^4$ Hz.

The spectrum of spherics defined in the latter sense has a maximum at 3 Hz and spectrum resembles EEG spectrum in this region. A possible interpretation of the delta band peak is in terms of the cavity resonances. The general scale of the inner magnetosphere is about $4R$ so that one would expect by scaling from Schumann resonance frequency $f \sim 7.8/4 = 1.95$ Hz for the fundamental frequency. Also the previously mentioned resonances with frequencies are 1.25 Hz and 2.5 Hz (rough estimate) associated with the radial degrees of freedom inside magneto-tail contribute to delta band. Since the plasma sheet becomes thicker and the magneto-tail gets thinner near Earth, one expects that the fundamental frequency increases for the local reflection modes from the rough estimate 2.5 Hz so that also 3 Hz frequency should belong to the spectrum.

These cavity resonances could amplify delta band around 3 Hz. That petit mal begins with the amplification 3 Hz EEG rhythm might relate to the resonant amplification by sferics. For proton 3 Hz corresponds to $r = 4.6R$ and for electron to $r = 6.7R$ and resonance condition for ME gives the distance $d = 16R$ which is in the outer magnetosphere. Here higher harmonics of proton cyclotron frequency would allow a resonant amplification. A loss of consciousness could result from the entanglement of entire self. The alternative option is that only mental image is entangled so that consciousness is not lost but that there is no memory representation about the conscious experience during the epileptic seizure (the situation would be same in the case of sleep state).

2.5 The hierarchy of magnetospheric representations

In the sequel magnetospheric representations and their interpretation are discussed in a more detail. The basic vision is that a hierarchy of selves extending up to the scales of lightlife can contribute to our own conscious experience. The mechanism generating sensory and motor representations would be the intersection of the magnetic mirrors associated with the personal sensory canvas with various magnetic flux tube structures of the magnetosphere. An essential correction to the earlier representation is that the frequencies correspond to $B_{end} = 2B_E/5$ ($= .2$ Gauss at Earth surface) rather than the Earth's magnetic field B_E . There reasons for this are explained in the introduction.

2.5.1 EEG and magnetospheric sensory representations

Resonance condition at lowest order gives extremely strong restrictions on sensory representations. These condition become even more stringent if one assumes that only the fundamental frequency $f = c/L$ of ME projector is of significance. The table below gives an overall view about how the frequency depends on the length of ME and allows to understand the implications of these conditions.

An especially interesting consequence of the resonance condition is that that audible frequencies must be represented inside brain as features and entangled to the sensory magnetic canvas rather than being directly coded to em or Z^0 frequencies.

$x = d/R$	1	2	3	4	5	6	8	10	60	10^3
f/Hz	49.0	24.5	16.3	12.3	9.8	8.2	6.1	4.9	0.8	.05
$y = r/R$	1	2	3	4	5	6	8	10	60	10^3
f_p/Hz	300	37.5	11.1	4.7	2.4	1.4	0.06	0.06	0.06	0.06
$f(e)/Hz$	902	112.8	33.4	14.1	7.2	4.2	0.18	0.18	0.18	0.18
$f_e(Z^0)/Hz$	707	88	26	11	5.7	3.3	0.14	0.14	0.14	0.14

Table 1. The first two rows give the dependence of the fundamental frequency $f = c/d$ of ME projector on its length d . The next rows give the dependence of of proton's cyclotron frequency f_p , electron's cyclotron spin flip frequency $f(e)$, and electron's Z^0 cyclotron frequency $f_e(Z^0)$ on the distance r from Earth's center. On outer magnetosphere the consideration is restricted to the plasma sheet. Earth's magnetic field of 10 nT is assumed in the plasma sheet above $r = 8R$ and below this distance dipole approximation neglecting polar angle dependence is used. Cyclotron frequencies are calculated for endogenous magnetic field $B_{end} = 2B_E/5$: the reasons for a little bit strange representation are discussed in introduction. Z^0 magnetic field is assumed to be related to magnetic field by scaling $g_Z B_Z = eB/16$.

Magneto-tail represents delta and theta bands

If the higher harmonics of the fundamental frequency $f = c/L$ of ME are *not* significant, one can deduce following conclusions about the representations in the magneto-tail.

1. The range of frequencies representable for projector lengths $d < L_t = 60R$, where L_t corresponds roughly to the distance to the tip of the plasma sheet (neutral point), contains frequencies between $f_{min} = .8$ Hz and $f_{max} = 8.1$ Hz and thus covers delta and theta bands. Perhaps it is not a mere accident that f_{min} defines a natural lower boundary of the delta band.
2. The lowest frequency representable inside the magneto-tail ($r < 10^3R$) is $f_{p,tail} = .049$ Hz which corresponds to a period of 20.4 seconds: $f_{p,tail}$ is rather near to the protonic cyclotron frequency f_p inside plasma sheet.
3. Higher harmonics of f_p can be used to widen the representational repertoire at distances, where $f > f_p$ condition holds true. The n :th harmonic of $f_{p,tail}$ defines an octave wide representation and distance $r_n = r_{max}/n$. Same applies to the harmonics of the electronic Z^0 cyclotron frequency $f_{e,tail}(Z^0) = .14$ Hz.
4. The frequencies which are lower than f_{tail} must be represented as magnetic transition frequencies in the heliosphere. Most naturally at the night side, where the solar magnetic field weakens with distance.

Inner magnetosphere represents alpha, beta and gamma bands

The lowest frequency representable inside the inner magnetosphere ($r \leq 4R$ at the day side, $r \leq 6R$ at the night side) is 12.5 Hz at day side and 8.6 Hz at night side: theta and delta bands are excluded at the night side and at the day side also alpha band is excluded.

By applying the constraints for the representations at the same and opposite side of the globe to the electronic case one obtains the following results: also proton and 4He are included for the sake of comparison.

f	f_d/Hz	f_u/Hz
f_p	12.5	100
$f(e)$ and $3f_p$	8.6	18.8
$5f_p$	7.0	12.5
$7f_p$	6.1	10.0
f_{He}	15.8	75
$f_e(Z^0)$	9.4	25.0

The allowed electronic frequency bands and higher protonic cyclotron bands are rather narrow. For Z^0 cyclotron frequency higher harmonics allow to reduce the lower bound but $n > 3$ harmonics lead out of the inner magnetosphere. Even harmonics are expected to define much weaker cyclotron quantum phase transitions because of parity conservation in lowest order. The only exception is formed by frequencies near the maximum frequency 902 Hz *resp.* 707 Hz representable locally: $d \sim 300 \text{ km} \ll R$. For Z^0 electronic representation also harmonics can be represented.

Audible frequencies allow magnetospheric representation only if higher harmonics of ME projector frequencies are allowed

Mother Gaia should also hear and speak so that auditory experience should have representation at the sensory magnetic canvas and control of speech should be possible to some degree from magnetosphere. From the foregoing it is clear that the spectrum of audible frequencies does not allow resonant magnetospheric representation unless one allows higher harmonics of the fundamental ME frequency $f = c/L$.

The first possibility is that audible frequencies are represented as features inside brain and quantum entangled to the points of both magnetospheric and personal sensory canvases. Also motor representations provided by sensory canvases could be high level representations involving only frequencies below 26 Hz (roughly the limit of audible frequencies) and perhaps identifiable as internal speech. This idea conforms with the view that motor actions are like four-dimensional fractal statues carved quantum by quantum jump by adding further details in increasingly shorter time scales. TGD based quantum model for hearing indeed assumes a local representation inside brain based on 'cognitive' neutrinos: the model predicts correctly the upper bound of audible frequency range [32].

The situation changes if higher harmonics for projector MEs are allowed. The range for audible frequencies is $20 - 2 \times 10^4$ Hz. This frequency range corresponds to that of sferics [64] and sferics might act as amplifiers of the signals between brain and Z^0 sensory canvas.

1. Place coding of frequencies of speech and sounds

Electron spin flip transition corresponds to frequency 33 Hz at $r = 3R$ and varies up to 900 Hz below this height. This would suggest that electron spin flip might place code for the frequency range between 33 – 900 Hz. Also protonic spin flip, $n = 3$ protonic cyclotron transition, and protonic spin flip plus cyclotron transition could be considered as translating sound frequencies to em frequencies in this frequency range.

Only the representations as electronic cyclotron transitions is possible above 10^3 Hz. Electronic cyclotron frequency is .564 MHz in the magnetic field of $B_{end} = .2$ Gauss. The magnetic field $B_{end} = 2B_E/10 = 4$ nT for $B_E = 10$ nT at plasma sheet corresponds to a frequency of 112.8 Hz. At a distance of $r = 8R$, where plasma sheet begins, the frequency is 1.1 kHz. At $r = 3R$ it is 2×10^4 Hz. Thus the audible frequencies above kHz could be represented as electron cyclotron frequencies inside the night side inner magnetosphere at personal magnetic body with $B_{end} = 2B_E/5$.

From the foregoing it is clear that the frequency of 1 kHz is in a special role. This frequency is a remarkable frequency also in many other aspects.

1. The duration of single bit of the memetic code word is near to one millisecond.
2. The sound wavelength corresponding to 1 kHz is corresponds to the head size: above these frequencies sounds can be treated using geometric acoustics and below this frequency diffraction effects are important: for instance, the mechanism allowing to decide the direction of sound is different above and below 1 kHz.
3. ~ 1 kHz is also the frequency neuronal synchrony.

2. Memetic code and speech

The harmonics of electron's Z^0 cyclotron frequency could be involved with the motor control of speech. The same mechanism provides an alternative coding of speech frequencies below ~ 1 kHz.

1. With the assumptions made about Z^0 magnetic field ($g_z B_Z = eB/16$), the representable range for $f_e(Z^0)$ is (.14 – 707) Hz, if only the lowest cyclotron harmonic is allowed. These transitions might relate to the control of speech using memetic code. The resonantly representable frequency range (9.4, 25) Hz indeed contains memetic code frequency and $r = 4.2R$ corresponds to the frequency 9.9 Hz: this distance corresponds to the maximum of the electronic flux.
2. All atomic (hydrogen atom forms an exception) and molecular Z^0 cyclotron frequencies are in the range (9.4, 11.3) Hz in endogenous Z^0 magnetic field. That the lower bound is same as for resonantly representable frequencies is to some degree a miracle. Z^0 MEs from Z^0 magnetospheric motor area could thus be responsible for the generation of speech. The fact that the cyclotron frequencies of all atoms and molecules are nearly identical might make possible effective amplification of Z^0 signal in the body and head to internal speech and possible even real sound by Z^0 piezo-electric effect. In accordance with the earlier speculations, Z^0 MEs could be also responsible for internal speech which would be analogous to an imagined motor action.
3. The harmonics of ~ 10 Hz frequency defining the duration of memetic codon are natural candidates for the frequencies appearing in the representation of the memetic codewords as fast amplitude modulation of the basic frequency ~ 10 Hz. What this means that higher harmonics add a small ripple to the basic oscillation. The higher harmonics of the cyclotron frequency $f_e(Z^0) \sim 10$ Hz up to 126^{th} harmonic would provide the coding of the memetic code words of duration .1 seconds representing basic information units of speech (perhaps phonemes). The duration of a single bit is of order one millisecond and coincides with the typical duration of the nerve pulse. Actually the number of harmonics needed is vanishingly small as compared to the maximum number 126 since the number of phonemes is much smaller than the maximal number $2^{126} \sim 10^{38}$. Hence brain utilizes only vanishingly small part of the resources allowed by the memetic code.

What looks nice is that the difference between inner speech and actually heard speech would reduce to the difference between em and Z^0 interactions. These considerations raise the question who is really expressing itself when I am speaking: me or Mother Gaia or some of its many sub-selves? To speak fluently is to let it go and it might be that magnetospheric selves are also expressing themselves when this happens.

What the emergence of the oxygen belt could mean?

Interestingly, during the last decade two sub-belts have emerged inside the inner radiation belt [68]. The first belt is electronic and at $r \sim 2R$. The second newcomer contains mainly O^+ ions. If the O^+ flux has maximum at $r = 2R$, this would mean the appearance of new strongly represented cyclotron frequency of about $f_{O^+} = 2.3$ Hz for B_{end} , and perhaps a new delta band contribution to the magnetospheric consciousness (and perhaps even to our consciousness in some altered states).

Resonance condition cannot be satisfied for ME projectors from brain but could be satisfied for ME projectors from the magneto-tail so that one can imagine the possibility of radiative magnetospheric brain circuit connecting these two levels. Note also that cavity resonances inside magnetotail might serve as amplifiers of the cyclotron frequencies in delta band.

What makes the situation interesting is that DNA and presumably also mRNA sequences have a constant charge density [82] so that the value of the cyclotron frequency does not depend on the length of the sequence. mRNA cyclotron frequency is very near to the cyclotron frequency $f(O^+) = 2.3$ Hz of O^+ ions at $r = 2R$ as the following argument shows. The nucleotide pairs in DNA have atomic weights 260 (C-G) and 261 (A-T) and the average weight of the DNA triplet is $A = 781$. DNA and presumably also mRNA sequence has constant charge density of 5.88 charges per triplet [82], which means cyclotron frequency $f_{mRNA} = 2.26$ Hz in the field of $B_e = .2$ Tesla. This holds true irrespective of the length of DNA or mRNA. The question is whether a chart about active mRNA sequences might be generated to the O^+ belt and provide kind of a 3-dimensional out-of-body hologram about organism.

A little summary before continuing

For the benefit of the reader it is worthwhile to collect the basic consequences of the proposed model.

1. Inner "endo"-magnetosphere in principle allows representation of frequencies above 8.6 Hz, that is alpha, beta and gamma bands. The EEG spectrum in the range 12.5 – 100 Hz is resonantly representable using protonic cyclotron frequency in the inner magnetosphere, where dipole field approximation is reasonable. The third harmonic of the protonic cyclotron frequency allow to reduce the lower bound for the representable frequencies to 8.6 Hz which is near to the lowest Schumann resonance frequency. Representations come as conjugate pairs corresponding to the representations at the same and opposite side of the globe.
2. Theta and delta bands are representable in the plasma sheet using higher harmonics of cyclotron frequencies and representations are octave wide. This might explain why they are not involved with sensory representations directly conscious-to-us requiring strong intensity in order to be not masked by the sensory input. If non-sensory memories are represented by theta and alpha bands symbolically, this would also explain why memories are usually symbolic rather than concrete re-experiences. Only linear written language like representations by the harmonics of cyclotron frequency make sense inside lobes where the average magnetic field is constant. Symbolic coding could allow to achieve reliability even when the signals are too weak to yield sensory representations not masked by the background noise.
3. Electrons allow the representation of audible frequencies if the higher harmonics of the fundamental frequency of ME are allowed. The representation of audible frequencies at the level of brain using cognitive neutrinos and quantum entanglement is favored. This means also that communications and motor control from the magnetosphere should take place at frequencies which are in EEG range. Kind of high level commands would be in question and perhaps experienced as internal speech.

2.5.2 Do magnetospheric structures correspond directly to brain structures?

p-Adic fractality characterizes the long range correlations of real physics. p-Adic and real space-time sheets are glued together along common rationals, and typically p-adically short scale corresponds to long scale in the real sense and vice versa. Hence the p-adic local physics defined by the p-adic variants of the basic field equations would reduce the p-adic fractality of real physics to mere p-adic smoothness and continuity [20]. This allows also a more precise view about the origins of p-adic length scale hypothesis.

If one takes seriously the origins of the p-adic fractality, the idea that magnetosphere could contain fractally scaled up representations of structures like brain, does not look so weird anymore. As a matter fact, infinite hierarchy of fractal copies of these structures are expected to be there and provide space-time realization for the universe as a hologram.

Protonic and electronic radiation belts [66] are optimal candidates for the magnetospheric sensory and motor representations since the densities of protons and electrons are exceptionally high inside belts. The working hypothesis is that from our point of view magnetospheric sensory representations correspond to various kinds of memories (sensory and symbolic memories). Motor representation in turn would correspond to higher level motor control (motor imagination and motor skills).

Inner radiation belt is rather stable unlike the outer radiation belt and there is no night-day variation involved. Inner radiation belt is therefore optimal for the representation of sensory memories whereas outer belt is better suited for the representation of verbal memories using memetic code.

What is the magnetospheric counterpart of the left-right asymmetry of brain functioning?

The decomposition of living systems into pairs of almost similar members such that the second member tends to entangle with the external world and the second member remains autonomous and un-entangled system is basic implications of TGD inspired theory of consciousness [32, 21, 18].

This division of labor seems to occur already at DNA level in the sense that the apparently passive conjugate strand entangles whereas the strand busily expresses itself. At brain level this asymmetry

corresponds to the left-right asymmetry. This asymmetry should have a counterpart also at the level of the magnetospheric consciousness and would mean that 'right' and 'left' magneto-hemispheres are magneto-anatomically different similar but the 'right' one is more able to entangle.

Northern and southern lobes are indeed very similar magneto-anatomically and plasma sheet in the equatorial plane separates the northern and southern hemispheres also naturally. Plasma sheet could be a counterpart for the region through which the axonal bundles connecting left and right hemispheres run through: axons are now replaced with magnetic flux tubes. Frontal lobes would correspond to the magneto-pause at the night side and hindbrain would correspond to the day side.

There indeed exists a seed of a functional North-South asymmetry in the sense that the flux tubes of the solar magnetic field are antiparallel (parallel) to the magnetic flux tubes inside the lobe at the northern (southern) magneto-pause. This implies that reconnection process occurs asymmetrically. Since reconnection makes possible entanglement with helio-magnetosphere, this asymmetry might imply that either northern or southern lobe quantum entangles with the helio-magnetosphere with a higher probability.

Magnetospheric counterparts of subcortical structures?

The identification of the counterparts for the structures of the middle brain can be based on the requirement that the typical EEG frequencies associated with a given structure are same as the cavity resonance frequencies of the magnetospheric counterpart.

1. *Magnetospheric thalamus*

There are several good reasons for identifying the space-time sheet of Earth's inner core as the magnetospheric counterpart of thalamus.

1. The characteristic property of thalamus is that it acts a neuronal relay station feeding sensory input to practically all parts of brain and receiving strong feedback. Since the magnetic flux tubes from the inner core of Earth can reach any point of the magnetosphere, the identification of the inner core as the magnetic relay station is uniquely fixed.
2. The space-time sheet of the inner core of Earth corresponds quite closely to 40 Hz cavity resonance frequency in accordance with the requirement that the counterparts of thalamus and primary sensory areas (protonic radiation belt) resonate at this frequency.
3. If the magnetospheric representations above ionosphere correspond to cortical representations, it would seem that the only possible identification for the magnetothalamus is as the inner core of Earth.

Magnetothalamus has even some nuclear structure in the sense that are two pairs of magnetic anomalies (Canada-East Siberia at northern hemisphere and Antartis-Brazil and southern hemisphere). This suggests that supra currents must have a crucial role in the transfer of information.

2. *Magnetospheric basal ganglia*

Basal ganglia responsible for motor control correspond naturally to frequency of about 14 Hz, which is the basic sensorimotor beta rhythm. The space-time sheet defined by the liquid outer core has this frequency as cavity frequency. Note that the magnetospheric thalamus is topologically condensed at the magnetospheric basal ganglia. Therefore it is perhaps more natural to identify the brain structure in question as that containing thalamus and basal ganglia.

3. *Magnetospheric pineal gland*

Earth's mantle decomposes to two layers such that the sheet associated with the inner sphere has cavity resonance frequency 9.3 Hz. This frequency is the lower bound for the nuclear Z^0 frequency defined by the duration of the memetic code word presumably involved with the symbolic representation of memories. Pineal gland seems to correspond to a frequency ~ 10 Hz defining a biological clock and might correspond to the sphere defined by the inner layer of the mantle.

4. *Magnetospheric limbic brain*

Schumann frequency 7.8 Hz and its harmonics are associated with the space-time sheet of the entire Earth with ionosphere possibly included. Strong resonant input to the tertiary sensory and

motor areas should characterize the counterpart of this brain structure. Perhaps a magnetospheric counterpart of hypothalamus, amygdala, and other parts of the limbic brain is in question. This identification is consistent with the fact that Schumann resonance has strong emotional effects.

5. Magnetospheric hippocampus

The lowest cavity resonance frequency corresponds to the top of ionosphere ($r = 2R$) is 3.9 Hz. Hippocampus is characterized by the so called hippocampal theta ranging from about 4 Hz up to 12 Hz. Thus it would seem that hippocampus corresponds to the highest structure in the subcortical brain, which by definition contains also the structures below as topologically condensed space-time sheets, so that also higher cavity frequencies are included. A strong input to the association areas should characterize the corresponding brain structure and hippocampus indeed has input to the entire cortex.

Magnetospheric counterparts of the sensory areas?

The next task is to identify the magnetospheric counterparts of the primary, secondary, and tertiary sensory areas of the cortex. These areas should correspond to a gradually decreasing frequency scale for resonant representations. The higher odd harmonics of cyclotron frequency indeed have this property (even harmonics couple weakly to cyclotron quantum phase transitions). For proton the two lowest harmonics have range above 8.6 Hz and correspond to the inner magnetosphere (with plasma sheet excluded).

The protonic inner radiation belt could define somatosensory representations of Mother Gaia such that single organism takes the role of neuron. Anatomically the protonic inner belt would correspond primary sensory areas. The primary sensory areas correspond to 40 Hz thalamocortical sensory representations and correspond to the maximum of protonic flux at the inner belt. Here also 40 Hz cavity resonance associated with the inner core of Earth and analogous to Schumann resonance might help (note that Earth as conducting solid body exists only at the atomic space-time sheets!). That thalamus is regarded as a generator of 40 Hz resonance frequency conforms with this correspondence.

Secondary sensory and motor areas could define magnetospheric sensory representations covering frequencies down to 8.1 Hz defining the boundary of the night side inner magnetosphere. The decreasing density of protons poses a strong limitation. Schumann resonances could help to increase the intensity at the upper boundary of the protonic belt, where the protonic supra-current is weakest so that also alpha band could be represented. Hippocampal theta is only partially representable: the genuinely theta like part of the hippocampal theta must be represented in the plasma sheet.

Because of the low intensity of supra currents, the representations had better to be symbolic rather than direct images. The coding of EEG features with the duration varying in the interval determined by the range of alpha band by fast and weak amplitude modulation using harmonics of alpha frequency could code these representations. Alpha frequency would code for the position and the higher frequencies would assign features associated with the lower level sensory canvases with this point.

Tertiary sensory and motor areas would correspond to magnetospheric sensory representations at the transition region between inner and outer magnetosphere. This region is just plasma sheet at the night side magneto-tail (, which is identifiable as the counterpart of the frontal brain). Plasma sheet defines an octave wide sensory representation for the harmonics of the protonic and electronic Z^0 magnetic frequencies. There are reasons to believe that the self representations in brain reside at the inner surfaces of the left and right brain hemispheres in frontal cortex (insula). This would suggest that plasma sheet which in a well defined sense is between internal and external world (rotating inner and non-rotating outer magnetosphere), is responsible for the magnetospheric self representation. This would also mean that plasma sheet is kind of a primus motor of the magnetosphere. This is consistent with the high level of self-organization (later the discovery about 'features' represented in the plasma sheet [51] will be described).

Plasma sheet and magneto-pause as counterparts of association regions?

Associations and imagination represent higher level mentality than sensory experience. Sensory associations are generated at the junction OPT of occipital, parietal and temporal lobes whereas frontal lobes could be seen as the seat of highest level mentality like imagination and planning.

Magneto-pause is self-organizing unstable structure and thus ideal for imagination, planning and associations. Occipito-parietal-temporal association regions would be mapped to the day side magneto-pause and frontal association regions to the night side magneto-pause having much higher representative power (the frequency spectrum extends to much lower frequencies). Outer magnetosphere is in a direct contact with this region as are also tertiary sensory areas with various association regions so that the identification is consistent with the continuity requirement.

In the magnetic case day side (shorter cyclotron time scale) perhaps corresponds to sensory imagination whereas night side would correspond to symbolic memories. In the Z^0 magnetic case night side would correspond to motor programs and day side to motor imagination. Communications between magneto-pause and plasma sheet could occur mainly via ME projectors since direct supra currents are not possible unless perhaps during magnetic storms and sub-storms. This is possible since cyclotron frequency scales are essentially same. Note that also entanglement between magneto-pause and plasma sheet making possible the generation of shared and fused mental images is possible. Hence plasma sheet is indeed an ideal candidate for the carrier of self model. Horizontal communications inside magneto-pause are made possible by surface (supra?) currents orthogonal to the discontinuity of the magnetic field.

2.5.3 How do the contributions of magneto-tail and inner magnetosphere to our consciousness differ?

The study of the magnetospheric sensory representations leads to considerable insights concerning the differences between sensory, verbal, and motor memories, and imagination. An explanation for the distinction between sleep and awake emerges, and ageing could be understood as a gradual shift of control from magneto-tail to the inner magnetosphere.

The difference between sleep and awake

Essentially entire EEG above 8.1 Hz is covered by the inner "endo"-magnetosphere. If the inner magnetosphere is responsible for daytime memories, one could understand why we do not possess memories from the period of sleep (we could be still conscious and the identification of plasma sheet as counterpart of self system in brain suggests this!). The dominance of the inner magnetosphere over the outer one should distinguish wake-up state from sleep state and the transition wake-up-to-sleep might be partially controlled by magnetosphere (sleeping spindles). During wake-up the dominance of the inner protonic belt over outer electronic belt would in turn distinguish high sensory alertness from a more inwardly oriented state. Non-autonomous and autonomous parts of the nervous system could correspond roughly to the inner and outer radiation belts. Autonomous system would be mostly unconscious to us because of the low density of protons and thus low rate of the cyclotron quantum phase transitions.

As already proposed, magneto-tail could correspond to frontal lobes and thus motor imagination and planning. This would mean that sleeping periods would involve kind of virtual world training of motor skills, which indeed seems very natural. Learned motor skills represent one type of memory and the magnetospheric electronic representations would have interpretation as this kind of memories. In Z^0 sector magneto-tail would correspond to higher level control of speech and verbal imagination: also speech faculties might be trained during sleep. Plasma tail would be responsible for the highest level of control as the magnetospheric self system.

Ageing as a gradual shift of consciousness from magneto-tail to inner magnetosphere

Delta band gets weaker during ageing and sleeping disorders increase during the old age. Delta band dominates in the EEG of infants and shifts gradually to become eventually alpha band. Thus ageing could be seen as a gradual shift of the consciousness from the outer magnetosphere to the inner magnetosphere. That motor skills and speech develop by trial and error during the first years of life, conforms with the fact that motor consciousness must be highest during this period.

It would seem that ageing means gradual stepping down along the ladder of consciousness and that Buddhist teachings about Karma's cycle might make sense in quite precise sense. This might be an illusion: the strong delta contribution in the EEG of infant could reflect strong higher level motor control and ageing might mean learning to survive without the advice and control from this level.

One could also see life as carving of a 4-dimensional statue and transition to the higher frequencies would mean concentration to increasingly finer temporal details.

The ability to generate new memories gets poorer during ageing whereas childhood memories are rather stable. This is contrary to what neuroscience models for the long term memory tend to predict but in consistency with TGD based mirror mechanism. This difference does not relate to the assumptions of a particular model but to the basic philosophy about time.

Motor and verbal memory representations would be stored to electronic belts whereas sensory memories would reside in the inner protonic belt. Highest level memory representation in a form of self narrative would be stored in the plasma sheet.

In this picture one could understand why we do not have long term memories from the age before 4 years as being due to the absence of ME projectors needed to generate the magnetospheric memory representations. The shift of the control downwards in the magnetosphere could explain why the ability to generate new memories becomes poorer at the older age. During sleep we could enjoy magneto-tail consciousness but would remember what it is to be conscious during sleep only during sleep. Infants could be in this mode of consciousness all the time.

Magnetospheric consciousness evolves

The strength of Earth's magnetic field has reduced by a factor of order two during the last thousand years whereas Schumann resonances must have remained same all the time. For 10^3 years ago the positions of the flux maxima have corresponded to frequencies which are twice the recent frequencies 37.5 Hz, 14 Hz, and 7.8 Hz. The ionic flux intensity at the distance corresponding to these frequencies has been weaker than today since the distance corresponding to these frequencies is scaled up by a factor 1.26. This might have had dramatic effects on the character of the magnetospheric consciousness and also to that of ours.

If sensory memories are represented protonically in the inner magnetosphere ($r < 4R$), the increase in the intensity of the ionic fluxes involved with the memory representations could correlate with the development of science and the emergence of the high tech civilization. Also the vision of Jaynes [69] about bicameral man who received commands and advices from collective levels of consciousness and gradually gained long term memory and self model during the last 10^4 years could be seen as a self-organization at the level of the magnetosphere, in particular as an evolution of plasma sheet leading to a magnetospheric model of self. This conforms with the fact that the anatomy of brain has not changed during this period appreciably and explains also the huge differences between chimpanzees and humans despite the fact that genomes are almost identical. An interesting question is whether the known temporary lowering of the temperature by several degrees for 10^4 years ago correlates with the magnetospheric dynamics and whether it might have initiated an evolutionary process in the magnetosheet with profound consequences.

Plasma sheet, imagination, dreams, and hallucinations

It would be rather strange if brains would be out of use almost half of the lifetime. Rather, one would expect that the magnetic Mother Gaia uses our brains for information processing purposes during sleep. Imagination and the construction of self model is the most plausible guess for the information processing involved. Dreams could be seen as sensory representations for this imagination.

It has become clear that dreams are cognitive activities involving frontal lobes in an essential manner. A considerable portion of dreams is known to be simulation of the situations encountered during the wake-up state. During daytime the information flow is dominantly from the sensory areas to the frontal lobes but during dreaming the direction is opposite. Brain stem makes dreaming possible but does not dictate the contents of dreams. Translating this to the level of magnetosphere one ends up with the conclusion that dreams and hallucinations are indeed communications from the magnetospheric self to the level of individual self. This view is completely consistent with the general vision of Jaynes [69] formulated in TGD framework using the notion of semitrance (which is essentially sharing of mental images by quantum entanglement).

As opposed to the relatively high stability of the inner magnetosphere making it suitable for sensory and memory representations, the dynamics of the plasma sheet is rather unstable and self-organizing. This is indeed what imagination requires. The gradual loss of spontaneity and ability to imagine during ageing could in this framework be understood as the gradual shift of the control

from outer magnetosphere to the inner one. This would mean also gradual fixation of the self narrative when person 'finds herself': or equivalently ending up to an asymptotic self-organization pattern also at the level of local plasma sheet self-representation. Imagination should not interfere with sensory input and also this condition is satisfied in the plasma sheet.

Moon has also a magnetosphere, and during the period (three days), when the moon is inside the magneto-tail of Earth, the conscious magnetospheres of moon and Earth interact. Perhaps this interaction could provide a justification to the belief that the phase of the moon has strong effects on consciousness of some sensitive persons.

Are the magnetospheric counterparts of brain circuits possible?

Brain is filled with circuits and there is a heavy feedback from cortex to midbrain and connections between various regions of brain. Also this circuitry should have a magnetospheric counterpart. Magnetic flux tubes define in a natural manner the counterpart of the neural circuitry (magnetic circulation should be present also in brain and represent the deeper quantum control level of neural signalling). Supra- and also ohmic currents running through, say, plasma sheet would provide a representation for their previous history. Even the quantum level counterparts of nerve pulses as solitons propagating along a pair of magnetic flux tubes connected by Josephson junctions realized as join along boundaries contacts are possible.

The supra currents emerging at Northern and Southern latitudes from the inner core, which is the magnetospheric counterpart of thalamus, are especially interesting since the flux tubes can lead anywhere in the magnetosphere. An interesting question is whether the leakage of ions in the polar regions could be somehow analogous to what happens when nerve pulse is transferred from neuron to another one. One can also wonder whether two parallel magnetic flux tubes with join along boundaries bonds between them defining Josephson junctions could carry soliton sequences associated with the phase difference of the super-conducting order parameters. These soliton sequences represent the deeper control signal giving rise to nerve pulse conduction in TGD based model of EEG and nerve pulse [23]. If so, then even the quantum counterpart of nerve pulse conduction might make sense at magnetospheric level.

The finding that plasma sheet indeed contains what might be called features [51], supports the view that this kind of representation mechanism might be involved. Similar findings are predicted at magneto-pause. Supra current circuits would be optimal in this respect. Higher harmonics of proton cyclotron frequency generated by transitions in the plasma sheet and magneto-pause could induce the feedback to the inner magnetosphere and even the resonance condition $f_m = c/L$ might be satisfied. This mechanism could also allow communications between various areas of the magnetospheric brain. The communication at 40 Hz frequencies between inner core and inner protonic radiation belt would be the magnetospheric analog of thalamocortical resonance.

Fractality inspires some speculations about the general structure of the magnetic circulation. For instance, does thalamus act as the magnetic dipole core of the nervous system? In particular, do the cortical neural loops from thalamus correspond to closed dipole lines at the day side and do the axons to the body define the thalamic counterparts of the magneto-tail? Do all nuclei of brain correspond to magnetic dipoles and does the neural circuitry follow field lines in reasonable approximation?

Plasmoids as living magnetic creatures?

Dipole type magnetic field is of course a huge idealization. For instance, plasmoids carry torus like magnetic flux configurations. In TGD Universe these structures could be regarded as higher level electromagnetic life forms. The flux tubes of magnetic field can form extremely complex knotted and linked structures. This topology provides almost enormous representational capacity and one can wonder whether the opportunistic Nature could really have failed to notice this opportunity.

Perhaps the simplest plasmoids (even ball lightning!) might be regarded as the magnetic counterparts of the simplest monocellulars. Note that small plasmoids should be generated also when supra-currents in bio-matter leak out from the magnetic flux tubes. Neural circuits might be accompanied by plasmoids responsible for the self-organization of the ordinary matter around them. Microwaves are effectively the 'food' of plasmoids and if magnetic flux tubes carry a magnetic field of order .2 Tesla, the cyclotron transitions of electrons generate microwaves at the upper limit 2.4 GHz for microwaves hearing, so that these plasmoids could generate their 'food' themselves. Sun has

magnetic field of order .1-1 Tesla in the convective zone and might be ideal place for the plasmoid like life forms of this kind.

Also the dropping of ions from $k = 151$ space-time sheet to larger space-time sheets generates microwaves (zero point kinetic energy), and this process is probably part of self-organization as suggested by the scaling law of homeopathy and the model of microwave hearing based on the scaling law $f_h/f_l = c/v = 2^{137-k} \times 2 \times 10^{11}$ giving $v = 6$ m/s for $k = 151$ (alpha wave phase velocity at the surface of skull).

Sun generates plasmoids, especially so during magnetic storms. plasmoids consist of closed magnetic flux tube structures and can be seen as conscious creatures leaving heliomagnetosphere and entering into the interstellar space. Also the plasma sheet of Earth's magnetosphere generates plasmoids which would become thus magneto-ETs containing as its crew sensory representations about ordinary living organisms at Earth. Perhaps also solar plasmoid like structures could provide living documents about solar magnetospheric history and contain similar sensory representations. Sharing of the plasmoid mental images by quantum entanglement would make possible for the magnetospheres of Sun and Earth to extend their senses to the entire cosmos.

Also ET experiences might have interpretation as a sharing of mental images induced by encounters with the plasmoids generated during the tectonic activity. The visible pseudo UFO itself could be the plasmoid generated by the leakage of supra currents from magnetic flux tubes, when the flux tubes in the stream of magnetic flux from the spot of the tectonic activity reconnect with the flux tubes of the personal sensory magnetic canvas or with those of Earth's magnetic field. Also genuine UFOs might be plasmoid structures emitted from the plasma sheet of some planet of a distant stellar system which have managed to penetrate through the cusp region of the magneto-pause of Earth, which serves as a magneto-immune system preventing the penetration of solar and other interplanetary magnetic life forms inside magnetosphere!

The somewhat ghostly crew of a magneto-UFO could consists of magnetospheric sensory representations for the inhabitants of this planet but this would not diminish the reality of the experience. Space travel of mental images would not require transfer of huge amounts of fuel through cosmos and light velocity would not be a limitation for the communications. There are good reasons to believe that higher levels of the self hierarchy have discovered mental space travel long ago if even we have been able to invent it!

There is however evidence for 'metallic' UFOs too. TGD based model [18] for the strange anti-gravity like effects observed in rotating magnetic systems [75] leads to a mechanism which might be behind flying saucers. The basic idea is that the space-time sheet of rotating magnet is connected to the space-time sheet carrying Earth's gravitational field by join along boundaries bonds, one can visualize them as threads connecting the rotating system to the environment. Along these threads the gravitational flux created by the magnet flows to Earth's space-time sheet and these threads mediate the gravitational interaction.

Rotation causes the entanglement of the threads and when the rotational speed becomes high enough, the threads begin to split. This means that the ends of the split threads become carriers of negative and positive gravitational mass. Effectively the gravitational mass of the magnet system remains to the Earth's space-time sheet and the mass of magnet system itself decreases and angular momentum conservation implies an acceleration of the spinning motion (pirouette effect). If the inertial mass is equal to the gravitational mass as Equivalence Principle requires, one gets a system which is light as a feather!

One can wonder whether this could provide a mechanism making possible flying saucers. For instance, the rotating system could liberate some of its chemical energy to generate a very fast motion. It could also accelerate and change direction of motion very quickly. The strange properties of UFOs suggest that if they are really flying saucers, a reduction of the inertial mass is indeed involved. Thus one might think of the possibility that plasmoid like structure and a more rigid structure accompany each other in some cases. The rotating magnet system involves also plasma near its outer boundary and would in this case be due to acceleration of ions in radial electric field generate by the rotating magnet. Plasmoid like structures indeed involve magnetic flux tubes and this suggests that they could rotate rapidly and in this manner reduce their gravitational mass.

What about abduction experiences? Could they be mere quantum telepathy or do they represent real encounters with plasmoid like life forms? And what about the claimed Roswell case involving a 'traffic accident' of UFO and dead bodies of aliens? The TGD based model for crop formations [23, 26] suggests that parallel space-time sheet do not only carry supra currents but could be inhabited!

Plasmoid like life forms would be much like ordinary life forms with DNA and proteins at magnetic flux tubes. The Chilbolton and Crabwood crop circles allow to even deduce rather precise information about the genetic codes of these life forms, and the second genetic code involves 80 DNAs and 23 aminoacids. This would mean that the civilization in question might be at a much higher evolutionary level than we are, and could have developed antigravity technology for long time ago. This forces to consider the possibility that abduction experiences are real interactions between life forms living at different space-time sheets.

Plasmoids in laboratory

It seems that one of the most craziest predictions of TGD inspired theory of consciousness has been realized at laboratory. Quite recent report tells about plasmoids generated in a simple diode involving plasma generator creating plasma column between itself and the positively charged anode [75]. The plasmoids are self-organizing structures able to evolve in a period of few microseconds. They possess many properties that life forms are expected to have. Plasmoids

1. grow from micrometer size up to cm size,
2. replicate by simply dividing into two pieces,
3. have an outer negatively charged surface separating the positively charged interior from the environment and obviously analogous to the cell membrane. Hence the plasmoid is analogous to a capacitor, and the exchange of matter with the environment could correspond to a di-electric breakdown essential for qualia in TGD based model of the sensory receptor,
4. possess a metabolic cycle involving the transfer of matter between the interior of the plasmoid and environment. This cycle is seen as a periodic generation of visible light at specific frequencies: the light balls are typically found to be red or yellow. The frequency of metabolic oscillations is at 25-45 kHz frequency range,
5. are able to communicate by generating electromagnetic radiation by inducing vibrations in the receiving plasmoid at the same frequency.

These findings give valuable hints concerning the more detailed modelling the "biology" of plasmoids. Plasmoids are in a key role in the TGD inspired model of pre-biotic evolution discussed in [19]. For instance, one can ask whether the preferred colors might be interpreted in terms of quantized increments of zero point kinetic energies liberated when atoms or ions (such as C, N, and O) drop from the hot $k = 131$ space-time sheets (temperature being of the order of the zero point kinetic energy) to larger space-time sheets.

2.5.4 Some applications

Also applications provide tests for a theory and below some tests for the notion of magnetospheric consciousness are discussed.

Space traveller consciousness

The understanding of the basic facts about EEG on basis of resonance condition suggests that magnetospheric representations are there. The resonant magnetospheric representations cannot however be the whole story since this would mean spectacular effects on the sensory consciousness of space travellers. Long distance space travelling might be even impossible without dramatic effects for consciousness. The distance to the moon corresponds to $d \sim 60R$ and in the interstellar space moon travellers should have experienced these effects. The fact that moon and space travellers have survived (although some of them have reported strange experiences and Edgar Mitchell has even founded Noethic Institute for the study of consciousness!) forces to consider the notion of resonance very critically.

The most realistic assumption is that our sensory representations are realized on personal magnetic bodies rather than that of Earth. This magnetic body would follow the space traveller. The representations at the magnetic sensory canvas defined by Earth's magnetic field are there but contribute mainly to the consciousness of the magnetic Mother Gaia and other higher level selves. These representations contribute also to our consciousness via the sharing of the mental images. The fact

that $B_{end} = 2B_E/5$ corresponds to the magnetic field strength explaining the effects of ELF em fields on matter supports this hypothesis.

Obviously, the study of consciousness of space travellers should provide valuable information about the importance of the magnetospheric contribution to the consciousness.

NDEs and OBEs

The distinction between out-of-body experiences and ordinary sensory experiences is a challenge for any model of sensory representations. Out-of-body experiences are associated with NDE experiences during which sensory input is absent and standard neuroscience suggest that brains do not contribute to the conscious experience. The characteristic aspect of out-of-body experience is third person aspect. This supports the naive conclusion that personal sensory magnetic canvas is not responsible for OBES but that third person perspective involves entanglement with the mental image of the magnetic Mother Gaia about us. We would share the mental image of Mother Gaia about us. Even in the case that our personal sensory magnetic canvas ceases to exist, the magnetospheric representations would continue to exist. Also the deceased relatives encountered during NDEs could be magnetospheric mental images about them.

An interesting little sidetrack is perhaps allowed here. Stopping of breathing is the crucial step in the process leading to the physical death. The magnetic particles in lungs generate magnetic field with strength of order 10 nT: a magnetic field of same strength prevails also in plasma sheet and night side magneto-pause so that magnetic mirror communications at protonic cyclotron harmonics are possible between lungs and plasma sheet. The rhythm of breathing is in delta range which belongs to the range of frequencies representable in magneto-tail. Could it be that there are direct ME projections from plasma sheet to lungs at delta band and that the control of breathing involves these MEs and that the command leading to the physical death is sent from plasma sheet? Could it be that the 'primitive' association of soul with breathing might carry some deep truth in it?

Relating the model to personal experiences

My personal altered states of consciousness have been a continual source of inspiration and challenge during the development of TGD inspired theory of consciousness. In the following I propose a model for the flow experience, which I have practically always when I close my eyes.

1. *The experience*

Especially inspiring has been the visual experience about complex background flow which becomes visible when eyes are closed. This experience does not seem to correlate with the sensory input although in light illumination the flow is brightly colored and the color varies in an unpredictable-by-me manner. The flow is most intense when I am in a calm state of mind and especially strong under creative periods of theory building. The flow contains in its 'unexcited' state a 'third eye' component, kind of a tunnel, to which the flow seems to converge. This sink can temporarily transform to a source. The disk like sink can also transform to a slit like sink. In a more aroused mental state the flow becomes very complex containing sources and sinks. The flow becomes also rotational: in particular, the flow whirls to the sink or from the source as a vortex.

I experience the background flow also at night time and there seems to be no sharp night-day difference. During night time immediately after wake-up I can also see very clear and beautiful organized abstract geometric patterns (like lattices) which vary very slowly. During my 'great experience' the flow served as a background for vivid hallucinations. The hallucinatory contributions were superposed to the ordinary sensory input and these contributions were more or less independent from each other.

The complex, unstable background flow carries high resemblance to an incompressible hydrodynamic flow. Also magnetic field satisfies condition analogous to the incompressibility condition for the hydrodynamic flow ($\nabla \cdot B = 0$). Hence the question has been whether this flow actually represents hydrodynamical flow, endogenous or exogenous magnetic field and supra current flow along its flux tubes, or whether it is a representation for a background neuronal activity which is usually not so strong.

2. *The explanation*

The most plausible interpretation for the experience is based on the observation that the background flow is best visible when eyes are lightly closed. This means that there is probably some amount of 40 Hz activity without definite sensory input and that alpha band dominates.

1. The flow represents alpha signal from the sensory canvas to brain mediated by Schumann resonances and is so weak because 40 Hz resonance is weak with closed eyes. The signal is masked by visual input when eyes are open. This mechanism explains also dreams and hallucinations as communications from various levels of magnetosphere via brain to the inner radiation belt and conforms with the semitrance model of bicameral consciousness.
2. The flow represents electronic supra-current flow running parallel to the magnetic flux tubes of the outer radiation belt. This flow could in turn represent the magnetic state of brain or body. The 'third eye' contribution could represent the supra currents converging to the spinal cord. Or the vision could represent cortical magnetic flux tube structure converging to the thalamus serving as the basic dipole core of the brain's magnetic field. Higher level selves might in fact represent it more or less automatically.
3. The presence of the hallucinatory component during great experience could be interpreted as additional communication from the magnetic sensory canvas via brain to the inner radiation belt. The simultaneous presence of both 40 Hz and alpha band vision would differentiate this period of a very intense brain activity from the experiences in which only alpha or gamma vision is present.
4. Also hypnagogic experiences which are sometimes transpersonal (I experience of being genuinely someone else) occur when alpha band dominates. This encourages to think that the amplification mechanism is based on Schumann resonance made possible by unusually strong coupling between magnetosphere and personal magnetic canvas: this coupling would become strong during creative periods. The correlation of the alpha band dominance with creativity is standard folk wisdom at least. Also this supports the view that communication from the outer radiation belt to brain and from brain to the first radiation belt is involved.

Besides the lowest 7.8 Schumann resonance also the second 14 Hz sleeping spindle Schumann resonance might be involved: I am often told that I have been sleeping when I have been sitting and thinking for a long time (I disagree strongly!). 14 Hz sleeping spindle Schumann resonance corresponds to $n = 3$ protonic cyclotron resonance and the electronic spin flip resonance at the electronic flux maximum $r = 4R$ in the outer radiation belt.

5. The night time vision about highly symmetric slowly varying lattice like structures might in turn correspond to a situation in which the self-organization pattern in plasma sheet is projected to brain in theta or delta band and from brain to the first radiation belt. Also now the lattice like patterns in plasma sheet might represent the state of brain or body.

2.6 Fatima Marian Apparitions and TGD inspired theory of consciousness

The MARIAN Project is an acronym form Multicultural Apparitions Research International Academic Network. Its funded on the data and results obtained by the trilogy books by the Portuguese historians Fina d'Armada and Joaquim Fernandes, since 1982 to 2002 [76]. There is also a book by Vallee [72] about Fatima apparition phenomenon.

The Project will take a deep look into a few clues, such as:

1. Identities and differences among human extraordinary experiences, i.e. OBEs, NDEs, AASs (Alien Abduction Scenarios) and MAs (Marian Apparitions), from the narrative, hermeneutic and sociopsychological levels and also cultural/religious backgrounds;
2. Neurophysiological details and all experimental elements that could be tested in laboratory, as the very common "buzzing" sounds heard by several witnesses at Fatima spot near the oak contact only when the Lady, according to Lucia, was speaking with her. This is the most hard clue ever depicted for a case of an hypothetical geomagnetic variables influence (very low magnetic fields?) tested in lab. by Michael Persinger and his team in Laurentian University [86].

In the sequel I shall comment Fatima Marian Apparition from the point of view of TGD inspired theory of consciousness. I base the discussion on what I learned about Fatima Marian Apparition via email exchanges with Joaquim Fernandes and some web sources. The basic data items used in the sequel are following.

Three children, Lucia, Francisco, and Jacinta met a brilliantly effulgent lady whom they identified as the Virgin Mary. This occurred six times at 13th of each month. The so called Sun miracle was witnessed by people in a large area measured about 20-30 miles (it is estimated that about 70.000 people congregated in the vicinity of Cova de Ira to witness the predicted miracle!).

The witnesses reported a light tunnel and little image of Mary at its center. Also reported were heat waves with sudden drying of clothes, healings, fall of white filaments ("hair angle"), and a strange auditory sensation defined by some witnesses as a "buzzing of bees within a vase". This sound was heard *only* when the seer Lucia told that "the Lady was talking to her *without* moving the lips". Also glowing globe-shaped vehicle appeared suggesting a similarity with UFO experiences.

2.6.1 General TGD based model

The TGD based model for Fatima Marian Apparition relies on the notion of self hierarchy allowing identify the entity 'Maria' as a collective higher level self, a real conscious field entity receiving information from human brains by TGD counterparts of EEG waves, realized perhaps in magnetosphere. The visions and also some experiences of witnesses could involve in an essential manner quantum entanglement with 'Maria' allowing sharing and fusion of mental images: no classical communication is needed. Quantum entanglement is the basic mechanism of remote mental interaction and remote healing: the occurrence of healings during Fatima apparitions were indeed reported. Microwave static, known to correlate with taos hum phenomenon involving sometimes also buzzing sounds [51], is a possible candidate for the inducer of TGD counterparts of intense EEG waves by a general mechanism to be discussed. Also tectonic activity could have generated microwaves. Microwave static explains the buzzing sound as microwave audition [81]. The presence of a plasmoid like structure serving as a relay station entangling with both seer and 'Maria' could have generated light at visible and infrared frequencies and induces effects like heating and drying.

Self hierarchy and collective levels of consciousness and 'Maria' as a conscious field entity

The basic notions of TGD inspired theory of consciousness are quantum jump between quantum histories identified as a moment of consciousness and self, which is essentially a pile of quantum jumps integrated to single experience. The sequence of quantum jumps corresponds to subjectively experienced time which is in principle separate from the geometric time of physicist.

The preservation of self identity means that self does not generate bound state entanglement with the external world and remains thus quantum autonomous system during the subjective time development by quantum jumps. The generation of entanglement leads to a loss of consciousness: one can say that everything is conscious but consciousness can be lost. Selves form a hierarchy having the hierarchy of space-time sheets as a geometric correlate. Fusion of two space-time sheets by join along boundaries bond is the geometric correlate for the generation of entanglement. Sub-selves of two separate selves can entangle and this results in a fusion and sharing of a common mental image. This mechanism provides a general explanation of various remote mental interactions, such as telepathy, remote healing, and collective experiences. Also phenomena like apparitions and UFO experiences can be explained in terms of remote mental interactions.

In TGD universe any system has besides the visible, physical, body also field (magnetic) body, which has much larger, actually astrophysical size in the case of humans. What I call personal sensory representations are realized at the personal magnetic body of astrophysical size. Second type of sensory representations (third person view) would be realized at the magnetosphere of Earth and would give rise to multi-brained electromagnetic selves representing collective levels of consciousness. Amazingly, plasma sheet at the night side of Earth's magnetosphere is known to be a highly self organizing structure and the ionic velocity distributions represent features like 'eyes' and 'wings' [51]. Even religions could represent to collective levels of consciousness having a rich repertoire of mental images like Maria and saints.

The simplest working hypothesis is therefore that the entity 'Maria' is self, a completely real conscious entity, at a higher level of self hierarchy. In TGD framework any self defines a mental

image of higher level self having it as a sub-self. The conscious entity 'Maria' could communicate with humans using quantum entanglement making possible telepathic sharing and fusion of mental images.

1. The most obvious identification of 'Maria' is as a mental image of a collective multi-brained consciousness realized at the magnetosphere and having only the field body. This would explain the cultural, standardized aspects of the vision.
2. One can consider also the hypothesis that the luminous 'Maria' was analogous to UFO and in TGD framework identifiable as plasmoid, electromagnetic life form in TGD Universe, in the lower atmosphere, perhaps generated by tectonic activity. The physical effects associated with Sun miracle indeed suggest the involvement of a plasmoid like structure. The identification as Virgin Maria would thus reflect only the cultural background. It is however not obvious how plasmoid like primitive conscious entity could have predicted the occurrence of Sun miracle beforehand.
3. A compromise of this views is that plasmoid like structure was involved and served as a relay station entangling with both seer and 'Maria', just like in TGD based model of UFO experiences. This option gives better hopes of explaining the physical effects involved and allows a lot of freedom in the identification of 'Maria': even the identification as an extraterrestrial becomes possible.

Many-sheeted space-time, topological field quantization, and extraordinary experiences

In TGD Universe space-times are 4-dimensional surfaces of certain 8-dimensional space-time. Many-sheeted space-time is the basic prediction of TGD and means roughly that various structures that we see in various length scales correspond to space-time sheets with outer boundary glued by tiny wormhole contacts to larger space-time sheets representing larger structures containing them.

Topological field quantization distinguishes between TGD and Maxwell's electrodynamics. What happens is that em field and classical fields in general decompose into flux quanta represented by space-time sheets. For instance, radiation field decomposes into cylindrical structures carrying em fields propagating with light velocity. These structures ('massless extremals', MEs [40]) are ideal for classical communications: classical signal propagates with light velocity inside a cylindrical tube and without weakening making high precision targeted communication possible, and the non-determinism of the associated vacuum current propagating also with light velocity allows a coding of arbitrary signal. At quantum level MEs serve as field bridges making possible quantum entanglement allowing sharing and fusion of mental images among other things. The mirror mechanism of long term memory relies on MEs allowing entanglement between geometric past and now and resulting in sharing of mental images.

Magnetic flux tubes and their electric counterparts represent also general solution families to field equations [44, 43]. The flux tubes of Earth's magnetic field are super-conductors in TGD Universe and this super-conductivity is crucial for life. Closed magnetic flux tubes plus ions and their electric duals (involved with bio-electrets and liquid crystals and also with cell membrane) are the fundamental electromagnetic life forms around which ordinary bio-matter self-organizes.

Magnetic flux tubes are an essential element of the model of sensory representations on magnetic sensory canvas. Schumann resonances transmit horizontal communications between brains and could make possible collective shared experiences characteristic for Fatima case. Hypnagogic states give also rise to analogous experiences and probably involve Schumann resonances. The nodes of the super-conducting circuitry formed by the magnetic flux tubes could be of special importance for phenomena involving communications with higher levels of self hierarchy. Therefore special geomagnetic features should characterize the places where apparitions occur.

Water has an especially complex many-sheeted space-time structure and the proposal of A. Brodziak [71] is that the spring water associated with places where apparitions have occurred plays some important role. We ourselves consist mostly of highly self-organized water and it would not be surprising if water would have varying degree of self-organization depending on external parameters such as the structure of the local magnetic field. Perhaps highly self-organized water helps to generate the quantum entanglement.

There are strong resemblances between TGD based models for UFO experiences, NDE experiences and Marian apparitions. Also in the case Fatima apparition structures which might have been interpreted as UFOs in our cultural context appeared and even 'Maria' could have been interpreted as

UFO in modern cultural context. The TGD based model of UFO experiences discussed involves in an essential manner quantum entanglement between conscious electromagnetic entities (plasmoids), and unifies Persinger's theories [86] with the view that ETs are real, although not in the sense usually thought. Plasmoids could be seen as advanced counterparts of spaceships having a rather ghostly crew consisting of mental images (sub-selves) entangled with the magnetosphere of some distant astrophysical object serving as its telesensory system and able to entangle also with the person having UFO experience. Translating directly to this case this would mean that plasmoid like structure in the vicinity of the apparition place would have served a role of relay station entangling with both seer and entity 'Maria', which could have been even extraterrestrial intelligence.

Did 'Maria' communicate quantumly or classically?

Taking seriously the idea about 'Maria' as a collective conscious entity and a mental image of some collective self communicating from magnetosphere, one is led to ask how this communication could have occurred.

1. If the communication occurred purely quantumly just by entangling collective mental image/self 'Maria' with the mental image of the receiver, the topological field quanta of EEG would have acted only as entanglers but not as carriers of classical information. This mechanism is extremely robust since there is no need to code information to a classical signal. TGD based model of long term memories relies on this mechanism. Very metaphorically: to have a long term memory from moment two years ago is to look at quantum mirror at distance of one light year. The attribute 'quantum' means a telepathic sharing of mental images between sender and receiver. No storage of memories of past to recent moment of geometric time is needed. The immediate implication is that length scales of order light life are relevant for human consciousness: against this background magnetic sensory canvas hypothesis does not look so radical.

In this case the task is to generate topological field quanta of EEG which are intense enough to generate sufficiently stable and long lasting bound state entanglement between 'Maria' and receiver making possible sharing of mental images by quantum entanglement. This requires only that a sufficient amount of energy is transformed to the energy of EEG MEs at definite resonance frequencies so that the mechanism is very robust. plasmoid like structure could have served as kind of relay station entangling with both seer and 'Maria' and perhaps also inducing at also visible radiation inducing heat waves and drying effects. Microwaves are not plausible candidates for causing heat waves since they might have caused too much biological damage.

2. One can imagine also classical, non-telepathic communication in which topological field quanta (topological light rays) carry classical signals regenerating the sound percepts in the brain of the receiver. This model raises many challenges: what is the code of communication for the classical signals, how the sender can resolve the problems caused by the fact that this code probably depends on receiver (by feedback one might hope), etc... Clearly, Occam's razor does not favor this option.

What was 'real' and what was 'hallucinatory'?

The basic question relates to what reported effects had local physical correlates and which represented shared mental images. The microwaves possibly explaining the buzzing sound should have been real. The buzzing sounds themselves could have been purely endogenous. The reported glowing globe-shaped vehicle might have identification as a real plasmoid like structure. Even what was identified as 'Maria' could correspond to a plasmoid like structure in the vicinity of the place of apparition. The 'Sun turning around' is an excellent candidate for a plasmoid like structure. The radiation responsible for effects like heat waves and drying of clothes must have been real and perhaps induced by plasmoid like structure emitting at least visible light resulting in ionization of the atoms of atmosphere.

Collective sharing of mental images with plasmoid like structure entangled with 'Maria' could explain the collective 'hallucinatory' aspects of the experience. These self-organizing conscious structures could reside also in the outer magnetosphere, say in the plasma sheet at the night side of Earth [62]. The reports about light tunnel with the image of little Mary at the center and about pouring of flower petals would suggest a collective experience based on the sharing of mental images.

Healing effects

TGD provides a general theory of remote healing relying on quantum entanglement occurring even in astrophysical length scales and involving collective selves [22]. There is support for the view that remote healing is possible even when the healer does not know the patient personally or where the patient lives. As if there would be a third party involved, a collective multi-brained higher level self, for whom the data, which is insignificant for healer, makes sense. Also the well documented healing effects of prayer and meditation groups can be understood if there is this third party. In this case this collective self would be 'Maria'.

2.6.2 The mystery of the buzzing sound

The witnesses of Fatima Marian Apparition report buzzing sounds like bees in a vase. It would be interesting to determine the frequency spectrum of the buzzing sound produced by bees: presumably it results from the periodic motion of wings. Also one could test how strongly the sensation depends on the average frequency and to what degree the shape and phase relationships of Fourier spectrum are responsible for the sensation.

Meteor sounds, taos hum, and physiophonic sounds

The buzzing sound might relate to several other strange sound phenomena like meteor sounds, taos hum, and physiophonic sounds. These exotic sound phenomena are discussed in [37].

1. A strange finding supporting the TGD view about sensory representations is that, contrary to expectations, the sounds generated by em fields of meteors have fundamentals around 40 Hz thalamocortical resonance band responsible for sensory representations [67]. This sound is like 'pop', not buzzing, but frequency spectrum might be nearly the same. One might check whether 40 Hz frequency band is involved also with the buzzing sound produced by bees.
2. Taos hum [51] is a strange phenomenon which might relate to the microwave audition. No source for this sound, which has frequency spectrum in the range 40-80 Hz, has been identified. Taos hum seems to be an endogenous sound generated by classical em or Z^0 field which does not penetrate outside the body. Buzzing sound is also sometimes associated with taos hum. If the buzz has the character of taos hum, this would require that sounds heard also by the witnesses were endogenous and not recordable by microphones. There is strong correlation between taos hum and so called microwave static having poorly understood biological origin [51].
3. Physiophonic sounds are endogenous sounds produced by electric stimulation of skin. One can transform speech to electric signals applied to skin and experienced as comprehensible speech. Physiophonic sounds are probably closely related to taos hum.

Microwave hypothesis

It has been proposed [76] that so called microwave audition [81] could be involved with the mysterious buzzing sounds reported by witnesses of the Fatima Marian Apparitions. There exists a standard physics explanation for microwave audition based on thermal effects caused by microwaves inducing small pressure pulses [81]. This explanation is however subject to objections to be discussed later and TGD suggests an alternative mechanism.

According to [76] French and Canadian researchers have found interesting results using a source of microwaves on the subjects heads: one of the sounds type heard was a "buzzing". The source was between 200 and 3000 MHz with a mean intensity of from 0.4 to 2 mW/cm^2 to a density level of above 300 mW/cm^2 . The modulating frequencies ranged from 200 to 400 Hz. According to [76], the insect sounds resulting from the motion of wings could be put between that interval. An order of magnitude for the resonance frequency of body guessing the sound velocity to be $v = 300$ m/s in body and body to have a size of order $L = 1$ m is $f \sim v/L = 300$ Hz. Microwaves could correspond to microwave static of biological origin [51] or be generated by plasmoid like structures.

Microwaves has been proposed as an explanation for the other physical effects reported in Fatima apparitions, namely those associated with the so-called Sun miracle when the people saw the "Sun" turning around itself and produce a heat wave that dry the soil that moments before has been wet by

a sudden rain, as well the clothes of people in the spot, also wet. The problem with this explanation is that microwaves with the required intensity might have had drastic physiological effects: there is no known evidence for this. A more plausible explanation is that the plasmoid like structure playing the role of entanglement relay station induced these physical effects at visible and infrared wave lengths and was erratically identified as Sun. Ionization of atmosphere would have indeed induced emission of visible light.

Most importantly, microwaves could accompany EEG MEs by a mechanism to be discussed later: these topological field quanta in turn make possible quantum entanglement and sharing of mental images. Topological field quanta corresponding to 40 Hz resonance band are especially interesting candidates in this respect since in TGD based model they are responsible for sensory representations at magnetic sensory canvas.

2.6.3 Microwaves, consciousness, and life

The TGD counterparts for strong EEG waves are topological field quanta (electromagnetic bridges or topological light rays connecting seer with "Maria") generating quantum entanglement making possible the sharing of mental images. Also witnesses could participate in the vision (image of Mary in the center of the cylindrical light tunnel, Sun turning around). Microwaves received by the brain and possibly by the body of the seer and also witnesses (creating sensation of buzzing sound) could have generated topological field quanta of EEG waves and induce as a byproduct also microwave hearing [81] responsible for the sensation of buzzing sounds.

Support for the importance of microwaves

Microwaves span the wavelength range 1 mm -30 cm corresponding to the frequency range 300- 1 GHz. Note that the size of the dots in X-ray film was of order one 1 milli-meter and corresponds to the upper limit of 300 GHz for microwave. There is support for the importance of microwaves for living systems coming from various anomalous phenomena involving microwaves.

1. Microwaves in GHz range are found to be involved with water memory and homeopathy [68]. Microwave frequencies are accompanied by ELF frequencies such that the high and low frequencies f_{high} and f_{low} are related by the scaling law to be discussed later.
2. Microwave hearing [81] is a phenomenon in which microwaves in the frequency range .2-3 GHz (wavelength range 150-10 cm) induce a hearing sensation. There is evidence that ears are not involved with the microwave hearing [79]. The average pressure of the radar wave at the threshold of hearing is roughly three orders of magnitude less than the average pressure of a sine wave in air at the threshold of hearing air waves. Second, the location of the most sensitive area for hearing radar is remote from the ears, on top of the head. Third, the subjective frequency spectrum seems to include higher frequencies for radar hearing than for normal hearing of air waves. Fourth, the direction from which sound seems to come does not change as the head is turned about in the radar field.
3. Microwave static of biological origin having strong correlation with taos hum [51] and taos hum could be seen as a particular case of microwave hearing [37].
4. The proposal of Joaquim Fernandez [76] that microwave hearing would also explain the strange buzzing sounds reported by the witnesses of the Fatima apparitions served as a clue to the TGD based model of this phenomenon. The model led to the realization that quite a many apparently unrelated phenomena rely on a general mechanism of remote mental interactions in which microwave MEs propagate like mass-less particles inside ELF MEs, which generate the entanglement between remote subjects and thus make possible sharing of mental images and remote realization of intentions. Microwave MEs in turn induce self-organization at the end of the receiver. The same mechanism is involved also with the endogenous realization of intentions and remote healing.

Breaking of super-conductivity in many-sheeted space-time and microwaves

The transfer of charged particles between space-time sheets is possible provided so called join along boundaries bonds connecting the boundary of a smaller space-time sheet to the boundary of a larger space-time sheet are generated [27]. Particles simply flow along this bond connecting the space-time sheet to the larger space-time sheet, say magnetic flux tube, and also vice versa. This mechanism leads to the breaking of super-conductivity since super-conducting matter from the magnetic flux tubes, which can be at extremely low temperature, flows to the atomic or possibly some other space-time sheets.

Microwave radiation could generate join along boundaries bonds. The energies of microwave photons in the wavelength range 1-100 mm are in the range $10^{-5} - 10^{-3}$ eV and correspond to the temperature range .1-10 K. The critical temperatures for low temperature super-conductors are in this range. One can interpret this by saying that super-conductivity is not destroyed by the heating of the magnetic flux tubes but by the generation of the join along boundaries bonds with bond energy of order of the gap energy causing the leakage of the supra current to non-super-conducting space-time sheets and thus inducing dissipative effects.

Microwaves and biological control circuitry

The basic vision of the TGD inspired theory of consciousness [26] is that everything is conscious and consciousness can be only lost. This philosophy naturally leads to the view that plasma structures consisting of closed magnetic flux tubes plus atomic space-time sheets containing plasma ions represent primitive life forms. All life forms metabolize. In the case of plasmoid like life forms micro-waves induce a primitive metabolic cycle in which ions are transferred from the magnetic flux tubes to atomic or some other space-time sheets, where they dissipate and induce ionization and UV and visible light and then "drop" back to the magnetic flux tubes. If the intensity of the magnetic field is about .2 Tesla, which by the quantization of magnetic flux, corresponds to p-adic prime $k = 157$ and p-adic length scale of 80 nanometers), electronic cyclotron transitions generate microwaves with frequency of about 2.4 GHz and the system can thus generate its "food" itself.

Microwaves can also "kick" ions from magnetic flux tubes to $k = 151$ space-time sheets since the zero point kinetic energies for $k = 151$ correspond to microwave frequencies. It seems that the process involves at least the following space-time sheet: $k = 137$ (atomic), $k = 151$ (cell membrane), $k = 157$, and $k = 169$ (magnetic flux tubes of Earth's magnetic field). UFOs are often observed near the lines of the tectonic activity could represent this kind of life form using the energy of microwaves of tectonic origin (quartz crystals are piezoelectrics and can amplify wide range of microwaves) as their "food" and therefore following the microwave beam emanating from the spot of tectonic activity. Also the UFO like structures associated with the Fatima apparition could be plasmoid like life forms.

In the living matter the same simple biological Karma's cycle has developed to an extremely complex many-sheeted circuitry in ionic flow equilibrium and controlling the homeostasis [18]. Microwaves radiated in the conformational transitions of proteins and possibly amplified by the rotational transitions of water molecules and clusters of them mimicking the rotational spectra of molecules generate bridges connecting super-conducting space-time sheets and atomic space-time sheets and thus sustain the dynamical circuitry. If some protein fails to be expressed genetically, this implies the absence of certain microwave frequencies so that corresponding bridges are not present and erratic functioning of the current circuitry result. Medicines and homeopathic remedies in which water clusters mimic the rotational spectrum of the medicine molecules generate the microwave spectrum of the proteins, which are not expressed.

The average number of the bonds per say area element is the natural measure for the effectiveness of the bridge, and the increase of the microwave radiation intensity at some frequency increases the effectiveness of the corresponding bond and thus modifies the homeostatic equilibrium. Electromagnetic radiation in microwave range is known to be lethal to micro-organisms: this could be due to the transformation of the biological current circuitry induced by the radiation. Too high leakage of supra-currents to atomic space-time sheets might be also fatal. Personal computers and travel phones produce microwave radiation and this raises interesting questions about their role in modifying many-sheeted current circuitry and thus modifying the homeostasis. One can also wonder about the role of this radiation in electric allergies.

Microwaves and the mechanism of remote intentionality

TGD based model of remote mental interactions is discussed in [22]. The model is based on the notion of bound state quantum entanglement having as a geometric correlate the formation of so called join along boundaries bonds. Magnetic flux tubes as well as topological field quanta of radiation ("mass-less extremals", or briefly MEs [40]) could act as such bonds. Many-sheeted space-time makes in principle entanglement possible in even astrophysical time scales. Also time-like entanglement is possible by the non-determinism of the basic variational principle and it provides quantum mirror mechanism of long term memory [25]). Essential is also the notion of adjunct serving as a kind of relay station entangling any two subjects during remote mental interaction, say healer and healed, and inducing sharing and fusion of mental images and making possible also classical communications. An object possessed by the healer or healed is one example of an adjunct.

The entanglement is generated by mass-less extremals having a length, which is a multiple of the wavelength of the radiation involved and therefore the frequencies involved are typically ELF frequencies. On the other hand, the work done after developing this model has shown that also microwave MEs are probably involved. Human intention could be able to generate microwave MEs giving rise to the bonds between magnetic flux tubes and atomic space-time sheets also outside the body. Brain and body certainly generate microwaves (GHz frequency scale corresponds to protein and DNA conformational dynamics and water's rotational transitions), and the intention could be remotely realized as these microwaves if the system is sensitive to the microwaves. The problem is to understand how ELF MEs and microwave MEs are related to each other.

How microwave MEs and ELF MEs are related?

The existing TGD based model for remote mental interactions is based on ELF (extremely low frequency) MEs serving as field bridges between sender and receiver and inducing entanglement. Also microwaves must relate closely to the remote realization of intentions. The question is how these two aspects of remote mental interactions are related.

1. ELF MEs are crucial for the sensory representations at the personal magnetic canvas and on the magnetic flux tubes structures in magnetosphere. The simple "feeling of existence" is generated by cyclotron transitions and the most effective manner to generate these is to "kick" superconducting ions first to the atomic or some other space-time sheet. The ions having large zero point kinetic energy can "drop" back to high n cyclotron states at the magnetic flux tubes and decay by emitting a large number of ELF photons. Microwaves might be responsible for generating the bridges making this flow of ions to the atomic space-time sheets possible. Microwaves could also "kick" ions from magnetic flux tubes to $k=151$ space-time sheets and the "dropping" of ions back by photon emission would generate further microwaves.
2. Magnetosphere is expected to contain plasmoid like life forms defining sensory representations getting input from biosphere. Microwaves are the "food" of the plasmoid like life forms and the question is where these life forms get their food from: from biosphere or from brains perhaps?
3. The so called scaling law [18] predicting that high and low frequency MEs somehow accompany each other, helps to understand the situation more clearly. The scaling law abstracted from the findings summarized in [68] reads as

$$f_{high} = (c/v) \times f_{low} \quad , \quad c/v = 2^{137-k} \times 2 \times 10^{11} \quad .$$

Here v is some velocity associated with the system transforming low frequency waves to high frequency waves and vice versa and k is prime of power of prime defining so called p-adic prime $p \simeq 2^k$, labelling the space-time sheets of the many-sheeted space-time and characterizing their sizes. $k = 137$ corresponds to the space-time sheets of atomic size and gives $c/v = 2 \times 10^{11}$. $k = 151$ corresponds to the cell membrane length scale and gives $v \simeq 6$ m/s, the phase velocity of alpha waves at the surface of skull.

TGD allows to understand the mechanism behind the scaling law: $f_{high}(k)$ corresponds to zero point kinetic energy of an ion at the space-time sheet labelled by k , and flow to cyclotron frequency at the magnetic flux tube of Earth's magnetic field: both these energies are inversely proportional to

the mass of the ion. k refers to the space-time sheet from which the ion "drops" to the magnetic flux tube. The value of c/v is inversely proportional to the local value of Earth's magnetic field and thus varies somewhat. In the case of $k = 151$ this could explain the variation of the nerve pulse conduction velocity and EEG phase velocity.

The problem is to understand how EEG MEs and microwave MEs are related. It has been already hypothesized that they implicate each other and TGD provides mechanisms for how this is possible. A more detailed hypothesis is that the ELF MEs serve as entangling em bridges along which the microwaves MEs propagate like mass-less particles to the magnetic sensory canvas to be used by the plasmoid like life forms. The ions are "kicked" by microwaves to the atomic or possibly also other space-time sheets and "drop" back to high n cyclotron states which then decay by cyclotron radiation in ELF energy range. This self-organization process generates the simple "feeling of existence" mental image at magnetic sensory canvas entangled with more complex mental images in brain.

Microwave hearing

The previous findings encourage to think that microwave hearing involves the transformation of microwaves to EEG waves responsible for entangling brain with the magnetic sensory canvas. It might be that microwave beam actually induces the transfer of ions from magnetic flux tubes to atomic space-time or cell membrane space-time sheet (say), which then "drop" back and in the latter process induce also cyclotron radiation at EEG frequencies generating the auditory experience. Interestingly, for $k = 151$ the zero point kinetic energies of ions are in microwave range and the "dropping" of ions from cell membrane space-time sheets to magnetic flux tubes of Earth could be involved with the amplification of both microwaves and generation of EEG waves by cyclotron transitions at magnetic flux tube. The velocity parameter v corresponds in this case to alpha wave phase velocity at the surface of skull. The lowest Schumann resonance at 7.8 Hz is in alpha band and there are reasons to believe that it is closely related to the UFO experiences and thus also to Fatima apparition.

In TGD universe these EEG MEs would project directly to the auditory magnetic canvas and generate the experience. Of course, one could argue that the modulation of EEG wave by a frequency higher than EEG wave does not make sense. There is actually however no reason forbidding "fast modulation" analogous to small ripples on sea waves and this kind of representation has been proposed to give rise to "features" [49] in alpha band [37]. The fast modulation could also occur with respect to subjective time: the fast modulation of the number of EEG MEs with respect to subjectively experienced time (defined by quantum jump sequence) is also possible: in this case there would be no modulation with respect to the geometric time. If the space-time sheet associated with brain and various brain structures (the sizes are correct!) serve as a receiving microwave antennae they could also act as active emitting antennae.

The amplification of microwaves could be seen as a maser like mechanism in which ions are pumped to $k = 151$ space-time sheet by microwaves. The existing microwave photons stimulate the dropping of ions back and thus also the generation of new microwave photons.

If the "dropping" of ions from $k = 151$ space-time sheet amplifies the microwaves, microwave hearing is predicted possible from 3.75 Hz (He cyclotron frequency 75 Hz) down to frequencies .16 GHz corresponding to delta band (1.5 Hz cyclotron frequencies possible for heavy ions). Delta band dominates during deep sleep and the model of magnetospheric sensory representations predicts that brains can entangle with the plasma sheet by EEG MEs at delta band. This could correlate with the appearance of microwave static at nighttime [51]. Perhaps delta waves entangle sleeping brains with magnetospheric selves and microwaves feed energy to the corresponding mental images. The plasma sheet at the night side of the magnetosphere is indeed known to contain self-organizing plasma structures with ionic velocity distributions representing features like "eyes" and "wings" [51]. The prediction is that heavy ions should play important role in the generation of EEG during sleep.

The resulting unification would be rather economical. The formation of sensory representations, remote mental interactions, homeostasis, and homeopathy would all rely on the same basic mechanism: high frequency MEs propagating as mass-less particles along low frequency MEs. Low frequency MEs would induce quantum entanglement and high frequency MEs would force self-organization at the end of the receiver.

Do electromagnetic life forms "eat" microwave energy?

In the case of UFO experiences, and perhaps also in the case of Fatima Marian apparition, microwaves, possibly generated by the tectonic activity, could have also a further important function besides entangling brains with the conscious entity involved. According to the TGD based proposal, so called plasmoids consisting of closed magnetic flux tube structures carrying supra currents plus atomic and $k = 151$ (at least) space-time sheets associated with them, are good candidates for primitive electromagnetic life forms, in particular plasmoids identified as UFOs. Ordinary bio-matter is assumed to self-organize around these structures and nerve circuit represents a good example of a structure resulting in this manner.

Plasmoids from outer space could leak into the magnetosphere mostly through pole gaps, where the magnetic field of Earth is weak: elsewhere magneto-pause serves as a magneto-immune system, which does not allow the penetration of the external magnetic life forms to compete about energy sources. In accordance with magneto-immune function, planetary magnetospheres are known to be self-organizing structures and the fact that Mars does not possess magnetosphere might relate to the disappearance of Martian life. Also the magnetic field of Earth is getting weaker and the change of the polarity expected to occur within two thousand years might have rather dramatic consequences for the life as we know it.

Also the magnetic life forms need energy feed to self-organize and stay awake. Plasmoids could populate magnetosphere and only wait for energy sources to self-organize. The basic metabolic mechanism would be the same as in the case of living matter [32]. Energetic super-conducting ions must be somehow driven from the magnetic flux tubes to the atomic space-time sheets, where they collide with atoms, ionize them, and generate visible light in the atomic transitions giving thus rise to the observed luminous phenomena interpreted as UFOs (perhaps as the luminous entity 'Maria' in Fatima case). The ions would eventually 'drop' back to super-conducting space-time sheet and liberate the zero point kinetic energy as a quantum of metabolic energy defining what is often referred to as a universal energy currency. Essentially identical energetic cycle of Karma would be realized also in living matter but involve a complex molecular organization and many-sheeted current circuitry responsible for the control of homeostasis. For the proton the quantum is predicted to be of order .5 eV liberated also when a single molecule of ATP is used.

The realization of this primitive metabolic cycle requires the breaking of super-conductivity: some mechanism must generate join along boundaries bonds serving as bridges connecting magnetic flux tubes with atomic space-time sheets along their boundaries so that supra current leakage becomes possible. Microwave radiation could generate the required join along boundaries bonds to $k = 151$ space-time sheets and pre-existing IR MEs could be responsible for the bridges between $k = 151$ and atomic space-time sheets. The energies of microwave photons in the wavelength range 1-100 mm are in the range $10^{-5} - 10^{-3}$ eV and correspond to the temperature range .1-10 K. The critical temperatures for low temperature super-conductors are in this range (note that the temperature at the magnetic flux tubes would be much lower). One can interpret this by saying that super-conductivity is not destroyed by the heating of the magnetic flux tubes but by the generation of the join along boundaries bonds with bond energy of order of the gap energy causing the leakage of the supra current to non-super-conducting space-time sheets and thus inducing dissipative effects, The dropping of protons and ions from $k = 151$ cell membrane space-time sheet generates also microwave radiation.

This suggests that microwave photons could induce these bridges, break super-conductivity, and induce energy feed and self-organization. A similar breaking of super-conductivity might be also involved with the driving of the super-conducting ions to the $k = 151$ space-time sheets in the living matter. Proteins could generate the needed microwave photons by coherently occurring conformational transitions. Also rotational transitions of clusters of water molecules could emit microwaves and perhaps mimic and amplify the microwaves generated by proteins. IR photons of .5 eV produced metabolically "kick" protons to atomic space-time sheets. The MEs with electrical potential difference of .5 eV define the classical correlate for this process as acceleration of proton in electric field in full consistency with the existing model of ADP-ATP process.

Plasmoids, being extremely light structures, could easily follow the energy beam flowing from the spot of tectonic activity, and the random variation of the beam direction could explain the random butterfly like motion of UFOs often observed and very difficult to understand if UFOs are structures built of steel and copper. The strange motion assigned with Sun in the case of Sun miracle can indeed be interpreted as an example of this kind of rapid random motion of plasmoid possible following

microwave beam of tectonic or some other origin.

One can also imagine that plasmoids generate partially their microwave 'food' themselves via the cyclotron transitions of electrons. This would require that the magnetic flux tubes in question carry a magnetic field of about .2 Tesla: the p-adic length scale in question corresponds to the thickness of the cell membrane. Solar convective zone contains magnetic fields with this strength.

2.6.4 Fatima apparition and microwave MEs

In the case of Fatima apparition the interaction of microwave MEs accompanied by ELF MEs would generate entanglement between the brains of people seeing the visions, plasmoid like life forms serving in the role of medium, and conscious entity "Maria". Same mechanism applies to UFO and ET experiences in general.

What was the source of microwaves?

The buzzing sound heard only when Maria talked with closed lips might be understood as follows. Buzzing sound would be due to microwave hearing. Facial expression is important part of communications, especially so when one cannot speak loudly. When microwave energy feed was near the threshold of the microwave hearing, "Maria" had to use also facial expression in order to become better understood. This explanation however implies that the strength of microwave radiation was not under the control of the sender of the message or that the control was only partial.

The microwaves could correspond to the so called microwave static having biological origin and correlating strongly with taos hum: also taos hum can involve buzzing sound sensations [51]. This microwave static appears at evening and ceases in the morning hours at definite local time. One plausible source of microwaves are transitions associated with protein conformations for which the time scale of dynamics is around .1 nanoseconds. It would be interesting to know what time of day the apparitions appeared. The occurrence of the event at 13th of every month is suggestive of both external intelligence and a biorhythm giving rise to especially intense microwave static with a period of month.

The possible biological origin of the microwave static raises the question whether the oak was the source of the microwave static. Oaks are holy trees in many ancient cultures: perhaps their ability to induce apparitions by strong microwave static could explain this partly. Some people (including me in very calm state of mind) are able to experience what might be called 'a silent conscious presence' of trees. The energy scale for the rotational excitations of molecules is in the microwave region. In particular, rotational transitions of water molecules and clusters of them can generate microwave radiation effectively. Quartz crystals, piezo-electrics used both in clocks and for healing purposes, could amplify the microwaves using the energy provided by the tectonic activity. If the dominating contribution of the microwave energy is of tectonic origin, the strange motion of Sun experienced by many witnesses during Sun Miracle could correspond to the motion of a plasma ball following tectonic microwave beam. Of course, this is not the only possibility. The reported healings during apparitions suggest that microwave photons directed from the plasmoid to the brains and bodies of the witnesses were involved. If plasmoids carrying magnetic fields of order .2 Tesla for which electron cyclotron frequency is 3 GHz were involved, they could have generated these microwave photons. Also the model for crop circle formations requires plasmoids with similar magnetic field strength [73] [23] and light balls are frequently observed near crop formations.

The heat wave causing drying of soil and cloths could have been caused by visible and possibly also infrared light generated by the plasmoid like structure, when highly energetic super-conducting ions flowing to the atomic space-time sheets dissipated their energy by colliding with the atoms of atmosphere and by ionizing them.

Connection with Schumann resonance

If microwave hearing involves the "dropping" of ions from $k = 151$ space-time sheet and liberation of zero point energy as microwaves propagating along EEG MEs one could understand the connection with the Schumann resonance at 7.8 Hz in alpha band.

a)As a cavity resonance Schumann resonance prevails in entire Earth size scale, and is in TGD based model of magnetospheric sensory representations responsible for horizontal communications

between different brains, and more generally, between various conscious entities. For instance, during hypnagogy alpha band dominates and could be the sharing of mental images give rise to the strange experiences in which one experiences of being another person. Alpha band is also associated with creativity: perhaps our ideas are not completely ours.

b) The velocity parameter v predicted by the scaling law for $k = 151$ (cell membrane space-time sheet) is the velocity of alpha waves at the surface of skull which suggests that alpha waves are generated in the process. For K^+ and Cl^- ions cyclotron frequencies are 7.5 Hz and 8.5 Hz respectively and near to Schumann frequency and these ions are important for brain functioning: their cyclotron radiation could resonate with Schumann resonance (note that the local value of Earth's magnetic field in brain could be subject to homeostatic control). Thus the "dropping" of these ions from cell membrane space-time sheet could be crucial for the quantum entanglement with the conscious entity Maria.

Angel hair

The mysterious angel hair might result when ions from magnetic flux tubes flow to atomic space-time sheets. Perhaps the process creates chemical compounds in molten state which then cool and solidify. Hair like appearance might reflect the geometry of magnetic flux tubes (whose thickness is about 2.5-5 micrometers for Earth's magnetic field). Many crop formations are known to contain magnetized iron [73] as well as small glass balls consisting of SiO_2 , that is quartz [74]. Meteoric iron could come from the ionosphere along magnetic flux tubes. Si ions or quartz could flow along magnetic flux tubes from the spot of the tectonic activity to the plasmoid, and become heated to high temperature when entering to atomic space-time sheets and colliding with oxygen atoms of the atmosphere. This in turn would give rise to glass balls. An analogous mechanism might be give rise to angel hair.

Were the "vehicles" real?

There is some anecdotal evidence suggesting that UFOs are more than mere plasma balls, and this kind of objects might have been involved also with the Marian apparition. Many-sheeted space-time concept predicts a mechanism leading to the reduction of inertial and gravitational masses of spinning magnetic systems [18]. These objects are predicted to be accompanied by plasma. There is laboratory evidence for this kind of phenomenon [75]. Hence some UFOs could be space crafts possessing almost vanishing gravitational and inertial masses and the vehicles observed by witnesses in the case of Marian apparition could be also genuine space crafts of this kind.

Healing phenomena and apparitions

Healings and water with special healing properties are also associated with Marian apparitions [71]. Microwave hypothesis provides understanding also about this aspect, and somewhat unexpectedly, about the mechanism of homeopathic healing.

In [18] it was proposed that the clusters of water molecules forming liquid crystals can mimic the rotational spectrum of various molecules, and that the ability to reproduce the rotational frequency spectrum of the medicine molecule is an essential element of homeopathic healing. The level of self-organization of water would thus be measured by how complex mimicry it is able to perform.

Why rotational microwave energy spectrum is so important for healing, can be understood as follows. The many-sheeted current circuitry, involving atomic space-time sheets and magnetic flux tubes and also other space-time sheets, is extremely complex control structure [44, 43]. The continual regeneration of bridges between say atomic space-time sheets and magnetic flux tubes by microwaves emitted by proteins is necessary to sustain this circuitry. An important category of diseases is due to the failure to generate the bridges between super-conducting and atomic space-time sheets so that this control circuitry suffers shortcuts. Perhaps the genetic expression of some proteins responsible for the microwaves generating particular bridges fails. The medicine or its homeopathic counterpart would help to generate (or even re-establish the generation of) the microwave spectrum responsible for the generation of the lacking bridges in the circuitry.

This would allow to understand why spring water with special healing properties seems to be a correlate of apparition places [71]. Just like the homeopathic remedy, the spring water would mimic the rotational energy spectrum of some medicine molecules and would induce the same healing effects (I am grateful for A. Brodziak for emphasizing the importance of the homeopathic aspect).

In present case the healing would require the feed of microwave energy to the healed. It could be the energy is transferred via the mediation of the self-organizing plasmoidic life form and has tectonic origin.

Appendix

1. Schumann resonances

Schumann resonances [63] represent resonant excitations of the Earth's electromagnetic field in the cavity defined by the spherical cell bounded by the Earth's surface and the lower edge of the ionosphere located at the height of roughly 100 km. The lowest Schumann resonance frequencies have nominal values 7.8, 14, 20, 26, 33, 39, 45 Hz with a temporal variation of ± 0.5 Hz.

It is often said that Schumann resonance frequencies characterize the cavity modes associated with the $d \sim 100$ km thick spherical shell below ionosphere acting effectively as a waveguide bounded by Earth and ionosphere acting as conductors. This is not the case since the cutoff frequency for this waveguide would be in a good approximation $f = c/d$ which is about $f = 3$ kHz and much higher than Schumann resonance frequencies. The only manner to understand Schumann resonance frequencies is to assume that boundary conditions analogous to those used for half-open system, such as organ pipe. This amounts to requiring that the field modes vanish at the surface of Earth or the lower edge of the ionosphere but not both. Schumann resonances would be selected by a boundary condition stating essentially that the energy does not leak out from the system at the upper edge of the ionosphere.

It seems that the web contains a lot of confusion related to the Schumann resonances and the motivation to write my own view came with the realization that also my own understanding about Schumann resonance was rather misty. My sincere hope is that my unprofessional, TGD inspired ponderings do not increase the already existing confusion. The article "Schumann resonances and human psychobiology" by Richard and Iona Miller [165] is recommended for a reader who wants to gain an overall view about various aspects of the phenomenon.

1.1 Schumann frequency spectrum

Consider now the calculation of Schumann frequency spectrum by taking into account the finite thickness of the Schumann cavity neglecting the complications caused by spin of photon. For scalar wave equation the wave equation in radial variable for solution proportional to spherical harmonic Y_m^l reads as

$$\left[-\partial_r^2 - \frac{2}{r}\partial_r + \frac{l(l+1)}{r^2} \right] F_l = \omega^2 F_l . \quad (2.6.1)$$

By writing $F_l = G_l/r$ this equation can be cast into the form

$$\left[-\partial_r^2 + \frac{l(l+1)}{r^2} \right] G_l = \omega^2 G_l . \quad (2.6.2)$$

The term proportional to angular momentum term varies very little in the thin Schumann cavity. Therefore it is reasonable to separate the constant part from the small variation by writing the equation in the form

$$\left[-\partial_r^2 + l(l+1)\left(\frac{1}{r^2} - \frac{1}{R^2}\right) \right] G_l = E G_l ,$$

$$\omega^2 = E + \frac{l(l+1)}{R^2} . \quad (2.6.3)$$

Here E , playing the role of energy in the analog with Schrödinger equation, can be also negative implying that omega is below the alpha peak frequency for $l = 1$.

The Schumann frequency spectrum should be continuous since the only sensible boundary conditions correspond to organ pipe type boundary conditions requiring that the G vanishes at the surface of Earth (or, less probably at the lower edge of the ionosphere).

One can use the analogy with one-dimensional Schrödinger equation for particle with mass $2m = 1$ ($\hbar = 1$) and energy E at half-line $r > R$ in order to understand the spectrum. The angular momentum term defines the potential function as

$$\begin{aligned} V(r) &= l(l+1) \left[\frac{1}{r^2} - \frac{1}{R^2} \right] , \\ V(r) &= \infty \text{ for } r \leq R \end{aligned} \quad (2.6.4)$$

The potential function vanishes at origin origin and approaches to $V(\infty) = -l(l+1)\frac{1}{R^2}$ at infinity. There are no classical bound state solutions since the force $f(r) = -\partial_r V = 2l(l+1)/r^3$ drives the particle to infinity.

The spectrum satisfies the condition

$$\begin{aligned} E &\geq V(\infty) = -l(l+1)\frac{1}{R^2} , \\ \omega^2 &\geq 0 . \end{aligned} \quad (2.6.5)$$

In accordance with the expectation that the spectrum of Schumann frequencies is continuous.

1.2 The identification of Schumann resonance frequencies

In order to identify the Schumann resonances from the continuum one should apply some natural boundary condition. The vanishing of G at $r = R+d$ is certainly not a natural condition. Schrödinger equation however suggests an analogy. The radial probability current is proportional to $\partial_r G_l$. In resonance this current should vanish at $r = R+d$ so that one would have

$$\partial_r G(r)_{r=R+d} = 0 . \quad (2.6.6)$$

This condition determines the possible values of f for resonances. When d varies, also Schumann resonance frequencies vary. That the lowest Schumann frequency should be $f_c = 1/(2\pi R) = 7.5$ Hz in a good approximation can be understood from the idea that in resonance ELF light rays move along geodesics of the sphere having length $\lambda = 2\pi R$ defining the frequency as $f_c = c/\lambda$. This would suggest that at least the lowest Schumann resonance frequency does not appreciably depend on the thickness of the Schumann cavity.

1.3 Dimensional reduction of Schumann cavity to a sphere and alpha peak frequency

In the case radially very slowly varying modes dimensional reduction of the thin Schumann cavity to sphere occurs and wave equation reduces to that on sphere with radius R and the solutions are spherical harmonics. This allows to immediately write the frequency spectrum as

$$\begin{aligned} f_l &= \sqrt{l(l+1)} f_c , \\ f_c &= \frac{c}{2\pi R} . \end{aligned} \quad (2.6.7)$$

where $f_c = 7.5$ Hz is the lowest Schumann resonance frequency and $l = 1, 2, 3, \dots$, characterizes the angular momentum quantum number of the spherical harmonic.

The following observations are rather interesting as regards to the interaction between magnetosphere and brain.

1. The lowest frequency of this kind corresponding to $l = 1$ is $f_1 = 10.6$ Hz. This is the peak alpha frequency and essentially the frequency of the memetic code! Note that this frequency does not depend on the thickness of the Schumann cavity at all. The lowest Schumann resonance frequency $f_c \simeq 1/2\pi R \simeq 7.5$ Hz is by a factor $\sqrt{2}$ lower than the peak frequency of alpha band.

2. The higher frequencies are $f_2 = 18.4$ Hz, $f_3 = 26.0$ Hz, $f_4 = 33.5$ Hz, $f_5 = 41.1$ Hz. The appearance of 26 Hz and 41 Hz, which are resonance frequencies of EEG, suggests a connection between alpha wave band and Schumann frequencies for almost radially constant modes. The comparison with the spectrum the spectrum 7.5, 14, 20, 26, 33, 39 Hz of Schumann frequencies shows that the two frequency spectra resemble each other.

Alpha wave peak and possibly also higher peak frequencies of EEG spectrum could correspond to zero modes, which are very slowly varying with respect to the radial coordinate.

3. The cutoff frequency for genuine Schumann cavity solutions is $f = c/d$ and for $d = 100$ km one has $f = 3$ kHz (note however that the values for d vary from 80 – 100 km. The time for the light ray to move forth and back in radial direction is .67 ms and only slightly shorter than the duration $\tau = .78$ for the bit of the memetic codon. If the corresponding ME is parallel to curvilinear magnetic flux tube turning back at the lower edge of the ionosphere, the time is longer. This could easily explain the discrepancy.

1.4 Coupling of the magnetospheric cavity modes with Schumann cavity frequencies

One can also consider the field modes associated with the space-time sheet representing a ball of radius R_1 vanishing at the boundary. The solutions of the radial wave equation for F_l already written explicitly can be constructed in terms of spherical Bessel functions for which one can derive explicit expressions in terms of elementary functions. The lowest $l = 0$ mode regular at origin is

$$F_0(r) = \frac{\sin(u)}{u} .$$

1. The vanishing of $F_0(r)$ at the surface of Earth gives $f_0 = c/R = 2\pi f_s$ giving $f_0 = 47.2$ Hz. The lowest Schumann resonance frequency of the core-inner core boundary is around this value assuming that geometric argument holds true, and one can consider the possibility that a communication analogous based on the coupling between these modes is occurring.
2. It is also interesting to look for the cavity modes for the inner magnetosphere. The boundary of the inner magnetosphere is located in the interval $[4R, 6R]$ which corresponds to the range $[7.86, 11.8]$ Hz for f_0 covering alpha band. For the lowest zeros of f_1 and f_2 the corresponding ranges are $[22.5, 33.7]$ Hz and $[28.8, 43.3]$ Hz. This suggests that discrete frequencies in alpha band and also higher EEG bands in Schumann cavity couple to the cavity modes associated with the space-time sheet of the inner magnetosphere. The erroneous identification of this frequency as Schumann resonance frequency is possible. Also cyclotron frequency of proton at $r \simeq 4R$ crucial for magnetospheric sensory representations is in alpha band.

This would imply a direct coupling between solar wind and brain: the solar wind would affect the size of the inner magnetosphere, in turn affecting the over all scale of the corresponding cavity frequency band in turn affecting the alpha band in Schumann cavity in turn affecting brain. Strong solar wind would compress the magnetosphere and tend to the discrete frequency in the alpha band. This could explain the negative effects of the solar wind on the mood of sensitive persons.

1.5 Variation of the Schumann frequency with time

The measured lowest Schumann resonance frequency varies with time. There is a variation of ± 0.5 Hz but also claims about variation up to 11 Hz. The argument allowing to understand geometrically the lowest resonance frequency suggests that the varying thickness of the Schumann cavity does not affect the lowest Schumann resonance frequency. One can imagine several explanations for the claimed wandering.

1. Due to the coupling of the Schumann cavity modes to the modes associated with the space-time sheet of the inner magnetosphere (with radius varying in the range $[4R, 6R]$) to be discussed below in detail, the wandering frequency identified as the lowest Schumann resonance frequency could actually be the cavity frequency of the inner magnetosphere. In this case quite wide variation range is possible.

2. The second option is that the boundary conditions stating the vanishing of field components fail to be satisfied at the surface of Earth. Physically this would mean the generation of an oscillating surface current and a surface charge density defined by the tangential discontinuities of magnetic and electric fields of the resonance modes. The simplest possibility is that there is a surface current parallel near to the surface of Earth with the rotational motion of Earth, which generates magnetic field discontinuity in the direction of longitudes and the discontinuity of electric field in the radial direction. This current would be oscillatory and might perhaps be seen as a parallel mirror image of the ionic current at the lower edge of the ionosphere of Earth: this real mirror current would cause Earth to effectively act like a conductor.

The lower edge of the Earth's crust at depth of 30-60 km is roughly a almost mirror image for the lower edge of the ionosphere and could be the seat of the mirror current. In the ideal situation the contributions of the two currents to the oscillating magnetic field at the surface of Earth would be of opposite sign and cancel but the variation for the height of the lower edge of the ionosphere would imply asymmetry, and the breaking of the standard boundary condition at the surface of Earth in turn changing the Schumann frequency.

2. Alfven waves, magnetic flux tubes, cosmic strings, and hadronic strings

In TGD framework Alfven waves correspond to the geometric oscillations of the magnetic flux tubes. The understanding of these oscillations represents a horrible mathematical problem and it is not even obvious that effectively massless modes are possible. It is however possible to understand magnetic flux tubes as a member of an extremely general family of solutions containing as special cases cosmic strings, hadronic strings and magnetic flux tubes. That Alfven waves would be mathematically very similar to the excitations of strings gives a glimpse about the mathematical beauties of the actual physics lurking behind such a simple looking thing as Earth's magnetic field.

One can in principle construct magnetic flux tube like solutions as deformations of cosmic string solution $X^2 \times D^2$, where X^2 is any minimal surface and D^2 is piece of the geodesic sphere S^2 of CP_2 . By allowing the M^4 coordinates transversal to X^2 to depend on D^2 coordinates so that one has field theory in $X^2 \times S^2$ with the transversal M^4 coordinates taking the role of fields. A static flux tube is obtained when X^2 is a piece of two-dimensional hyperplane $M^2 \subset M^4$. Thus an infinitely thin string representing projection to M^4 spreads to a magnetic flux tube. The general stringy solutions $X^2 \times D^2$ describe excitations travelling with light velocity along string. If the deformation inherits this property, one can say that the oscillations of the flux tube propagate with light velocity and $f = c/L$ dispersion relation holds true apart from effects caused by the deviation of the induced metric from a flat metric.

Thanks to the progress in the understanding of the spectrum of the extremals of the Kähler action it is now possible to construct rather explicitly the deformations of "cosmic strings" to magnetic flux tubes. The construction demonstrates that the massless transverse modes of string indeed become Alfven waves [18, 43].

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Chapter 3

Evolution in Many-Sheeted Space-Time

3.1 Introduction

This chapter was originally about prebiotic evolution but gradually extended so that it became natural to drop the attribute "prebiotic" away. Of course, a collection of ideas rather than detailed history of life is in question.

It was already early that the notion of many-sheeted space-time could allow to understand many puzzles related to the pre-biotic evolution [102, 90]. There are many constraints on the models for pre-biotic evolution. The models have also many difficulties [112, 114].

TGD replaces materialistic view about universe with a continual re-creation in which classical universe in 4-dimensional sense is replaced by a new one in each quantum jump. p-Adic length scale hypothesis allows to formulate the notion of evolution precisely as a generation of increasingly larger space-time sheets characterized by preferred p-adic primes. A second aspect is the emergence of new levels in dark matter hierarchy making possible macroscopic quantum coherence and inducing great leaps in evolution. Also a hierarchy of dark weak bosons and gluons becomes an essential part of the physics of living matter. The notion of field/magnetic body carrying dark matter is a further key element in the model and has become increasingly important during years, and the vision about DNA-cell membrane system as a topological quantum computer utilizing braids defined by magnetic flux tubes connecting nucleotides to lipids meant a breakthrough in the understanding of the real function of DNA in information processing.

3.1.1 Questions and answers about evolution

A good manner to introduce the essentials of the TGD inspired model for the prebiotic evolution is by a sequence of questions and answers relating to evolution.

Q: Is life as we know it result of an accident?.

A: Quantum TGD predicts a genuine cosmic evolution occurring by quantum jumps for which dynamics is characterized by Negentropy Maximization Principle [33]. The generalization of the notion of space-time implies dark matter hierarchy with levels characterized by arbitrarily large values of Planck constant so that macroscopic quantum coherence is possible even in astrophysical length scales. Even astrophysical systems are analogous to atomic systems which implies a strong standardization of planetary system so that Earth like planets are abundant. There are also other good reasons for why the evolution of life would not have been accident in TGD Universe and life should appear everywhere in TGD Universe.

Q: What were the most primitive living systems?

A: The notion of magnetic body brings to biology several completely new elements. Magnetic flux quanta containing dark charged matter and quantum controlling ordinary matter in plasma phase is perhaps the simplest system which can develop characteristics of a living system. The braiding of magnetic flux tubes makes possible topological quantum computation and a fundamental representation of memories and its presence could be even taken as a definition for what it is to be

living. Tqc programs correspond to asymptotic self organization patterns for liquid flows inducing braidings and are non-trivial in presence of external energy feed.

Q: How metabolic machinery emerged?

A: Many-sheeted space-time concept predicts a hierarchy of universal metabolic energy quanta as differences of zero point kinetic energies for space-time sheets characterized by different p-adic length scales. What remains is to understand how chemical energy storage and utilization mechanisms developed.

Q: What is behind biocatalytic machinery?

A: The magnetic flux tubes connecting bio-molecules imply long range correlations between molecules. The reduction of Planck constant for magnetic flux tubes implying their shortening provides a mechanism making possible for bio-molecules to "find" each other in a very selective manner, and explains also why molecules end up to precisely defined conformations necessary for a selective bio-catalysis.

Q: How symbolic dynamics emerged?

A: The notion of fractional atom suggested by the fractionization of electron and nucleon quantum numbers for dark matter hierarchy brings in a candidate for a symbolic dynamics assigning to molecules "names" which need not correlate very strongly with the chemical properties of the molecule but would dictate to a high degree its biochemical behavior. Molecular "sex" emerges in the sense that molecules labeled with "names" and "co-names" tend to pair. The model of DNA as tqc assumes a 4-coloring of braid strands realized by an assignment of DNA nucleotides to quarks and anti-quarks. Also this means symbolic dynamics since only molecules connected by colored braids have high probability to participate in same biochemical reaction and do it in a very specific manner. Since the quarks involved with braid strands can have fractional charges, molecular sex can be realized also in this manner.

Q: What selected the bio-molecules during chemical evolution?

A: The proposed symbolic dynamics based on the notions of colored braids and fractional atom poses very strong constraints on the subsets of bio-molecules that can react with considerable rates.

Q: How biochemical pathways emerged?

A: It is now possible to realize in practice sequences of arbitrarily complex self-catalyzing biochemical reactions utilizing DNA hairpins. The mechanism generalizes to more complex molecules. At a given step of the reaction sequence the structure formed during the previous steps acts as a key fitting to a lock represented by some hairpin in the solution, and opens it to a linear molecule and in this manner makes it a key. The braids between reactants make it possible for the key and lock to find each other.

Q: How genetic code evolved?

A: The symmetries of the third codon of the genetic code allow in DNA as tqc model an interpretation as isospin and matter antimatter symmetries for quarks and antiquarks assigned with DNA nucleotides and representing 4-color of braid strands. These symmetries together with the study of the detailed structure of tRNA lead to a model for the evolution of the genetic code as a fusion of a non-deterministic 1-code and one-to-one 2-code corresponding to the conjugation of mRNA molecules. During RNA era two kinds of RNAs, call them RNA_1 and RNA_2 , were present and played the roles of mRNA and aminoacid sequences. 2-code *resp.* 1-code mediated the analog of replication *resp.* translation using hairpin like molecules $tRNA_1$ and $tRNA_2$ to bring in RNA nucleotides and RNA doublets to the growing RNA_i sequence. Amino-acids attached to the stem of $tRNA_2$ acted as catalysts. The transition to RNA-aminoacid era took place via a fusion of the $tRNA_1$ and $tRNA_2$ to the ordinary tRNA and instead of sequences of two kinds of RNAs were replaced by aminoacid sequences were formed. After a period of symbiosis involving all these three tRNAs a transition to DNA-RNA-aminoacid world took place as an aminoacid sequence acting like reverse transcriptase emerged.

Q: Did RNA world precede the life as we know it?

A: The model for the evolution of the genetic code forces to conclude tha RNA world [147] preceded the recent biology and allows also to deduce that the nucleotides involved with second form of RNA where A,T,U,I(nositol). The exotic RNA in question could have been 2',5' form of RNA rather than 3',5' RNA produced also in the classical experiments of Leslie Orgel [122].

Q: Does the notion of protocell make sense?

A: The model of DNA as tqc involves essentially the magnetic flux tubes connecting DNA nucleotides and cell membrane. Since topological quantum computation should have taken place also during the RNA era, some kind of cell membrane consisting of exotic RNA should have been present.

It has been found that DNA indeed forms membrane like structures which are liquid crystals consisting of sequences of DNA nucleotides with length up to 20 nucleotides [135] and same might be true in the case of exotic RNA.

Q: How life could evolve in the harsh primordial environment? Does the notion of primordial ocean make sense?

A: Evolving life had to cope with the grave difficulties due to the irradiation by UV light and meteoric bombardment. A simple solution of these problems is to evolve in the interior of Earth, say in underground lakes. This idea conforms nicely with the observation that continents would have formed a single super continent at time of Cambrian explosion provided the radius of Earth at that time was by a factor 1/2 smaller than now. TGD predicts that cosmic evolution does not occur continuously but by quantum jumps in which the Planck constant of appropriate space-time sheet increases. A phase transition of this kind increasing the radius of Earth during a relatively short time interval would have led to a burst of life from underground lakes to the surface of Earth. This would also explain the sudden emergence of a huge variety of highly developed life forms during Cambrian explosion.

3.1.2 Topics of the chapter

The topics of the chapter has been restricted to those, which seem to represent the most well-established ideas. The topics of the article have been restricted to those, which seem to represent the most well-established ideas about evolution in TGD Universe. There are many other, more speculative, ideas such as the notion of fractional atom [20] based on fractalization of electron charge and strong form of the hypothesis that some life forms has evolved in "Mother Gaia's womb", maybe even in the hot environment defined by the boundary of mantle and core.

1. Basic facts about and TGD based model for pre-biotic evolution are discussed.
2. A model for the evolution of the recent genetic code (3-codons) as a fusion of codes for which codons are nucleotides (1-codons) and di-nucleotides (2-codons) is discussed. The symmetries of the genetic code, the observation that tRNA can be seen as a fusion of two hairpin like DNA molecules, and the finding that the first nucleotides of 3-codon code for the reaction path leading from a precursors of the aminoacid to aminoacids for hydrophobic/hydrophilic dichotomy, serve as motivations of the model. 1- and 2-codes corresponding to the two forms of RNA (the exotic 2' – 5' RNA and the usual 3' – 5' RNA) would have prevailed in RNA world. Aminoacids would have served as catalysts for the copying of RNA on one hand, and RNA molecules would have catalyzed the formation of aminoacids from their precursors on one hand, meaning the presence of a positive feedback loop. In the transition to DNA-aminoacid era RNA began to be translated to aminoacid sequences.
3. Cambrian explosion represents a rather mysterious period in biology: new highly developed phylas emerged out of nowhere. A second strange finding is that continents would fit together to form single super-continent covering entire Earth's surface at time of Cambrian explosion if the radius of Earth would have been one half of its recent value. This finding has inspired Expanding Earth theories but it has not been possible to identify the mechanism causing the expansion. The success of the standard tectonic plate theory requires that possible expansion must have occurred in relatively short geological time scale. The hierarchy of Planck constants implies that cosmic expansion has occurred in quantum leaps increasing the value of \hbar and thus of quantum scales by factors which tend to be powers of 2. Cosmic expansion would have occurred as jerks even in the case of planets. In the proposed model Cambrian explosion would have accompanied the expansion of the Earth's radius by a factor of 2: during this period an outburst of highly developed life forms from underground seas to the surface of Earth would have taken place.
4. TGD based view about the evolution of genetic code is compared to the views of McFadden [139]. This section is a little bit out of date. For instance, the hypothesis that magnetic body of DNA could induce mutations purposefully is not discussed. This hypothesis is natural if one believes that magnetic flux tubes connecting bio-molecules play a key role in bio-catalysis. This idea is discussed in the chapter devoted to protein folding [34].

5. A vision about biological evolution and evolution of brain is discussed on basis of the wisdom gained from the construction of the models of sensory receptor and generalized EEG [22, 32, 20].

3.2 What is known about pre-biotic evolution?

In the following the basic facts and ideas about pre-biotic are summarized.

3.2.1 Some believed-to-be facts about the early history of life

The following basic facts allow to get rough view about the time scales of the pre-biotic evolution.

1. The origin of Earth occurs roughly 4.5 Ga (Ga=billion years ago). Bombardment phase, that is the period of large scale impacts, ended roughly 4-3.8 Ga.
2. ^{12}C enrichment is seen as a signature of photosynthesis. By this criterion the oldest known micro-fossils date back to 3.5 Ga and are found in volcanoes. There is a hot debate going on about whether these micro-fossils are really genuine micro-fossils. For instance, they are accompanied by complex quartz structures and this does not conform with what one might expect.
3. Levels of atmospheric oxygen began to increase during second half of precambrian era (2 Ga) and reached 10 per cent level at the eon's end at 1 Ga.
4. There are not many fossils or fossil bearing rocks from the precambrian eon. The simplest explanation is that the precambrian fossils have been soft bodied. Abundant fossils appear at Cambrian period which started .55 Ga. Cambrian explosion meant emergence of extremely rich spectrum of various life-forms.
5. The time interval between bombardment phase and the emergence of the first micro-fossils is only .3 billion years. This means that the time window for the life to develop on the surface of Earth is surprisingly narrow, and one can ask whether the primordial life could really have developed spontaneously in the environment provide by the surface of young Earth.

3.2.2 Standard approaches are mechanistic

Various hard science approaches to the pre-biotic evolution share a common philosophy dating to the beginning of the previous century. This philosophy is reductionistic materialism according to which life can be explained as a purely mechanistic phenomenon which just happened to occur by change ("change and necessity" using the phrase in the title of the classic of Monod). This view is highly questionable and certainly in dramatic conflict with more modern views relying on macroscopic and even astrophysical quantum coherence as basic elements.

At the experimental level the failure of mechanistic approach is easy to see. The components of cell inside test tube do not form a living system. The numerical simulations using computer models have demonstrated convincingly that spontaneous emergence of life is not possible. Empirical facts support completely different conclusion: the emergence of life is unavoidable and occurs everywhere in the universe, and there are good reasons that it has some universal characteristics. The challenge is to develop the conceptual framework so that it can explain this naturally.

3.2.3 The notion of primordial ocean

The following discussion uses basic facts which I have learned from articles of Chris King [102] representing updated view about facts and theories about pre-biotic evolution as well as articles criticizing the existing theories [112, 114].

The generation of biomonomers requires the presence of C, H and O. During 1920's Oparin and Haldane independently proposed that life, or its chemical precursors including amino-acids, formed spontaneously under the conditions associated with primordial atmosphere. Genetic code was not yet known, and both Oparin and Haldane believed that life evolved from proteins, and that life's precursors including amino-acids were formed spontaneously in a reducing atmosphere whose principal components were CH_4 and/or CO_2 , NH_3 , and H_2O .

Oparin suggested that methane served as the source of carbon whereas Haldane believed that the source was CO_2 . Oparin also suggested that what he called coacervatives were precursors of the cell. Haldane thought that the gradual increase in the complexity of pre-biotic molecules in the presence of UV radiation led automatically to the generation of a protocell.

The assumption that the atmosphere is reducing is essential: the presence of oxygen would be fatal for the biomonomers. This assumption can be however questioned. The primordial atmosphere was due to the outgassing associated with volcanic eruptions but around volcanic fumes the atmosphere is oxidizing which means that biomonomers would have been rapidly destroyed by oxidation. Interestingly, the photographs of Earth taken during the Apollo 16 mission allow to conclude that a gigantic cloud of hydrogen, extending 40,000 miles into space surrounds the Earth. The only source of hydrogen can be water vapour, bombarded by high energy UV light rays above ozone layer [151]. If this water has been there during the primordial period, the atmosphere must have contained oxygen so that the basic assumption would be wrong.

Even if the atmosphere was reducing, one encounters a problem. There would have been no shield against UV radiation which according to [112] would have dissociated COOH whereas CH_4 and heavier hydrocarbons would have polymerized forming an oil slick 1-10 deep over the surface of the Earth. Ammonium would have photo-dissociated into nitrogen and hydrogen so that the conditions of the experiments of Miller [165] and others to be discussed below would not been satisfied.

3.2.4 Urey-Miller experiment

Urey-Miller experiment [165] meant a dramatic step of progress on the experimental side, and for a long time it was believed to be conform the vision of Oparin and Haldane. The experiment involved a reducing atmosphere and electric sparks simulating the effect of lightnings. In the later experiments 19 of 20 amino-acids were identified. Also nucleosides A, G were produced. Cyanoacetaldehyde together with urea believed to be accumulated to primordial ponds, allowed to generate U and C as was discovered by Miller 40 years after his classical experiment. These impressive results were interpreted as a support for the view about primordial ocean as a "dilute soup" of organic molecules which precipitated out of the atmosphere.

For a long time it was believed that the synthesis of ribose necessary for the generation of RNA was impossible in these circumstances. It turn out that ribose was generated from glyseraldehyde phosphate in presence of COOH [150]. Glyseraldehyde phosphate was generated also in Miller's experiments. In case of deoxiribose necessary for DNA no plausible synthesis mechanism has been identified.

Organic compounds (in particular A, U, C, G) and even membrane forming products are present in carbonaceous chondrites (meteorites). Chondrites are essentially what the Earth is made of. Galactic gas clouds contain sugars, amino-acids, nucleic acids. In an experiment of Dworkin and his colleagues [149] thin ice at temperature of 10 K containing H_2O , ammonia, CO, CO_2 methanol was located in vacuum and bombarded by UV radiation to mimick the situation prevailing in the interstellar space. Contrary to expectations, hundreds of different complex organic molecules appearing also in meteorites were generated. Thus it seems that the molecules generated by pre-biotic evolution appear everywhere in cosmos but ironically, the environment provided by the surface of young Earth's does not seem to favor the pre-biotic evolution.

3.2.5 RNA world

One of the basic questions in theorizing about pre-biotic evolution is which came first: proteins, nucleic acids or both or possibly something else. The vision known as RNA world [147, 106] is dominating the stage at this moment. It is assumed that RNA polymers serve all the basic functions associated with DNA, RNA and amino-acids. These functions are based on genetic and catalytic capacity of RNA. Later a genetic takeover occurred involving the emergence of DNA and genetic code in which amino-acids replaced RNA somehow.

One can represent good experimental justifications for the RNA world vision (for the summary and for references the article of Chris King [102] is recommended warmly).

1. Ribose can be synthesized in the same circumstances as amino-acids and nucleosides. The presence of kaolinite clays and volcanic magmas stabilizes RNA polymerization. When montmorillonite, a positively charged clay believed to exist copiously in young Earth, was added to

a solution of negatively charged amino-acids, a solution of RNA nucleotides gave rise to RNA 10-15 nucleotides long [137]. These chains attached to the surface of the clay, and when more nucleotides were added by washing them with the solution, they grew up to 55 nucleotides long. It seems that reversible dehydration in a medium containing phosphates, bases and sugars provides the routes to polynucleotide formations. Besides water, Mg_{++} plays a key role in stabilizing mono- and oligonucleotides by compensating the negative charges of the phosphates.

2. RNA can form double helices and has 3-dimensional tertiary structures analogous to that of proteins so that one might expect the ability to act as catalyst. The discovery of spontaneous splicing of RNAs in living systems is possible meant a breakthrough in this respect [126]. Second crucial finding was that these RNAs could act as catalysts in transesterifications crucial for the protein synthesis [106]. Even high fidelity complementary replication of arbitrary short RNA sequences has been demonstrated [82]. Simple biological RNAs have shown to have autocatalytic self-assembling capacity. The catalytic activity hinges on various forms of proton transfer (perhaps the leakage of protons between space-time sheets is involved). RNA appears to be the agent of peptide-bond synthesis in the modern ribosome [117] and modified ribozymes are able to act as amino-acyl esterases [138]. Thus RNA seems able to serve synthesizing, transfer, messenger and ribosomal functions so that it can guide both its own replication and ordered polymerization of proteins.
3. Support for the RNA world pictures comes also from the fact that the ancient fossil nucleotide coenzymes including *ATP*, *NAD*, coenzyme A and vitamin B12 are all ribonucleotides. Eucariote organisms continue to possess massive RNA processing within the nucleus. Reverse transcriptase, whose function contradicts the Central Dogma, and encountered in retro-viruses (such as HIV), might have ancient origin. Reverse transcriptase is indeed crucial for the transition from RNA→RNA predecessor of genetic code to DNA→amino-acid genetic code in TGD framework.

3.2.6 How biochemical pathways and DNA-amino-acid code emerged?

The traditional viewpoint is that biochemical pathways have developed from some simple basic systems. This approach encounters difficulties when one tries to understand how integrated systems such as electron transport and metabolic machinery could have worked in primitive systems. TGD based solution to the problem is the universality of metabolism and other basic functions relying on super-conductivity and its breakdown by the leakage of various supra currents between space-time sheets.

Furthermore, one can also decompose the evolution to two parts corresponding to the development of genetically controlled structures and self-organizing structures not controlled genetically [21]. Chris King has formulated the same idea in a more concrete manner in his article [102] from the point of view of complex systems. According to King, the basic mechanisms developed without genetic control and were finally taken under control as the genetic takeover occurred. These kind of generic structures include proteins and nuclei acids, nucleotide coenzymes, bilayered membrane structures, ion transport and membrane excitability, membrane bound electron transport, glycolysis and the citric acid cycle. In TGD framework one can add to this list topologically quantized classical fields as universal structures.

A second open question is how DNA and amino-acids took the command. Here many-sheeted space-time provides a possible answer. DNA nucleotides are stable only inside regions containing ordered or liquid crystal water forming a macroscopic quantum phase. The transformation of DNA to RNA nucleotide requires water molecule which is not available in this kind of environment. The transition from RNA-RNA predecessor of genetic code to DNA-amino-acid genetic code is also a deep problem and here the trick might be very simple: reverse RNA transcriptase used by retro-viruses (also HIV) could have transformed RNA genes to DNA genes.

The model for the evolution of genetic code as a fusion of singlet and doublet codes in turn allows to understand the emergence of amino-acids as being due to a change in tRNA structure implying that amino-acids acting as catalyzers of the attachment of RNA to tRNA molecule began to stick to tRNA, and were loosened only when tRNA was attached to RNA so that the used amino-acids began to form amino-acid sequences replacing RNA sequences as coded sequences.

3.2.7 Problems with the polymerization in primordial ocean

Polymerization occurs universally by dehydration in case of polynucleotides, polypeptides, polysaccharides and lipids serving as basic building blocks of living structures. The basic difficulty is that polymers are not stable in an aqueous environment. Several cures to this problem have been proposed.

1. Various mineral interfaces could serve as templates for the formation of polymers and the evaporation of water from these structures could give rise to polymers. For instance, mud flats might have made possible polymerization.
2. Fox has proposed that the heat flow from geoactive sites like hot springs, volcanic rims and submarine vents could have caused the dehydration [96]. Fox has indeed managed to show how to generate protenoids consisting of up to several hundred amino-acids possessing weak catalytic activities. The temperatures needed are typically above 100 C and somewhat too high. Archea as well as nanno-bacteria are indeed found in this kind of environments, and they utilize heat and sulphur compounds as a source of metabolic energy. The first objection is that the high temperature destroys the biological molecules in this kind of environment. Furthermore, the atmosphere around volcanoes contains CO₂ and water and only minor amounts of nitrogen, hydrogen sulfide and sulfur dioxide so that this kind of atmosphere does not give rise to the biomonomers in analogs of Urey-Miller experiments.
3. The un-stability of polymers against hydration is so serious a shortcoming for the primordial soup approach that it has inspired quite radical alternative proposals. For instance, Crick has concluded that pre-biotic life might have extraterrestrial origin. The panspermia hypothesis however only shifts the problem to the outer space. The evolution of life in intra-terrestrial environment is much less radical variant of this approach if one is ready to accept the notion of many-sheeted space-time.
4. Dr. Cairns-Smith has proposed that so called clay genes appeared as predecessors of genes [143]. For instance, Al atoms in the lattice containing Si and O can have three states at each site so that enormous information storage capacities become available. These structures would have acted as scaffolding for present day bio-molecules of RNA and DNA. This idea might create more problems than it solves. One could however turn the idea around and ask whether primitive life-forms such as nanno-bacteria could express their genetic code with the help of kaolinite clays.

To my personal opinion, an invention of a clever mechanism is probably not enough to solve the basic problem. Polymerization in modern cells is basically a process involving metabolic control, and it seems that the metabolic control must have been present from the beginning in some primitive form. TGD predicts that magnetosphere can perform quantum control in astrophysical length scales from the magnetic flux tubes of the Earth's magnetic field B_E or, rather, from the flux quanta of dark magnetic field accompanying it and having strength $B_E = 2B_E/5$. A further prediction is that metabolism is completely universal and existed in primitive form already during the primordial period. This in turn makes possible the option that the pre-biotic life need not have developed through stages differing dramatically from the recent life forms. One could even assume that a generalization of ontogeny recapitulates phylogeny principle holds true for the intracellular dynamics so that it would give precise information about pre-biotic evolution.

One must also clarify what one really means when one speaks of aqueous environment. Water allows an extremely rich variety of structures. Liquid crystal water/ordered water encountered inside cells might automatically stabilize polymers, and provide also a solution to how DNA and polymers were stabilized. Sol-gel transition giving rise to macroscopic quantum coherence would generate this liquid crystal phase.

3.2.8 The notion of protocell

The emergence of membrane bounded structures has certainly been decisive for the evolution of life. Cell membrane made possible differentiation forced by the competition for metabolic resources. Cell membrane imports metabolics, exports waste products, and acts as a signalling system. In TGD universe the receptors at cell membrane also serve as cellular sensory receptors.

A variety of answers to the question about the predecessor of the cell has been proposed. The natural constraint is that the membrane in question results via self-organization. If one requires consistency with the generalization of ontogeny recapitulates phylogeny principle (ORP), the number of options is reduced dramatically.

1. Lipid bi-layers are certainly a natural guess since they formed spontaneously in solutions on biological conditions. There is thus a consistency with the generalized ontogeny recapitulates phylogeny principle requiring that all primordial structures appear also in modern cells.
2. An elegant and plausible candidate for protocell is the gel phase resulting in sol-gel transition inside cell [93, 102]. Gel phase has indeed many properties of cell membrane bound region and is routinely generated also inside modern cells. A compact ordered liquid crystal type phase is in question. Negatively charged proteins are generated inside the gel phase and gel phase rejects Na_+ ions and attracts K_+ ions just as cell interior. Also negatively charged proteins are stable inside gel phase. In TGD framework gel phase is a macroscopic quantum phase so that new physics is necessary involved. In particular, the evolution by quantum jumps is expected to lead to this kind of self-organized structures automatically. In TGD framework one expects that the liquid crystal/ordered water phase leads to the stabilization of RNA and that even DNA nucleotides become stable.
3. The proposal of Sidney Fox [96] is that protocells could correspond to the called micro-spheres formed from protenoids in geologically active sites like hot springs and volcanic rims. He also demonstrated that this really occurs. Protodoids are amino-acid sequences differing from ordinary peptides in that peptide bonds are different: hence this option is not consistent with the generalization of ORP. When proteneids are washed into a warm water allowed to cool, micro-spheres are formed. Micro-spheres are bilayered structures able to divide. A concentration roughly 10 million times higher than believed to appear in primordial soup is required so that either the idea of protenoid or of primordial soup is wrong. Further objections are that micro-spheres do not perform any functions of cell, and that the structure is like an impermeable cell wall or spore coat rather than a cell membrane [112, 114].

The common problem of all these options is that the required concentrations of biomonomers are much higher than those expected in the primordial soup. This forces to question the notion of primordial soup and even the assumption about the occurrence of the pre-biotic evolution at the surface of Earth.

3.3 TGD based scenario about pre-biotic evolution

TGD framework leads to a radical view about life. Magnetosphere can be seen as a living system controlling the evolution of life and chicken-egg question can be seen in a totally new perspective. Super-conducting magnetosphere can be seen as a higher level life-form which controls and guides the biological evolution from the very beginning. Second key element is dark matter hierarchy.

3.3.1 Basic prerequisites

A short summary of basic requirements and problems is in order.

1. A stable star and planet providing appropriate conditions such as temperature for liquid water is needed.
2. Atoms like C, N, and O and smaller amounts of P and S giving rise to bio-monomers, and metals like Al, Fe, and Zn are the basic building blocks. The formation of various chemical bonds like hydrogen bonds, covalent bonds, and peptide bonds is necessary.
3. The formation of biological monomers (amino acids, nucleotides, fatty acids, sugars) is an essential element of life. Except for DNA nucleotides, basic monomers evolve in the circumstances simulating to what have been believed to be the primordial atmosphere. These bio-monomers are found even in the interstellar space and in galactic clouds so that the question is not whether the pre-biotic life can develop but whether our recent day materialistic science allows to understand how it develops. The standard wisdom about primordial atmosphere as a reducing

environment (containing no oxygen) indeed leads to grave difficulties. Also the concentrations in the primordial ocean seem to be quite too low for the bio-monomers to be synthesized [114].

4. The formation of the biological polymers such as proteins, nucleic acids, lipids, and carbohydrates occurs universally by dehydration. The problem is that in water environment polymers are unstable against decay by hydration: it would seem that a metabolic energy feed is required already at this stage to guarantee non-equilibrium situation. The assembly of these macro-molecules into organized aggregates like chromosomes, micro-tubules and cell organelles suggests the emergence of symbolic representations and only a weak independence of hard facts of chemistry which makes the problem even more difficult from the point of view of standard physics.
5. The emergence of catalysts and metabolism, should be understood. Here one encounters an egg-hen problem. Standardized metabolic currency seems to be necessary for effective catalysis but metabolism according to the standard view involves extremely complex web of reaction pathways needing refined catalytic actions.
6. Membrane bound structures are essential for life and one should understand how they emerge and even predict correctly basic facts about them.
7. The emergence of the genetic code has remained a mystery in various scenarios of pre-biotic evolution.
8. How the incredible ability of the components of bio-systems to co-operate pops up from primordial soup is not always included to the list of mysteries since everything smelling "holism" is regarded as pseudo science in reductionistic circles.

3.3.2 TGD based vision about pre-biotic evolution

The prevailing mechanistic world view forces to conclude that life emerged accidentally in young Earth during a relatively short time period of about .3 billion years. On basis of extensive computer simulations, one can fairly say that a spontaneous generation of life in primordial ocean seems extremely implausible [112].

TGD replaces materialistic view with a continual re-creation in which classical universe in 4-dimensional sense is replaced by a new one in each quantum jump. p-Adic length scale hypothesis allows to formulate the notion of evolution precisely as a generation of increasingly larger space-time sheets characterized by preferred p-adic primes meaning also a sequence of symmetry breakings. A second aspect is the emergence of new levels in dark matter hierarchy meaning great leaps in evolution. A crucially new element is the predicted fractal hierarchy of copies of electro-weak and color physics. Dark weak bosons and gluons thus become an essential part of the physics of living matter.

Macroscopic and even astrophysical quantum coherence becomes a key feature of living matter. Theory is partially non-deterministic also in classical sense but the variational principle for Kähler action implying that space-time surfaces are analogous to Bohr orbits and self-organization lead to Darwinian selection of selected patterns.

Is life really a result of accident?

Life is often regarded as an extremely improbable accident. The estimates for the probability of the formation of amino-acids, DNA, and of emergence of genetic code from random soup of molecules are indeed found to be extremely small. In TGD Universe the situation is different.

1. Intentional action is basic aspect of TGD Universe. Negentropy Maximization Principle [33] states that the dynamics of quantum jumps maximizes the information content of the conscious experience and implies evolution as a continual recreation of the Universe eventually leading unavoidably to the emergence of information rich systems and explaining also why the values of "fundamental constants" seem to be tailored for the emergence of life as we are used to identify it. p-Adic dynamics for cognitive space-time sheets implies local randomness but long range fractal correlations for the real dynamics.

2. The hierarchy of Planck constants implies macroscopic and macro-temporal quantum coherence in all length scales. Universe becomes single conscious organism in this framework. This has many implications. For instance, low frequency photon can have arbitrarily high energy. This makes it possible control of short length and time scales by the dynamics in long scales, say by EEG. The enormous values of gravitational Planck constant for dark matter and the assumption that visible matter condenses around dark matter imply that planetary orbits correspond to Bohr orbits [21, 18]. Only very few orbital radii are possible and for a star with mass around solar mass planets at distance of Earth are possible and probable irrespective of the mass of the planet. Hence solar systems are standardized to high degree. Also the quantization of masses of stars is highly suggestive and the number of stars with mass not far from solar mass is large. Obviously this raises the probability for having Earth like environments dramatically.
3. TGD based nuclear physics [47] explains cold fusion[50, 55] as well as biological nuclear transmutations for which there is considerable empirical support [51]. The direct empirical evidence comes from the observation that the abundances of heavier elements in an astrophysical object at distance of order 10 billion light years are essentially the same as in solar system [56]. If elements are created only in the stellar interiors, the abundances should be much smaller. This suggests that the heavier elements result by cold fusion in the interstellar space. The implication is that environments allowing life have existed much earlier than believed hitherto.
4. The hierarchy of Planck constants and the notion of magnetic body allow a mechanism of topological quantum computation [38] based on the representation of braids represented as flux tubes of wormhole magnetic field whose presence might provide a definition for what it is to be living. The first implication is an explanation for the miraculous ability of biomolecules to find each other in terms of the reduction of Planck constant inducing a shortening of the flux tubes connecting reactants and catalysts. The structure of flux tube patterns connecting various molecules allows to program complex series of biochemical reactions to the structure of braids connecting the molecules since given spots of molecules can be forced to meet each other in reaction. Conserved braid color allowing to identify whether the braid strand comes from A,T,C or G implies even stronger selection rules. One can assign also to amino-acid a 3-braid corresponding to one of the DNA codons coding for it. These extremely selective interactions between living bio-molecules give good hopes of understanding why DNA and amino-acids were selected as molecules able to co-operate.
5. Many-sheeted space-time concept implies the existence of fundamental metabolic energy currencies [31] defined by the differences of zero point kinetic energies of particles for space-time sheets labeled by different value of p-adic prime p . The existence of standardized metabolic currencies simplifies the situation dramatically and living matter must face only the problem of storing metabolic energy. Plasmoid like life forms suggest themselves as predecessors of biological life. p-Adic length scale hypothesis $p \simeq 2^k$ is what implies standardization of zero point kinetic energies and follows from zero energy ontology which also assigns to a particle labeled by prime p a time scale $T_p = \sqrt{p}L_p/c = L_p(2)/c$ characterizing the temporal size of the space-time sheet having particle and its negative energy counterpart at its time-like boundaries. The fact that the fundamental 10 Hz biorhythm corresponds to the time scale assignable to electron suggests that fundamental biological time scales are hidden in the space-time structure of fundamental particles.

The notions of magnetic body and plasmoid

The model of high T_c super-conductivity and the general vision about dark matter hierarchy have led to a rather precise model for magnetic body as an intentional agent utilizing biological body or its part as motor instrument and sensory receptor[20]. Dark matter plasmoids and plasma oscillation patterns as representations of control commands are one important aspect of the model. The prediction is that plasmoids should have been predecessors of ordinary life forms. There is laboratory evidence that plasmoids behave like life forms [75]. Very high temperatures catastrophic for ordinary life forms could prevail at magnetic flux quanta associated with plasmoids. This forces a radical reconsideration of the question how pre-biotic life have evolved and forces to ask whether even the hot interior of Earth could have served or still serve as a seat of life.

Does the Earth's magnetic field have a dark counterpart?

The notion of dark matter as a hierarchy of phases characterized by arbitrarily large values of Planck constant has established itself as a part of TGD [16, 20]. This raises several questions. For instance: does the magnetic body of Earth have a dark counterpart and its the dark magnetic body relevant for functioning of living matter?

A partial answer to this question came from a frustrating realization that I had for years erratically believed that the magnitude of the magnetic field assignable to the biological body is $B_E = .5$ Gauss, the nominal value of the Earth's magnetic field. Probably I had made the calculational error at very early stage when taking Ca^{++} cyclotron frequency as a standard. I am grateful for Bulgarian physicist Rossen Kolarov for pointing to me that the precise magnitude of the magnetic field implying the observed 15 Hz cyclotron frequency for Ca^{++} is .2 Gauss and thus slightly smaller than the minimum value .3 Gauss of B_E . This value must be assigned to the magnetic body carrying dark matter rather than to the flux quanta of the Earth's magnetic field. This field value corresponds roughly to the magnitude of B_E at distance $1.4R$, R the radius of Earth.

Dark matter hierarchy leads to a detailed quantitative view about quantum biology with several testable predictions [20]. In principle all integer and even rational values of Planck constant are allowed. Number theoretical arguments suggest a general formula for the favored values of $r \equiv \hbar/\hbar_0$ [16] as $r = n_1^{\pm 1} n_2^{\pm 1}$, where n_i characterizes the quantum phase $q = \exp(i\pi/n_i)$ characterizing Jones inclusion [19]. The values of n_i for which quantum phase is expressible in terms of squared roots are number theoretically preferred and correspond to integers n expressible as $n_i = 2^k \prod_n F_{s_n}$, where $F_s = 2^{2^s} + 1$ is Fermat prime and each of them can appear only once. The lowest Fermat primes are $F_0 = 3, F_1 = 5, F_2 = 17$. The prediction is that also r -multiples of p-adic length scales are possible as preferred length scales.

TGD inspired quantum biology and number theoretical considerations suggest preferred values for $r = \hbar/\hbar_0$. For the most general option the values of \hbar are products and ratios of two integers n_a and n_b . Ruler and compass integers defined by the products of distinct Fermat primes and power of two are number theoretically favored values for these integers because the phases $\exp(i2\pi/n_i)$, $i \in \{a, b\}$, in this case are number theoretically very simple and should have emerged first in the number theoretical evolution via algebraic extensions of p-adics and of rationals. p-Adic length scale hypothesis favors powers of two as values of r .

The hypothesis that Mersenne primes $M_k = 2^k - 1$, $k \in \{89, 107, 127\}$, and Gaussian Mersennes $M_{G,k} = (1 + i)k - 1$, $k \in \{113, 151, 157, 163, 167, 239, 241.. \}$ (the number theoretical miracle is that all the four p-adic length scales with $k \in \{151, 157, 163, 167\}$ are in the biologically highly interesting range 10 nm-2.5 μ m) define scaled up copies of electro-weak and QCD type physics with ordinary value of \hbar and that these physics are induced by dark variants of corresponding lower level physics leads to a prediction for the preferred values of $r = 2^{k_d}$, $k_d = k_i - k_j$, and the resulting picture finds support from the ensuing models for biological evolution and for EEG [20]. This hypothesis - to be referred to as Mersenne hypothesis - replaces the earlier rather ad hoc proposal $r = \hbar/\hbar_0 = 2^{11k}$ for the preferred values of Planck constant.

In the case of magnetic flux simplest quantization suggests the scaling $B \rightarrow B/r$ for the magnetic fields. This is assumed to hold true also in more general case when the quantization condition reads as $\oint (p - ZeA) dl = n\hbar$ and involves currents flowing at the boundaries of flux quanta so that magnetic flux need not be anymore quantized to a multiple of Planck constant. For axonal membranes the flux quantization with $n = 0$ is natural since the size of flux quantum does not depend on the value of Planck constant. Assuming flux quantization and standard value of Planck constant $B_{end} = .2$ Gauss would give flux tube radius $L = \sqrt{5/2} \times L(169) \simeq 1.58L(169)$, which does not correspond to any p-adic length scale as such.

Concerning the interpretation of B_{end} there are two options. It could correspond to a personal magnetic body or to a dark variant of the Earth's magnetic field. At this moment it is impossible to say which if any hypothesis is right. However the fact that the ELF fields have no direct effect on conscious experience mildly supports the identification as the dark variant of B_E .

Emergence of symbols at molecular level and new view about hydrogen bond, water, and bio-catalysts

The hierarchy of dark matter leads to novel ideas about what distinguishes living matter from ordinary matter. The emergence of symbols and symbolic dynamics and what might be called "molecular sex" could be a fundamental step in the process and I have considered two visions for how this would take place.

1. First vision

First vision is relies on the model of DNA as tqc based on braids and has quite close contact with empirical reality [38, 31]. In this case DNA nucleotides are analogous to colors of braid strands and base pairing corresponds to molecular sex for DNA molecules. The color of braid strand implies long ranged highly selective interactions between DNA and distant molecules, such as lipids of the lipid layer of cell membrane or amino-acids. Free amino-acids inherit the colors of the first two nucleotides in the codon XYZ whereas the color of the third nucleotide corresponds to a quantum superposition of colors for codons coding for the amino-acid this defines the quantum counterpart of wobble base pairing. Amino-acids can be divided into amino-acids and their conjugates analogous to opposite sexes and generalized base pairing determines the interactions of the amino-acids to a high degree. Hydrogen bond can be identified as a special case of flux tube. There are also flux tubes connecting acceptors of hydrogen bonds acting as plugs in the connection lines formed by the magnetic flux tubes and Y corresponds to this kind of plug at the level of amino-acids.

2. Second vision

The mathematical realization for the hierarchy of Planck constants leads to a generalization of the notion of imbedding space and this leads to four kinds of phases resulting as combinations of phases with increased or reduced unit of spin and quantum numbers associated with CP_2 degrees of freedom. Each phase corresponds to its own Planck constant and is characterized by a discrete symmetry group.

Especially interesting are phases with large value of Planck constant involving charge fractionization and increase of spin unit. The electrons of free electron pairs of aromatic cycle are reasonable candidates for dark electrons of this kind. One can consider variants of hydrogen atom containing $n \leq N$ fractionally charged electrons with with lepton number and electronic charge equal to n/N . The values n/N and $(N - n)/N$ for the fractional charge would correspond "name" and "conjugate name" since their combination would give a maximal charge and a state analogous to a full electron shell. Thermal stability poses strong constraints since atomic and molecular energy scales are reduced as Planck constant increases.

The notion of fractional electron inspires the notion of "half" hydrogen bond for which electron has a fractionized fermion number. The full hydrogen bond would be formed in the fusion of half hydrogen bonds and give rise to a structure analogous to a full electron shell expected to be especially stable. Catalyst sites might correspond to half hydrogen bonds and the basic recognition mechanism could be the fusion of half bond and its conjugate to form a full hydrogen bond. One could speak about "molecular sex". The sequences of half bonds would represent words so that molecules would have names. Also interpretation as quantum computer codes might make sense. The problem of this vision is the lack of direct contact with experimental facts and for this reason it will not be discussed in the sequel.

Universal metabolic currencies

In TGD framework a primitive many-sheeted metabolism is present from the beginning and becomes only refined during evolution. Most importantly, metabolic currencies identified as zero point kinetic energies liberated as particles drop to larger space-time sheets are constants of nature by the p-adic length scale hypothesis.

Phosphate-sugar polymers form the backbone of nucleic acids and metabolism is based on ADP and ATP formed from adenine and phosphate ions. It has been already earlier found that the generation of ATP and its metabolic utilization involve the flow of protons between the atomic space-time sheets and some larger space-time sheets, say magnetic flux tube of Earth [32]). It will be found that this mechanism is involved also with the dehydration leading to polymerization and phosphorylation. The reversal of this process also implies the in-stability of DNA in an ordinary aqueous environment.

The interpretation of the role of phosphate ions as metabolic energy batteries seems to be wrong in TGD framework: the main function of negatively charge phosphates would be to make bio-polymers critical against local modifications making them thus ideal for catalytic manipulations. Even deeper function would be the role as standard plugs to which magnetic flux tube can attach and which second flux tube can begin. $ATP \rightarrow ADP$ would in this framework mean reconnection process for a magnetic flux tubes modifying the hardware of tqc.

Time mirror mechanism, intentional action, memory, and remote metabolism

Time mirror mechanism having negative energy MEs as space-time correlate has phase conjugate laser waves as standard physics counterparts. Essentially negative energy signals propagating to the geometric past and reflecting back is in question. Intentional action realized in terms of negative energy signals to the geometric past and appearing already at the level of molecular magnetic bodies, is expected to become an increasingly important when the complexity of the structures increases. The charge entanglement by negative energy W MEs is especially interesting control mechanism and makes also possible sharing of mental images. Time mirror mechanism allows also remote metabolism by inducing the dropping of population inverted system to the ground state liberating in this manner positive energy photons received by the sender of negative energy signal. What makes this mechanism so elegant is its enormous flexibility (credit card is the counterpart in economy). Time mirror mechanism provides also a mechanism of memory as communications with the geometric past.

Emergence of membrane bounded structures

Self-organization in many-sheeted space-time is expected to automatically lead to the generation of the ordered water phases which would have evolved to the gel phase defining in turn a natural predecessor of the membrane bounded structures. Self-organization would have also led to the emergence of membrane structures containing liquid crystal water stabilizing also DNA nucleotides.

In fact, the TGD inspired model for high T_c super-conductivity as quantum critical super-conductivity involving simultaneously two kinds of super-conductivities in a narrow range of temperatures around critical temperature (presumably $T \simeq 37$ °C) predicts correctly the double-layered structure of cell membrane and the length scales involved [28, 27]. A fractal hierarchy of super-conductivities and cell membrane like structures is predicted corresponding to the dark matter hierarchy and p-adic length scale hierarchy [20]. Josephson junctions and corresponding Josephson currents are in a crucial role in the model for the hierarchy of generalized EEGs responsible for the communication to and control by magnetic body.

According to unexpected findings about behavior of the cell membrane [93] discussed from TGD viewpoint in [23], the usual picture based on pumps and channels for ions is not correct. Rather, cell interior is in gel phase in which water is in structured phase around charged bio-polymers intermediate between ice and water. One implication of this is stabilization of RNA and DNA polymers since hydrolysis is impossible due to the lack of free water molecules. Cell membrane would have guaranteed the long term stability of gel phase.

Second function of the membrane like structure consisting of lipids or perhaps even DNA or RNA molecules could relate to the topological quantum computation and memory in the manner discussed in [38]. The phase transitions changing the length of the wormhole magnetic flux tubes defining the braid strands and making possible tqc would also make possible biocatalysis via reconnection of flux tubes and via \hbar changing phase transitions changing the length of flux tube.

In this framework water and lipids molecules playing the role of lipids could have been present in very early stage since they emerge as a result of self-organization process and are not genetically determined.

Did life evolve in Mother Gaia's womb?

The proposed framework poses strong conditions on pre-biotic environment and one ends up to to interpretations for the notion of Mother Gaia's womb, which are by no means mutually exclusive.

1. Mother Gaia's womb as underground seas?

Braiding in the proposed sense requires the presence negatively charged polymers and membranes consisting of lipids or their analogs. Water seems to be necessary but also gel phase is needed since

free water induces depolymerization. The coherent structure of gel would be due to the braiding of distant molecules. The phase transitions of gel phase are good candidates for a basic mechanism of bio-control and would stabilize these polymers via the formation of structured water around them preventing hydrolysis. The developing life forms should be shielded from UV radiation and meteor bombardment.

The combination of these constraints leads to the idea that life as we define it could have evolved in the womb of Mother Gaia in underground seas with the Earth's crust shielding from UV and meteors. The necessary ingredients of biomolecules, in particular phosphates making possible phosphorylation making DNA and RNA charged and appearing also in hydrophilic ends of phospholipids, would have dissolved to the water from the ground. Cambrian revolution would have meant the burst of these highly developed life-forms to the Earth surface and resulting as a phase transition increasing the value of Planck constant for Earth's space-time sheet by a factor of two would have occurred. This would also provide a justification of Expanding Earth theory explaining the strange finding that the continents fits nicely together to form a single super continent covering entire Earth's surface if the radius of Earth is one half of its recent value and actually the same as the recent radius of Mars, which is now known to contain reservoirs of underground water.

2. *Mother Gaia's womb as mantle-core boundary?*

What about the period before the life in underground seas?

1. The plasma like aspects of cytoplasm suggests that some kind of plasma phase must have been present. Also the postulated Bose-Einstein condensates of bosonic ions at dark magnetic flux quanta represent kind of quantum plasma.
2. Plasmoids involving magnetic flux tubes and charged particles could have been predecessors of more complex molecular life forms and could have developed in the interstellar space. Their metabolism could have been based on universal metabolic energy quanta. Simple metabolic cycles and short term chemical storage of energy based on fusion and decay of simple molecules induced by say UV radiation from the nearby stars might have developed during this era. Quite high temperatures can be considered so that after the interstellar period this kind of life forms could have survived and developed in the hot interior of planets receiving their metabolic energy from radiation by high temperature plasma. A possible candidate for the womb of Mother Gaia is the mantle-core boundary, where intensive self-organization processes are expected to take place.
3. Ultimately the charged molecules must have come in contact with ordinary water in underground seas. One can imagine that the polymerization of the charged molecules and the formation of structured water around them stabilizing them and giving rise to a gel phase took place simultaneously in presence of metabolic energy feed.

The primordial womb containing plasmoid like life forms could have been located somewhere below the boundary at which $k = 137$ atomic space-time sheets transform to very hot $k = 131$ space-time sheets: this should occur when the thermal de Broglie wave length becomes equal to the p-adic length scale $L(131)$. The transition occurs above the crust-mantle boundary (1300 K). Mantle-core boundary (4000 K) is a good candidate for a seat of high- T life forms.

The dropping of O, C, N ions from the hot $k = 131$ space-time sheets to larger space-time sheets generates light at visible frequencies replacing solar light so that even intra-terrestrial counterpart of photosynthesis could develop. The dropping of oxygen atoms could make also possible development of oxygen based metabolism.

Magnetic flux quantum structure of the magnetosphere acting as a nervous system and a metabolic circuitry of the magnetic Mother Gaia could make possible controlled metabolism already during the pre-biotic period and allow to circumvent these difficulties.

Model for the genetic code

The emergence of genetic code is one of the basic mysteries of models for pre-biotic life. The exact A-G symmetry and slightly broken T-C symmetry of the genetic code strongly suggest that the evolution of the triplet code occurred as a fusion of singlet and doublet codes. One ends up with a detailed

model for how this happened by studying the structure of tRNA molecule carrying in its fossilized parts detailed information about the evolution of the code.

Nanno-bacteria [62, 50] might correspond to some predecessor of the recent genetic code. Nanno-bacteria accompany mineral structures and actively manipulate them: this conforms with the view that mineral interfaces have been indeed important for the evolution of polymers.

Introns are the basic mystery of DNA. TGD predicts that language is a universal phenomenon appearing at level of eukaryotes. Memes represented as sequences of 21 DNA triplets and expressing themselves as field patterns associated with MEs would realized this universal language.

What makes possible the coherence of bio-chemical activities?

In TGD Universe the control of genome by magnetic body relies on magnetic flux sheets traversing through DNA strands [20, 21]. The model implies a generalization of the notion of gene. Super-genes correspond to sequences of genes inside single organism belonging to single magnetic flux sheet and organize like text lines at a page of a book. The expression of super-genes as an intentional action of magnetic body occurs therefore coherently at the level of entire organs. This explains to the miraculous coherence of bio-chemical activities at the level of single organism. Also hyper-genes involving genomes of several organisms, not necessary belonging to even same species, become possible. Collective gene expression at this level makes possible the development of co-operation and social structures and are predicted to be present already at the bacterial level.

Braiding defined by magnetic flux tubes of their wormhole counterparts carrying dark variants of charged particles seem to represent especially important part of the magnetic body and this leads to models of topological quantum computation and bio-catalysis.

3.3.3 Pre-biotic chemistry and new physics

The emergence of symbolic representations at dark matter level is certainly the most fascinating possibility suggested by dark matter hierarchy.

Overall view

The most important implications can be deduced readily.

1. The dropping of ions and atoms between space-time sheets involves a liberation of zero point kinetic energy. By p-adic length scale hypothesis these energies define a fractal hierarchy of universal metabolic currencies which have not changed at all during evolution and are the same in the entire universe. The presence of the metabolic machinery from the beginning helps enormously in the attempts to understand how life has evolved.
2. Chiral selection resulting in bio-polymers having a definite handedness is a deep mystery in standard physics framework. TGD predicts entire hierarchy of standard model physics meaning scaled up variants of electro-weak and color physics and dark variants of these. The hierarchy of dark weak gauge bosons predicted by TGD imply strong parity breaking effects in arbitrarily long length scales above atomic length scales, and the presence of the chiral selection supports the view that also dark weak bosons play key role in bio-control. Indeed, charge entanglement generated by W MEs would be in central position in TGD based model for how magnetic bodies control biological bodies.
3. The emergence of life means emergence of symbolic representations (including names), and also what might be called "molecular sex". Formation of wormhole magnetic flux tubes between biomolecules having quark pair and its conjugate is an attractive candidate for this process and means coding of DNA nucleotides to quarks and antiquarks appearing as dark matter at the flux tubes. This leads to a new view about bio-catalysis based on the temporary dropping of the liberated proton to a larger space-time sheets and ensuing liberation of metabolic energy quantum kicking the complex formed by reactants over the potential wall separating it from the final state. A new view about water and its role in bio-catalysis emerges. Stability considerations allow a general model for how first bio-polymers able to replicate emerged.

Dark matter and the emergence of symbolic representations at molecular level

The most important new physics element of pre-biotic chemistry has been already discussed and corresponds to the presence of dark matter hierarchy suggesting new views about hydrogen bond, water, and catalytic action. A highly attractive hypothesis is that symbolic representations at molecular level in the sense that quarks and antiquarks code for DNA nucleotides [38] and also for amino-acids [34].

Evolution of pre-biotic chemistry as a sequence of bifurcations

In his article "Biocosmology" [102] Chris King discusses biochemistry from the point of view of mathematician using the notions of symmetry breaking and bifurcation. This discussion allows for a physicists to get a wider perspective to the complexities of biochemistry. In the following I modify the arguments of King to TGD framework. The first basic new element is that generation of new space-time sheets corresponds to a sequence of symmetry breakings.

Besides hydrogen C, N, and O atoms with charges 6, 7, and 8 are the most important elements appearing in basic bio-monomers. The bonds with hydrogen are formed between $1s$ and $2p^3$ orbitals. The covalent bonds between C, N, and O atoms are the bonds appearing in various bio-monomers like ribose. Also peptide bonds between C and N in amino-acid sequence are covalent bonds. In standard chemistry one can characterize the atom in given molecule by its electronegativity telling how effectively it attracts electrons.

Electronegativity increases in the sequence C, N, O so that the bonds are more and more polar. Also Si, P, and S in the next row of the periodic table form covalent bonds but the bond energy tends to be lower which reflects itself as lower boiling points. For instance, the boiling point of H_2S is below the freezing point of water). Consider now the bifurcations.

1. Polar-non-polar bifurcation is fundamental in biology. Non-polar molecules are hydrophobic and are not water-soluble whereas polar molecules are hydrophilic and water-soluble. For instance, the formation of biological membranes is based on hydrophobic character of the second ends of lipids. A rough characterization of amino-acids is by polar-non-polar dichotomy. Also DNA base stacking is based on polarity.
2. Second bifurcation corresponds to acid-base dichotomy. Acids are able to act as donors of positive and bases donors of negative charge. For instance, this allows to classify polar amino-acids to acidic and basic ones. A working hypothesis worth of studying is that many-sheeted physics is involved in the sense that the protons in acid and electrons in base have dropped to some larger space-time sheet from the atomic space-time sheet.
3. The third bifurcation corresponds to that between second and third row of the periodic table that is Na^+-K^+ and $Mg^{++}-Ca^{++}$ bifurcations. The covalent bonds involving K and Ca are in general weaker. Na^+ concentration is higher outside cell whereas K^+ concentration is higher inside cell. Same applies to gel phase, a possible predecessor of cell membrane bound regions. Mg^{++} acts as stabilizer of polymers and Ca^{++} ions are key players in cellular and intracellular control. In particular, Ca^{++} waves appear in extremely wide range of frequencies and conduction velocities.
4. The fourth bifurcation corresponds to the d-orbital elements forming a catalytic group. Almost all transition elements Mn, Fe, Co, Cu, Zn are essential biological trace elements, promote pre-biotic synthesis and are optimal in their catalytic ligand-forming capacity and valency transitions. For instance, Zn^{2+} catalyzes RNA polymerization in pre-biotic synthesis and occurs in both polymerases and DNA binding proteins.
5. The fifth bifurcation corresponds to chiral symmetry breaking not easy to understand in standard model predicting extremely small parity breaking. There is empirical evidence such as circular polarization of light from the region of star formation in the constellation of Orion suggests that parity breaking occurs also in interstellar space. Also the amino-acids in Murchison meteorite were found to be dominantly left handed.

In TGD Universe the interpretation of bifurcations is not quite the same as in the world obeying standard chemistry.

1. The polar-non-polar bifurcation corresponds to hydrophilic-hydrophobic dichotomy. The model for protein folding and bio-catalysis relies on the hypothesis that wormhole flux tubes connect conjugate amino-acids. This process is analogous to base pairing. Stating it roughly, amino-acid and its conjugate correspond hydrophilic and hydrophobic amino-acid. This bifurcation is thus important from the point of view of molecular symbolism and bio-catalysis if it is based on the coding of DNA are nucleotides and amino-acids by quarks and antiquarks at the ends of wormhole magnetic flux tubes connecting them to other molecules. The emergence of wormhole magnetic flux tubes could be seen almost as a definition of emergence of life. This might have happened already during prebiotic molecular evolution if water molecules have been present from the beginning.
2. Acid-non-acid bifurcation brings in protons and there is obviously a connection with the role of protons in the basic mechanisms of metabolism and catalysis. What is also essential is the role of negative charge of bio-polymers making bio-polymers critical against local deformations so that a wide repertoire of catalytic actions using \hbar changing phase transitions of wormhole magnetic flux tubes and their reconnections becomes possible. Phosphate ions would not serve as batteries of metabolic energy but make bio-polymers sensitive to catalytic actions.
3. Fifth bifurcation is difficult to understand in standard physics framework but is consistent with the presence long ranged weak fields predicted by TGD and possibly associated with dark matter. This bifurcation is not the last one in TGD Universe since already plasmoids identified as rotating magnetic systems break parity because the sign of the charge density generated by the induced radial ohmic current depends on the orientation of rotation and only the second orientation is favored energetically. W MEs induce charge entanglement giving rise to plasma oscillation patterns in turn inducing various physiological waves. This mechanism can be used as a control tool by magnetic bodies at various levels of hierarchy. Long range weak forces due to the exotic ionization of atomic nuclei could provide a tool for controlling conformations of nucleic acid polymers. Same applies to kaolinite clays consisting of Al, Si, O suggested to be of biological importance (Al can have three different states at a given lattice site): in this case the state of Al atoms in the lattice might be manipulated using weak forces.
4. The hierarchy of bifurcations defines also a hierarchy of decreasing cyclotron frequencies. The cyclotron frequencies would be associated with both with Bose-Einstein condensates of ordinary and exotic bosonic ions at magnetic flux sheets. For the bosonic ions cyclotron frequencies in the $B_{end} = 2B_E/5$ are in alpha band and in TGD Universe they play a fundamental role in communications to and control by magnetic body using hierarchy of generalized EEGs. Ca^{++} and other waves associated with bosonic ions are of special importance in the bio-control by magneticbody using plasmoids and plasma oscillation patterns.

What selected the bio-molecules?

The extremely low probabilities for the selection of bio-molecules from a super-astrophysical number of alternatives represents one of the bottleneck problems of biology relying on the prevailing view about biochemistry. The notion of braid could resolve this problem.

Suppose that the presence of braids distinguishes between living and dead matter, that the four nucleotides are mapped to colored braid strands (that is to 2 quarks + 2 anti-quarks), and that a given amino-acid is mapped in a non-deterministic manner to one of the 3-braids associated with the DNA triplets coding for it. Braids could be associated besides DNA, amino-acids, and lipids also to other bio-molecules and define more general analogs of genetic codes as correspondences between bio-molecules able to react.

The implication would be that the step of catalytic reactions bringing together the catalyst and reactants would occur by a temporary reduction of Planck constant only for subsets of bio-molecules connected by braid strands and the pattern of braid strands involved would define the geometrodynamical pattern of the reaction. The outcome would be a selection of very restricted subsets of bio-molecules able to form reaction networks and of reaction pathways. This would imply Darwinian selection of subsets of bio-molecules able to co-exist and dramatically enhance the probability for the emergence of life as we know it.

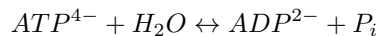
One challenge is to predict what kind of braids can begin from a given bio-molecule, say nucleotide or amino-acid. The physicist's guess would be that the (electromagnetic only?) interaction energy between bio-molecule and given pattern of wormhole contacts having quark and anti-quark at its throats should select the preferred braids as minima of the interaction energy. How closely the presence of hydrogen bond relates to this is also an interesting question.

Polymerization, dehydration, phosphorylation, and new physics

The generation of phosphate polymers and polymers in general occurs by dehydration which quite generally seems to involve dropping of a proton to larger space-time sheet and liberation of metabolic energy quantum. It is interesting to find how one could understand these processes in TGD framework. Since the notion of wormhole magnetic flux tube playing a central role in the model of DNA as topological quantum computer and in the model of bio-catalysis, it is natural to look whether the basic steps of these processes could be understood in this conceptual framework.

1. $ATP \rightarrow ADP$ process

AMP, ADP, ATP are phosphorylated RNA nucleosides [113] and the hydrolysis of ATP to ADP [80] plays a key role in the metabolism. Obviously also the molecules XMP, X=U,C,G are important biologically. Each PO_3 in ATP corresponds to one unit of negative charge except for the last one which carries two units of negative charge. According to the standard chemistry $ATP \leftrightarrow ADP$ corresponds to the hydrolysis



where P_i denotes orthophosphate HPO_4^{-2} . In ADP the last phosphate group is $HO - PO_2^{-2}$ rather than $O = PO_2^{-2}$ as in the case of ATP.

The actual process is however much more complex than this.

1. The process involves several steps such that energy is liberated in two steps in which the change of Gibbs free energy is $\Delta G = .42$ eV and $\Delta G = .31$ eV making altogether .73 eV, which should closely relate to the liberated metabolic energy.
2. Three protons are accelerated in electric field during the generation of ATP. The interpretation would be in terms of driving of electrons from larger space-time sheet to $k = 137$ atomic space-time sheet. If the larger space-time sheet corresponds to $k = 139$, the increment of the zero point kinetic energy of proton is $(1 - 1/4) \times E_0(137) = .375$ eV for $E_0(137) = .5$ eV of metabolic energy quantum. Three protons would give net zero point kinetic energy increment of 1.125 eV which is higher than $\Delta G_{tot} = .73$ eV. The explanation of the discrepancy should relate to Coulombic binding energy of protons with ATP and F_1 . This interpretation conforms with the observation that the liberated energy is higher for the third proton.

Consider now a more detailed model for the process. The binding of ATP to the catalytic site involves several steps.

Step 1: The binding $ATP + F_1 \rightarrow ATP \cdot F_1$ to the catalyst site is a complex process involving the break-up of the hydrogen bonds between cellular water and ATP molecule and cell water and catalyst site and generation of hydrogen bonds between catalyst site and ATP molecule. In TGD framework this means that protons can be kicked to and dropped back from atomic space-time sheets. Only the net number of protons dropped however matters.

This process involves liberation of Gibbs free energy about $\Delta G_{ATP} = .42$ eV. It was earlier believed that this energy is liberated instantaneously but the findings about the behavior of the F_1 motor coupled to dissipative load, lead Oster and Wang to suggest that the process is more complex and starts from a loose binding and ending up to a strong binding [108].

Step 2 Hydrolysis: $F_1 \cdot ATP \rightarrow F_1 \cdot ADP \cdot P_i$. The change of free energy is small during this step: $\Delta G \sim 0$.

Step 3: Orthophosphate is released from the catalyst site: $F_1 \cdot ADP \cdot P_i \rightarrow F_1 \cdot ADP + P_i$. Free energy $\Delta G \sim .31$ eV is liberated at this step.

Step 4: ADP is released from the catalyst site: $F_1 \cdot ADP + P_i \rightarrow F_1 + ADP + P_i$. $\Delta G \sim 0$ holds true also for this process.

This picture suggests that the notion of the high energy phosphate bond is not quite correct as suggested also by some empirical findings [101, 53, 54]. The metabolic energy could be stored as the zero point kinetic energy of protons rather than in phosphate bonds. Perhaps one fundamental function of phosphates would be to make DNA and RNA polymers charged in turn making possible the formation of wormhole magnetic flux tubes and braiding making possible a wide repertoire of catalytic actions. Phosphorylation of say protein could mean a reconnection process for magnetic flux tubes with flux tubes attached to O= atom transferred from *ATP* to the target to which phosphate is attached.

2. *Model of $ATP \rightarrow ADP$ based on wormhole magnetic flux tubes*

Consider first the basic philosophy behind model.

1. In the model of DNA as topological quantum computer *XMPs*, $X = A, T, C, G$ can be connected to oxygen atoms by wormhole magnetic flux tubes having quark and antiquark at opposite throats of wormhole contact and charge conjugated quark-anti-quark pairs at the ends of the flux tubes. Dark u quark and its charge conjugate code for A, T and d quark and its conjugate for G, C so that the conjugation for nucleotides corresponds to charge conjugation for quarks and $A - G$ and $T - C$ symmetries of the third nucleotide of the codon to isospin symmetry.
2. Basic bio-catalytic processes are identified as a reconnection of the wormhole magnetic flux tubes and change of the length of the flux tube induced by the change of the value of Planck constant associated with it. It would not be too surprising if this kind of mechanism were involved also in $ATP \rightarrow ADP + P_i$. The reason for the special role of *ATP* among *XTP* might be that the positive charge $q(u) = 2/3$ of u -quark maximizes the attractive interaction between u quark and phosphate.
3. Flux tubes connect to oxygen atoms in the proposed model of bio-catalysis and protein folding [34]. The model relies on ideas inspired by the model of DNA as topological quantum computer [38]. In this model hydrogen bonds are assumed to correspond or to be accompanied by (wormhole) magnetic flux tubes. Also flux tubes connecting acceptor atoms or molecules of hydrogen bonds are assumed to be connected long flux tubes and represent genuinely new physics. Examples of acceptors are $O =$ atoms in phosphates and amino-acids and aromatic rings in DNA and also in some amino-acids. The model for protein folding has tight connections with existing chemistry and leads to a very simple criterion for the formation of hydrogen bond between $N - H$ and $O =$ in the constant part of amino-acid and to a proposal for the folding code.
4. DNA as tqc model gives further constraints. The structure of the phospholipids suggest that in the case DNA nucleotides long flux tubes connect the aromatic ring of the nucleotide to the $O =$ atom at the hydrophilic end of the lipid acting as a standard plug which in turn can be connected to another acceptor and eventually terminates to a donor of hydrogen bond. The detailed charge structure of the aromatic ring(s) should determine the quark-nucleotide correspondence. The connection line to the lipid could involve several intermediate $O =$ plugs and the first plug in the series would be the $O =$ atom of the monophosphate of the nucleotide. Not surprisingly, phosphorylation would be absolutely essential for the operation of DNA as topological quantum computer. $O = -O =$ flux tubes could also act as switches inducing a shortcut of the flux tube connection by reconnecting with a hydrogen bond connecting two water molecules. This is an essential step in the model for how DNA acts as topological quantum computer.

A possible model (perhaps the simplest one found hitherto) for the reaction $ATP \rightarrow ADP + P_i$ is based on the assumption that it splits a flux tube connection defining strand of a braid defining topological quantum computation. A change of the hardware of topological quantum computer would be therefore in question.

1. Suppose that *ATP* defines a standard plug in flux tube connections. This would mean that aromatic ring and the oxygen atoms $O =_1$, $O =_2$, and $O =_3$ of the phosphates are connected by magnetic flux tubes to some molecules. These flux tubes represent genuinely new physics in accordance with the fact that "high energy phosphate bonds" are not really understood in the standard chemistry. Suppose that the flux tube associated with $O =_2$ connects it with $O =_3$

and defines the somewhat mysterious high energy phosphate bond. This bond would be formed during cellular breathing and the metabolic energy would go the formation of the magnetic flux tube between $O =_2$ and $O =_3$. Suppose that $O =_1$ - the innermost O has a flux tube connecting it to catalyst in this case F_1 .

2. At Step 1 F_1 and ATP molecule would find each other. This would be due to the shortening of the magnetic flux tube connecting them and associated with the innermost phosphate. This would liberate .42 eV of metabolic energy.
3. At Step 2 hydrolysis would induce $F_1 \cdot ADP \cdot P_i \rightarrow F_1 \cdot ADP + P_i$. Since no energy is released at this step, there is temptation to conclude that a reconnection of $O_2 - O_2$ flux tube and a flux tube associated with catalyst occurs. ADP and P_i forms now a high energy bond with catalyst. the reconnection of $(O =_2) - (O =_3)$ flux tube with the hydrogen bond connecting two water molecules leads to the disappearance of this flux tubeso that the incoming and outgoing the flux tubes are shortcut by $(O =_2) - -H - (OH)$ resp. $(O =_3) - -H - (OH)$ hydrogen bonds (connection to ground is the analog in circuit theory). This would correspond in the usual terminology the liberation of the third phosphate: $ATP \rightarrow ADP + P_i$. P_i however remains at the end of flux tube to be attached later to another ADP . The resulting bonds to water molecules would have low energy and the liberated energy would be usable metabolic energy. In this case the function of the splitting would be purely energetic.
4. One can imagine also a function related to information processing. P_i could be also attached to some other molecule in phosphorylation process so that the outcome would be a reconnection in the web of magnetic flux tubes. Phosphorylation is indeed known to play a key role in activation and deactivation of proteins and in the formation of signal pathways. In the case of AMP associated with DNA there would be only single flux tube involved and it could connect DNA nucleotide to nuclear or cell membrane.
5. The process involves also hydration. $(OH)^-$ ion joins to the third P to give P_i^{-3} and H^+ to $O - P$ in second P to give $H^+ - O$ in ADP^{-1} . The exchange of electron would lead to the final state $ADP^{-2} + P_i^{-2}$.

A possible model for the dropping of protons would be following.

1. It is absolutely essential to realize that F_1 is an open system and that naive thermodynamic considerations can lead to misunderstandings. In particular, the notion of high energy phosphate bond does not make sense. The source of the metabolic energy is the chemical energy used to drive protons to the atomic space-time sheets of F_1 . The function of the large negative charge of ATP is to increase the rate for the binding of ATP^{-4} to F_1 . In the classical picture the binding to F_1 is followed by the dropping of two protons to larger space-time sheet. The value of the metabolic quantum could be reduced from .5 eV to about .21 eV by the Coulombic interaction energy of proton with PO_4^{4-} . The Coulombic binding energy of the remaining protons at F_1 with $ADP + P_i$ is smaller and the dropped proton liberates larger energy about .31 eV. In quantum picture the division of the process to this kind of sequence might not be a good approximation.
2. One function of the $ATP \rightarrow ADP$ would be to induce the dropping of the third proton from F_1 space-time sheet. Second function would relate to the topological quantum computation like process since the decay would correspond to a splitting of a braid strand coming to the aromatic ring of A and proceeding along string defined by the ring and three $O =_s$ of phosphates and continuing further. This would make possible tqc as a braiding for both halves of the split flux tubes. After the reconnection the total braid structure would be different. Quite generally, reconnection process would make possible to modify the hardware of topological quantum computer.
3. The reason for why P_i leaves the catalyst site and proton is dropped (step 2) should be the in-stabilization of the bound state of positively charged proton with $ADP^{-2} + P_i^{-2}$ which does not have so strong Coulomb interaction energy with proton as ATP^{-4} . As a consequence, proton can drop to the larger space-time sheet.

4. What remains open are the details of the transformation of the chemical energy to zero point kinetic energy of protons. Remote metabolism suggests that protons send negative energy phase conjugate photons to the geometric past inducing a transition of an energy carrying molecule to a lower energy state (zero energy ontology gives justification for this picture). This would mean the failure of the standard description in terms of reaction kinetics. The catabolism of nutrients is the eventual provider of the metabolic energy and the coenzyme nicotinamid adenine dinucleotide NAD^+ [78] receives electron and the energy liberated in the catabolic reaction. In the proposed framework it is not an surprising that NAD^+ is analogous to RNA dinucleotide (perhaps as remnant from RNA era when dinucleotides defined the 2-codon code) and consists of two phosphates and adenine and nicotinamide nucleosides. The oxidation reaction $NADH \rightarrow NAD^+$ in turn liberates this energy. Protons could gain their energy by sending negative energy photons to $NADH$. Negative energy photons would propagate along "topological light rays" parallel to the flux tubes connecting the system in a precisely targeted manner to NADH aromatic rings. Alfven waves propagating along magnetic field lines would be the standard electrodynamics counterpart for these topological light rays.

Many details of the process remain open but it would seem that the key ideas of TGD based quantum vision about living matter are fused together in rather detailed manner in this picture.

3. Polymerization of DNA and RNA

The polymerization of RNA and DNA by dehydration involves the fusion of $PO_4H_2^-$ phosphate molecule with ribose. In this process the stub $\dots-O-H$ of the phosphate ion combines with $H-O-C-\dots$ stub of ribose (here C is the carbon atom not belonging to the ribose cycle). This gives rise to $\dots-O-(H-O)^--C-\dots$ plus proton dropping to a larger space-time sheet and liberating metabolic energy quantum. Too large negative charge of three units makes the complex unstable and $(H-O)^-$ ion splits out. Metabolic energy quantum might be also used in the process.

DNA as tqc model would suggest a possible interpretation. Perhaps the polymerization creates flux tube connections from nucleotides to to other molecules -say lipid molecules of the nuclear membrane or some catalyst molecule- via the attached $O=$ attached to phosphate. Also the phosphorylation of proteins could involve this kind of reconnection process creating flux tube connection of protein with some other molecule.

Hydration destabilizes long polymers unless there is a continual feed of protons to the atomic space-time sheets. This could be achieved by irradiation with photons with energy equal to the metabolic energy currency. Situation changes also if water is ordered/structured water, in liquid crystal form, or as ice, and therefore unable to provide the water molecules needed for the hydration. Stabilization of RNA and DNA polymers could be achieved in this manner in gel phase.

Clay structures are known to act as catalyzers of RNA polymerization. The general model of catalysis based on the recombination and \hbar changing transition for magnetic flux tubes should explain also this.

Why DNA is stable inside cell nucleus?

Inside membrane bound surface both DNA and RNA nucleotides and polymers are stable. The un-stability of the DNA nucleotides and polymers outside membrane bound surfaces could involve many-sheeted physics.

1. What one expects that DNA transforms to RNA unless it is inside a membrane bound region. A possible reason is that water molecule is needed to transform DNA to RNA but not available inside membrane bound structure where water is structure water in gel phase.
2. In the case of A, G, and C nucleotides DNA \rightarrow RNA transformation means simply an addition of one oxygen atom to the de-oxyribose ring, that is replacement of one C-H with C-O-H. If ordinary water is present this could be achieved by the dissociation of the water molecule to $OH^- + H^+$ followed by the replacement of C-H in the de-oxyribose cycle with C-OH $^-$ so that a negatively charged ribose results. The outcome is free hydrogen atom. If H^+ drops to a larger space-time sheet, the liberated zero point kinetic energy is of order .5 eV. This process is basically the same which should occur when single *ATP* molecule is utilized in metabolism.

3. In the case of T nucleotide also CH_3 group differentiating T from U must be de-attached. This is achieved if the hydrogen atom from the water molecule is taken by the de-attached CH_3 group to give CH_4 molecule. As a result a negatively charged U results. Inside cell nucleus or in gel phase this process is not favored because the water is in liquid crystal form and it costs energy to take the needed H_2O molecule from it.

3.3.4 Could high energy phosphate bond be negentropic bond with negative binding energy?

Most people assign the word "love" to the word "life" as their first association. There is a notable exception to this: scientists including biologists. Un-educated layman might however wonder whether one can understand life without identifying any physical counterpart for this notion (, which could be replaced with that of compassion, sex, or ability to act synergetically or just X if some of these notions sounds less un-scientific). Certainly the word "love" stimulates a deep feeling of disgust in a reductionistically conditioned scientist. But isn't the duty of scientist to win this kind of feelings and try to see whether this identification might be possible after all? The prize could be high: the understanding of what distinguishes between living and dead matter could change the entire culture. Who knows, maybe it could be possible to identify some poorly understood fundamental biological process allowing a quantitative model using a guess for what this physical correlate could be. The basic step of metabolism is at the core of life and indeed poorly understood, and I shall argue that the identification of the negentropic entanglement as the counterpart for the notion of love could allow to model quantitatively what happens in this process.

Basic ideas

Before continuing general motivating comments about implications of negentropic entanglement are in order.

1. Ordinary bound states are stable because they have positive binding energy. One can visualize this kind of binding as a jail: the second particle resides near the bottom of a potential well. Organized marriage is a social analogy for this situation. Negentropic entanglement makes possible bound states for which binding energy can have and perhaps even has always a wrong sign. The state is not prevented from decaying to free particles in state function reduction by energy conservation: Negentropy Maximization Principle (NMP) [33] takes care that they remain correlated. The social analogy would be a voluntary marriage based on love. Partners are completely free to leave but want to stay together. One implication could be explanation for the stability of highly charged basic molecules of life such as DNA and ATP.
2. The presence of the negentropic entanglement implies the directedness of the biological processes since the outcome of the state function reduction would be far from random since the behavior of negentropic bonds could be almost deterministic. In the case of time-like entanglement this would select only particular initial final state pairs so that determinism would emerge also in this sense and could lead to almost deterministic irreversible cellular automaton behavior characteristic for the living matter very different from the reversible determinism of classical physics and very difficult to understand in quantum context.
3. The determinism would of course be only partial and would allow volition not spoiled by randomness of quantum jump. This would provide a general explanation for the ability of the living matter to overcome the second law basically implied by quantum randomness predicted by the standard quantum theory. This would happen in time scales shorter than the time scale of the appropriate causal diamond (CD) only but one would have hierarchy of CD meaning that in arbitrary long time scales there are levels of hierarchy at which second law is broken. The hierarchy of Planck constants would be also crucial since it would allow zooming up to arbitrarily long time scale. Non-equilibrium thermodynamics and cellular automaton models could be seen as phenomenological descriptions for the actual breaking of second law in the intersection of real and p-adic worlds.
4. High energy negentropic bonds need not be present only in phosphates. $\text{O}=\text{s}$ are present in all important biomolecules. Phosphates are present in DNA. Each peptide bond in aminoacid

polymer contains O=. Also sugars contain it. Maybe O= indeed acts as a universal plug defining then ends of negentropic flux tube bonds between biomolecules. For instance, protein folding for which a possible model is discussed in [34] from different view point could be more or less deterministic cellular automaton like process if the bonds are negentropic. Negentropic entanglement would also guarantee the stability of the folding pattern. Certainly the assumption that the process is random -as standard quantum theory would suggest- leads to Levinthal paradox stating that the rate of the process is quite too slow. The simplest possibility is that the flux tube bonds are between O=s of subsequent aminoacids before folding and the folding process involves formation of reconnections possibly drawing by a reduction of Planck constant certain aminoacids near to each other. O=s could also act as plugs connecting protein to other biomolecules. One must however notice that many neurotransmitters, hallucinogens, and alcohol having strong effects on consciousness have O-H groups instead of O=s. This inspires the question what happens to the flux tube in $O=\leftrightarrow O-H$ process.

General formulation of the model

Consider now the model. High energy phosphate bond [120] assigned with the two outer-most phosphates of ATP [113] is fundamental for the basic processes in living matter. The $ATP \rightarrow ADP + P_i$ liberates metabolic energy loaded to ATP in the cellular respiration process [128] or its equivalent and occurs again and again and defines a kind of Karma's cycle in living matter. The phosphate bond is assumed to have a high energy content liberated as ATP is hydrated to ADP [121] and phosphate ion $P_i = PO_4^{3-}$ [124]. The notion of high energy phosphate bond has been however challenged as being meaningless [101, 53, 54].

1. One can of course consider a high energy bond for which the interaction potential looks like a well at the top of mountain and spin glass degeneracy of quantum TGD would certainly allow to consider this kind of notion. I do not know whether models realizing this idea concretely have been really constructed.
2. My earlier proposal for $ATP \rightarrow ADP + P_i$ process is inspired by the notion of many-sheeted space-time and p-adic length scale hypothesis making sense in the intersection of real and p-adic worlds and involves the dropping of protons (or electrons) to larger space-time sheets and driven back in oxidative metabolism. The energy liberated in this process corresponds to the zero point kinetic energy of protons (or electrons), which is smaller at the larger space-time sheet. The maximum value of zero point kinetic energy is predicted to be $E_0 \simeq .5$ eV for $k = 137$ in the case of proton and for $k = 148$ in the case of electron (for electron the energy would be by a factor $2^{-11}m_p/m_e \simeq .94$ smaller).
3. With an inspiration coming from DNA as topological quantum computer model [38] I have also proposed that the magnetic flux tubes connecting bio-molecules to each other define a kind of Indra's net plays a key role in the biological information processing. For instance, topological quantum computations could be realized in terms of braids formed by flux tubes [38, 34]. O=:s associated with phosphates would serve as universal plugs to which flux tubes could be connected connecting intronic nucleotides and lipid layers of nuclear or cell membrane. In particular, the innermost O= of ATP could be connected by a flux tube to any biomolecule needing metabolic energy- say some catalyst or the F_1 machine central for energy metabolism. The reduction of Planck constant would bring ATP and biomolecule near each other and lead to a formation of a weakly bound state making catalytic processes possible. The outer O=:s of the ATP molecule could be connected by a flux tube to each other, which could be rather long loop. This flux tube could provide the new physics realization of the high energy phosphate bond.
4. ATP (P_i) has 4 (3) units of negative charge and at least ordinary layman might wonder why this does not induce instability. Similar problem is encountered in the case of DNA, which contains two units of negative charge per nucleotide. This particular problem is regarded as completely real. The idea about life as something in the intersection of real and p-adic worlds [39] raises the question whether these high energy states could be made possible by the presence of negentropic bonds- most naturally associated with the flux tubes with large \hbar . This love marriage would stabilize ATP , ADP , and DNA and other charged biomolecules. The presence of phosphates

would be a clear-cut signature of this stabilization mechanism. Also proteins involve phosphates playing a key role in the bio-control: typically phosphorylation activates or de-activates the protein and is also involved with the generation of signal pathways. Why this happens would be easy to understand in Indra's net model.

5. In $ATP \rightarrow ADP + P_i$ transformation the energy carried by the negentropic bonds would be liberated but leave the flux tube bonds negentropic. Cell respiration would take care of the loading of the batteries with negentropic metabolic energy. This would involve also the kicking of protons back to the smaller space-time sheets. Also the molecular lovers ADP and P_i would find each other again as the Planck constant for the flux tube connecting them would be reduced during the cellular respiration transform ADP and P_i back to ATP .

Quantitative estimates

Consider now a more detailed model for $ATP \rightarrow ADP + P_i$. The binding of ATP to the catalytic site involves several steps. I have described them in the previous section and in the following add to this template the interpretation suggested by the proposed picture.

1. **Step 1:** The binding $ATP + F_1 \rightarrow ATP \cdot F_1$ to the catalyst site is a complex process involving the break-up of the hydrogen bonds between cellular water and ATP molecule and cell water and catalyst site and generation of hydrogen bonds between catalyst site and ATP molecule. In TGD framework this means that protons can be kicked to and dropped back from atomic space-time sheets. Only the net number of protons dropped however matters.

This process involves a liberation of Gibbs free energy per single attachment, which is about $\Delta g_{ATP} = .42$ eV. It was earlier believed that this energy is liberated instantaneously but the findings about the behavior of the F_1 motor coupled to dissipative load, lead Oster and Wang to suggest that the process is more complex and starts from a loose binding and ending up to a strong binding [108].

Comment: One can question the assumption that strong binding is generated. Instead of binding proton or electron would be dropped to a larger space-time sheet and liberate zero point kinetic energy.

- (a) The simplest interpretation in the proposed picture is that the negentropic flux tube connecting ATP and F_1 molecule and behaving as high energy phosphate bond associated with the innermost O= is contracted via the reduction of Planck constant. Then proton is dropped from $k = 137$ space-time sheet to a much larger space-time sheet and liberates metabolic energy quantum $E(137) \simeq .5$ eV. Another possibility is that electron at $k = 148$ space-time sheet is dropped. This process would replace the instantaneous generation of binding energy and in zero energy ontology the time scale for this process would correspond to the time scale of appropriate causal diamond (CD).
- (b) Instead of single particle energy macroscopic Gibbs energy $G = E + PV - TS$ is the useful notion now since macroscopic quantities of matter are studied and pressures and temperature are typically constant in the situations considered ($dG = -SdT + VdP$). G is minimized for constant T and P prevailing in the situation considered.
- (c) In the attachment of ATP to catalyst S is reduced and a good guess is that volume is not affected so that PV term does not change. From this one can deduce that the liberated energy per catalyst particle -call it $\Delta e = e_i - e_f = \Delta g - T\Delta s$ (i and f refer to initial and final states) satisfies $\Delta e > \Delta g = .42$ eV.
- (d) One must estimate the value of Δe . The attachment reduces the kinetic energy of relative motion of catalyst and ATP to zero. If it makes sense to speak about thermal equilibrium for ATP an catalyst in translational degrees of freedom the reduction of kinetic energy is $\Delta e_K = 3T/2$, which is of order .045 eV at room temperature. Whether this energy remains in the catalyst- ATP system or is it liberated in the process is not clear. The energy liberated in the dropping of the proton or electron gives a contribution $\Delta e = E_0 = .5$ eV. This gives the condition

$$\Delta g_1 = E_0 + 3T/2 - T\Delta s = .42 \text{ eV} . \quad (3.3.1)$$

If the liberated kinetic energy remains in the system, the first guess is $\Delta e = E_0 = .5 \text{ eV}$, where E_0 is the nominal value of zero point kinetic energy. This would give for $T\Delta s$ the estimate $T\Delta s = .08 \text{ eV}$ about 3 times thermal energy corresponding to three translational degrees of freedom. This looks rather reasonable order of magnitude estimate.

- (e) NMP suggests-maybe even requires- that the bond remains negentropic. The binding energy associated with *ATP*- catalyst binding could be small- of the order of thermal energy about .045 eV.

2. **Step 2** Hydrolysis: $F_1 \cdot ATP \rightarrow F_1 \cdot ADP \cdot P_i$. The change of free energy is small during this step: $\Delta G \sim 0$.

Comment: The simplest option explaining the fact that the change of energy is small is that hydrolysis leaves the flux tube between outer O=:s of *ATP* intact and removes only the P-O-P bond. This flux loop could have rather large \hbar .

3. **Step 3:** Orthophosphate is released from the catalyst site: $F_1 \cdot ADP \cdot P_i \rightarrow F_1 \cdot ADP + P_i$. Free energy $\Delta G \sim .31 \text{ eV}$ is liberated at this step.

Comment: The simplest option is that the negentropic flux tube liberates its energy but remains negentropic. The increase of Planck constant might be involved.

- (a) The value of Δe is now smaller than ΔG , which suggests that the metabolic energy quantum in the case of proton corresponds to $\Delta e = E(139) \simeq .25 \text{ eV}$. The average change of kinetic energy can be assumed to be equal to thermal energy in final state and is same as above. This gives the condition

$$\Delta g_2 = E_0/2 - 3T/2 + T\Delta s = .32 \text{ eV} .$$

- (b) By adding this equation with the similar equation for Step 1 (see Eq. 3.3.1) one obtains the condition

$$\Delta g_1 + \Delta g_2 = 3E_0/2 = .74 \text{ eV} .$$

This gives $E_0 = .49 \text{ eV}$ so that the model seems to be internally consistent.

4. **Step 4:** *ADP* is released from the catalyst site: $F_1 \cdot ADP + P_i \rightarrow F_1 + ADP + P_i$. $\Delta G \sim 0$ holds true also for this process.

Comment: \hbar increases back to the original value for the innermost flux tube which could it still have small positive energy and be negentropic.

The model would predict that *ADP* and P_i and remain highly correlated (connected by flux tubes) as do also *AXP* and F_1 . These predictions should be testable by marking *ADP* and P_i of *ATP* with the same "color" (say radioactively) and finding whether the colors of *ADP* and P_i remain the same during the subsequent cycles or whether they mix immediately. These love affairs at molecular level could be modified only by reconnections of flux tubes as also in human relationships. For instance, two *ADPs* could exchange their P_i s or F_1 s. Negentropic entanglement could guarantee the highly organized and directed nature of basic bio-catalytic processes.

3.3.5 DNA as a topological quantum computer

For years ago I developed a model of topological quantum computation combining TGD based view about space-time with basic ideas about topological quantum computation and ended up with the proposal that DNA might act as a topological quantum computer. One can imagine several manners in which DNA or RNA could act as a topological quantum computer and it good to try to state clearly what one wants.

1. Natural requirements are that the topological quantum computer programs can be naturally combined to larger programs and evolution means this kind of process; that the programs have a natural modular structure inherited from the previous stages of evolution; and that the computation is not restricted inside single nucleus.
2. DNA and/or RNA defines the hardware of topological computation and at least for more advanced topological quantum computers this hardware should be static so that only programs would be dynamical. This leaves only DNA in consideration and the entangled initial and quantum states at the ends of braids quantum states would be assignable to static DNA structures.
3. The program would be determined by different braidings connecting the states of DNA in time direction or in spatial direction. Since the genomes are identical in different nuclei, the strands could connect different nuclei or conjugate strands of double DNA strand. Reconnection process would allow to modify the hardware for tqc.

The recent progress in quantum TGD and TGD inspired quantum biology

After the advent of the first model for topological quantum computation in TGD Universe [25], the mathematical and physical understanding of TGD has developed dramatically and the earlier quite speculative picture can be replaced with a framework which leads to a rather unique view about topological quantum computations by DNA.

1. Universe as a topological quantum computer

One can say that the recent formulation of quantum TGD states that the entire Universe behaves like a topological quantum computer. This notion of topological quantum computer differs however from the standard one in many respects.

1. The emergence of hierarchy of Planck constants realized as a generalization of the notion of imbedding space is now a basic piece of TGD allowing an elegant formulation of quantum TGD [19, 16]. The phases of matter with large Planck constant are interpreted as dark matter. Large values of Planck constant make possible topological quantum computations in arbitrary long time scales so that the most fundamental objection against quantum computation can be circumvented.
2. Zero energy ontology forces to unify S-matrix and density matrix to M-matrix - the product of the square root of density matrix and S-matrix- defined as time-like (or rather light-like) entanglement coefficients between positive and negative energy parts of zero energy state [19, 24]. Connes tensor product emerging naturally from the notion of finite measurement resolution described in terms of inclusions of hyperfinite factors of type II_1 defines highly uniquely the M-matrix. M-matrix would be natural candidate for defining topological quantum computation in light-like direction. Connes tensor product makes sense also in space-like direction and would define quantum storage of functions represented as entanglement coefficients.
3. The notion of number theoretic braid [22, 19] is now well-understood and has become a basic element of the formulation of quantum TGD based on the requirement of number theoretical universality. As a matter fact, the notion of braid is generalized in the sense that braid strands can fuse and decay. The physical interpretation is as motion of minima of the generalization eigenvalue of the modified Dirac operator which is function of transversal coordinates of light-like partonic 3-surface and has interpretation as vacuum expectation of Higgs field. Fusion of braid strands corresponds to fusion of minima.

For generalized Feynman diagrams partonic light-like 3-surfaces meet at 2-dimensional vertices defined by partonic 2-surfaces [24]. This implies that braids replicate at vertices: the interpretation is as a copying of classical information. Quantum information is not copied faithfully. The exchange of partonic 2-surfaces in turn corresponds to quantum communications. Hence quantum communication and quantum copying emerge naturally as additional elements. Space-like Connes tensor product in turn defines quantum memory storage.

4. Computation time is a fundamental restriction in both ordinary and quantum computation. Zero energy ontology makes possible communications in both directions of geometric time, which

suggests the possibility of geometric time loops in topological quantum computations. Could this mean that computation time ceases to be a restriction and ordinary computations lasting for infinite amount of geometric time could be performed in a finite time interval of observer's time? This is perhaps too much to hope. The subjective time taken by the computation would be infinite if each step in the iteration corresponds to single quantum jump. If this is the case and if each quantum jump of observer corresponds to a finite increment of geometric time perceived by the observer, time loops would not allow miracles.

2. *The notion of magnetic body and the generalization of the notion of genome*

The evolution of ideas related to quantum biology provides also new valuable insights. In particular, the notion of magnetic body leads to a model of living system in which dark matter at magnetic flux quanta of the field body of biological system uses biological body as a motor instrument and sensory receptor [20]. Quantum control would be naturally via the genome and sensory input would be from cell membrane containing all kinds of receptors. This would suggest that magnetic flux sheets traverse through DNA strands and cell membranes.

The quantization of magnetic flux with unit defined by Planck constant having arbitrarily large values leads naturally to the notions of super-genome and hyper-genome [21]. Super-genome would consist of DNA strands of separate nuclei belonging to single magnetic flux sheet and these sequences of genomes would be like lines of text at the page of book. Super-genomes in turn can combine to form text lines at the pages of a bigger book, I have used the term hyper-genome. This hierarchy of genomes would give rise to a collective gene expression at the level of organs, individuals of a species, and at the collective level consisting of populations containing several species. Even biosphere could express itself coherently via all the genomes of the bio-sphere. The model of topological quantum computation performed by DNA should be consistent with this general picture.

Model for DNA based topological quantum computation

The most promising model of DNA as topological quantum computer relies on the hierarchy of genomes. The flux sheets or collections of parallel flux tubes assignable to a magnetic body would traverse the DNA strands of several nuclei so that strands would be analogous to lines of text on the page of a book.

DNA strands would define the intersections of magnetic or number theoretic braids with plane and braiding would be associated with the magnetic field lines or flux tubes transversal to DNA. The M-matrix defining topological quantum computation would act on quantum states assignable to nucleotides.

1. *The interpretation of nucleotides*

The interpretation of the A,T,C,G degree of freedom is not obvious and one can consider several options.

1. The quantum numbers entangled by braids having nothing to do with (A,T,C,G) assignable to nucleotides and the braiding does not affect nucleotides.
2. The nucleotides (A,T,C,G) correspond to four different colors (a,t,c,g) for braid strands with conjugate nucleotides defining conjugate colors. The subgroup of allowed braidings would preserve the color patterns. The minimal assumption consistent with the mapping of nucleotides to quarks and antiquarks [38] is that braid strands connect only nucleotides and conjugate nucleotides.
3. The model requires that the genomes in different nuclei are identical: otherwise it is not possible to realize braidings as symmetry transformations mapping portions of DNA to their conjugates (as noticed, this map would not occur at the chemical level). An interesting question is whether also the permutations of nucleotides of different codons are allowed or whether only codons are permuted so that they would define fundamental sub-programs.
4. One can understand why the minimum number of nucleotides in a codon is three. The point is that braid group is non-commutative only when the number of strands is larger than 2. The braidings acting as symmetries would correspond to a subgroup of ordinary braidings leaving

the color pattern of braid invariant. Obviously the group is generated by some minimal number of combinations of ordinary braid generators. For instance, for two braid strands with different colors the generator is e_1^2 rather than e_1 (two exchange operations/full 2π twist). For codons one would have four different subgroups of full braid group corresponding to codons of type XXX, XYY, XXY, and XYZ. Each gene would be characterized by its own subgroup of braid group and thus by an M-matrix defining topological quantum computation.

5. It might be possible to understand the "junk DNA" character of introns. Introns are the most natural candidates for the portions of genome participating topological quantum computations. The transcription process would disturb topological quantum computation so that introns should be chemically passive. Since the portion of "junk DNA" increases with the evolutionary level of the species evolution would indeed correspond to an increase the amount of topological quantum computations performed.

2. Two realizations of topological quantum computation and their combination

One can imagine two basic realizations of topological quantum computation like processes- or to be more precise - entanglement by braiding. In TGD framework this entanglement could be interpreted in terms of Connes tensor product.

2.1 Space-like entanglement

The first realization would rely space-like braids. Braid strands would connect identical lines of text at the page of book defined by sequences of genomes of different nuclei. Inside nucleus the strands would connect DNA and its conjugate. The braiding operation would take place between lines.

In this case it would be perhaps more appropriate to speak about quantum memory storage of a function realized as entanglement. These functions could represent various rules about the behavior of and survival in the physical world. For this option A,T,C,G cannot correspond to entangled quantum numbers and the interpretation as braid colors is natural. Braiding cannot correspond to a physical braiding of nucleotides so that (A,T,C,G) could correspond to braid color (strands would connect only identical nucleotides).

Strands would not connect strand and its conjugate like hydrogen bonds do but would be like long flux lines of dipole field starting from nucleotide and ending to its conjugate so that braiding would emerge naturally. Color magnetic flux tube structures of almost atom size appear in the TGD based model of nucleus and have light quarks and anti-quarks at their ends [47]. This could be the case also now since quarks and anti-quarks appear also in the model of high T_c superconductivity which should be present also in living matter [20].

2.2. Light-like entanglement

Second realization would rely on light-like braids at the boundaries of light-like 3-surfaces connecting 2-surfaces assignable to single genome at different moments of time. Braiding would be dynamical and dance metaphor would apply. The light-like surface could intersect genomes only at initial and final moments and strands would connect only identical nucleotides. Light-likeness in the induced metric of course allows the partonic 3-surface to look static at the level of imbedding space. The fundamental number theoretic braids defined by the minima of the Higgs like field associated with the modified Dirac operator would be very natural in this case.

Genes would define only the hardware unless they code for the magnetic body of DNA too, which looks implausible. The presence of quantum memory and quantum programs would mean a breakdown of genetic determinism since the braidings representing memories and programs would develop quantum jump by quantum jump and distinguish between individuals with the same genome. Also the personal development of individual would take place at this level. It would be these programs (that is magnetic bodies) which would differentiate between us and our cousins with almost identical genome.

2.3 Combination of the two realizations

These two variants of tqc accompany each other automatically if DNA nucleotides are connected to the lipids by magnetic flux tubes [38]. In this case the 2-D flow of lipids induced by the self organization pattern of the metabolically induced flow of cellular water would induce the tqc as dance

and this in turn would generate braiding of flux tubes connecting lipids to the nucleotides. Presumably a gel-sol transition of cytoplasm accompanies tqc in this kind of situation.

Biological evolution as an evolution of topological quantum computation

This framework allows to understand biological evolution as an evolution of topological quantum computation like processes in which already existing programs become building blocks of more complex programs.

1. The transition from RNA era to DNA era involving also the emergence of cell membrane bounded structures would mean the emergence of the topological quantum computation using a static hardware.
2. For mono-cellulars double DNA strands define space-like topological quantum computations involving only single step if the braids connect the nucleotides of the two DNA strands: obviously a reason why for double DNA strands.
3. For multicellular organisms more complex space-like topological quantum computations would emerge and could code rules about environment and multicellular survival in it. At this step also introns specialized to topological quantum computation would emerge.
4. A further evolution as a generation of super-genomes in turn forming hyper-genomes and even higher structures would have a concrete counterpart as the organization of braids of lower level to form braids at higher level so that topological quantum computations would become increasingly complex and program module structure would emerge very naturally.

subsection Water memory and braids

There are several grand visions about TGD Universe. One of them is as a topological quantum computer in a very general sense. This kind of visions are always oversimplifications but the extreme generality of the braiding mechanism suggest that also simpler systems than DNA might be applying tqc.

Water memory: general considerations

With few exceptions so called "serious" scientists remain silent about the experiments of Benveniste and others relating to water memory [77, 74, 79, 118] in order to avoid association with the very ugly word "homeopathy".

The Benveniste's discovery of water memory initiated quite dramatic sequence of events. The original experiment involved the homeopathic treatment of water by human antigene. This meant dilution of the water solution of antigene so that the concentration of antigene became extremely low. In accordance with homeopathic teachings human basophils reacted on this solution.

The discovery was published in Nature and due to the strong polemic raised by the publication of the article, it was decided to test the experimental arrangement. The experimental results were reproduced under the original conditions. Then it was discovered that experimenters knew which bottles contained the treated water. The modified experiment in which experimenters did not possess this information failed to reproduce the results and the conclusion was regarded as obvious and Benveniste lost his laboratory among other things. Obviously any model of the effect taking it as a real effect rather than an astonishingly simplistic attempt of top scientists to cheat should explain also this finding.

The model based on the notion of field body and general mechanism of long term memory allows to explain both the memory of water and why it failed under the conditions described.

1. Also molecules have magnetic field bodies acting as intentional agents controlling the molecules. Nano-motors do not only look co-operating living creatures but are such. The field body of molecule contains besides the static magnetic and electric parts also dynamical parts characterized by frequencies and temporal patterns of fields. To be precise, one must speak both field and relative field bodies characterizing interactions of molecules. Right brain sings-left brain talks metaphor might generalize to all scales meaning that representations based on both frequencies and temporal pulse with single frequency could be utilized.

The effects of complex bio-molecule to other bio-molecules (say antigene on basofil) in water could be characterized to some degree by the temporal patterns associated with the dynamical part of its field body and bio-molecules could recognize each other via these patterns. This would mean that symbolic level in interactions would be present already in the interactions of bio-molecules.

If water is to mimic the field bodies of molecules using water molecule clusters, at least vibrational and rotational spectra, then water can produce fake copies of say antigenes recognized by basofils and reacting accordingly.

Also the magnetic body of the molecule could mimic the vibrational and rotational spectra using harmonics of cyclotron frequencies. Cyclotron transitions could produce dark photons, whose ordinary counterparts resulting in de-coherence would have large energies due to the large value of \hbar and could thus induce vibrational and rotational transitions. This would provide a mechanism by which molecular magnetic body could control the molecule. Note that also the antigenes possibly dropped to the larger space-time sheets could produce the effect on basofils.

2. There is a considerable experimental support for the Benveniste's discovery that bio-molecules in water environment are represented by frequency patterns, and several laboratories are replicating the experiments of Benveniste as I learned from the lecture of Yolene Thomas in the 7:th European SSE Meeting held in Rörös [164]. The scale of the frequencies involved is around 10 kHz and as such does not correspond to any natural molecular frequencies. Cyclotron frequencies associated with electrons or dark ions accompanying these macromolecules would be a natural identification if one accepts the notion of molecular magnetic body. For ions the magnetic fields involved would have a magnitude of order .03 Tesla if 10 kHz corresponds to scaled up alpha band. Also Josephson frequencies would be involved if one believes that EEG has fractally scaled up variants in molecular length scales.
3. Suppose that the representations of bio-molecules in water memory rely on pulse patterns representing bit sequences. The simplest realization of bit would be as a laser like system with bit 1 represented by population inverted state and bit 0 by the ground state. Bits could be arranged in sequences spatially or by variation of zero point energy defining the frequency: for instance increase of frequency with time would define temporal bit sequence. Many-sheeted lasers are the natural candidates for laser like systems are in question since they rely on universal metabolic energy quanta. Memory recall would involve sending of negative energy phase conjugate photons inducing a partial transition to the ground state. The presence of metabolic energy feed would be necessary in order to preserve the memory representations.

Water memory in terms of molecular braidings

It is interesting to look water memory from the point of view of tqc. Suppose that the molecules and water particles (space-time sheet of size of say cell length scale) are indeed connected by color flux tubes defining the braid strands and that splitting of the braid strands can take place so that water flow can give rise to a braiding pattern and tqc like process.

The shaking of the bottle containing the diluted homeopathic remedy is an essential element in the buildup of water memories also in the experiments of Benveniste [77]. Just like the vigorous flow of sol near the inner monolayer, this process would create a water flow and this flow creates a braiding pattern which could provide a representation for the presence of the molecules in question. Note that the hardware of braiding could carry information about molecules (cyclotron frequencies for ions for instance).

The model for the formation of scaled down variants of memories in hippocampus discussed above suggests that each half period of theta rhythm corresponds to tqc followed by a non-computational period during which the outcome of tqc is expressed as 4-D nerve pulse patterns involving cyclotron frequencies and Josephson frequency. Josephson currents at the second half period would generate dark Josephson radiation communicating the outcome of the calculation to the magnetic body. Entire hierarchy of EEGs with varying frequency scale would be present corresponding to the onion like structure of magnetic body. This pattern would provide an electromagnetic representation for the presence of the antigene and could be mimicked artificially [74, 164].

This picture might apply be the case also in the case of water memory.

1. The shaking might drop some fraction of antigene molecules to dark space-time sheets where they generate a dark color magnetic field. Because of the large value of Planck constant superconductivity along color flux tubes running from molecular space-time sheets could still be present.
2. TGD based model of super conductivity involves double layered structures with same p-adic length scale as cell membrane [28]. The universality of p-adic length scale hierarchy this kind of structures but with a much lower voltage over the bilayer could be present also in water. Interestingly, Josephson frequency ZeV/\hbar would be much lower than for cell membrane so that the time scale of memory could be much longer than for cell membrane for given value of \hbar meaning longer time scale of memory recall.
3. Also in the case of homeopathic remedy the communication of the result of tqc to the magnetic body would take place via Josephson radiation. From the point of view of magnetic body Josephson radiation resulting in shaking induced tqc induced would replace the homeopathic remedy with a field pattern. The magnetic bodies of basophils could be cheated to produce allergic reaction by mimicking the signal representing the outcome of this tqc. This kind of cheating was indeed done in the later experiments of Benveniste involving very low frequency electromagnetic fields in kHz region allowing no identification in terms of molecular transitions (magnetic body and cyclotron frequencies) [74].

Why experimenter had to know which bottle contained the treated water?

Why experimenter had to know which bottle contained the treated water? The role of experimenter eliminates the possibility that the (magnetic bodies of) clusters of water molecules able to mimic the (magnetic bodies of) antigene molecules electromagnetically are present in the solution at geometric now and produce the effect. The earlier explanation for experimenter's role was based on the idea that memory storage requires metabolic energy and that experimenter provides it. Tqc picture suggests a variant of this model in which experimenter makes possible the recall of memories of water represented as braiding patterns and realized via tqc.

1. *Does experimenter provide the metabolic energy needed to store the memories of water?*

What could be then the explanation for the failure of the modified experiment? Each memory recall reduces the occupation of the states representing bit 1 and a continual metabolic energy feed is needed to preserve the bit sequence representations of antibodies using laser light systems as bit. This metabolic energy feed must come from some source.

By the universality of metabolic energy currencies population inverted many-sheeted lasers in living organisms define the most natural source of the metabolic energy. Living matter is however fighting for metabolic energy so that there must be some system willing to provide it. The biological bodies of experimenters are the best candidates in this respect. In this case experimenters had even excellent motivations to provide the metabolic energy. If this interpretation is correct then Benveniste's experiment would demonstrate besides water memory also psychokinesis and direct action of desires of experimenters on physics at microscopic level. Furthermore, the mere fact that we know something about some object or direct attention to it would mean a concrete interaction of our magnetic with the object.

2. *Does experimenter make possible long term memory recall?*

The alternative explanation is that experimenter makes possible long term memory recall which also requires metabolic energy.

1. If braiding pattern represents, the water memory the situation changes since the robustness of the braiding pattern suggests that this representation is still in the geometric past (which is replaced with a new one many times). If the dark variants of molecules created in the process are still in the water, the braid representation of water memories could be available even in the geometric now but it is better to not make this assumption. The challenge is to understand how this information can be made conscious.
2. What is certainly needed is that the system makes the tqc again. This would mean a fractal quantum jump involving unitary U process and state function reduction leading to the generation

of generalized EEG pattern. Only the sums and differences of cyclotron frequency and Josephson frequency would matter so that the details of the flow inducing braiding do not matter. The shaking process might be continuing all the subjective time in the geometric past so that the problem is how to receive information about its occurrence. Experimenter might actually help in this respect since the mechanism of intentional action initiates the action in the geometric past by a negative energy signal.

3. If the magnetic body of the water in the geometric now can entangle with the geometric past, tqc would regenerate the experience about the presence of antigene by sharing and fusion of mental images. One can however argue that water cannot have memory recall in this time scale since water is quite simple creature and levels with large enough \hbar might not be present. It would seem that here the experimenter must come in rescue.
4. The function of experimenter's knowledge about which bottle contains the homeopathic solution could be simply to generate time-like entanglement in the required long time scale by serving as a relay station. The entanglement sequence would be *water now - experimenter now - water in the past* with "now" and "past" understood in the geometric sense. The crucial entanglement bridge between the magnetic body of water and experimenter would be created in the manufacturing of the homeopathic remedy.

Note that this explanation does not exclude the first one. It is quite possible that experimenter provides also the metabolic energy to the bit representation of water memories possibly induced by the long term memory recall.

This picture is of course just one possible model and cannot be taken literally. The model however suggest that magnetic bodies of molecules indeed define the braiding; that the generalized EEG provides a very general representation for the outcome of tqc; that liquid flow provides the manner to build tqc programs - and also that shaking and sudden pulses is the concrete manner to induce visible-dark phase transitions. All this might be very valuable information if one some day in the distant future tries to build topological quantum computers in laboratory.

3.4 Model for the hierarchy of Josephson junctions

As far as hierarchy of EEGs and its generalizations is considered the hierarchy of Josephson junctions assignable to cell membrane itself is relevant. Dark matter hierarchy and p-adic fractality allow to imagine a fractal hierarchy of structures analogous to cell membrane with arbitrarily large thickness. One can even imagine scaled up variants of cell membrane with different p-adic length scale and value of Planck constant but possessing same membrane potential as ordinary cell membrane. The generalization of the imbedding space helps to understand what is involved and is discussed in Appendix.

3.4.1 The most recent model for the generation of nerve pulse

For some time ago I learned [161, 160, 158, 159, 152] (thanks to Ulla Mattfolk) that nerve pulse propagation seems to be an adiabatic process and thus does not dissipate: the authors propose that 2-D acoustic soliton is in question. Adiabaticity is what one expects if the ionic currents are dark currents (large \hbar and low dissipation) or even supra currents. Furthermore, Josephson currents are oscillatory so that no pumping is needed. Combining this input with the model of DNA as topological quantum computer (tqc) [38] leads to a rather precise model for the generation of nerve pulse.

1. The system would consist of two superconductors- microtubule space-time sheet and the space-time sheet in cell exterior- connected by Josephson junctions represented by magnetic flux tubes defining also braiding in the model of tqc. The phase difference between two super-conductors would obey Sine-Gordon equation allowing both standing and propagating solitonic solutions. A sequence of rotating gravitational penduli coupled to each other would be the mechanical analog for the system. Soliton sequences having as a mechanical analog penduli rotating with constant velocity but with a constant phase difference between them would generate moving kHz synchronous oscillation. Periodic boundary conditions at the ends of the axon rather than

chemistry determine the propagation velocities of kHz waves and kHz synchrony is an automatic consequence since the times taken by the pulses to travel along the axon are multiples of same time unit. Also moving oscillations in EEG range can be considered and would require larger value of Planck constant in accordance with vision about evolution as gradual increase of Planck constant.

2. During nerve pulse one pendulum would be kicked so that it would start to oscillate instead of rotating and this oscillation pattern would move with the velocity of kHz soliton sequence. The velocity of kHz wave and nerve pulse is fixed by periodic boundary conditions at the ends of the axon implying that the time spent by the nerve pulse in traveling along axon is always a multiple of the same unit: this implies kHz synchrony. The model predicts the value of Planck constant for the magnetic flux tubes associated with Josephson junctions and the predicted force caused by the ionic Josephson currents is of correct order of magnitude for reasonable values of the densities of ions. The model predicts kHz em radiation as Josephson radiation generated by moving soliton sequences. EEG would also correspond to Josephson radiation: it could be generated either by moving or standing soliton sequences (latter are naturally assignable to neuronal cell bodies for which \hbar should be correspondingly larger): synchrony is predicted also now.
3. The previous view about microtubules in nerve pulse conduction can be sharpened. Microtubular electric field (always in the same direction) could explain why kHz and EEG waves and nerve pulse propagate always in same direction and might also feed energy to system so that solitonic velocity could be interpreted as drift velocity. This also inspires a generalization of the model of DNA as tqc sine also microtubule-cell membrane systems are good candidates for performers of tqc. Cell replication during which DNA is out of game seems to require this and microtubule-cell membrane tqc would represent higher level tqc distinguishing between multi-cellulars and mono-cellulars.
4. New physics would enter in several manners. Ions should form Bose-Einstein cyclotron condensates. The new nuclear physics predicted by TGD [47] predicts that ordinary fermionic ions (such as K^+ , Na^+ , Cl^-) have bosonic chemical equivalents with slightly differing mass number obtained by replacing one or more neutral color flux tubes connecting nucleons of neutral atom with a charged one. Anomalies of nuclear physics and cold fusion provide experimental support for the predicted new nuclear physics. Electronic supra current pulse from microtubules could induce the kick of pendulum inducing nerve pulse and induce a small heating and expansion of the axon. The return flux of ionic Josephson currents would induce convective cooling of the axonal membrane. A small transfer of small positive charge into the inner lipid layer could induce electronic supra current by attractive Coulomb interaction. The exchange of exotic W bosons which are scaled up variants of ordinary W^\pm bosons is a natural manner to achieve this if new nuclear physics is indeed present.

3.4.2 Quantum model for sensory receptor

This original model of nerve pulse and EEG was still based on the implicit assumption that the space-time sheet carrying the Josephson currents is far from vacuum. The model for sensory receptor and sensory qualia however led to a the proposal that the space-time sheet in question is near vacuum extremal [32, 22]. Near vacuum extremal property does not affect the general structure of the model in an essential manner.

1. The only change [32, 23] is the replacement of charges ± 1 of ions with effective charges given as

$$Q_{eff} = -\frac{Z - N}{2p} + 2Z + q_{em} . \quad (3.4.1)$$

Z and N denote nuclear charge and neutron number. $p = \sin(\theta_W)$ corresponds to Weinberg angle. For K^+ , Cl^- , Na^+ , Ca^{++} one has $Z = (19, 17, 11, 20)$, $Z - N = (-1, -1, -1, 0)$, and $q_{em} = (1, -1, 1, 2)$. Table 1 below gives the values of Josephson energies for some values of

resting potential for $p = \sin(\theta_W) = .0295$ reproducing the frequencies of peak sensitivity for photoreceptors. Rather remarkably, they are in IR or visible range.

2. The energies are in UV and visible range. Hence one can consider also Josephson junctions with considerably lower membrane potentials of order mV are possibly without losing the thermal stability. For instance, one could consider $k = 151, 157, 163, 167$ Josephson junctions with a membrane potential scaling as $1/L(k)$. For $k = 167$ the energies would be scaled down by a factor $2^{-(167-151)/2} = 2^{-8}$ giving for $V_{eff} = .09$ V a photon energy somewhat below the thermal energy at room temperature. On the other hand, the fact that Josephson junctions with a vanishing Z^0 field are at the verge of thermal instability suggests that also they might be present in living matter.
3. From Table 1 one can evaluate the value of Planck constant for a given Josephson frequency for various ions. For $f_J = 5$ Hz giving a first estimate for neuronal Josephson frequency and $V = -55$ mV corresponding to the critical voltage for the generation of action potential one obtains the values $r = \hbar/\hbar_0 = (1.51, 1.89, 2.11, 1.59) \times 2^{46}$ for $(Na^+, Cl^-, K^+, Ca^{++})$. For $V = -70$ mV corresponding to the resting potential of neuron and same Josephson frequency one obtains $r = (0.961, 201.341, 01) \times 2^{47}$. For Ca^{++} ion r is very near to a power of 2. A good mnemonic is that the Josephson energies of biologically important ions vary in an interval, which is in a reasonable approximation half octave ($E_J(K^+)/E_J(Na^+) = 1.3958 \simeq \sqrt{2} \simeq 1.4142$).

Ion	Na^+	Cl^-	K^+	Ca^{++}
$E_J(40 \text{ mV}, p = .0295)/eV$	1.60	2.00	2.23	1.68
$E_J(50 \text{ mV}, p = .0295)/eV$	2.00	2.49	2.79	2.10
$E_J(55 \text{ mV}, p = .0295)/eV$	2.20	2.74	3.07	2.31
$E_J(65 \text{ mV}, p = .0295)/eV$	2.60	3.25	3.64	2.73
$E_J(70 \text{ mV}, p = .0295)/eV$	2.80	3.50	3.92	2.94
$E_J(75 \text{ mV}, p = .0295)/eV$	3.00	3.75	4.20	3.15
$E_J(80 \text{ mV}, p = .0295)/eV$	3.20	4.00	4.48	3.36
$E_J(90 \text{ mV}, p = .0295)/eV$	3.60	4.50	5.04	3.78
$E_J(95 \text{ mV}, p = .0295)/eV$	3.80	4.75	5.32	3.99
Color	R	G	B	W
E_{max}	2.19	2.32	3.06	2.49
energy-interval/eV	1.77-2.48	1.97-2.76	2.48-3.10	

Table 1. The table gives the prediction of the model of photoreceptor for the Josephson energies for typical values of the membrane potential. For comparison purposes the energies E_{max} corresponding to peak sensitivities of rods and cones, and absorption ranges for rods are also given. R,G,B,W refers to red, green, blue, white. The values of Weinberg angle parameter $p = \sin^2(\theta_W)$ are assumed to be .23 and .0295. The latter value is forced by the fit of Josephson energies to the known peak energies.

It interesting to try to interpret the resting potentials of various cells in this framework in terms of the Josephson frequencies of various ions. Table 1 gives the values of Josephson frequencies of basic biological ions for typical values of the membrane potential.

1. The maximum value of the action potential during nerve pulse is +40 mV so that Josephson frequencies are same as for the resting state of photoreceptor. Note that the time scale for nerve pulse is so slow as compared to the frequency of visible photons that one can consider that the neuronal membrane is in a state analogous to that of a photoreceptor.
2. For neurons the value of the resting potential is -70 mV. Na^+ and Ca^{++} Josephson energies 2.80 eV and 2.94 eV are in the visible range in this case and correspond to blue light. This does not mean that Ca^{++} Josephson currents are present and generate sensation of blue at neuronal level: the quale possibly generated should depend on sensory pathway. During the hyperpolarization period with -75 mV the situation is not considerably different.
3. The value of the resting potential is -95 mV for skeletal muscle cells. In this case Ca^{++} Josephson frequency corresponds to 4 eV metabolic energy quantum.

4. For smooth muscle cells the value of resting potential is -50 mV. In this case Na^+ Josephson frequency corresponds to 2 eV metabolic energy quantum.
5. For astroglia the value of the resting potential is -80/-90 mV for astroglia. For -80 mV the resting potential for Cl^- corresponds to 4 eV metabolic energy quantum. This suggests that glial cells could also provide metabolic energy as Josephson radiation to neurons.
6. For all other neurons except photo-receptors and red blood cells Josephson photons are in visible and UV range and the natural interpretation would be as biophotons. The biophotons detected outside body could represent sensory leakage. An interesting question is whether the IR Josephson frequencies could make possible some kind of IR vision.

3.4.3 The role of Josephson currents

The general vision is that Josephson currents of various ions generate Josephson photons having dual interpretations as bio-photons and EEG photons. Josephson photons can in principle regenerate the quale in the neurons of the sensory pathway. In the case of motor pathways the function would be different and the transfer of metabolic energy by quantum credit card mechanism using phase conjugate photons is suggested by the observation that basic metabolic quanta 2 eV *resp.* 4 eV are associated with smooth muscle cells *resp.* skeletal muscle cells.

As already found in the previous section, the energies of Josephson photons associated with the biologically important ions are in general in visible or UV range except when resting potential has the value of -40 mV which it has for photoreceptors. In this case also IR photons are present. Also the turning point value of membrane potential is +40 mV so that one expects the emission of IR photons.

Josephson photons could be used to communicate the qualia to the magnetic body.

1. If Josephson currents are present during the entire action potential, the entire range of Josephson photons down to frequencies of order 2 kHz range is emitted for the standard value of \hbar . The reason is that lower frequencies corresponds to cycles longer than the duration of the action potential. The continuum of Josephson frequencies during nerve pulse makes it possible to induce cyclotron transitions at the magnetic body of neuron or large structure. This would make possible to communicate information about spatial and temporal behavior of the nerve pulse pattern to the magnetic body and build by quantum entanglement a sensory map.
2. The frequencies below 2 kHz could be communicated as nerve pulse patterns. When the pulse rate is above $f = 28.57$ Hz the sequence of pulses is experienced as a continuous sound with pitch f . f defines the minimum frequency for which nerve pulses could represent the pitch and there remains a 9 Hz long range to be covered by some other communication method.
3. The cyclotron frequencies of quarks and possibly also of electron would make possible a selective reception of the frequencies emitted during nerve pulse. Same applies also to the Josephson frequencies of hair cell (, which does not fire). If the value of Planck constant is large this makes possible to communicate the entire range of audible frequencies to the magnetic body. Frequency would be coded by the magnetic field strength of the flux tube. Two options are available corresponding to the standard ground state for which Z^0 field is very weak and to almost vacuum extremals. For the first option one as ordinary cyclotron frequencies. The cyclotron frequency scales for them differ by a factor

$$r(q) = \frac{Q_{eff}(q)}{Q_{em}(q)} = \frac{\epsilon(q)}{2pQ_{em}(q)} + 1, \quad \epsilon(u) = -1, \quad \epsilon(d) = 1 \quad (3.4.2)$$

from the standard one. For $p = .0295$ one obtains $(r(u), r(d), r(e)) = (24.42, 49.85, 15.95)$. The cyclotron frequencies for quarks and electron with masses $m(u)=2$ MeV, $m(d)=5$ MeV, and $m(e)=.5$ MeV are given the table below for the two options. If one assumes that B_{end} defines the upper bound for field strength then the standard option would require both d quark and electron. For dquark with kHz CD the upper bound for cyclotron frequencies would be 20 kHz which corresponds to the upper limit of audible frequencies.

fermion	$f_c(e)/MHz$	$f_c(u)/MHz$	$f_c(d)/MHz$
standard	.564	.094	.019
nearly vacuum extremal	8.996	2.275	.947

Table 2. Cyclotron frequencies of quarks and electron in magnetic field $B_{end} = .2$ Gauss for standard vacuum with very small Z^0 field and nearly vacuum extremal.

- Besides cyclotron frequencies also the harmonics of the fundamental frequencies assignable to quark and electron CDs could be used and in case of musical sounds this looks a highly attractive option. In this case it is now however possible to select single harmonics as in the case of cyclotron transitions so that only the rate of nerve pulses can communicate single frequency. Lorentz transform sub- CD scales up the frequency scale from the secondary p-adic time scale coming as octave of 10 Hz frequency. Also the scaling of \hbar scales this frequency scale.

3.4.4 What is the role of the magnetic body?

The basic vision is that magnetic body receives sensory data from the biological body- basically from cell membranes and possibly via genome - and controls biological body via genome. This leaves a huge amount of details open and the almost impossible challenge of theoretician is to guess the correct realization practically without any experimental input. The following considerations try to clarify what is involved.

Is magnetic body really needed?

Libet's findings and the model of memory based on time mirror hypothesis suggests that magnetic body is indeed needed. What is the real function of magnetic body? Is it just a sensory canvas? The previous considerations suggest that it is also the seat of geometric qualia, in particular the pitch of sound should be coded by it. It would be relatively easy to understand magnetic body as a relatively passive sensory perceiver defining sensory map. If one assumes that motor action is like time reversed sensory perception then sensory and motor pathways would be just sensory pathways proceeding in opposite time directions from receptors to the various layers of the magnetic body. Brain would perform the information processing.

Certainly there must exist a region in which the motor and sensory parts of the magnetic body interact. What comes in mind is that these space-time sheets (or actually pairs of space-time sheets) are parallel and generate wormhole contacts between them. This interaction would be assignable to the region of the magnetic body could receive positive energy signals from associative sensory areas and send negative energy signals to motor motor neurons at the ends of motor pathways wherefrom they would progate to premotor cortex, supplementary motor cortex and to frontal lobes where the abstract plans about motor actions are generated.

Is motor action time reversal of sensory perception in zero energy ontology?

One could argue that the free will aspect of motor actions does not conform with the interpretation as sensory perception in reversed direction of time. On the other hand, also percepts are selected -say in binocular rivalry [163]. Only single alternative percept need to be realized in a given branch of the multiverse. This makes possible metabolic economy: for instance, the synchronous firing at kHz frequency serving as a correlate for the conscious percept requires a lot of energy since dark photons at kHz frequency have energies above thermal threshold. Similar selection of percepts could occur also at the level of sensory receptors but quantum statistical determinism would guarantee reliable perception. The passivity of sensory perception and activity of motor activity would reflect the breaking of the arrow of time if this interpretation is correct.

What magnetic body looks like?

What magnetic body looks like has been a question that I have intentionally avoided as a question making sense only when more general questions have been answered. This question iseems how unavoidable now. Some of the related questions are following. The magnetic flux lines along various parts of magnetic body must close: how does this happen? Magnetic body must have parts of size

at least that defined by EEG wavelengths: how do these parts form closed structures? How the magnetic bodies assignable to biomolecules relate to the Earth sized parts of the magnetic body? How the personal magnetic body relates to the magnetic body of Earth?

1. The vision about genome as the brain of cell would suggest that active and passive DNA strands are analogous to motor and sensor areas of brain. This would suggest that sensory data should be communicated from the cell membrane along the passive DNA strand. The simplest hypothesis is that there is a pair of flux sheets going through the DNA strands. The flux sheet through the passive strand would be specialized to communicate sensory information to the magnetic body and the flux sheet through the active strand would generate motor action as DNA expression with transcription of RNA defining only one particular aspect of gene expression. Topological quantum computation assignable to introns and also electromagnetic gene expression would be possible.
2. The model for sensory receptor in terms of Josephson radiation suggests however that flux tubes assignable to axonal membranes carry Josephson radiation. Maybe the flux tube structures assigned to DNA define the magnetic analog of motor areas and flux tubes assigned with the axons that of sensory areas.
3. A complex structure of flux tubes and sheets is suggestive at the cellular level. The flux tubes assignable to the axons would be parallel to the sensory and motor pathways. Also microtubules would be accompanied by magnetic flux tubes. DNA as topological quantum computer model assumes and the proposed model of sensory perception and cell membrane level suggests transversal flux tubes between lipids and nucleotides. The general vision about DNA as brain of cell suggest flux sheets through DNA strands.

During sensory perception of cell and nerve pulse the wormhole flux tube connecting the passive DNA strand of the first cell to the inner lipid layer would recombine with the flux tube connecting outer lipid layer to some other cell to form single flux tube connecting two cells. In the case of sensory organs these other cells would be naturally other sensory receptors. This would give rise to a dynamical network of flux tubes and sheets and axonal sequences of genomes would be like lines of text at the page of book. This structure could have a fractal generalization and would give rise to an integration of genome to super-genome at the level of organelles, organs and organism and even hypergenome at the level of population. This would make possible a coherent gene expression.

4. This vision gives some idea about magnetic body in the scale of cell but does not say much about it in longer scales. The *CDs* of electrons and quarks could provide insights about the size scale for the most relevant parts of the magnetic body. Certainly the flux tubes should close even when they have the length scale defined by the size of Earth.

Additional ideas about the structure follow if one assumes that magnetic body acts a sensory canvas and that motor action can be regarded as time reversed sensory perception.

1. If the external world is represented at part of the magnetic body which is stationary, the rotation of head or body would not affect the sensory representation. This part of the magnetic body would be obviously analogous to the outer magnetosphere, which does not rotate with Earth.
2. The part of the magnetic body at which the sensory data about body (posture, head orientations and position, positions of body parts) is represented, should be fixed to body and change its orientation with it so that bodily motions would be represented as motions of the magnetic , which would be therefore analogous to the inner magnetosphere of rotating Earth.
3. The outer part of the personal magnetic body is fixed to the inner magnetosphere, which defines the reference frame. The outer part might be even identifiable as the inner magnetosphere receiving sensory input from the biosphere. This magnetic super-organism would have various life forms as its sensory receptors and muscle neurons. This would give quantitative ideas about cyclotron frequencies involved. The wavelengths assignable to the frequencies above 10 Hz would correspond to the size scale of the inner magnetosphere and those below to the outer magnetosphere. During sleep only the EEG communications with outer magnetic body would remain intact.

4. Flux quantization for large value of \hbar poses an additional constraint on the model.

- (a) If Josephson photons are transformed to a bunch of ordinary small \hbar photons magnetic flux tubes can correspond to the ordinary value of Planck constant. If one assumes the quantization of the magnetic flux in the form

$$\int BdA = n\hbar$$

used in super-conductivity, the radius of the flux tube must increase as $\sqrt{\hbar}$ and if the Josephson frequency is reduced to the sound frequency, the value of \hbar codes for the sound frequency. This leads to problems since the transversal thickness of flux tubes becomes too large. This does not however mean that the condition might not make sense: for instance, in the case of flux sheets going through DNA strands the condition might apply.

- (b) The quantization of magnetic flux could be replaced by a more general condition

$$\oint (p - ZeA)dl = n\hbar , \quad (3.4.3)$$

where p represents momentum of particle of super-conducting phase at the boundary of flux tube. In this case also $n = 0$ is possible and poses no conditions on the thickness of the flux tube as a function of \hbar . This option looks reasonable since the charged particles at the boundary of flux tube would act as sources of the magnetic field.

- (c) Together with the Maxwell's equation giving $B = ZeNv$ in the case that there is only one kind of charge carrier this gives the expression

$$N = \frac{2m}{RZ^2e^2} \quad (3.4.4)$$

for the surface density N of charge carrier with charge Z . R denotes the radius of the flux tube. If several charge carriers are present one has $B = \sum_k N_k Z_k e v_k$, and the condition generalizes to

$$N_i = \frac{2m_i v_i}{RZ_i \sum_k Z_k v_k e^2} . \quad (3.4.5)$$

It seems that this condition is the most realistic one for the large \hbar flux sheets at which Josephson radiation induces cyclotron transitions.

What are the roles of Josephson and cyclotron photons?

The dual interpretation of Josephson radiation in terms of bio-photons and EEG photons seems to be very natural and also the role of Josephson radiation seems now relatively clear. The role of cyclotron radiation and its interaction with Josephson radiation are not so well understood.

1. At least cell membrane defines a Josephson junction (actually a collection of them idealizable as single junctions). DNA double strand could define a series of Josephson junctions possibly assignable with hydrogen bonds. This however requires that the strands carry some non-standard charge densities and currents- I do not know whether this possibility is excluded experimentally. Quarks and antiquarks assignable to the nucleotide and its conjugate have opposite charges at the two sheets of the wormhole flux tube connective nucleotide to a lipid. Hence one could consider the possibility that a connection generated between them by reconnection mechanism could create Josephson junction.
2. The model for the photoreceptors leads to the identification of biophotons as Josephson radiation and suggests that Josephson radiation propagates along flux tubes assignable to the cell membranes along sensory pathways up to sensory cortex and from there to motor cortex and back to the muscles and regenerates induced neuronal sensory experiences.

3. Josephson radiation could be used quite generally to communicate sensory data to/along the magnetic body: this would occur in the case of cell membrane magnetic body at least. The different resting voltages for various kinds of cells would select specific Josephson frequencies as communication channels.
4. If motor action indeed involves negative energy signals backwards in geometric time as Libet's findings suggest, then motor action would be very much like sensory perception in time reversed direction. The membrane resting potentials are different for various types of neurons and cells so that one could speak about pathways characterized by Josephson frequencies determined by the membrane potential. Each ion would have its own Josephson frequency characterizing the sensory or motor pathway.

The basic questions concern the function of cyclotron radiation and whether Josephson radiation induces resonantly cyclotron radiation or vice versa.

1. Cyclotron radiation would be naturally associated with the flux sheets and flux tubes. The simplest hypothesis is that at least the magnetic field $B_{end} = .2$ Gauss can be assigned with the some magnetic flux quanta at least. The model for hearing suggests that B_{end} is in this case quantized so that cyclotron frequencies provide a magnetic representation for audible frequencies. Flux quantization does not pose any conditions on the magnetic field strength if the above discussed general flux quantization condition involving charged currents at the boundary of the flux quantum are assumed. If these currents are not present, $1/\hbar$ scaling of B_{end} for flux tubes follows.
2. The assumption that cyclotron radiation is associated with the motor control via genome is not consistent with the vision that motor action is time reversed sensory perception. It would also create the unpleasant question about information processing of the magnetic body performed between the receipt of sensory data and motor action.
3. The notion of magnetic sensory canvas suggests a different picture. Josephson radiation induces resonant cyclotron transitions at the magnetic body and induces entanglement of the mental images in brain with the points of the magnetic body and in this manner creates sensory maps giving a third person perspective about the biological body. There would be two kind of sensory maps. Those assignable to the external world and those assignable to the body itself. The Josephson radiation would propagate along the flux tubes to the magnetic body.
4. There could be also flux tube connections to the outer magnetosphere of Earth. It would seem that these reconnections could be flux tubes traversing through inner magnetosphere to poles and from there to the outer magnetosphere. These could correspond to rather low cyclotron frequencies. Especially interesting structure in this respect is the magnetic flux sheet at the Equator.

3.4.5 Dark matter hierarchies of Josephson junctions

The hierarchy of Josephson junctions assignable to cell membrane and characterized by values of Planck constant provides a rather nice model for cell membrane but one can consider also more general dark hierarchies of Josephson junctions. This model conforms with the general vision that living matter processes information by locating it to various pages of the "Big Book".

Maximization of Planck constant in quantum control and communication in living matter

The sectors of the imbedding space for which CD and CP_2 are replaced with their n_a - resp. n_b -fold coverings define the most promising candidates concerning the understanding of living matter, at least the quantum control of living matter. The reason is that the value of the Planck constant is maximized and given by $r = \hbar/\hbar_0 = n_a n_b$. Also the number of pages with same Planck constant would be finite unlike for the more general option allowing rational values of Planck constant. In particular, infinite number of pages with the standard value of Planck constant would be possible and this might lead to mathematical difficulties.

Experimental constraints allow to consider also the possibility that only covering spaces are possible. One must be however very cautious in making hasty conclusions. If also factor spaces are allowed one can have G_a or G_b as discrete and exact symmetry groups at the level of dark matter and these symmetries would be manifested as approximate symmetries of the visible matter topologically condensed around the dark matter.

1. In M^4 degrees of freedom since the restriction to the orbifold \hat{M}^4/G_a is equivalent to the exact G_a -invariance of dark matter quantum states. Molecular rotational symmetries correspond typically to small groups G_a and might relate to this symmetry. Small values of n_a would not affect dramatically the value of Planck constant if n_b is large.
2. $G_a = Z_n$, $n = 5, 6$ are favored for molecules containing aromatic cycles. Also genuinely 3-dimensional tetrahedral, octahedral, and icosahedral symmetries appear in living matter.

In the sequel only integer values of Planck constant will be considered. An especially interesting hierarchy corresponds to ruler and compass integers expressible as a product of power of two and distinct Fermat primes (see Appendix). The reason is that these integers correspond to number theoretically very simple quantum phases. This hierarchy includes as a special case powers of two and one can imagine a resonant interaction between p-adic length scale hierarchy and hierarchy of Planck constants.

Dark hierarchy of Josephson junctions with a constant thickness

The model for EEG relies on fractal hierarchy of cell membrane like structures with a fixed thickness and membrane potential. Therefore cell membrane thickness is not scaled by \hbar as one might naively expect. Same applies to magnetic flux tubes: this is possible since the condition for the quantization of magnetic flux can be replaced with a more general one if one allows charged currents at the boundaries of flux quanta [32]. In this model the value of \hbar becomes a measure for the evolutionary level of cell and neurons in hippocampus, associative regions of cortex and their motor counterparts, and frontal lobes are expected to correspond to the largest values of \hbar measuring also the time scale of long term memory and planned action. Note that cell membrane corresponds to twin primes $k = 149$ and $k = 151$ with $k = 151$ defining a Gaussian Mersenne so that it is indeed very special.

Page of a book is rather precise metaphor for the magnetic flux sheet going through a linear array of strings of nuclei and also for a collection flux tubes parallel to axons. This raises several questions. Do the lines of the text of this book correspond to axons in neural circuits? Do the pages correspond to larger structures formed by the axons?

The quantum model for qualia [32] implies that Josephson radiation travels through flux tubes parallel to sensory pathways and there could be also a horizontal organization of the neurons- at least at the level of sensory receptors in the sense that magnetic flux tubes connecting DNA nucleotides to lipids of cell membrane fuse to form longer flux tubes between DNA nucleotides of different cells when sensory receptor is active. Axons could thus be seen as the analogs of text lines which however can interact with each other. Similar organization would appear at the level of flux sheets traversing through DNA strands.

Books are made for reading and one can thus ask whether the book metaphor extends. Could the observed moving brain waves scanning cortex relate to the "reading" of the information associated with these sheets of book by the magnetic body and does our internal speech correspond to this "reading"? One is also forced to ask whether these brain waves are induced by waves propagating along magnetic flux quanta of the magnetic body of Earth or personal magnetic body in the case that it has components other than magnetic flux sheets serving as Josephson junctions.

An objection against a fractal hierarchy of Josephson junctions with thickness scaling as \hbar

One can consider also a hierarchy of Josephson junctions with a scaled up thickness proportional to \hbar instead of constant thickness. If these junctions have same voltage at all levels of the hierarchy a resonant interaction between various levels of the hierarchy would become possible.

One can represent common sense objections against this idea. The electric field involved with the higher levels of Josephson junction hierarchy is very weak: something like 10^{-7} V/m for lithospheric Josephson junctions (of thickness about 176 km from the scaling of the cell membrane

thickness by $\lambda^4 = 2^{44}$) which might be responsible for EEG. The electric field of the Earth at space-time sheets corresponding to ordinary matter is much stronger: about $10^2 - 10^4$ V/m at the surface of Earth but decreasing rapidly as ionosphere is approached being about .3 V/m at 30 km height. The estimate for the voltage between ionosphere and Earth surface is about 200 kV [71].

The many-sheeted variant of Faraday law implies that on order to have a voltage of order .08 V over lito-ionospheric Josephson junction at dark matter space-time sheet, the voltage over ionospheric cavity must be almost completely compensated by an opposite voltage over litosphere so that lito-ionospheric double layer could be seen as a pair of capacitor plates in a radial electric field of order 10^{-7} V/m generated by the charge density in sub-litospheric part of Earth. This condition requires fine-tuning and therefore looks unrealistic.

A natural distance scale in which the electric field is reduced would correspond to 10-20 km thick layer in which whether phenomena are present. The mirror image of this layer would be Earth's crust. The cell membrane counterpart would be a dipole layer like charge density between the lipid layers of the cell membrane. Note that the electric field at dark matter space-time can be constant. However, as far as Josephson junction is considered, it is only the net voltage what matters.

3.4.6 p-Adic fractal hierarchy of Josephson junctions

p-Adic length scale hypothesis allows to imagine a hierarchy of Josephson junctions at least in length scales regarded usually as biologically relevant. The voltage through the junction need not however be same as for the ordinary cell membrane anymore. Twin primes are especially interesting since they would naturally correspond to pairs of structures analogous to a pair of lipid layers defining cell membrane.

In particular, twin primes abundant in the p-adic length scale range assignable to living matter could define double layered structures acting as Josephson junctions.

$(k, k + 2)$	(137, 139)	(149, 151)	(167, 169 = 13^2)	(179, 181)
$L(k)$	.78 A	5 nm	$2.5\mu m$	.32 mm
$(k, k + 2)$	(191, 193),	(197, 199)		
$L(k)$	1 cm	8 cm		

Table 3. Twin primes define especially interesting candidates for double membrane like structures defining Josephson junctions. Also included the pair (137, $13^2 = 169$) although $k = 169$ is not prime. The two largest scales could relate to structures appearing in brain.

Also Gaussian Mersennes define highly interesting p-adic length scales and the length scale range between cell membrane thickness and the size of cell contains as many as four Gaussian Mersennes corresponding to $k = 151, 157, 163, 167$. Only the smallest one is associated with a twin prime but p-adic length scale hypothesis allows also non-prime values of k .

The possibility of a p-adic hierarchy of membrane like structures accompanied by Josephson junctions

One can imagine the existence of fractally scaled up variants of cell membrane defining hierarchy of Josephson junctions possibly realized as magnetic flux tubes. The possible existence of this hierarchy is however not relevant for the model of EEG in its recent form.

The first hierarchy correspond to the p-adic length scales varying in the range of biologically relevant p-adic length scales $L(k)$ involving membrane like structures. Twin primes $(k, k + 2)$ are good candidates here (Table 3). Second hierarchy corresponds to dark matter hierarchy for which length scales come as $\sqrt{r}L(k)$, $r = \hbar/\hbar_0$. Later the question which values of r are favored will be discussed.

The size of cell nucleus varies in the range ($L(169) = 5 \mu m$, $2L(169) = 10 \mu m$). This is consistent with the assumption that cell nucleus provides the fundamental representation for this block. This would mean that at least the multiply coiled magnetic flux quantum structures associated with DNA appear as fractally scaled up copies.

Each dark matter level corresponds to a block of p-adic length scales $L(k)$, $k = 151, \dots, 169$. Also new length scales emerge at given level and correspond to $L(k)$, $k > 169$. The dark copies of all these length scales are also present. Hence something genuinely new would emerge at each level.

Fractal hierarchy of magnetic bodies assignable to cell

Second hierarchy corresponds to a dark matter hierarchy involving values of Planck constant. The original hypothesis was that the values of Planck constant comes as $r \equiv \hbar/\hbar_0 = 2^{11k}$ of given p-adic length scale assignable to biological membrane like structure. A possible justification for the hypothesis is that the ratio of electron and proton masses is rather near to 2^{11} and that this number appears in quantum TGD in the role of fundamental constant. This hypothesis is however un-necessarily restrictive and it is better to consider at least the values of r given as products of two ruler and compass integers n_F expressible as a product of distinct Fermat primes and some power of two. The justification comes from the number theoretic vision about evolution and number theoretical simplicity of the phases $q = \exp(i2\pi/n_F)$ (Appendix).

The emergence of a genuinely new structure or function in evolution would correspond to the emergence of new level in this fractal hierarchy. Quantum criticality would be essential: phases corresponding different values of Planck constant would compete at quantum criticality.

The flux sheet or tubes through cell membranes should integrate to larger structures at the higher levels of dark matter hierarchy implying the integration of sensory inputs from a large number of cells to single coherent input at higher levels of dark matter hierarchy. One can think two options: the sensory inputs from cell membranes are communicated directly to the magnetic body or via the DNA. The second option would require that the flux sheets or tubes starting from cell membrane traverse also the DNA.

3.5 Physical model for genetic code and its evolution

The original number theoretic models for genetic realied on the idea that genetic code has deeper number theoretical significance. The neglect of some obvious physical inputs however generated some pseudo problems. These models however led to what I believe is the correct track concerning the understanding of the prebiotic evolution. The original model for the evolution of genetic code as a fusion of singlet and doublet codes to triplet code has been discussed in [46]. The model to be discussed here is obtained from this model by some dramatic simplifications.

The basic questions are following.

1. What were the physical counterparts of the pre-amino-acids and pre-tRNAs for singlet and doublet codes?
2. How the triplet code emerged from the singlet and doublet codes? How the tRNA molecules evolved and how the amino-acids replaced pre-amino-acids?
3. Can one identify singlet and doublet life-forms or at least some predecessors of triplet life forms as existing life-forms?

In an attempt to answer these questions p-adic length scale hypothesis and the vision about the molecular evolution as a sequence of spontaneous symmetry breakings induced by the generation of new space-time sheets serve as valuable guide lines. The following biological input is needed.

1. RNA world [147] as a model for pre-biotic evolution allows to identify pre-amino-acids as RNA sequences (RNA_1 for short) differing somehow from the ordinary RNA sequences (RNA_2 for short). 1-code was associated with the transformation of $RNA_2 \rightarrow RNA_1$ and 2-code in the simplest case with the transcription of RNA_2 to its conjugate.
2. The cross like structure of tRNA molecule identifiable as a composite of its singlet and doublet predecessors allows to read directly the main steps in the evolution of the triplet code as a fusion of singlet and doublet codes and also gives detailed and highly non-trivial information about RNA_1 .
3. The reverse transcriptase, appearing in retro-viruses like HIV and acting also as a transcriptase [157], provides the mechanism transforming RNA sequences to DNA sequences inside pre-nucleus so that DNA \rightarrow RNA code emerged and also evolved rapidly since reverse transcriptase makes a lot of errors.

4. The basic idea is that the fusion of tRNA₁ and tRNA₂ to to tRNA₃, the recent tRNA, made RNA₂ → RNA₁ and RNA₂ → RNA₂ transformations impossible and the amino-acids originally catalyzing the attachment of RNA₂ doublet in RNA₂ transcription began to be attached to a growing amino-acid sequence and mRNA → amino-acid part of genetic machinery was established. The emergence of reverse transcriptase brought in DNA. DNA as topological quantum computer idea generalized to RNA context provides tight additional conditions on the course of events: in particular, membrane like structures, most naturally consisting of RNA₁ should have been present already at RNA era.
5. Nanno-bacteria claimed to be even the dark bio-matter are excellent candidates for singlet and doublet life-forms or at least, predecessors of the recent life-forms. There are reasons to believe that RNA era is still continuing inside cell nucleus.

Second group of questions relates to the quantum control of the translation process. There are many questions also now.

1. What makes a codon stopping codon?
2. What is behind the symmetries of the code with respect to the third codon.
3. What is the origin of breaking of the canonical A-T, C-G rules for mRNA-tRNA association?

The model for the transition from RNA era to RNA-amino-acid era allows to answer these questions and the DNA as tqc picture leads to a physical interpretation of these symmetries and their breaking.

3.5.1 RNA world

The hypothesis that pre-biotic life before the emergence of the cell membrane structures was RNA dominated (the notion of RNA world) is based on a strong empirical evidence summarized in detail in [102]. For instance, only RNA can be generated spontaneously in the absence of cell membrane bounded structures. There is also a lot of support for the ability of RNA to take care of functions like replication, translation, and transfer (see the [102] and references therein). Ribozymes could even replace enzymes as RNA based catalyzing agents so that even amino-acids might be unnecessary in RNA world and the system could consist of RNA only. This of course does not mean that this system could yet realize genetic code and evolve.

An important implication is that pre-amino-acids might be identifiable as 2', 5' RNA, which was produced in the classical experiments of Leslie Orgel at 1980s mimicking primordial ocean. There are however also other candidates and the structure of tRNA more or less fixes identification to a high degree.

Ontogeny recapitulates phylogeny principle suggests that if RNA coded RNA during primordial period, the remnants of these RNAs could still exist and be coded by specific genes. This is indeed the case [104] (for an article about RNA genes and RNA world see [123]). RNA genes were discovered already 1990 in the genome of *Caenorhabditis elegans*, the small nematode worm but it took years to realize that they do not code proteins but small RNA molecules that somehow turn off other genes that play a role in worm development. Later these small RNA coding genes were found in flies, mollusks, fish, and even humans. As many as 200 microRNA genes in *C. elegans* were known at time of the writing of the article, which would represent about 1 percent of the genes of its genes. There is also evidence that centrosomes possess their own genome based on RNA rather than DNA [127].

3.5.2 Programming of bio-molecular self assembly pathways from TGD point of view

The beautiful results (for a popular summary see [95]) about programming of bio-molecular self assembly - described above - when combined with the earlier model for the pre-biotic evolution - inspire interesting insights about the role of braiding in translation. The basic observation is that the structure of tRNA- although more complex than that of hairpin- has much common with that of hairpins. Therefore it is interesting to look this structure from the point of view of TGD. For instance, one can find whether the notions of braiding, anomalous em charge and quark color could provide additional insights about the structure and function of tRNA.

The brief summary of the resulting picture is as follows. According to the TGD based model of pre-biotic evolution, 3-code should have resulted as a fusion of 1- and 2- codes to 3-codes involving fusion of $tRNA_1$ and $tRNA_2$ to $tRNA_3 \equiv tRNA$. Second hypothesis is that during RNA era the function of $tRNA_2$ was to generate RNA_2 double helix from single RNA strand and that amino-acids catalyzed this process. The considerations that follow strongly suggest that $tRNA_1$ was involved with a non-deterministic generation of new RNA sequences essential for the evolution. After the establishment of 3-code these two process fused to a deterministic process generating amino-acid sequences. RNA era could still continue inside cell and play an important role in evolution.

There is an interesting work about programming bio-molecular self assembly pathways [148]. The catalytic self assembly of complexes of nuclei acids is carried out automatically by a program represented implicitly as a mixture of linear DNA strand acting as catalyst and so called hairpin DNA:s containing three nucleation sites a_t, b_t, c_t - so called toeholds.

Key ideas

The basic idea is that a set of bio-molecular reactions can be programmed to occur in a desired order by using a generalization of lock and key mechanism. The simplest self assembly pathway can be specified by a collection of keys and locks. In the beginning there is only one key and the this key fits to only one door, which leads into a room with several doors. The lock eats the key but gives one or more keys. If the room contains several doors to which the keys fits, the reaction corresponds to addition of several branches to the already existing reaction product. By continuing in this manner one eventually ends up to the last room and at the last step the lock gives back the original key so that it can act as a catalyst.

The translation of this idea to a program defining self assembly pathway is following.

1. DNA hairpin define key structural element of the self-assembly program. Hairpin is a single-stranded DNA strand in meta-stable configuration having form $A+B+C$ [81] such that B forms a loop and C is a palindrome [85]. The formal expression for palindromy is $C = A_t^*$: this means that C read backwards (C_t) is conjugate A^* of A implying that A and C running in opposite direction can form a double helix (duplex) by hydrogen bonding. As catalytic a^* acting as key forms a double helix with a , the hairpin molecule opens to a linear DNA molecule and energy is liberated. In this process original key is lost but the two other toe-holds b_t and c_t contained by the hairpin become available as keys. Each hairpin in the mixture of catalyst and hairpin molecules has its own lock and two keys.
2. The process of opening new doors continues until all hairpin molecules are used. The key given by the last lock must be catalyst strand a^* . The outcome is a molecule consisting of pieces of DNA strands and can possess a very complex topology. For instance, the formation trees and star like structures can be easily programmed.
3. To run this program one needs only an optimal mixture of catalyst molecule and hairpin DNA molecules. In the applications discussed in [148] hairpins have length of order 10 nm which corresponds to p-adic length scale $L(151)$ defining also cell membrane thickness. That $L(151)$ corresponds also to the length of 30-nucleotide sequence defining the codon of the code associated with Mersenne prime $M_{61} = 2^{61} - 1$ might not be an accident. The simplest applications are autocatalytic formation of DNA dublex molecules and of branched junctions, nucleated dendritic growth, and autonomous locomotion of a bipedal walker.

The basic idea in the realization of the autonomous motion of bipedal walker is to cheat the walker to follow a track marked by food. The walker literally eats the food and receives in this manner the metabolic energy needed to make the step to the next piece of food. The menu contains two kinds of hairpins as foods: hairpins A attached regularly along the desired path of the walker (second DNA strand) and hairpins B but not attached to the strand. The front leg l of the walker attaches to A and this catalyzes the formation of the duplex $A \cdot B$ as a waste and the liberated metabolic energy allows to make a step in which hind leg becomes the front leg.

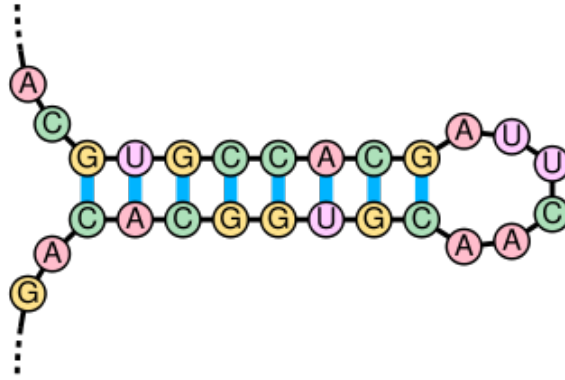


Figure 3.1: The structure of DNA hairpin (stem loop)

TGD view about the situation

The possibility to program the self-assembly relies on the almost deterministic realization of the lock and key mechanism. The presence of braid strands could make this possible.

1. Consider first the hypothesis about the cancelation of anomalous DNA charge. The palindromic character of A means that the neck of the hairpin has vanishing anomalous em charge and also vanishing color charge is possible. Hence palindromes are favored in TGD Universe. The circular piece B is not in general color singlet. It could have braid strands connecting it to it to some other DNA or nuclear membrane but this is not necessary. Same applies to the toehold a_t at the end of the other strand of neck.
2. The attachment of the lock to key could be seen as a process in which a braid consisting of magnetic flux tubes connecting lock and key strands (DNA and its conjugate) is formed spontaneously and followed by a phase transition reducing \hbar contracting the flux tubes and in this manner guiding the key to the lock.

If one assumes that only paired nucleotides of single DNA strand possess braid strands, one must assume the same for mRNA. As a consequence one would lose the nice interpretation for the formation of AAA... tail of mRNA as a manner to guarantee integer valuedness and small value (or even vanishing) of the anomalous em charge. If there is braid strands associated with entire mRNA, it could end at the nuclear membrane. In this case the transfer of tRNA to mRNA during translation by a phase transition reducing \hbar of braid strands could be initiated by the fusion of the braid strand ends coming from mRNA codon and from its conjugate codon at tRNA at nuclear membrane.

3.5.3 The archeology of tRNA molecules as a guideline

The study of the structure of the ordinary tRNA molecule is of considerable help in the attempts to guess what might have been its predecessor.

The structure of the tRNA molecule

The shape of the tRNA molecule [105] in 2-D representation is that of cruciform.

1. tRNA molecule has a cross like appearance, and decomposes into a body coded by tRNA gene and an acceptor stem which is same for all amino-acids and added separately and can be replaced during the lifetime of the tRNA molecule. Acceptor stem, to which the amino-acid is attached with the mediation of amino-acyl-tRNA synthase, can be said to be a passive component and is same for all tRNAs so that its structure does not determine which amino-acid is attached to it. The stem is not coded by genes and contains 4 nucleotides.

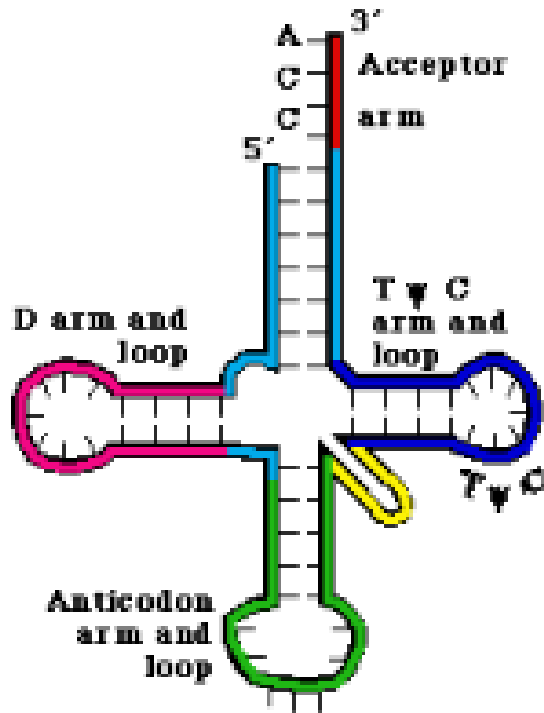


Figure 3.2: The structure of tRNA

2. tRNA molecule can be seen as single RNA strand just as hairpin. The five stems are double helices analogous to the necks of the hairpin. Strand begins at 5' end of the acceptor stem directed upwards. The second strand of acceptor stem continues as a toehold ending to 3' end of tRNA. The toehold has at its end ACC to which the amino-acid (rather than conjugate DNA) attaches.
3. tRNA molecule contains three arms with hairpin structure. A arm containing the anticodon is directed downwards. D and T arms are horizontal and directed to left and right. Between T arm and A arm there is additional variable hairpin like structure but with highly degenerate loop is degenerate. It has emerged during evolution.
4. The structure of tRNA minus anticodon depends on anti-codon which conforms with the fact T and D arms are related to the binding of amino-acid so that their nucleotide composition correlates with that of anticodon.
5. Anticodon arm contains the anticodon of mRNA codon and thus corresponds to RNA. For doublet part of the mRNA codon the correspondence is 1-1 but for the third nucleotide the correspondence is more complex due to wobble base pairing to be discussed below. Wobble base pairing indeed leads to the recent simplified model for the evolution of the triplet code as a fusion of 1-code and 2-code.

Wobble base pairing

The phenomenon of wobble base pairing [116] is very important. There are only about 40 tRNA molecules instead of 61 which means that one-to-one map between mRNA nucleotides and tRNA conjugate nucleotides is not possible. Crick suggests that so called wobble base pairing resolves the problem. What happens that the first nucleotide of anticodon is either A, G, U, or I(nosine) [79]. The base-pairings for third nucleotide are $\{A-U, G-C, U-\{A, G\}, I-\{U, A, C\}\}$. The explanation

for the non unique base pairing in the case of U is that its geometric configuration is quite not the same as in ordinary RNA strand. I is known to have 3-fold base pairing.

Minimization of the number of tRNAs requiring that only three mRNA codons act as stopping signs predicts that the number of tRNAs is 40.

1. It is convenient to classify the 4-columns of code table according to whether all four codons code for the same amino-acid ($(T, C, A, G) \rightarrow X$, whether 4-column decomposes into two doublets: $[(T, C), (A, G)] \rightarrow [X, Y]$, or whether it decomposes to triplet and singlet ($[(T, C, A), G] \rightarrow [ile, met]$). There are also the 4-columns containing stop codon: $[(U, C), (A, G)] \rightarrow [(tyr, tyr), (stop, stop)]$ and $[(U, C), A, G] \rightarrow [(cys, sys), stop, trp]$. Mitochondrial code has full A-G and T-C symmetries whereas for vertebrate nuclear code 3 4-columns break this symmetry.
2. Consider first 4-columns for which the doublet symmetry is broken. $[tyr, tyr, top, stop]$ column must correspond to first tRNA nucleotide which is A or G (tyr). The absence of anti-codons containing U implies stop codon property. For $[cys, sys, stop, trp]$ one must have A, G and C but U is not allowed. ile-met column can correspond to tRNAs with I and C as the first nucleotide.
3. For 4-columns coding for two doublet amino-acids the minimal set of first tRNA codons is $\{A, G, U\}$. For completely symmetric 4-columns the minimal set of tRNA codons is $\{I, U\}$. Thus $\{A, G, U, I\}$ would replace $\{A, G, U, C\}$.
4. There are 9 completely symmetric 4-columns making 18 tRNAs, 5 doublet pairs making 15 tRNAs, ile-met giving 2 tRNAs, and the columns containing stopping codons giving 5 tRNAs. Altogether this gives $18+15+2+5=40$. Also the deviations from the standard code can be understood in terms of the properties of tRNA.

Consider the interpretation of wobble base pairing in TGD framework assuming the braiding picture and the mapping of nucleotides to quarks. The completely symmetric 4-columns correspond to unbroken isospin and matter-antimatter asymmetries. 4-columns decomposing into doublets result from the breaking of matter-antimatter asymmetry at quark level. ile-met column corresponds to the breaking of both symmetries. The base pairings of I obviously break both symmetries.

The non-unique based pairing of U and I means that they cannot correspond to a unique quark or anti-quark in braiding U pairs with both A and G so that the braid strands starting from these RNA nucleotides must both be able to end to tRNA U . Hence tRNA U is not sensitive to the isospin of the quark. This non-uniqueness could relate to the assumed anomalous geometric character of the binding of U codon to tRNA sequence. The braid strands beginning from U , A , and C must be able to end up to I so that I can discriminate only between $\{U, C, A\}$ and G .

Anomalous em charge and color singletness hypothesis for tRNA

One can test also whether the vanishing of anomalous em charge of tRNA leads to testable predictions. One can also try understand translation process in terms of the braiding dynamics. One must distinguish between the states of tRNA alone and tRNA + amino-acid for which braidings are expected to be different.

Before continuing it must be made clear that braiding hypothesis is far from being precisely formulated. One question is whether the presence of the braiding could distinguish between matter in vivo and vitro. For instance, the condition that anomalous em charge is integer valued or vanishing for DNA hairpins in vivo gives strong condition on the loop of the hairpin but or hairpins in vitro there would be no such conditions. Second point is that amino-acids and I and U in tRNA₁ could carry variable anomalous em charge allowing rather general compensation mechanism.

1. tRNA without amino-acid

1. The minimal assumption is that braiding hypothesis applies only to the stem regions of tRNA in this case. In this case the strands can indeed begin from strand and end up to conjugate strand. The possibility of color singletness and vanishing of total anomalous em charge are automatically satisfied for the stem regions as a whole in absence of non-standard base pairings. In general the acceptor stem contains however $G*U$ base pair which is matter-antimatter asymmetric but breaks isospin symmetry and gives unit anomalous charge for the acceptor stem. Also other

stems can contain $G * U$, $U * G$ pairings as also $P * G$ and $L * U$ pairings (P and L denote amino-acids Pro and Leu). The study of concrete examples [98] shows that single $G * U$ bond is possible so that anomalous em charge can be non-vanishing but integer valued for double strand part of tRNA. Suppose that a given amino-acid can have anomalous of any codon coding for it. If P in $G * P$ pair has the anomalous em charge of the codon CCG, $G * P$ pair has vanishing anomalous em charge. If L corresponds to CUA the value of anomalous em charge is integer.

2. The anomalous em charge in general fails to vanish for the loops of hairpins. For the braids possibly associated with the loops of tRNA the strands can only end up to tRNA itself or nuclear membrane. If there are no braid strands associated with these regions, there is no color or anomalous em charge to be canceled so that the situation trivializes. On the other hand, in the case of tRNA I and U associated with the first nucleotide of the anticodon of tRNA can have a varying value of anomalous em charge. Therefore integer valued em charge and color singletness become possible for tRNA. tRNA can also contain amino-acids. If the amino-acids can carry a varying anomalous em charge with a spectrum corresponding to its values for DNA codons coding it, also they could help to stabilize tRNA by canceling the anomalous em charge.

2. tRNA plus amino-acid

1. Amino-acyl tRNA synthetase, which is the catalyst inducing the fusion of amino-acid with ACC stem [87], could have braid strands to both amino-acid and tRNA and have regions with opposite anomalous em charges compensating separately that of amino-acid and of the active part of tRNA. The required correlation of amino-acid with anticodon would suggest that both D and T loops and A -loop are included. The simplest option is however that the anticodon is connected by braid to amino-acid so that braiding would define the genetic code at the fundamental level and the many-to-one character of genetic code would reflect the 1-to-many character of amino-acid-quark triplet correspondence. This hypothesis is easy to kill: for the portion of catalyst attaching to a given portion of DNA strand amino-acids and codons should have opposite anomalous em charges: $Q_a(\text{amino}) = -Q_a(\text{codon})$.
2. After the catalysis involving reduction of \hbar amino-acid and tRNA would form a system with a vanishing net anomalous em charge but with a braiding structure more complex than that before the fusion.
3. In the translation process the braiding structure of tRNA- amino-acid system should re-organize: the braid strands connecting anticodon with amino-acid are transformed to braid strands connecting it to mRNA codon with a subsequent reduction of \hbar of braid strands bringing tRNA into the vicinity of mRNA. In the transcription the anticodon-codon braiding would be replaced with amino-acid-mRNA braiding forcing formation of the amino-acid sequence. It will be later found that the simpler option without this step corresponds to the earlier hypothesis according to which amino-acids acted originally as catalysts for the formation of RNA double helix.
4. tRNA is basically coded by genes which suggests that the general symmetries of the genetic code apply to the variants of tRNA associated with same anticodon. Hence the variants should result from each other by isospin splits and modifications such as permutations of subsequent nucleotides and addition of AT and CG pairs not changing overall color and isospin properties. Also anomalous base pairs $X * Y$ can be added provide their net anomalous em charge vanishes.
5. tRNA has a complex tertiary (3-D) structure [115] involving base pairing of distant nucleotides associated with the roots of the stem regions where tRNA twists sharply. This pairing could involve formation of braid strands connecting the nucleotides involved. The reduction of Planck constant for these strands could be an essential element of the formation of the tertiary structure.

The fossilized components of tRNA as record about the evolution of the recent form of the genetic code

The ordinary tRNA indeed seems to contain in its structure fossilized components providing a record about how the molecular evolution proceeded. $tRNA_1$ and $tRNA_2$ correspond naturally to the horizontal and vertical segment in the recent tRNA formed as a fusion of $tRNA_1$ and $tRNA_2$ to form a

cross like structure (see figure above). Hence trRNA_1 and trRNA_2 should represent in their structures the respective genetic codes.

1. trRNA_2 should contain both the conjugate of the coding RNA nucleotide attaching to RNA_2 plus the conjugate of the coded nucleotide to which RNA nucleotide was attached and then transferred to RNA_2 and added to the growing RNA sequence. This means that the structure of trRNA should help to deduce the doublet code experimentally. The pairs formed by the RNA triplet XYZ at the end of the anticodon arm of the ordinary trRNA and the pair formed by the triplet $X'Y'Z'$ and its conjugate on right and left sides of XYZ should provide detailed information about the doublet code. The pairs $XY - X'Y'$ should represent the doublet code apart from possible symmetry breaking effects. These effects might be induced at the level of $X'Y'Z'$ -amino-acid correspondence level and thus not visible in the structure of trRNA .
2. The transition to the triplet code added one RNA nucleotide to both the exotic doublet (XY)₂ and the doublet $X'Y'$ and its conjugate coded by it. The exotic 2', 5' doublet plus the added singlet transformed to ordinary triplet. The simplest assumption is that these RNAs came from D arm and T ψ C arm. This is possible since all loops are physically near to each other. The structure of D and T ψ loops conforms with the assumption that the predecessor of the first *resp.* second loop has lost the coding *resp.* coded RNA. The structure of these loops forces also to conclude that all trRNA loops have been stem like structures before their de-activation just as the acceptor stem is. Deactivation of RNA_1 translation process must have meant the completion of these stems to loops by addition of a conjugate of the conjugate of the coded RNA.

The components of trRNA as ribozymes which have acted originally as RNA polymerases

The mechanism of ribozyme catalyzed polymerization for both the exotic RNA with mono- *resp.* diphosphate backbones, and their their double strand can be guessed from the fact that the process can be seen as an unfaithful replication. Hence the trRNAs involved would play a role analogous to DNA polymerase in the polymerization of DNA. The only difference is that, instead of the conjugate of the template strand, a copy of strand is reproduced and the copy can be un-faithful.

DNA replication utilizes the conjugate strand as a template and occurs with the mediation of DNA polymerase enzyme, which brings dXTP , $X = A, T, C, G$ rather than dXMP , to the vicinity of the DNA conjugate strand [136]. The di-phosphate is cleaved out from dXTP and the liberated energy makes it possible to add the resulting dXMP to the growing DNA strand.

The prediction is that trRNA_1 and trRNA_2 have originally been ribozymes acting as exotic RNA polymerases. In the case of DNA strand dXMP pairs with its conjugate in the template strand by hydrogen bonds and 3', 5' bond is formed between monophosphate deoxiribose of previous nucleoside. In the case of exotic RNA strand the XMP associated with the trRNA pairs with its conjugate in the template RNA strand, 2', 5' bond with the ribose of the previous RNA unit is formed. trRNA is not so selective as a polymerase as DNA polymerase and this ultimately gives rise to the many-to-one correspondence crucial for the non-triviality of the genetic code.

1. RNA_2 consists of exotic RNA doublets with nucleotides connected by 2', 5' monophosphate bonds. trRNA_2 brings 2', 5' doublet $\text{XMP}_2 \circ \text{YTP}_2$ to the growing strand and glues it to the 5' position of the ribose in the already existing polymer. The YTP suffers the cleavage $\text{YTP}_2 \rightarrow \text{YMP}_2$ as in the case of DNA polymerization and the amount of metabolic energy provided by the cleavage is the same. The formation of $\text{XMP}_2 \circ \text{YTP}_2$ proceeds by gluing of XTP_2 to YTP_2 by a similar process so that the net metabolic energy used per nucleotide is essentially the same as in the ordinary DNA polymerization.
2. RNA_1 consists of exotic RNA singlets connected by 2', 5' diphosphate bonds. trRNA_1 brings XTP_2 near the growing strand, the cleavage $\text{XTP}_2 \rightarrow \text{XDP}_2$ occurs, and XDP_2 is glued to the 5' position of the ribose of the previous RNA nucleotide. The amount of metabolic energy provided by the cleavage is roughly one half of that in the case of RNA_2 polymerization, and this might partially explain why diphosphate exotic RNA strands are rare whereas monophosphate exotic DNA strands can be found inside cells. On the other hand, it is $\text{ATP} \rightarrow \text{ADP}$ cleavage, which usually occurs in the ordinary metabolism instead of $\text{ATP} \rightarrow \text{AMP}$ cleavage: only during a very intense metabolism $\text{ATP} \rightarrow \text{AMP}$ cleavage occurs. Since ATP metabolism is a functional

fossil from a very early period of evolution, one might expect that $ATP \rightarrow ADP$ cleavage has in fact occurred naturally, if not even more naturally, also in the polymerization of 2',5' RNA during (exotic) RNA era.

3. In the case of double exotic RNA strand of ordinary and exotic RNA the predecessor of the recent tRNA formed by $tRNA_1 + tRNA_2$ would be a ribozyme bringing energized singlet and doublet RNAs to the double strand acting as a template with $tRNA_1$ component catalyzing the cleavage of the monophosphate and $tRNA_2$ component catalyzing the cleavage of the diphosphate.

The crucial and testable prediction is that the ribozymes responsible for the exotic mono- and diphosphate 2',5' RNA polymerization should have a strong resemblance with the two structural components of the recent tRNA. Furthermore, the replication catalyzed by these ribozymes should be unfaithful, perhaps in a manner consistent with the genetic code before the breaking of its symmetries. Ribozymes responsible for the ordinary RNA polymerization are known but I am not aware about how much is known about the corresponding ribozymes in the case of 2',5' RNA. The building blocks of recent tRNA would however provide a good starting point for innovative RNA engineers. In any case, the very fact that this form of RNA does not even allow DNA, makes it a more natural candidate for the basic building block of RNA life than 3',5' RNA.

3.5.4 Recent genetic code as a fusion of singlet and doublet codes?

There are several guidelines helping to answer the question how DNA-amino-acid translation might have emerged from singlet and doublet codes producing only RNA from RNA.

The following vision about evolution leading from RNA era to the recent DNA-RNA-amino-acid era inspired by a combination of RNA world vision [147] with the detailed study of the structure of tRNA suggesting the presence of 1- and 2-codes during RNA era with the DNA as tqc vision suggesting the presence of cell membrane like structures as a necessary ingredient making possible topological quantum computation like processes already during RNA era. The recent model is considerably simpler than the earlier models [46].

RNA era and the transition to RNA-amino-acid era

1. Translation of mRNA to amino-acid sequences separates from the transcription of DNA to mRNA. One expects that during RNA two different kinds of RNAs, call them RNA_2 and RNA_1 , analogous to mRNA and proteins existed. RNA_2 can be identified as the ordinary 3',5' RNA acting in the role of mRNA. A natural candidate for RNA_1 playing the role of proteins is 2',5' RNA since it is generated in the experiments of Orgel and appears also in genomes. Of course, also other candidates can be considered and the structure of tRNA gives valuable information about the character of this RNA. The copying of RNA_2 to its conjugate was the counterpart of RNA replication. The transcription of RNA_2 to RNA_1 was the counterpart of translation.
2. The structure of tRNA, call it $tRNA_3$, gives valuable information about the course of events leading to the translation of mRNA to amino-acids. The cross like structure of $tRNA_3$ and the decomposition of RNA triplet appearing in it to 2-codon and 1-codon suggests that it resulted as a fusion of two hairpin like molecules $tRNA_1$ and $tRNA_2$. $tRNA_2$ brought pairs of nucleotides forming the 2-codon part of RNA triplet to the growing RNA_2 sequence during replication and 2-code was simply RNA conjugation. $tRNA_1$ was involved with transcription of RNA_2 to RNA_1 bringing RNA_1 nucleotides one-by one to the growing sequence. In $tRNA_3$ the third nucleotide does not quite correspond to ordinary RNA but to A, G, U or I (inositol) and is believed to differ geometrically from ordinary nucleotide, and one can assume that these nucleotides were the building blocks of RNA_1 possibly appearing in 2',5' form. The phenomenon of the wobble pairing can be assumed to have been present already during RNA era so that correspondence 1-code was not 1-to-1 nor deterministic but given by the correspondence $\{U \rightarrow A, C \rightarrow G, \{A, G\} \rightarrow U, \{U, A, C\} \rightarrow I\}$ deduced from the number 40 of tRNAs and assigning unique 1-codon to only G could be interpreted as a many-to-one and non-deterministic correspondence generating new RNA sequences from existing ones. If there was RNA_2 sequence coding for $tRNA_1$, this sequence appearing in hairpin structure could have coded the inverse of the translation. As a consequence, the occurrence of transcription and its reversal generated a rapid evolution by creating new kinds of RNA_2 sequences.

3. From the fact that amino-acids are attached to the ACC stem of tRNA₂, one can guess that the role of amino-acids during RNA era was to catalyze the replication. If single amino-acid would have catalyzed the attachment of given RNA doublet to the growing sequence, there would be at most 16 amino-acids and genetic code would not depend at all on the third nucleotide. This is indeed the case for roughly half of the code table (both matter antimatter symmetry and isospin symmetry with respect to third codon). For those mRNA codons for which A,G and T,C correspond to different amino-acids (breaking of matter antimatter asymmetry but isospin symmetry) two amino-acids catalyzed the attachment. Same amino-acid could also catalyzed two different attachments (ser, arg, leu for standard genetic code).
4. The crucial step was the fusion of the 1-code and 2-code to 3-code took place via fusion of tRNA₁ and tRNA₂ to tRNA₃ along their ends containing RNA₁ nucleotide and RNA₂ doublet which thus combined to RNA triplet. Presumably tRNA₃ in its original form was translated from a linear mRNA molecule and transformed spontaneously to the cross like shape because of the presence of palindrome structures in both. The original functions of tRNAs were not possible anymore since the triplet was not at the end of the molecule. The catalyzing amino-acid however was at the ACC end of and the function of tRNA₃ became to assist the translation of mRNA to amino-acid sequence. For those 3-codons for which single amino-acid catalyzed the fusion of 2-codon, a full matter antimatter and isospin symmetry resulted. For those 3-codons for which two amino-acids catalyzed the fusion, a breaking of matter antimatter symmetry took place in the sense that for given mRNA codon only the tRNA₃ corresponding to single amino-acid was stable. Isospin symmetry was broken only weakly or not at all (human mitochondrial code). Thus codons with A,G as third nucleotide almost always coded the first amino-acid and those with T,C as the third nucleotide the second one. Stopping codons resulted when all tRNA₃ corresponding to mRNA triplet were unstable. That same RNA can code for both amino-acid and act as a stop codon in certain situations, can be understood if the stability of corresponding tRNA₃ depends on the chemical environment.

Symbiosis with membrane bounded structures

In DNA as tqc picture nuclear and cell membranes make possible topological quantum computation. The magnetic flux tubes connecting DNA nucleotides to lipids of the cell membrane could also explain why DNA is stable inside cell. The emergence of cell membranes consisting of lipids and generated via self-organization rather being coded by genes would have stabilized DNA generated in this manner during DNA-RNA-amino-acid era. Membrane bounded structures emerged when the space-time sheets corresponding to the p-adic length scale $k = 151$ emerged in the condensate.

Topological quantum computation should have taken place already during RNA era. This suggest that the counterpart of the cell membrane was present already at that time. Quite recently it was reported [135] that DNA duplexes of length 6 to 20 base pairs can join to longer cylinders which in turn form liquid crystals and that the liquid crystal phase separates from the phase formed by single DNA strands. Long strands had been already earlier known to form liquid crystals. This encourages to think that also RNA duplexes are able to self-organize in this manner so that the analog of cell nucleus containing RNA double helices as genetic material could have existed already during RNA era.

The latter option would allow to distinguish between RNA₂ and RNA₁ used as building block of various structures. This suggests that RNA₁, which disappeared in the transition to RNA-amino-acid era, might have formed liquid membranes containing inside then RNA₂ such that RNA₂ nucleotides were connected by magnetic flux tubes to RNA₁ nucleotides. The minimal function of RNA₁ would have been to make possible the buildup of cell membrane. In this case the lengths of RNA₁ needed to be only of order $L(151) = 10$ nm. The sequences consisting of 30 RNA₁ base pairs would correspond roughly to the thickness of cell membrane and to the codon of M_{61} code. Lipid layer of thickness 5 nm would correspond to roughly 16 base pairs and to the codon assignable to M_{17} . If magnetic flux tubes indeed stabilize DNA, the presence of RNA₁ membrane might have been enough to stabilize also DNA so that RNA era could have been followed by DNA-RNA era and eventually by DNA-RNA-amino-acid era with RNA₁ membrane being replaced by double lipid layer membrane.

Reverse transcription of RNA to DNA

The basic problem was how to build DNA sequences which would later take the command. If one, in conflict with the Central Dogma, assumes the presence of the predecessor of the so called reverse RNA transcriptase [157] associated with retro-viruses (in particular HIV virus), one can understand how this step occurred. Reverse RNA transcriptase allowed to transform ordinary RNA sequences to DNA sequences inside newly emerged pre-nuclei. The reverse transcriptase catalyzes also the transcription of DNA back to RNA so that DNA began to produce new RNA.

Reverse transcriptase requires amino-acids sequences. Amino-acids appeared as catalysts in tRNA₂ already during RNA era but the spontaneous emergence of reverse transcriptase before RNA → amino-acids translation look improbable. After the fusion of tRNA₁ and tRNA₂ RNA₂ could replicate only if tRNA₁, tRNA₂ and tRNA₃ continued to live in symbiosis for some time. This could have led naturally to the generation of reverse transcriptase and DNA. After that DNA could have taken care of the production of RNA and tRNA₁ and tRNA₂ might have lost in the fight for molecular survival or at least their importance could have diminished. The emergence of DNA could have been associated with the replacement of RNA₁ membrane with ordinary cell membrane. For instance, it might be that DNA was able to form only magnetic flux tubes only with lipid bilayer membrane.

The reverse transcription is not reliable (one error per about 1000 nucleotides), and this led to a rapid evolution of DNA analogous to that of HIV virus. This meant an escape from the fixed point situation, and a genuine DNA → RNA predecessor of the genetic code emerged. Together with the emergence of membrane bounded structures this meant genuine evolution at DNA level. Reverse transcription is possible only for the ordinary RNA and explains why exotic doublet RNA has disappeared from cell.

What were the first self replicators?

The TGD inspired model of pre-biotic evolution suggests a reasonable guess for the first self-replicating molecular entities. Both tRNA₁ and tRNA₂ molecules must have resulted as more or less copies of corresponding RNA₂ sequences (amino-acid was added after transcription to tRNA₂) and the minimal self-reproducing system could have consisted of tRNA₁, tRNA₂ and corresponding RNA₂ molecules. Since tRNA₁ and tRNA₂ are hairpins in the usual configuration and the mechanism making possible biochemical reaction series suggests that these hairpin molecules catalyzed the opening of the corresponding RNA₂ pieces and their coding to tRNA₁ or tRNA₂.

Note that double strands in the sense they occur for DNA are not necessary since the double strand part of hairpin is analogous to DNA double strand and the opening of hairpin structure is analogous to the opening of DNA double strand during transcription and replication. The non-determinism of 1-code could have rapidly led to a genuine evolution and one can also imagine a spontaneous generation of RNA₂ sequences as oligonucleotides consisting of copies of pieces of RNA₂ coding for tRNA₂.

Also more general hairpin might be used to construct a self-catalyzing system. Since exotic and normal RNA do not differ too much, a reasonable amount of guess work might allow to identify tRNA₁ and tRNA₂, and perhaps even create simple pre-biotic life-forms in the laboratory.

3.5.5 Is RNA era continuing inside cell nuclei?

The last issue of [97] contains an article about the discovery that only roughly one half of DNA expresses itself as amino-acid sequences. A detailed summary of the results has been published in Nature [129]. The Encyclopedia of DNA Elements (ENCODE) project has quantified RNA transcription patterns and found that while the "standard" RNA copy of a gene gets translated into a protein as expected, for each copy of a gene cells also make RNA copies of many other sections of DNA. In particular, intron portions ("junk DNA", the portion of which increases as one climbs up in evolutionary hierarchy) are transcribed to RNA in large amounts. What is also interesting that the RNA fragments correspond to pieces from several genes which raises the question whether there is some fundamental unit smaller than gene.

None of the extra RNA fragments gets translated into proteins, so the race is on to discover just what their function is. TGD proposal is that the RNA gets braided and performs a lot of topological quantum computation [25]. Topologically quantum computing RNA fits nicely with replicating number theoretic braids associated with light-like orbits of partonic 2-surfaces and with their spatial "printed text" representations as linked and knotted partonic 2-surfaces giving braids. An interesting

question is how printing and reading could take place. Is it something comparable to what occurs when we read consciously? Is the biological portion of our conscious life identifiable with this reading process accompanied by copying by cell replication and as secondary printing using amino-acid sequences?

This picture conforms with TGD view about pre-biotic evolution. Plasmoids [75], which are known to share many basic characteristics assigned with life, came first: high temperatures are not a problem in TGD Universe since given frequency corresponds to energy above thermal energy for large enough value of \hbar [16]. Plasmoids were followed by RNA, and DNA and amino-acid sequences emerged only after the fusion of 1- and 2-letter codes fusing to the recent 3-letter code. The cross like structure of tRNA molecules carries clear signatures supporting this vision. RNA would be still responsible for roughly half of intracellular life and perhaps for the core of "intelligent life".

I have also proposed that this expression uses memetic code which would correspond to Mersenne $M_{127} = 2^{127} - 1$ with 2^{126} codons whereas ordinary genetic code would correspond to $M_7 = 2^7 - 1$ with 2^6 codons. Memetic codons in DNA representations would consist of sequences of 21 ordinary codons. Also representations in terms of field patterns with duration of .1 seconds (secondary p-adic time scale associated with M_{127} defining a fundamental bio-rhythm) can be considered.

A hypothesis worth of killing would be that the DNA coding for RNA has memetic codons scattered around genome as basic units. It is interesting to see whether the structure of DNA could give any hints that memetic codon appears as a basic unit.

1. In a "relaxed" double-helical segment of DNA, the two strands twist [141] around the helical axis once every 10.4 base pairs of sequence. 21 genetic codons correspond 63 base pairs whereas 6 full twists would correspond to 62.4 base pairs.
2. Nucleosomes [140] are fundamental repeating units in eukaryotic chromatin [88] possessing what is known as 10 nm beads-on-string structure. They repeat roughly every 200 base pairs: integer number of genetic codons would suggest 201 base pairs. 3 memetic codons makes 189 base pairs. Could this mean that only a fraction $p \sim 12/201$, which happens to be of the same order of magnitude as the portion of introns in human genome, consists of ordinary codons? Inside nucleosomes the distance between neighboring contacts between histone and DNA is about 10 nm, the p-adic length scale $L(151)$ associated with the Gaussian Mersenne $(1 + i)^{151} - 1$ characterizing also cell membrane thickness and the size of nucleosomes. This length corresponds to 10 codons so that there would be two contacts per single memetic codon in a reasonable approximation. In the example of Wikipedia [140] nucleosome corresponds to about 146=126+20 base pairs: 147 base pairs would make 2 memetic codons and 7 genetic codons. The remaining 54 base pairs between histone units + 3 ordinary codons from histone unit would make single memetic codon. That only single memetic codon is between histone units and part of the memetic codon overlaps with histone containing unit conforms with the finding that chromatin accessibility and histone modification patterns are highly predictive of both the presence and activity of transcription start sites. This would leave 4 genetic codons and 201 base pairs could decompose as memetic codon+2 genetic codons+memetic codon+2 genetic codons. The simplest possibility is however that memetic codons are between histone units and histone units consist of genetic codons. Note that memetic codons could be transcribed without the straightening of histone unit occurring during the transcription leading to protein coding.

3.5.6 Could nano-bacteria correspond to predecessors of the triplet life-forms?

The experiments of Leslie Orgel (at 1980) imitating the primordial ocean demonstrate the emergence of the exotic RNA for which doublet effectively replaces the triplet. The so called nano-bacteria represent a mystery at the borderline between living and non-living matter. The web article of Robert L. Folk [62], who is one of the pioneers in the field besides Y. Morita [94] and E. O. Kajander [50], provides a brief summary about nano-bacteria and contains also references. A priori one cannot exclude the possibility that nano-bacteria might represent a predecessor of the triplet code, perhaps even singlet or doublet life-form or their symbiosis.

Basic facts about nanno-bacteria

Nanno-bacteria (often called also nanobacteria) are considerably smaller than ordinary bacteria. The sizes of the nanno-bacteria vary from about 20 nm to .2 micro-meters. Thus the smallest nanno-bacteria have size scale not much above $L(151)$ so that optical microscope does not allow to study them. Indeed, geologists discovered nanno-bacteria by using scanning electron microscope.

Nanno-bacteria can originate a precipitation in calcite and argonite crystals by providing the seed of the crystal. Nanno-bacteria act also as catalysts by attracting cations to their negatively charged cell walls. They appear as dense clumps in various minerals and rocks such as limestones, dolomites, native sulphur crystals, and metallic sulfide minerals [62]. Nanno-bacteria produce complex silicates such as clays, where their sizes can be as small as 30 nanometers. They are involved even with the construction of birds' eggs! Nanno-bacteria of size about .1 micro-meters were found in the Martian meteorite ALH84001 [57], and there is evidence that carbonaceous chondrite meteorite Allende [62] contains them. According to Folk, the nanno-bacteria might be the biological counterpart of the dark matter perhaps dominating over the ordinary bio-matter in the entire universe. An interesting question is how deep in the rock nanno-bacteria based life forms can survive. The hypothesis about intra-terrestrial life suggests that there is no limit here!

Although nanno-bacteria have been demonstrated to replicate [62], the prevailing belief has been that nanno-bacteria cannot be real life forms since by their small size they cannot contain the usual genetic apparatus. A Finnish biologist Kajander and his collaborators have done a lot of self-funded pioneering work in the study of the nanno-bacteria [50]. It has not been demonstrated that nanno-bacteria possess DNA-mRNA-amino-acid translation machinery, the existence of which is often taken almost as a definition for what it is to be a living system (a size larger than .2 micro-meters has been the second prevailing definition of a living system!). This failure could be understood if nanno-bacteria contain only replicating DNA or if only the RNA-to-RNA translation machinery exists possibly accompanied by RNA-DNA transcriptase transforming the code to DNA-RNA code. Due to the hard cell wall of nanno-bacteria, the study of DNA/RNA is very difficult but according to the Kajander's private communication to Folk [62], the nanno-bacterial DNA exists and consists of very short strands.

Nanno-bacteria as RNA life?

Nanno-bacteria could correspond to some predecessor of the recent genetic code. One can consider several options.

1. Nanno-bacteria represent an RNA life form involving two kinds of RNA sequences and closed inside RNA_1 membrane. This does not require DNA.
2. If the claim of Kajander about nanno-bacterial DNA is correct, then two options remain.
 - i) Nanno-bacteria are able to just replicate DNA and do not possess genetic code. Thus nanno-bacteria would be at a higher level than viruses.
 - ii) RNA-DNA reverse transcription is utilized so that nanno-bacteria could realize DNA-RNA code and would probably be at a higher developmental level than RNA life-forms but had not yet realized DNA-amino-acid code. The objection against this is that the reverse transcriptase enzyme probably requires RNA-aminoacid translational machinery.

One can ask what what RNA life-forms (option 1) would look if they still exist.

1. Singlet RNA would express itself as RNA sequences containing only U (or C) and A (or G) nucleotides. The tRNAs used by these life-forms should appear as fossil remnants in the ordinary tRNA.
2. In the case of a singlet life-form the layer could correspond to the length scale $L(2, 73) = L(146)$ and be formed by doublet atomic layer corresponding to the twin pair of p-adic length scales formed by $L(16, 9) = L(144)$ and $L(2, 73) = L(146)$.
3. In the case of doublet life-forms the length scale $L(2, 29) = L(145)$ and the tertiary p-adic length scale $L(3, 7^2) = L(147)$ form a twin pair and could define a double-layered structure. The reported hard cell wall could correspond to this double layered structure. A cell wall consisting of minerals (also nanno-bacteria induce also the precipitation of mineral crystals)

might however be most appropriate for life-forms living in the pores of rock, and possibly utilizing tectonic energy in some form to satisfy their metabolic needs.

The generation of the triplet code would have been accompanied by the generation of double lipid layers and possibly a transition to water environment. The most natural location for the primitive RNA-RNA translation machinery is at the inner surface of a lipid membrane if present inside nanno-bacteria.

The singlet or doublet RNA life-forms and their fusions could correspond to what I have christened plasmoids. Intelligent looking plasma balls occur repeatedly in UFO reports and they are also reported to occur around crop formations. There is even a report about a plasma ball in the act of constructing the crop formation. The plasmoid like life forms serving as couriers of ITs could be also seen as multicellulars consisting of nanno-bacterial cells or, more probably, of their predecessors. The immune response against nanno-bacteria and their predecessors generated during very early evolution would make possible encounters with crops and even humans (abduction experiences) without fatal consequences. The reported immune response against exotic doublet RNA suggests that plasmoids contain exotic doublet RNA. The visible light from plasmoids suggests that the metabolism indeed involves also the hot $k = 131$ space-time sheet so that ITs or IPs might be in question.

Was the encounter of nanno-bacteria and plasmoids the moment of Gaian fertilization?

Earth consists mostly of ancient meteorites known as chondrites. Carbonaceous chondrites are shown to contain not only basic bio-monomers but even nanno-bacteria. The meteoritic material can end up to the interior of Earth along magnetic flux tubes even today. Recall that this mechanism actually explains the magnetized iron from meteors found in crop circles [23]).

Thus IT life might have developed nanno-bacteria contained by meteorites in the womb of Mother Gaia. The bio-molecules/nanno-bacteria contained by the meteorites from outer space would thus take the role of the sperm as in panspermia theory.

There is a temptation to develop the fertilization metaphor to a more concrete level in order to understand what happened when the symbiosis of pre-nucleus containing DNA and and pre-cell containing RNA was established and led to the development of the genetic code and established a genuine evolution.

1. The simple nanno-bacteria in the meteorites having only replicating DNA or perhaps only the ability to produce DNA nucleotides would have been the sperm. Cell nucleus is much smaller than cell and might itself be regarded as having originated from ancient nanno-bacteria. The much more complex pre-cells containing RNA, amino-acids, and reverse transcriptase as well as the potentiality for the realization of the genetic code plus the needed metabolic machinery, were located in the interior of Earth and played the role of the egg. Since the hot $k = 131$ space-time sheets essential for the metabolic machinery were also involved, primitive plasmoid is an excellent candidate for the egg.
2. The encounter of nanno-bacteria and plasmoids led to the fertilization of Mother Gaia. What is fascinating that balls of light reported to appear near the crop circles and reported to even fabricate them might be there in order to get fertilized by nanno-bacteria contained by meteors! Alternatively, the simultaneous appearance of pre-biotic egg and sperm might be interpreted as a symbolic hint about what happened in the key event of the pre-biotic evolution.

3.6 Did life evolve in the womb of Mother Gaia?

The idea that Earth interior, even the hot regions at the boundary of core and mantle, could serve as a seat for life, sounds totally outlandish in the standard physics framework. The many-sheeted space-time and hierarchy of Planck constants however allow to consider at least half seriously this idea although I hasten to admit that during these years I have very often had the feeling that this is one of those painfully stubborn fix ideas that like to tease imaginative theoretician. This idea has variants characterized by a varying degree of craziness. It is a fact that rocks contain simple life forms down to surprising depths. A crazier idea is that underground lakes could have served as seats for evolving life. The really crazy variant of the idea is that the boundary between mantle and Earth's core as a

regions containing strong gradients has been a seat of self organization leading to the emergence of life in some form.

Recently however completely unexpected support for this idea came as I learned that the geological evolution of Earth involves an anomaly. The continents would fit nicely to form a single super continent (Wegener's theory does not predict complete fit) if the radius of Earth would have been at the time of Cambrian explosion by factor of 1/2 smaller than now. The fact that Cambrian explosion is one of the biggies mysteries of biology puts bells ringing. For long time ago this anomaly has inspired what have been called Expanding Earth Theory but the physical mechanism giving rise to expansion has been lacking.

Quantum TGD provides this mechanism. TGD predicts that cosmic expansion does not take place smoothly but via quantum jumps induced by the growth of the Planck constant by a factor of 2 for space-time sheet considered. This holds true also in planetary scales and TGD variant of Expanding Earth theory predicts relatively fast expansion of Earth's radius with a factor 2. The sudden appearance of completely new life forms in Cambrian explosion could be understood as a burst of various multicellular life forms which have developed in the womb of Mother Gaia sheltered from UV light and meteoric bombardment. What remains open is how deep in Earth's interior life is possible. This of course depends also on the definition of life: probably biological life would not be possible at core mantle boundary but one can consider much more general forms of molecular life.

In the following I will proceed in stepwise manner from not totally crazy (I hope so) to really crazy and discuss first the quantum version of Expanding Earth theory and its possible connection with Cambrian explosion and only after consider the really crazy possibilities.

3.6.1 Quantum version of Expanding Earth theory and Cambrian explosion

TGD predicts that cosmic expansion at the level of individual astrophysical systems does not take place continuously as in classical gravitation but through discrete quantum phase transitions increasing gravitational Planck constant and thus various quantum length and time scales. The reason would be that stationary quantum states for dark matter in astrophysical length scales cannot expand. One would have the analog of atomic physics in cosmic scales. Increases of \hbar by a power of two are favored in these transitions but also other scalings are possible.

This has quite far reaching implications.

1. These periods have a highly unique description in terms of a critical cosmology for the expanding space-time sheet. The expansion is accelerating. The accelerating cosmic expansion can be assigned to this kind of phase transition in some length scale (TGD Universe is fractal). There is no need to introduce cosmological constant and dark energy would be actually dark matter.
2. The recently observed void which has same size of about 10^8 light years as large voids having galaxies near their boundaries but having an age which is much higher than that of the large voids, would represent one example of jerk-wise expansion.
3. This picture applies also to solar system and planets might be perhaps seen as having once been parts of a more or less connected system, the primordial Sun. The Bohr orbits for inner and outer planets correspond to gravitational Planck constant which is 5 times larger for outer planets. This suggests that the space-time sheet of outer planets has suffered a phase transition increasing the size scale by a factor of 5. Earth can be regarded either as $n=1$ orbit for Planck constant associated with outer planets or $n=5$ orbit for inner planetary system. This might have something to do with the very special position of Earth in planetary system. One could even consider the possibility that both orbits are present as dark matter structures. The phase transition would also explain why $n=1$ and $n=2$ Bohr orbits are absent and one only $n=3,4$, and 5 are present.
4. Also planets should have experienced this kind of phase transitions increasing the radius: the increase by a factor two would be the simplest situation.

The obvious question - that I did not ask - is whether this kind of phase transition might have occurred for Earth and led from a completely granite covered Earth - Pangeia without seas - to the

recent Earth. Neither it did not occur to me to check whether there is any support for a rapid expansion of Earth during some period of its history.

Situation changed when my son visited me and told me about a Youtube video [68] by Neal Adams, an American comic book and commercial artist who has also produced animations for geologists. We looked the amazing video a couple of times and I looked it again yesterday. The video is very impressive artwork but in the lack of references skeptic probably cannot avoid the feeling that Neal Adams might use his highly developed animation skills to cheat you. I found also a polemic article [63] of Adams but again the references were lacking. Perhaps the reason of polemic tone was that the concrete animation models make the expanding Earth hypothesis very convincing but geologists refuse to consider seriously arguments by a layman without a formal academic background.

The claims of Adams

The basic claims of Adams were following.

1. The radius of Earth has increased during last 185 million years (dinosaurs [145] appeared for about 230 million years ago) by about factor 2. If this is assumed all continents have formed at that time a single super-continent, Pangeia, filling the entire Earth surface rather than only 1/4 of it since the total area would have grown by a factor of 4. The basic argument was that it is very difficult to imagine Earth with 1/4 of surface containing granite and 3/4 covered by basalt. If the initial situation was covering by mere granite -as would look natural- it is very difficult for a believer in thermodynamics to imagine how the granite would have gathered to a single connected continent.
2. Adams claims that Earth has grown by keeping its density constant, rather than expanded, so that the mass of Earth has grown linearly with radius. Gravitational acceleration would have thus doubled and could provide a partial explanation for the disappearance of dinosaurs: it is difficult to cope in evolving environment when you get slower all the time.
3. Most of the sea floor is very young and the areas covered by the youngest basalt are the largest ones. This Adams interprets this by saying that the expansion of Earth is accelerating. The alternative interpretation is that the flow rate of the magma slows down as it recedes from the ridge where it erupts. The upper bound of 185 million years for the age of sea floor requires that the expansion period - if it is already over - lasted about 185 million years after which the flow increasing the area of the sea floor transformed to a convective flow with subduction so that the area is not increasing anymore.
4. The fact that the continents fit together - not only at the Atlantic side - but also at the Pacific side gives strong support for the idea that the entire planet was once covered by the super-continent. After the emergence of subduction theory this evidence as been dismissed.
5. I am not sure whether Adams mentions the following objections [77]. Subduction only occurs on the other side of the subduction zone so that the other side should show evidence of being much older in the case that oceanic subduction zones are in question. This is definitely not the case. This is explained in plate tectonics as a change of the subduction direction. My explanation would be that by the symmetry of the situation both oceanic plates bend down so that this would represent new type of boundary not assumed in the tectonic plate theory.
6. As a master visualizer Adams notices that Africa and South-America do not actually fit together in absence of expansion unless one assumes that these continents have suffered a deformation. Continents are not easily deformable stuff. The assumption of expansion implies a perfect fit of *all* continents without deformation.

Knowing that the devil is in the details, I must admit that these arguments look rather convincing to me and what I learned from Wikipedia articles supports this picture.

The critic of Adams of the subduction mechanism

The prevailing tectonic plate theory [67] has been compared to the Copernican revolution in geology. The theory explains the young age of the seafloor in terms of the decomposition of the lithosphere to

tectonic plates and the convective flow of magma to which oceanic tectonic plates participate. The magma emerges from the crests of the mid ocean ridges representing a boundary of two plates and leads to the expansion of sea floor. The variations of the polarity of Earth's magnetic field coded in sea floor provide a strong support for the hypothesis that magma emerges from the crests.

The flow back to would take place at so called oceanic trenches [72] near continents which represent the deepest parts of ocean. This process is known as subduction. In subduction oceanic tectonic plate bends and penetrates below the continental tectonic plate, the material in the oceanic plate gets denser and sinks into the magma. In this manner the oceanic tectonic plate suffers a metamorphosis returning back to the magma: everything which comes from Earth's interior returns back. Subduction mechanism explains elegantly formation of mountains [70] (orogeny), earth quake zones, and associated zones of volcanic activity [66].

Adams is very polemic about the notion of subduction, in particular about the assumption that it generates steady convective cycle. The basic objections of Adams against subduction are following.

1. There are not enough subduction zones to allow a steady situation. According to Adams, the situation resembles that for a flow in a tube which becomes narrower. In a steady situation the flow should accelerate as it approaches subduction zones rather than slow down. Subduction zones should be surrounded by large areas of sea floor with constant age. Just the opposite is suggested by the fact that the youngest portion of sea-floor near the ridges is largest. The presence of zones at which both ocean plates bend down could improve the situation. Also jamming of the flow could occur so that the thickness of oceanic plate increases with the distance from the eruption ridge. Jamming could increase also the density of the oceanic plate and thus the effectiveness of subduction.
2. There is no clear evidence that subduction has occurred at other planets. The usual defense is that the presence of sea is essential for the subduction mechanism.
3. One can also wonder what is the mechanism that led to the formation of single super continent Pangeia covering 1/4 of Earth's surface. How probable the gathering of all separate continents to form single cluster is? The later events would suggest that just the opposite should have occurred from the beginning.

Expanding Earth theories are not new

After I had decided to check the claims of Adams, the first thing that I learned is that Expanding Earth theory [77], whose existence Adams actually mentions, is by no means new. There are actually many of them.

The general reason why these theories were rejected by the main stream community was the absence of a convincing physical mechanism of expansion or of growth in which the density of Earth remains constant.

1. 1888 Yarkovski postulated some sort of aether absorbed by Earth and transforming to chemical elements (TGD version of aether could be dark matter). 1909 Mantovani postulated thermal expansion but no growth of the Earth's mass.
2. Paul Dirac's idea about changing Planck constant led Pascual Jordan in 1964 to a modification of general relativity predicting slow expansion of planets. The recent measurement of the gravitational constant imply that the upper bound for the relative change of gravitational constant is 10 time too small to produce large enough rate of expansion. Also many other theories have been proposed but they are in general conflict with modern physics.
3. The most modern version of Expanding Earth theory is by Australian geologist Samuel W. Carey. He calculated that in Cambrian period (about 500 million years ago) all continents were stuck together and covered the entire Earth. Deep seas began to evolve then.

Summary of TGD based theory of Expanding Earth

TGD based model differs from the tectonic plate model but allows subduction which cannot imply considerable back-flow of magma. Let us sum up the basic assumptions and implications.

1. The expansion is or was due to a quantum phase transition increasing the value of gravitational Planck constant and forced by the cosmic expansion in the average sense.
2. Tectonic plates do not participate to the expansion and therefore new plate must be formed and the flow of magma from the crests of mid ocean ridges is needed. The decomposition of a single plate covering the entire planet to plates to create the mid ocean ridges is necessary for the generation of new tectonic plate. The decomposition into tectonic plates is thus prediction rather than assumption.
3. The expansion forced the decomposition of Pangeia super-continent covering entire Earth for about 530 million years ago to split into tectonic plates which began to recede as new non-expanding tectonic plate was generated at the ridges creating expanding sea floor. The initiation of the phase transition generated formation of deep seas.
4. The eruption of plasma from the crests of ocean ridges generated oceanic tectonic plates which did not participate to the expansion by density reduction but by growing in size. This led to a reduction of density in the interior of the Earth roughly by a factor $1/8$. From the upper bound for the age of the seafloor one can conclude that the period lasted for about 185 million years after which it transformed to convective flow in which the material returned back to the Earth interior. Subduction at continent-ocean floor boundaries and downwards double bending of tectonic plates at the boundaries between two ocean floors were the mechanisms. Thus tectonic plate theory would be more or less the correct description for the recent situation.
5. One can consider the possibility that the subducted tectonic plate does not transform to magma but is fused to the tectonic layer below continent so that it grows to an iceberg like structure. This need not lead to a loss of the successful predictions of plate tectonics explaining the generation of mountains, earthquake zones, zones of volcanic activity, etc...
6. From the video of Adams it becomes clear that the tectonic flow is East-West asymmetric in the sense that the western side is more irregular at large distances from the ocean ridge at the western side. If the magma rotates with slightly lower velocity than the surface of Earth (like liquid in a rotating vessel), the erupting magma would rotate slightly slower than the tectonic plate and asymmetry would be generated.
7. If the planet has not experienced a phase transition increasing the value of Planck constant, there is no need for the decomposition to tectonic plates and one can understand why there is no clear evidence for tectonic plates and subduction in other planets. The conductive flow of magma could occur below this plate and remain invisible.

The biological implications might provide a possibility to test the hypothesis.

1. Great steps of progress in biological evolution are associated with catastrophic geological events generating new evolutionary pressures forcing new solutions to cope in the new situation. Cambrian explosion indeed occurred about 530 years ago (the book "Wonderful Life" of Stephen Gould [125] explains this revolution in detail) and led to the emergence of multicellular creatures, and generated huge number of new life forms living in seas. Later most of them suffered extinction: large number of phylae and groups emerged which are not present nowadays.

Thus Cambrian explosion is completely exceptional as compared to all other dramatic events in the evolution in the sense that it created something totally new rather than only making more complex something which already existed. Gould also emphasizes the failure to identify any great change in the environment as a fundamental puzzle of Cambrian explosion. Cambrian explosion is also regarded in many quantum theories of consciousness (including TGD) as a revolution in the evolution of consciousness: for instance, micro-tubuli emerged at this time. The periods of expansion might be necessary for the emergence of multicellular life forms on planets and the fact that they unavoidably occur sooner or later suggests that also life develops unavoidably.

2. TGD predicts a decrease of the surface gravity by a factor $1/4$ during this period. The reduction of the surface gravity would have naturally led to the emergence of dinosaurs 230 million years

ago as a response coming 45 million years after the accelerated expansion ceased. Other reasons led then to the decline and eventual catastrophic disappearance of the dinosaurs. The reduction of gravity might have had some gradually increasing effects on the shape of organisms also at microscopic level and manifest itself in the evolution of genome during expansion period.

3. A possibly testable prediction following from angular momentum conservation ($\omega R^2 = \text{constant}$) is that the duration of day has increased gradually and was four times shorter during the Cambrian era. For instance, genetically coded bio-clocks of simple organisms during the expansion period could have followed the increase of the length of day with certain lag or failed to follow it completely. The simplest known circadian clock is that of the prokaryotic cyanobacteria. Recent research has demonstrated that the circadian clock of *Synechococcus elongatus* can be reconstituted in vitro with just the three proteins of their central oscillator. This clock has been shown to sustain a 22 hour rhythm over several days upon the addition of *ATP*: the rhythm is indeed faster than the circadian rhythm. For humans the average innate circadian rhythm is however 24 hours 11 minutes and thus conforms with the fact that human genome has evolved much later than the expansion ceased.
4. Scientists have found a fossil of a sea scorpion with size of 2.5 meters [99], which has lived for about 10 million years for 400 million years ago in Germany. The gigantic size would conform nicely with the much smaller value of surface gravity at that time. The finding would conform nicely with the much smaller value of surface gravity at that time. Also the emergence of trees could be understood in terms of a gradual growth of the maximum plant size as the surface gravity was reduced. The fact that the oldest known tree fossil is 385 million years old [119] conforms with this picture.

Did intra-terrestrial life burst to the surface of Earth during Cambrian expansion?

Intra-terrestrial hypothesis is one of the craziest TGD inspired ideas about the evolution of life and it is quite possible that in its strongest form the hypothesis is unrealistic. One can however try to find what one obtains from the combination of the IT hypothesis with the idea of pre-Cambrian granite Earth. Could the harsh pre-Cambrian conditions have allowed only intra-terrestrial multicellular life? Could the Cambrian explosion correspond to the moment of birth for this life in the very concrete sense that the magma flow brought it into the day-light?

1. Gould emphasizes the mysterious fact that very many life forms of Cambrian explosion looked like final products of a long evolutionary process. Could the eruption of magma from the Earth interior have induced a burst of intra-terrestrial life forms to the Earth's surface? This might make sense: the life forms living at the bottom of sea do not need direct solar light so that they could have had intra-terrestrial origin. It is quite possible that Earth's mantle contained low temperature water pockets, where the complex life forms might have evolved in an environment shielded from meteoric bombardment and UV radiation.
2. Sea water is salty. It is often claimed that the average salt concentration inside cell is that of the primordial sea: I do not know whether this claim can be really justified. If the claim is true, the cellular salt concentration should reflect the salt concentration of the water inside the pockets. The water inside water pockets could have been salty due to the diffusion of the salt from ground but need not have been same as that for the ocean water (higher than for cell interior and for obvious reasons). Indeed, the water in the underground reservoirs in arid regions such as Sahara is salty, which is the reason for why agriculture is absent in these regions. Note also that the cells of marine invertebrates are osmoconformers able to cope with the changing salinity of the environment so that the Cambrian revolutionaries could have survived the change in the salt concentration of environment.
3. What applies to Earth should apply also to other similar planets and Mars [58] is very similar to Earth. The radius is .533 times that for Earth so that after quantum leap doubling the radius and thus Schumann frequency scale (7.8 Hz would be the lowest Schumann frequency) would be essentially same as for Earth now. Mass is .131 times that for Earth so that surface gravity would be .532 of that for Earth now and would be reduced to .131 meaning quite big dinosaurs! have learned that Mars probably contains large water reservoirs in it's interior and that there

is an un-identified source of methane gas usually assigned with the presence of life. Could it be that Mother Mars is pregnant and just waiting for the great quantum leap when it starts to expand and gives rise to a birth of multicellular life forms. Or expressing freely how Bible describes the moment of birth: in the beginning there was only darkness and water and then God said Let the light come!

To sum up, TGD would provide only the long sought mechanism of expansion and a possible connection with the biological evolution. It would be indeed fascinating if Planck constant changing quantum phase transitions in planetary scale would have profoundly affected the biosphere.

3.6.2 Did pre-biotic life evolve in mantle-core boundary?

In the sequel this question is taken to mean simple prebiotic life forms preceding the life that possibly developed in underground seas near to the surface of Earth. One can imagine that pre-biotic life moved from high temperature environment in the Earth's interior to the underground seas and charged molecules polymerized in this process and generated gel like phase around them.

Some arguments supporting IT life

The following arguments favor IT hypothesis.

1. Life would have originated already in interstellar space via evolution of primitive metabolic cycles involving temporary chemical storage of metabolic energy. The decay of molecules would have been induced by incoming radiation in UV and visible range and fusion would have occurred spontaneously liberating energy quantum. As stars and planetary systems formed these primordial predecessors of life would have naturally ended into the planetary and even interiors and received their metabolic energy from the hot environment. The dropping of particles, in particular protons and electrons, to large space-time sheets would have provided fundamental metabolic energy quanta, and the anomalies lines in the IR, visible, and UV radiation from interstellar space indeed contains this kind of lines with energies which can be understood in terms of the spectrum of these quanta [31].
2. Boundary layers are ideal places for self-organization since they contain gradients which give rise to energy currents feeding self-organization. Liquid state is certainly crucial for life since this makes it possible quantum control the atomic space-time sheets very effectively. Ordinary life relies actually on the liquid crystal property of water which suggests that the same is the case quite generally. Thus those parts of the planetary core which correspond to boundary regions between solid and liquid phases and thus analogous to ordered water, could be ideal places for IT life forms to flourish, and it is actually difficult to imagine any other state of matter making possible life able to control the surrounding world effectively.
3. This picture is consistent with and would realize concretely the general vision about magnetosphere as a living system. In Earth's interior the mantle-core and core-inner core boundaries are especially interesting in this respect since these boundaries represent solid liquid boundaries.
4. Mg, Fe, Al, Si, and O are the dominant elements in mantle. Also Ca is present. These are the basic minerals involved with life. Also the minerals believed to be important for the evolution of polymer structures (like kaolinites consisting of Al, Si, and O) could form both at the hot space-time sheets and atomic space-time sheets. Below mantle-core boundary Fe and S are the prevailing elements. Fe-S centers play a key role in high temperature and pressure models for photosynthesis pathways [102]. The establishment of the photosynthesis has been proposed to occur first in a sulphur containing environment with S replacing O. Inner core contains mainly Fe at hot space-time sheets.
5. A further possibly important aspect is the transparency of the liquid glass state at mantle-core boundary implying that visible light propagates over long distances without absorption. This might be absolutely essential for the possibility of visible photons to propagate through sufficiently long distances. For dark photons situation changes, and the transparency of liquid glass might be due the fact that some fraction of photons propagate as dark photons through it.

Hence quartz is transparent in liquid state, and thus an optimal candidate for a medium whose behavior is quantum controlled from larger space-time sheets.

6. Magnetic body means the presence of both magnetic nervous system and the analog of blood circulation which could bring in sufficient amounts of elements needed for the synthesis of bio-polymers. The low concentrations of the elements needed to build up bio-monomers need not be a problem anymore since magnetic Mother Gaia could control them.

Structure of the Earth's interior and IT life

Combining the above described general ideas with the knowledge about Earth interior, one ends up with a more detailed picture.

1. Earth's interior decomposes into a relatively thin crust of thickness 30-60 km; a plastic mantle consisting mainly of Si, O, Mg, Fe, and Al mostly in form of silicates FeO-SiO_2 and MgO-SiO_2 ; a liquid core containing mainly Fe and S; and the inner core consisting mainly of solid Fe. There are thus two solid-liquid boundary regions. The upper boundary region could contain at least glass in liquid crystal form and the lower boundary region Fe in liquid crystal form.
2. Theoretically, the thickness for the mantle-core layer is expected to be of order few meters. The reflection of tectonic waves from mantle-core boundary has given evidence for a rich structure at this boundary and suggests that this expectation is not quite correct [40]. Structures of thickness about 150 meters and with of several kilometers and between liquid and solid state have been identified at the top of the liquid core. One explanation is that lighter elements in the core-inner core boundary saturate and condense to solid form and being lighter than iron, raise up and form kind of puddles at the highest points of core.

A more radical explanation is that these structures relate to a highly developed self-organization patterns which have given rise to some kind of life-forms. In the mantle-core layer the velocity of tectonic waves gets ultra-low. The velocity of sound in solid phase is quite generally higher than in liquid phase: this reflects directly the fact that the approximately harmonic forces between atoms are stronger. If liquid crystal phase is present the velocity in transversal liquid directions should be low. What is fascinating that sooner or later the analysis of reflected tectonic waves could give detailed information about mantle-core boundary.

3. Earth contains a previously unidentified core region with size of 300 km [39]. Assuming that the magnetic field behaves like a dipole field down to the distances of order 300 km, the electronic cyclotron frequency at this distance is 5 GHz which corresponds to the wave length of about 6 cm, the size scale of BOLs for the dark companion $B_{end} = 2B_E/5$ of B_E . If the magnetization density below this distance is constant (so that the core would be like ordinary magnet), the magnetic field would be constant below this length scale.

Also some other experimental findings support this picture. It has been found that the times for of the compressional waves to travel through Earth in magnetic north-south direction and equatorial direction differ by 2-3 seconds [41]. This suggests a gigantic crystal structure with symmetry axis parallel to magnetic field. If the join along boundaries condensate associated with atomic space-time sheets is hollow with a hole of radius 300 km, and if only $k = 151$ space-time sheet consisting of cold and magnetized iron is at this space-time sheet one can understand the crystal structure and how Earth's magnetic field results by magnetization. The estimated velocity of propagation for compressional waves in the crystal is about 3 km/s which is rather near to the 5 km/s for steel at room temperature. The appearance of a relatively small hole at the atomic space-time sheet is not so surprising since typically the field equations of TGD imply hole like singularities at given space-time sheet, and the hole could be analogous to black hole like singularity carrying inertial and gravitational masses at its boundary.

The simplest hypothesis is that the magnetic field associated with the plasmoids is the Earth's magnetic field in the core region of Earth. This would mean that some kind of plasmoid like life forms could reside also at the boundary layer associated with the new core. If the $k = 151$ space-time sheet is not ferromagnet above the radius $r = 300$ km, the boundary region could be in spin glass type magnetic phase and the bio-control from magnetic flux tubes would operate on the local direction of magnetization of the magnetized regions in the boundary region.

3.6.3 What conditions can one pose on life at mantle-core boundary?

In the following some conditions on life at high temperatures at pressures are discussed as a mere intellectual exercise certainly not to meant taken deadly seriously. The speculations rely on the ideas which should be already familiar such as presence of strong gradients driving self-organization as indeed found in mantle-core boundary, magnetic bodies as controllers of biological bodies, dark matter as phases with large value of Planck constant able to form macroscopic quantum phases even at high temperatures, and the notion of universal metabolic currencies. Gel-sol phase transitions are also key element in the model of life. The condition that topological quantum computation like information processing based on braids requires existence of some kind of polymers defining braids and consisting of some basic building blocks stable under the conditions in question. The presence of analogs of lipids and cell membranes might be argued to be also necessary.

Plasmoid life as minimum option

The least non-realistic assumption is that IT life corresponds to plasmoid like life forms having magnetic body containing dark matter with large Planck constant controlling visible matter at high temperatures and in plasma phase. Fractality suggests that the high frequency analog of EEG is present and allows magnetic body to use the visible body as a sensory receptor and motor instrument. Frequencies and the values of Planck constant should be such that the energies of dark photons are above thermal energy. General vision about evolution suggests that the values of Planck constant are not very high so that frequency scale should be rather high.

1. Only biologically important ions and relatively simple molecules are expected to be present. Primitive metabolic cycles based on the fusion and decay of molecules induced by the radiation coming from environment can be considered. Cyclotron Bose-Einstein condensates of ions at magnetic flux tubes correspond to energies above thermal threshold only if the magnetic field is strong enough.
2. At temperature of about 4000 K at mantle core interior hydrogen bonds are still stable and metabolic energy quantum of $E_0 = .5$ eV is near thermal energy. There exists of course other metabolic quanta comings as power of two multiples of this quantum. Hence one can assumes that the dropping of protons and possibly of electrons from larger space-time sheets is responsible for metabolic energy quanta also now. One might argue that the typical p-adic length scale associated with the space-time sheets corresponds to the de-Broglie wave length $\lambda_{dB} = \sqrt{3\hbar}/\sqrt{2mT}$ associated with electron. For electron this wavelength is around 35 slightly below $L(149) = 50$ A defining the thickness of the lipid layer of ordinary cell membrane. This scale increases with increasing \hbar .
3. Dark micro-waves amplified by quartz crystals might be crucial for the metabolism of plasmoid life-forms and replace visible light serving as the "food" of the terrestrial life forms. Tectonic activity might be as important for these life-forms as solar radiation is for us. The crust and mantle could serve as amplifiers of em waves is a wide wave length range and make possible communications between IT and us.

Could topological quantum computation like activities be considered?

Could even more advanced life forms have evolved in the environment provided by mantle-core boundary? The presence of magnetic body makes possible braidings and simple versions for the mechanisms of memory, of topological quantum computation like information processing, and of catalysis. The presence of braids could be taken almost as a basic prerequisite of life. The presence of polymers of some basic molecules seems necessary if one wants something resembling DNA as tqc.

1. The presence of polymers consisting of some thermally stable basic units is the basic requirement. Hydrocarbons, lipids, aminoacids, and nucleotide polymers are not chemically stable at temperatures considered and mantle contains carbon only in trace amounts. The dominating elements in mantle are O , Si , and Mg whereas C is present only in trace amounts. S is present in core and thus also in mantle-core boundary. P is so called siderophilic element meaning that it tends to avoid Si . It is theorized that during the formation of Earth from magma ocean

siderophilic elements including P separated from the mantle and went to core. In [62] ratio of concentrations of P in core and mantle was estimated to be $D(P) = 30$ but the article does not report the concentration of P on mantle. In [76] the phosphorus content of upper mantle is reported to be in the range 130-220 ppm which would give 3-7 percent in core. One can also imagine a formation of phosphate deposits in mantle core boundary: in absence of oxygen these kind of deposits are formed at sea floor. This kind of deposits might have formed at the top of the solid structures reported to exist at mantle core boundary [40]. These structures could themselves have formed as light elements from inner core has gradually diffused to the mantle core boundary and could include phosphate deposits. If so then mantle-core boundary could contain considerable amounts of P and the replacement C, N, O with Si, P, O or Si, P, S might make sense.

2. Water flow is not the only flow which could generate the self-organization patterns defining braidings as the analogs of tqc programs. Since O dominates in mantle water is however the first guess. It is known that lower mantle can contain water at least up to .2 weight per cent [74]. Water molecules are stable at the temperatures considered. The phase diagram of water [52] shows that water is in overcritical phase in the temperatures and pressures considered 4000 K and 1.4 million atm and at the bottom of the mantle.
3. The replacement of O with S might be considered in the mantle-core boundary since S is present in liquid core. Water would be replaced with hydrogen sulfide H_2S (responsible for the smell of rotten eggs!) if it appears in liquid form H_2S at temperatures and pressures considered. H_2S could be also used as food. H_2S is used by some bacteria living in deep ocean volcanic vents as a nutrient and also in our own gut: chemically this means that H_2S acts as electron donor in primitive photosynthesis like process to give ATP . That sulphur is essential for growth and physical functioning of plants might be due to the fact that it preceded oxygen based life [65]. For instance, Cys and met containing sulphur are very important amino-acids.
4. The polymers should contain atoms acting as plugs for flux tubes acceptors flux tubes ($O =$ or $S =$) and terminal points of flux tubes identifiable as donors of hydrogen bonds. $S-H$ shows only very weak tendency for hydrogen bonding so that Si, P, O option looks more promising and is of course especially natural if IT life forms are considered. For instance, silicic acids [69] satisfying the formula $[SiO_x(OH)_{4-2x}]_n$ are candidates for polymers containing both $O =:s$ and $OH:s$. The presence of PO_4 could have made possible the formation simple analogs of nucleotides and AMP, ADP, and ATP molecules. It might be possible to abstract nucleotides with a polymer consisting of four different simple molecules which are phosphorylated and attached to the backbone made of sugars.
5. One can continue the analogy with carbon life even further. The backbone could consist of the variants of riboses with carbon cycles replaced with Si cycles, the variants of aromatic rings with C and N replaced with P , and base pairing between $N-H$ and $O =$ replaced with $P-H$ and $O =$. In the case of amino-acids one can also consider the replacement of $C, N \rightarrow Si, P$. It is of course far from obvious that the possibly existing silicon analogs of organic polymers are stable enough against rapid burning to SiO_2 and water. One might hope that the higher mass of Si stabilizes them chemically at temperatures involved. Professional chemist could probably kill this kind of ideas without big effort.

Could one consider analogs of cell membrane and gel phase crucial for cellular life?

1. The first guess would be that gel like phase might have emerged only after these plasmoid like life-forms came in contact with water and induced the generation of structure water in presence of metabolic energy feed. On the other hand, it could well be that structured dater might form around charged polymers also at high temperatures and pressures as in the case of ordinary cell. Also silica (SiO_2) is known to form a gel. Also glass consists of SiO_2 : the transparency of glass to visible light might be also relevant. A group of algae polymerize silicic acid to so called biogenic silica used to construct their cell walls.
2. Lipids forming cell membrane would be replaced with structures consisting of hydrosilicons with the silicon analog of carbon residue as its hydrophilic head and silicon analog of the hydrophobic

fat forming the tail of the lipid. The formation of these double layers would be an outcome of self-organization. The analogs of phospholipids having PO_4 at their hydrophilic tail would be needed for tqc.

3. Super-conductivity plays an essential role in the TGD based model for cell membrane. Large enough values of Planck constant in principle allow to have super-conductivity at magnetic flux tubes.
4. The requirement that the energy $E = ZeV$ associated with Josephson junctions over the cell membrane like structure is above thermal energy requires very strong electric field over the membrane unless the membrane is thick. In the case of ordinary cell membrane the energy is rather near to thermal energy at room temperature. Now the energy would be roughly ten times higher and correspond to about .5 eV. Whether this kind of strong electric field is realizable is not clear. One might hope that the densities of ions could be high enough in the dense environment.

Do metabolism and photosynthesis possess signatures telling about intra-terrestrial evolution?

Also the intra-terrestrial metabolism should rely on atomic/molecular "Karma's cycles". Assume that the protons and electrons can be modeled as free particles in box. This assumption might not be correct as the model for ATP - ADP involving Coulomb binding energy of proton with negatively charge ATP molecule reducing the size of metabolic energy quantum already demonstrated. In this case the wavelength would be roughly by a factor 1/2 longer than predicted meaning Coulombic binding energy of order .25 eV.

In any case, with this assumption the quanta saturating to $E_{max}(k) = [.5, 1, 2, 4, 8, 16]$ eV and wavelengths $\lambda_{min} = [1240, 620, 310, 155]$ nm could have been important. The maximal quanta $E_0(k)$ correspond to the dropping from space-time sheet labeled by $k = 137 - \Delta k$ (in the case of proton) to a very large space-time sheet. The size of the space-time sheets would be given by $L(k) = r \times 2^{(k-151)/2} \times L(151)$, $L(151) = 10$ nm and $r = \hbar/\hbar_0$ the ratio of the Planck constant in question to its standard value. Actually and entire spectrum of quanta given by the formula $E_n = (1 - 2^{-n})E_0(k)$ saturating to $E_0(k)$ for large values of n . In [31] the presence of unidentified lines in the spectrum of UV, visible, and IR radiation from interstellar space has been shown to have a satisfactory explanation in terms of universal metabolic energy quanta.

The spectrum of diffuse interstellar medium exhibits three poorly understood structures [107]: Unidentified Infrared Bands (UIBs), Diffuse Interstellar Bands (DIBs) [100], and Extended Red Emission (ERE) [130] allowing an interpretation in terms of dropping of protons or electrons (or their Cooper pairs) to larger space-time sheets. The model also suggests the interpretation of bio-photons in terms of generalizes EREs.

1. Unidentified infrared bands (UIBs) contain strong bands at $\lambda = 3300, 6200, 11, 300$ nm. Th
2. There are diffuse interstellar bands (DIBs) at wavelengths 578.0 and 579.7 nanometers and also at 628.4, 661.4 and 443.0 nm. The 443.0 nm DIB is particularly broad at about 1.2 nm across - typical intrinsic stellar absorption features are 0.1 nm [107].
3. The Extended Red Emission (ERE) [107, 130] is a broad unstructured emission band with width about 80 nm and located between 540 and 900 nm. The large variety of peak wavelength of the band is its characteristic feature. In majority of cases the peak is observed in the range 650-750 nm but also the range 610-750 nm appears. This general vision can be compared with experimental facts.

The generalization ontogeny recapitulates phylogeny principle would suggest that the recent metabolism should have some features serving as telltale signatures of the IT past. The IT past could in turn reflect the primordial evolution in interstellar dust. The signatures of this period would be maxima of the action spectrum for wavelengths which correspond to both the universal metabolic energy quanta and transition energies for transitions of simple molecules present in the molecular dust. Visible and UV range are the most promising regions to consider.

1. There are two wave lengths of maximal effectiveness in the photosynthesis of plants and these correspond to what are called photo-system I and II (see p. 287 of [136]). Photo-system I is maximally activated at $\lambda = 680$ nm, corresponds to the chlorophyll a, and is not involved with the oxygen evolution. $k = 136$ corresponds to wavelength saturating to $\lambda_{min} = 620$ nm (1 eV). The model of *ATP-ADP* process suggests that Coulombic binding energy increases the wavelength.
2. Photo-system II is activated by shorter wave lengths and maximum effectiveness is between 500-600 nm. Photo-system II utilizes second type of chlorophyll (b, c or d) plus some accessory pigments. All photosynthetic cells producing oxygen possess both photo-systems whereas bacteria which do not produce oxygen have only the photo-system I. Hence at least the photo-system I might derive from a very early intra-terrestrial period. The spectrum of metabolic energy quanta for $k = 135$ corresponds to the wave length range [620,413,354,...,310] nm. Coulombic binding energy could increase the wavelength from the 413 nm for $k = 135$ and $n = 2$.
3. The action and absorption spectra of green alga *Ulva Taeniata*, see p. 284 of [136], have besides 680 nm maximum also a broad maximum in the range 400-500 nm peaked around 430 nm. The action spectrum has also a shoulder like structure around 600 nm. For $k = 135$ the first peak could correspond to $n = 1$ (620 nm) and second peak $n = 2$ (412 nm).
4. For some bacteria encountered in hot springs [133] the effective wave length range is in the near infrared range 700-1000 nm rather than in the range of visible frequencies dominating the sunlight. This looks strange since in general the evolution favors maximal metabolic economy. This leads to ask whether these bacteria might be kind of living fossils evolved in an intra-terrestrial environment. This range of wavelength corresponds in a reasonable approximation to that obtained by scaling the wave length range 400-500 nm in previous case and thus to $k = 136$.
5. DNA bases (A, G, T, C) strongly absorb UV light at around 260 nm. For $k = 16$ the nearest metabolic energy quanta correspond to $n = 2$ and $n = 3$ giving wavelengths 310 nm and 207 nm. For proton the p-adic length scale is below atomic size for $\hbar/\hbar_0 \geq 16$.

3.6.4 What about analogs of EEG?

It looks strange to mention EEG if one speaks about primordial life forms. These analogs of EEG have of course nothing to do with brains. The prediction is that the fractally scaled counterparts of EEG (in loose sense of course) provide the fundamental communication and control tool for the magnetic body. This analog of EEG is determined by the cyclotron energy spectrum nE_c of biologically important ions scaling like \hbar and by the characteristic energy $E_J = ZeV$ associated with Josephson junctions assignable to membrane like structures and having no dependence on \hbar . The energies nE_c and the differences $nE_c \pm E_J$ define the harmonics of bands and their satellites. Alpha band corresponds to E_c and beta and theta bands to differences in the case of ordinary EEG.

Conditions from the thermal stability of the analog of EEG

The analogs of EEG and its scaled up variants are in a fundamental role in the control of biological body by magnetic body and this should hold true also for ITs. According to the model of EEG resulting as a special case of the model for the fractal hierarchy of EEGs and its generalizations [20], the analog of EEG involves two components.

1. Cyclotron component

The first component corresponds to the harmonics of cyclotron frequencies of biologically important ions: many of them belong to the alpha band in the case of ordinary ions.

Since 10 Hz corresponds to a secondary p-adic time scale assignable to electron defining an inherent time scale of elementary particle in zero energy ontology, one can ask whether this frequency means breakdown of the fractality hypothesis and raises the frequency scale of ordinary EEG in special role. One can also wonder whether 10 Hz frequency could define a universal biorhythm.

Dark ions reside at magnetic flux sheets traversing DNA and cyclotron radiation affects directly DNA. Cyclotron frequencies are associated with motor control affecting directly DNA and inducing

gene expression among other things. The models leads naturally to the introduction of the notions of super genome and hyper genome [20].

2. Josephson junction component

Josephson junctions assumed to be associated with cell membrane define second contribution to EEG as frequencies associated with coherent state of photons emitted by Josephson current. This component is present only if Josephson junctions, naturally assignable with a membrane like structure separating the plasmoid from environment, are present.

The frequencies are expressible as $f_{n,\pm} = nf_c \pm f_J$ and in the case of ordinary EEG alpha band and its harmonics split into counterparts of beta and theta band. Alpha band has scaled variant also in more general case and corresponds to ions which define alpha band for ordinary ions.

1. The essential condition is that cyclotron energy scale is above the thermal energy $E_{th} = 2.88T$ ($k_B = 1$ in the units used) . This fixes the minimal value of the integer k_d characterizing the level of dark matter hierarchy involved. For ordinary EEG frequency of order 1 Hz the minimal value of k_d is roughly $k_d = 44$. DNA cyclotron frequencies assuming that the charge of DNA is solely due to the phosphate groups PO_4^{2-} are around 1 Hz and just above the thermal threshold.
2. Second condition is that Josephson energy determined by the membrane voltage defines Josephson energy which is above thermal energy. This gives $Q_{em}eV \geq 2.88T$ for far from vacuum extremals. For almost vacuum extremals the classical Z^0 field proportional to the classical em field contributes to the coupling and one must replace the charge Q_{em} of charge carrier with effect em charge Q_{eff} [20]: this increases the scale of Josephson energies roughly by a factor 10. For far from vacuum extremals Josephson energies are near thermal energies whereas for almost vacuum extremals they are in visible and UV region, and one can identify biophotons and EEG photons as decay products of dark Josephson photons.
3. Superconductivity prevails only below some critical temperature whereas vacuum extremal property is expected to be possible only above some critical temperature. This suggests that cell membrane functions properly only in a narrow temperature range. The range 36-37 C is suggested by the fact that the effects of ELF em fields on vertebrate brain are observed only in this range.

Josephson frequency f_J is inversely proportional to \hbar and would scale in the case of EEG would scale as

$$f_J = \frac{T}{T_{room}} \times f_{J,room} ,$$

where $f_{J,room} \simeq 5$ Hz holds true. Alpha band and its harmonics and also the widths of theta and beta bands would scale like B . The positions of theta and beta bands would scale like temperature, and one would have the formula

$$f_{n,\pm} = \frac{B}{B_E} nf_c \pm \frac{T}{T_{room}} f_J$$

for the frequencies in the generalized beta and theta bands, when $k_d = 44$ holds true also in the high- T environment.

It is illustrative to consider some examples.

1. Mantle-core boundary

The temperature is $T = 4000$ K $\sim 13T_{room}$ at the mantle-core boundary. This temperature allows simple ordinary molecules like carbon monoxide and water (due to the high pressure). Thermal energy is still eV and below Josephson energy and super-conductivity is possible only if cyclotron energies are high enough. For 5 Hz cyclotron frequency $r = 47$ gives energy of order eV. One could thus consider the possibility that both the super-conductivity and criticality could be possible in scaled up temperature range.

2. Sunspots

The average temperature of the solar photosphere is about 5800 K whereas the minimum temperature is $T_{min} = 4000$ K and same as the temperature at mantle-core boundary. Inside sunspots

the temperature varies in the range 3000-4800 K and sunspots, which are analogous to tornadoes, would be good candidates for the seats of solar life forms. Spectral analysis demonstrates the presence of water inside sunspots [37]. There is also evidence for a solid calcium ferrite surface at photosphere [34].

The value of the sunspot magnetic field is between 1600-2500 Gauss and thus cyclotron frequency is about 3200 – 5000 times higher than at the surface of Earth. Also in this case $k_d = 44$ level would correspond to thermally stable "EEG" photons with frequencies in the range of ordinary EEG.

What could the analog of EEG for IT look like?

In the following estimates for cyclotron frequencies are for the possibly existing dark companion $B_{end} = 2B_E/5$ of the Earth's magnetic field for which the effects of ELF fields on vertebrate brain provide a direct support.

If the sensory representations of IT life-forms are realized at the personal magnetic canvas and at magnetosphere in the same manner as ours, the cyclotron frequency of the representing ion at distance r_1 is must be same as the cyclotron frequency of the represented ion at distance r_0 . Assuming that magnetic field strength scales like $1/r^3$, this gives cyclotron transitions at the distance of about

$$r_1(A) = (A/A_1)^{1/3} \times r_0 ,$$

giving

$$y(A, A_1) = (A/A_1)^{1/3} \times x .$$

Here $r_0 = xR$ is the radius associated with the life-form, and $r_1 = yR$ is the distance at which the sensory representation is realized. R denotes the radius of Earth and A the mass of the ion at r_0 associated with IT cyclotron transition and A_1 the mass of the ion at r_1 defining the cyclotron transitions associated with the sensory representation.

If the most important frequencies of generalized EEG correspond to cyclotron frequencies, if pre-biotic live resides at the mantle-core and core-inner core boundaries, and if the magnetic field inside Earth behaves as dipole field in a reasonable approximation, one can deduce the EEG frequency range of aliens by scaling the human frequency range by the ratio

$$x^{-3} = \left(\frac{R}{r}\right)^3 = \left[\frac{f_S(r)}{f_S(R)}\right]^3 ,$$

where r is the distance of the boundary region from the center of the Earth. The constraint that representation is realized in inner magnetosphere gives the bound $y \leq 6$ and the constraint that it is realized in ionosphere gives $y \simeq 1$.

1. Biosphere

In this case the basic equation is obtained by putting $x = 1$ in the general equation so that one has

$$y = \left(\frac{A}{A_1}\right)^{1/3} .$$

For protonic representations with $A_1 = 1$ possible in entire inner magnetosphere the constraint $y \leq 6$ allows all possible values of A .

2. Mantle-core boundary

For mantle-core boundary the ratio is roughly $x^{-3} = 7.1$ so that the EEG frequency range 1.5 – 90 Hz scales up to 107 – 639 Hz. Sensory representations can in this case be realized as ionic transitions in atmosphere. The basic equation is

$$y = \left(\frac{A}{A_1}\right)^{1/3} x ,$$

where A is the mass number of the ion in mantle-core boundary and A_1 is the mass number of representative ion. For protonic representation one has

$$y = 1.92A^{1/3} .$$

The condition $y \leq 6$ guarantees that representation is realized in the inner magnetosphere and gives $A \leq 27$. This corresponds in ordinary EEG to frequencies $f \geq 11$ Hz. For $A_1 > 1$ also scaled up variants of alpha and theta frequencies are representable: note however that the densities of these ions are probably much smaller than in ionosphere.

One can consider also ionospheric ion representations satisfying $y \simeq 1$ for mantle-core boundary. Now the mass numbers of the ions involved are related by

$$\frac{A}{A_1} \simeq x^{-3} \simeq 7.1 .$$

The biologically most interesting ions have $A > 7$ and are representable. One manner to realize this sensory representation is using cells or brains of various organisms and one might consider the possibility that we actually are life-forms which have developed as magnetospheric sensory representations of the life-forms at the mantle-core boundary.

3. Core-inner core boundary

For core-inner core boundary the ratio is roughly $x^{-3} = 263$ for $f_S(r) = 50$ Hz and $x^{-3} = 135$ for $f_S(r) = 40$ Hz. In this case only electronic sensory representations are possible and one has

$$y = \left(\frac{Am_p}{m_e}\right)^{1/3} x ,$$

1. For $x^{-3} = 263$ this gives

$$y \simeq 1.98 \times A^{1/3} .$$

The range $[1, 6]$ for y corresponds to the inner magnetosphere and the upper bound $A \leq 27$ and to scaled up variants of cyclotron frequencies above 11 Hz in ordinary EEG. Only beta and gamma bands would be represented.

2. For $x^{-3} = 135$

$$y \simeq 2.48 \times A^{1/3}$$

The upper bound for A is $A \leq 14$ and to the scaled up variants of cyclotron frequencies above ~ 20 Hz in ordinary EEG.

4. Inner core-most inner core boundary

The boundary of the most inner core of radius 300 km could also be carrier of life-forms, perhaps plasmoid like life-forms. The simplest hypothesis is that the magnetic field associated with the plasmoids is the Earth's magnetic field in the core region of Earth, which would be constant and of order .2 Tesla below this distance if dipole approximation makes sense.

If important "EEG" frequencies correspond to cyclotron frequencies, part of the "EEG" would be scaled up by a factor $2^{169-157} = 2^{12} \simeq 4000$ so that EEG frequency range .25–90 Hz would be mapped to 1–360 kHz. Ionic cyclotron frequencies would be in the MHz range with proton cyclotron frequency equal to 1.2 MHz. The cavity resonance frequency analogous to the lowest Schumann frequency for a structure with radius 300 km is 159 Hz.

If the sensory representations of IT life-forms possibly existing at at $r_0 = 300$ kilometers are realized as electronic cyclotron transitions one has

$$y \simeq .59 \times A^{1/3} .$$

Ions with $A \geq 6$ would be represented above Earth's surface. All ionic representations would be realized in Earth's interior.

3.7 Comparison of McFadden's views with TGD

In his book *Quantum Evolution* [139] Johnjoe McFadden discusses the deep problems of molecular biology from quantum point of view and develops very interesting ideas about evolution and consciousness. Because of deep insights about what is not understood in biology, this discussion should provide new insights for any quantum consciousness theorist attempting to build a bridge between theory and biological reality. In the sequel McFadden's vision is compared with TGD view and some new ideas inspired by it in TGD framework are proposed.

3.7.1 General ideas

Before dwelling into concrete examples, it is good to compare McFadden's general starting points with those of TGD.

1. In accordance with most interpretations of quantum mechanics, McFadden assumes that the initial situation involved no de-coherence and that the biological evolution means basically the emergence of de-coherence, essentially the appearance of conscious observers performing quantum measurements.

In TGD framework the situation is just the opposite: evolution means the emergence of effective macro-temporal quantum coherence meaning that the duration of sharp mental images (sub-selves) increased. During the primordial stage typical lifetime of self was of order 10^4 Planck times and defined minimal de-coherence time. Dark matter hierarchy provides a hierarchy of Planck constants a concrete realization for a hierarchy of moments of consciousness with increasing geometric duration and quantum parallel dissipation which is second new element of TGD picture.

The number theoretic generalization of Shannon entropy having negative values for rational and even algebraic entanglement is a further mathematical concept. Quantum computers are basic examples of systems possessing positive number theoretic negentropy, and this certainly conforms with the genuine information content of multi-verse states. It is not clear whether Negentropy Maximization is really consistent with the Second Law of thermodynamics and one must keep mind open for the possibility that Second Law is illusion created by the neglect of dark matter hierarchy meaning at the same time neglect of living life forms.

2. McFadden does not fix his views about quantum measurement theory but assumes that de-coherence is an outcome of quantum measurements performed by environment or some subsystem of it. McFadden sees enzymatic action as a basic example of quantum measurement in which an amplification to a macroscopic phenomenon occurs.

In TGD framework one can imagine two basic elements.

- (a) The emergence of symbolic representations as names of molecules made possible lock and key mechanism and "molecular sex". Once it is possible to name molecules, it becomes possible to regard bio-chemical pathways as analogs of computer programs proceeding rather deterministically. As already found, this idea has very concrete implications for understanding of bio-catalysis.
 - (b) The most important bio-molecules could be seen as selves with especially long wake-up periods in a highly negentropic state of macro-temporal quantum coherence, and able to perform intentional actions applying the time mirror mechanism. The magnetic bodies of bio-structures are at the top of the intentional hierarchy.
3. McFadden sees quantum Zeno effect and its inverse as basic quantum control tools used by enzymes to increase reaction rates or induce mutations. Although the Zeno effect has also TGD counterpart, the intentional action of molecular magnetic bodies based on time mirror mechanism seems a more plausible option. Long ranged dark weak forces, in particular charge entanglement by W MEs, exotic ionization, and the control of the strength of the screening of the classical Z^0 force provides an additional mechanisms of enzyme control explaining chiral selection. Sol-gel transition inducing polymerization and its reverse allows to control the stability of bio-polymers. The leakage of particles between space-time sheets is a further control mechanism and involved with the time mirror mechanism.

4. McFadden assumes that the superpositions of peptide-environment product states involving different peptides with different neutron and proton numbers are possible so that the measurement involves also measurement of proton and neutron numbers. This option looks implausible because it is very difficult to think that states with different fermion numbers, masses, and charges would quantum superpose.

In fact, it has become clear quite recently that TGD could in well-defined sense allow also quantum superpositions of different DNA molecules. This kind of superpositions are routinely assumed for coherent states of Cooper pairs in super-conductivity although they break conservation of charge, fermion number, and energy. The point is that in zero energy ontology [24] the total quantum numbers of physical states always vanish and the states decompose into positive energy part such that negative energy part located in its geometry future. Therefore it is possible to have quantum superpositions which in positive energy ontology, which is excellent approximation, would look like quantum superpositions of different DNA molecules. This possibility is not discussed in this chapter but it is needless to say that it could mean a revolution in the understanding of living matter. Even thermodynamics could be interpreted in a completely new manner since thermodynamical states which are "superpositions" of states with different values of conserved charged could have genuine quantal counterparts.

McFadden's view about biochemistry

McFadden represents a very general view about the essentials of bio-chemistry.

1. Protons associated with hydrogen bonds and electronic Cooper pairs serve as basic tools of quantum bio-control.
2. The localization of proton induces what McFadden interprets as a quantum measurement of proton's position.

In TGD framework the mechanism of catalytic action based on the temporary dropping of proton from the H_N -atom associated with catalyst or reactant, replaces this mechanism. Catalytic action could be seen as a short lasting period of "group sex" between catalyst and reacting molecules. Liberation of standard metabolic energy quantum is automatically involved with the process.

Important problems of quantum biology

The following list provides examples of problems that McFadden wants to understand in terms of quantum physics.

1. The extreme effectiveness of enzyme action.
2. The mechanism of mutations, in particular that of adaptive mutations and multiple mutations.
3. Evolution.
 - i) The loss of complexity in computational models of evolution contra the increase of complexity in real evolution.
 - ii) The emergence of the first self replicators.
 - iii) The evolution of extremely complex reaction pathways, such as the one leading to the buildup of the *ATP* ase enzyme.

3.7.2 Enzyme action

Enzymes as quantum mouse traps is the metaphor introduced by McFadden. Typically enzyme catches the reactant molecules to a fixed conformation and fires a proton to the substrate molecule inducing in this manner a re-organization of some chemical bonds. The enzyme gains the lost proton later from a water molecule.

Mouse trap metaphor conforms completely with the TGD described view about catalytic action and also with the idea about enzyme as a quantum critical system.

1. *Production of lactic acid from pyruvate*

McFadden represents the production of the lactic acid from pyruvate, which is one of the last steps of catabolism, as a typical example of enzyme action. The process involves LDH, lactate dehydrogenase, catalyzing the transformation of the pyruvate to lactic acid, and NADH providing a proton and an electron pair. LDH donates the proton involved with the transformation of $C=O$ to $C-O-H$. NADH in turn provides proton and electron pair so that $C=O$ is replaced with $H-C-OH$. NAD^+ receives proton and a compensating electron pair from water and LDH_- receives a proton from a water molecule.

2. Catabolism of lactose

Second example used by McFadden relates to the catabolism of lactose induced by the enzyme beta galactase. The rate of the process is trillion times higher than one might expect. McFadden proposes that the process involves a localization of proton in certain amino-acid of the beta galactase to a particular hydrogen bond. If the localization occurs to a correct hydrogen bond, the proton is injected to the lactose molecule and induces hydration. The suggestion is that a repeated quantum measurement of proton's position in beta galactase keeps the proton in the correct position so that the decay occurs with a much higher rate than it would occur otherwise.

It is not necessary to repeat how the catalysis could be understood in TGD framework. The decay of the lactose involves hydrolysis in which lactose molecule receives water H_N-O-H molecule from the environment and the loss of proton destabilizes the negatively charged molecule.

Hydrolysis could involve local gel-sol type transition transforming ordered water to ordinary water, which is able to provide the needed water molecule. The gel-sol transition could closely correlate with the non-standard localization of the proton inside enzyme. The process could involve an intentional action of a magnetic body of some system involved and thus negative energy topological light rays and charge entanglement by W MEs.

3.7.3 Quantum evolution

McFadden considers evolution from a quantum point of view. After the criticism of the RNA world paradigm McFadden poses several questions. How complexity could have emerged during the evolution? What was the first self-replicator? How the complex metabolic pathways could have evolved? What might be the quantum mechanisms of adapted and multiple mutations?

How evolution can create complexity?

McFadden pays attention to the fact that in the computational models of evolution final states tend to be less complex than the initial ones. This can be seen as a consequence of dissipation which leads to asymptotic self-organization patterns which are very simple. This is just the opposite of what is observed in Nature (note however the fact that the rapid extinction of new species after Cambrian explosion might be interpreted in terms of a loss of complexity).

In TGD framework the ability of living systems to circumvent the loss of complexity is due the facts that TGD Universe is quantum critical and p-adic cognition implies p-adic evolution predicting the emergence of systems characterized by increasing values of the p-adic prime and the integer characterizing the levels of dark matter hierarchy serving as their "intelligence quotients".

At the molecular level TGD allows to resolve this puzzle elegantly. During the pre-biotic exotic RNA period the predecessor of the genetic code is realized as many-to-one replication of exotic RNAs meaning a loss of information. This occurred for both singlet and doublet exotic RNA and for their composite forming a double helix with the size of the singlet helix being scaled up by a factor two. This however led to a dead alley involving only the RNAs representing the maximal invariant set of the $RNA \rightarrow RNA$ mapping as an asymptotic state. Final state was indeed simpler than the initial state.

At some stage the product code transformed to a code coding for RNA triplets, and amino-acids which originally catalyzed the mapping of RNA to RNA, took the role of the coded molecules. RNAs were mapped to DNAs by reverse transcriptase and the high error rate of the reverse transcription implied a rapid mutational rate. The many-to-one character of $RNA \rightarrow RNA$ replication implying the dead alley thus transformed from a curse to a blessing since it represented implicitly the protein-DNA genetic code.

Criticism of RNA world

McFadden represents severe critics against RNA world paradigm which is the dominating vision about pre-biotic evolution [106]. The basic objections are following.

1. In water environment bio-polymers become un-stable against depolymerization by hydration. This makes the idea of primordial sea implausible. The presence of the ordered water could resolve this problem even in the standard physics based models. In many-sheeted space-time the hypothesis that pre-biotic evolution occurred intra-terrestrially in the womb of the magnetic Mother Gaia makes sense and could resolve basic objections against the notion primordial sea.
2. Enzymatic action requires chiral selection. In TGD framework this can be interpreted as a strong indication for the necessity of the classical long ranged weak forces in the enzymatic control (say charge entanglement by W MEs).
3. McFadden lists several reasons for why RNA is implausible as a pre-biotic chemical. RNA consists of three components: RNA base, ribose, and phosphate. RNA bases and phosphate have been generated in the experiments trying to simulate pre-biotic evolution but the spontaneous emergence of ribose looks implausible. The problem is that a plethora of other sugars are produced.

Some property of ribose should distinguish it from the other sugars. In TGD framework one might argue that for the ribose self "wake-up" periods or even periods of macro-temporal quantum coherence meaning sharp and non-entropic mental images are longer than for the other sugars. Quite generally, important bio-molecules could be identified as maximally autonomous systems able to "stay awake" and realize intentions.

A more concrete explanation is based on stability.

- i) Both RNA, DNA and aminoacids are negatively charged and thus inherently unstable. The assignment of "names" to generalized hydrogen bonds represented by quark and antiquark at the ends of the magnetic flux tube to the basic building bricks of these polymers could make them stable and lead automatically to highly selective catalytic actions.
 - ii) Suppose that the OH groups associated with the sugars have tendency to form a hydrogen bond with water molecules leading to ionization of the water molecule and liberation of proton dropping to a larger space-time sheet so that the polymer generates negative charge. If the number of O-H groups is too large the resulting negative charge can destabilize polymers formed by ribose, phosphate, and RNA nucleotides. Note that also the formation of double strand liberates one proton per hydrogen bond which has a further de-stabilizing effect. This could explain why RNA with 4 O-H groups forms only short double strands whereas DNA having only 3 O-H groups forms very long double strands.
4. One can also wonder why just phosphate, ribose and RNA bases find each other and why the large number of other combinations are not realized. The naming based on flux tubes would restrict dramatically the possible combinations able to form spatially and temporally coherent systems bound together by flux tubes and automatically lead to a final state in which molecules having no braids with environment disappear from the system. Phosphate, ribose and RNA base could also find each other by tuning to common wave length by sending negative energy MEs entangling them with each other.
 5. The presence of RNA bases, phosphate and ribose is not enough. McFadden finds it difficult to understand why only RNA molecules amongst many other reaction products of its three basic components are selected. In laboratory the activation of the RNA base allows to select RNA as a dominant reaction product. One possibility is that the liberation of activation energy helps to overcome the potential wall hindering the formation of RNA. This is could also due to the fact that the bound states of the activated RNA base with other two components are short-lived or decay to RNA in accordance with the idea RNA selves have especially long wake-up periods and is winner in the fight for survival. Magnetic body could be able to intentionally activate the RNA bases using universal metabolism present even without *ATP* ase machinery.

6. In the laboratory isolation, purification, and channeling of the reactants to the reaction volume are crucial parts of the process producing RNA and ribozymes, and almost-self-replicators. In the conventional chemistry framework it is very difficult to imagine how these processes could have occurred during pre-biotic evolution.

The notion of magnetic body might come in rescue. Magnetic flux quanta could make possible highly controlled reaction network. A possible concrete toy model goes as follows. Suppose that quantum-classical correspondence holds true in the sense that the shape of the magnetic flux tube containing charged particles reacts to the presence of the charged particles so that it can be regarded as a classical orbit of a charged particle in the average magnetic field inducing Lorentz force. This makes sense only if a given magnetic flux tube contains particles with a fixed charge-to-mass ratio, and means that magnetic body indeed isolates and purifies the reactants to the magnetic flux tubes and allows them to react at the nodes of the magnetic web.

Evolution of metabolism

McFadden describes basic aspects of catabolism in an enjoyable manner. Catabolism can be seen as a process in which electrons from the orbitals of complex bio-molecules (in particular glucose) are gradually transferred to the orbitals of oxygen atoms. This process releases energy used as a metabolic energy in the form of *ATP* molecules.

In the standard chemistry framework the mechanisms behind $ADP \rightarrow ATP$ transformation seem miracle like. It is not easy to understand how an evolution based on mere chance and necessity could have led to the recent form of this machinery: intermediate steps seem to be simply absent. For instance, according to McFadden the reaction pathways generating the *ATP* ase enzyme catalyzing the generation of *ATP* involves 13 steps and all these steps are necessary. The probability that this pathway could have been generated by a random change is infinitesimally small and comparable to that for a monkey playing with a typewriter to compose Shakespeare's sonnets by accident.

1. Universal metabolic currencies

In TGD framework the predicted universal metabolic currencies remove partially the veil of mysteries surrounding the evolution of metabolism.

The dropping of a proton from atomic space-time sheet to a larger one generates a universal metabolic energy quantum. Thus metabolism would have been present already before the chemical storage of the metabolic energy. At the pre-biotic period the generation of negative energy topological light rays with photon energy $\sim .5$ eV could have induced the dropping of protons and remote utilization of the liberated energy. Indeed, the model for intra-terrestrial life led to the hypothesis that the infrared radiation corresponding to a temperature of about 4000 K near the mantle-core boundary could have provided the energy quanta of about .4 eV driving protons back to the atomic space-time sheets. The evolution of photosynthesis led later to the chemical storage of the metabolic energy.

The mitochondrial battery is kept at the potential of .15 eV by the metabolic energy feed. This process involves oxidation process in which electrons from the orbitals of molecules like glucose end down to the orbitals of oxygen atoms. The electron pairs are provided by NADH molecules in mitochondrial metabolism occurring in the water filled space between mitochondrial membranes. The energy liberated in this manner drives protons from the interior of the mitochondria to the space between the membranes. NAD^+ ion then receives the compensating electronic Cooper pair from water later.

The molecular battery provides the energy to generate *ATP* molecules serving as universal energy currencies. Three protons leaking back along the channel inside *ATP* ase molecule, which is analogous to the wire connecting the plus and minus poles of a battery, gain a net energy of $3 \times .15 = .45$ eV. This energy they donate to a proton, which uses it to get back to the atomic space-time sheet of the *ATP* molecule.

2. Does metabolism generate cell level qualia?

In a philosophical mood one could wonder the purpose of the endless *ATP* Karma's cycle: why not just the primitive metabolism involving only .5 eV photons? A partial explanation is the possibility to store metabolic energy chemically so that system becomes less dependent on environment. A

connection with the TGD based model of sensory receptor as a quantum capacitor suggests a deeper interpretation. The dielectric breakdown of the quantum capacitor gives rise to qualia which correspond to the increments of the total quantum numbers at either electrode when the dielectric breakdown occurs. ATPase could be seen as generating local di-electrical breakdown inducing primitive protonic qualia as a side product.

3. *Molecular intentionality*

The basic challenge of the bio-chemistry based approach to evolution is to understand how simple reaction steps coherently integrate to long multi-step reaction pathways. The assumption of molecular intentionality simplifies dramatically this task. Indeed, the best manner to understand and plan a complex electronic instrument is to know its purpose. The manual provides explanation of the purpose and magnetic body serves as the manual of the bio-logical body. For instance, it is much easier to understand how the reaction pathway leading to *ATP* ase has developed if one knows that the function of this pathway is to liberate universal metabolic energy quanta from mitochondrial battery besides possibly producing protonic qualia.

The fact the number of steps is 13 suggests 13-adicity and it would be interesting to see whether various reaction pathways tend to have a prime number of steps. It deserves to be noticed that $k = 169 = 13^2$ defines the p-adic prime associated with the magnetic flux tubes of the Earth's magnetic field and its possible dark companion $B_{end} = 2B_E/5$, and that the micro-tubular surface defines naturally cognitive code with $k = 13^2$ bits consisting of 13 13-bit sequences defined by tubuline conformations for a full 2π twist around micro-tubule.

Biological evolution could be seen as being induced by the evolution of cognition and of intentional actions. By the properties of the p-adic topology it proceeds from long time and length scales to shorter ones (p-adically short corresponds to something long in the real sense since rational space-time points are common to real and p-adic sectors of the imbedding space). This would suggest that the evolution of bio-logical functions is induced by the evolution of the intentional actions of the magnetic bodies, which were initially like rough sketches and gradually became more and more refined. Also motor skills develop in the same manner.

4. *The emergence of molecular pathways*

The emergence of names attached to molecules makes possible generation of computer program like dynamics in which programs call corresponds to association of molecules with names conjugate to some name of catalyst molecule to clusters so that catalytic action leading to a particular final state becomes possible.

The names of molecules could dictate the dynamics to a high degree. Situation could be like in the human society: knowing that person carries the label "physics teacher" allows to make amazingly precise long term predictions about the daily behavior of the person whereas the knowledge of all imaginable chemical and physical data about the person would not allow to predict anything interesting about the activities of the person in time scales longer than few seconds.

Quantum mechanism of mutations

McFadden suggests the reduction of the superposition of normal and enol configurations of T nucleotide to a tautomeric enol configuration as a quantum mechanism of mutation. The position measurement of the proton can locate it to the second nitrogenic hydrogen bond and thus transform T nucleotide to the isomeric but short-lived enol configuration having only two hydrogen bonds connecting it to the complementary base. In the enol state DNA replication assigns G instead of A with T.

Zeno effect could allow to effectively freeze T to this configuration and thus increase the rate of mutations. The same mechanism could work also at the level DNA \rightarrow mRNA transcription and protein translation and assign lys instead of glu to the enol configuration.

The mechanism poses an additional condition to the proposal that DNA nucleotides correspond to quarks and antiquarks. The question is what determines which quark or antiquark corresponds to a given nucleotide and the mechanism of mutation based on disappearance of hydrogen bond suggests that the number of hydrogen bonds (2 or 3) determines this so that one would have correlation with with the weak isospin of quark (u or d) and number of hydrogen bonds (3 or 2).

1. *Adaptive mutations of E. coli*

In adaptive mutations the bacterium *E. coli* unable to catabolize lactose to get metabolic energy develops a mutation allowing it to generate beta galactose inducing the decay of the lactose. This mutation occurs with a probability which is higher than predicted by randomness. McFadden poses the question how the information about the presence of the lactose is communicated from the environment to the DNA level.

If life would be mere quantum chemistry, the only possibility would be that the information transfer sequence DNA→mRNA→ proteins of Central Dogma is somehow reversed. What McFadden suggests is DNA-mRNA-beta galactose-lactose entanglement such that DNA appears as a superposition of ordinary and enol configurations. Lactose would take the role of quantum measurer of the proton's position inside T nucleotide, and Zeno effect would increase the rate of the mutation.

In TGD Universe the bacterial magnetic body receives information about the presence of lactose and its intention to "eat" lactose is transformed to a desire represented by a negative energy ME entangling directly with DNA. The intention of the magnetic body of *E. coli* would be to push the DNA to enol configuration by kicking the proton to the abnormal position. Negative W ME could induce long lasting entanglement with normal and enol configurations of T nucleotide so that the enol configuration would appear with a higher probability than in the absence of quantum entanglement and mutated DNA results more often in the replication. The alternative option is that magnetic body induces the gel-sol transition inducing mutation in the manner already described.

Quite generally, feeding of dark protons to atomic space-time sheets and gel-sol transition would serve as switches used by the cellular magnetic body to realize its desires. This mechanism could be seen as a refined form of remote metabolism providing metabolic energy for the starving bacterium.

2. Multiple mutations of *TB* bacteria

TB (tubercle bacillus) bacteria are able to develop a simultaneous resistance against several drugs [139]. This occurs for bacteria which have only brief growth periods followed by long dormant periods. McFadden interprets dormant periods in terms of entanglement with the environment. When this period ends even multiple mutations could result in the quantum measurement at DNA level.

In the TGD framework the magnetic body of TB population would receive information about the fates of various members of the population in the multi-drug environment and would have a strong desire to develop multi-drug resistance. The long dormant periods of bacteria allowing them to survive bring in mind the sleeping periods of higher life forms, and suggests the entanglement of the bacteria with the other members of the population, also those living in the geometric past and already deceased as victims of the drugs. This kind of entanglement would allow the magnetic body to manipulate the genomes of the still-living bacteria so that they have better changes to survive in the multi-drug environment. McFadden does not discuss whether the simple mechanism of mutations working in the case of *E. coli* might be enough in the case of TB bacteria.

Note that the notion of hyper-genome allows to understand bacterial colonies as systems analogous to multi-cellulars controlled by genes expressed collectively.

3. Mutations and intronic DNA

The TGD based view about pre-biotic evolution allows to imagine more effective mechanisms of mutations replacing the simple mechanism utilized by *E. coli* and working in case of eukaryotes.

In the TGD Universe reverse transcriptase plays a key role in the pre-biotic evolution as a generator of the genetic variation. The variation is due to the high error rate of the reverse transcription. For instance, the amazing ability of the HIV virus (retro-virus) to adapt is based on the reverse transcription of HIV RNA to DNA. It would be strange if this ability would have been lost during the sub-subsequent evolution. Perhaps fragments of DNA are transformed to mRNA also during dormant, "inwards directed" periods. mRNA fragments are however not translated to proteins now but transformed back to DNA fragments by reverse transcriptase replacing the previous DNA fragment in DNA with a new one. This mechanism might work at least in case of eukaryotes having cell nucleus and mean that mRNA is not transferred outside the nucleus. The replacement of DNA fragment need not occur immediately. mRNA fragments would thus act like retro-viruses to produce the needed genetic variation. In this framework ordinary retro-viruses such as HIV might be seen as kind of fallen angels.

This kind of activity in which collective selves of populations modify the genomes of their members might be present in all eukaryotes during sleeping (or more generally, dormant) periods. The generation of mutations might be one of the fundamental purposes of sleep and explain why sleep is so important for healing.

This mechanism of mutations might be still too primitive for eukaryotes. In TGD framework the intronic portion of DNA expresses itself as temporal field patterns using p-adic cognitive codes, in particular memetic code. Introns play the role of the computer software whereas genes take the role of the hardware. In this picture introns would be naturally involved with the control of the adaptive mutations of higher organisms. In the modern home computers hardware is becoming more and more dynamical, and computer metaphor suggest that the passive DNA could contain segments representing kind of computer store containing variants of various genes taken in use if required. Transposons might represent these new pieces of the hardware.

This replacement need not involve the removal of the old gene fragment and could be only functional. Computer metaphor inspires the idea that the intronic portion of DNA represents a given gene as a dynamical list of addresses, kind of links or program calls, specifying which portions of DNA contribute to the gene, and that this list characterizes how the splicing of mRNA occurs. Therefore the mutation could occur at the intronic software level as a mere updating of the list representing the gene.

The challenge is to understand how this addressing might be realized physically. For instance, addressing might involve simply common fragments of DNA in meme and corresponding portions of gene serving as addresses making possible a "tuning to a common wave length". Alternatively, magnetic flux tubes might serve as space-time correlates of the links. They could be generated intentionally as wormhole magnetic fields consisting of pairs of positive and negative energy magnetic flux tubes parallel to DNA strand. The generation of wormhole magnetic fields identified as the basic motor activity of the magnetic body could also explain the appearance and disappearance of EEG bands. By the p-adic fractality similar mechanism could be at work also in DNA length scale.

4. *Could zero energy ontology be relevant for living matter?*

Zero energy ontology [24, 20] emerged originally from the observation that Robertson-Walker cosmologies correspond in TGD framework to vacuum extremals for which all conserved classical charges vanish (the non-conserved gravitational mass density does not vanish). The construction of S-matrix led to a precise formulation of zero energy ontology.

Zero energy ontology states that physical states have vanishing net quantum numbers and consist of positive energy states at boundaries of future directed light-cones in the geometric past ("not so big bang") and negative energy states at the boundaries of past directed light cones in the geometric future ("not so big crunch") assignable to arguments of N-point function.

Due to the fact that conformal weights are complex it is possible to distinguish between positive energy particles propagating to the geometric future and negative energy particle propagating to geometric past. Phase conjugate laser photons contra ordinary laser photons represent basic empirical example about this distinction.

In the construction of S-matrix identified as unitary entanglement coefficients between these two kinds of states (this notion makes sense for hyper-finite factors of type II_1) these states represent incoming and outgoing states of particle reaction so that measurement of reaction rates is basically quantum measurement in which time-like entanglement is reduced instead of space-like entanglement [24].

A rather strong argument in favor of zero energy ontology comes from superconductivity [28]. The models super-conductivity utilize formally the notion of coherent state of Cooper pairs involving quantum superposition of arbitrary numbers of Cooper pairs. This is in conflict with various conservation laws in standard ontology but in zero ontology it is quite possible to consider quantum superposition of zero energy states with various values of quantum numbers for positive energy states.

This opens the gates for rather fascinating speculations. Time-like charge entanglement would allow to imagine a time-like variant of the capacitor model of sensory receptor. For instance, sensory qualia could result in the reduction of coherent state of Cooper pairs to a state with a well defined charge.

Also different DNA sequences with different masses and charges might appear in quantum superpositions for time like entanglement and this might be relevant for evolution of genetic code. In particular, the model of McFadden for mutations might generalize dramatically. As a matter fact, the proposed identification of S-matrix (or rather its generalization M-matrix which need not be unitary) as time-like entanglement coefficients assumes the presence of all pairs of initial and final states appearing in the S-matrix in the superposition so that this possibility could be seen as a prediction.

3.8 Great vision about biological evolution and evolution of brain

The following great vision about evolution and is not perhaps strictly about hierarchy of EEGs. The hierarchy of dark matter and EEGs however leads to this vision naturally. The first part of vision relates to biological evolution. Second part is about the evolution of brain. Here the key thread is evolution of two kinds of intelligences, the ordinary fast intelligence evolving via the emergence of fast computation type activities and emotional slow intelligence developing via the emergence of higher levels of dark matter hierarchy. The latter intelligence is what distinguishes us from animals.

3.8.1 Basic assumptions

The great vision about evolution and brain relies on two several new notions and ideas.

1. Life as something in the intersection of real and p-adic worlds making possible negentropic entanglement- both space-like and time-like. This makes possible to understand what conscious intelligence is and NMP reduces evolution to a generation of negentropic entanglement. DNA as topological quantum computer hypothesis [38] finds also a justification.
2. The notion of many-sheeted space-time implying a universal hierarchy of metabolic energy quanta, and the notion of magnetic body.
3. Communication and control based on Josephson radiation and cyclotron transitions crucial for understanding biophotons and EEG and its fractal generalization as a key element of bio-communications.
4. Zero energy ontology and the closely related notion of causal diamond (CD) assigning a hierarchy of macroscopic time scales to elementary particles coming as octaves of the basic time scale and justifying p-adic length scale hypothesis. Zero energy energy ontology also justifies the vision about memory and intentional action and the idea that motor action can be seen as time reversal of sensory perception.
5. The hierarchy of Planck constants and the identification of the fundamental evolutionary step as an increase of Planck constant. Evolutionary steps mean migration to the pages of the Big Book labeled by larger values of Planck constant and living system can be regarded as a collection of pages of the Big Book such that a transfer of matter and energy between the pages is taking place all the time. The change of the Planck constant implies either reduction or increase of the quantum scales-this leads to a model for biocatalysis and a model of cognitive representations as scaled down or scaled up "stories" mimicking the real time evolution.
6. A resonant like interaction between hierarchy of Planck constants and p-adic length scale hierarchy favoring the values of Planck constant proportional to powers of two, and idea that weak and color interactions are especially important in the length scales which correspond to Mersenne primes and Gaussian Mersennes. The simplest option is that weak bosons have their standard masses but appear as massless below their Compton length which scales up like \hbar and preferred p-adic length scales correspond to Mersenne primes. Also copies of weak bosons and gluons with ordinary value of Planck constant and reduced mass scale can (and will) be considered.

How to identify the preferred values of Planck constant?

The basic problem is to identify the preferred values of Planck constant and here one can only make theoretical experimentation and all what follows must be taken in this spirit. One can consider assumptions which become increasingly stronger.

1. If only singular coverings of CD and CP_2 are possible Planck constant is a product of integers. Algebraic simplicity of algebraic extensions of rationals favors ruler and compass integers (Appendix).
2. A resonant interaction between the dark length scales and p-adic length scales with ordinary value of Planck constant favors Planck constants coming as powers of two.

3. An even stronger assumption would be that p-adic length scales coming as Mersennes and Gaussian Mersennes are especially interesting.

- (a) If weak bosons can appear with the ordinary value of Planck constant only in the p-adic length scale $k = 89$, one obtains the condition

$$k_d = k - 89 \quad , \quad k \in \{89, 107, 113, 127, 151, 157, 163, 167\} \quad (3.8.1)$$

for the values of $r = 2^{k_d}$ allowing dark weak bosons in p-adic length scales assignable to Mersennes. These values of k_d assign to electrons and quarks dark p-adic length scales $L(k_{eff}) = \sqrt{r}L(k)$, $r \equiv \hbar/\hbar_0 = 2^{k_d}$. The scales could correspond to size scales of basic units of living systems.

- (b) If weak bosons and possibly also gluons with ordinary value of Planck constant are possible in all p-adic length scales $L(k)$, $k \in \{89, 107, 113, 127, 151, 157, 163, 167\}$, one obtains much richer structure. This hierarchy defines secondary dark matter hierarchies from the condition that the scaling the p-adic length scale $L(k_1)$ in this set by \sqrt{r} , $r \equiv \hbar/\hbar_0 = 2^{k_d}$, gives a p-adic length scale equal to another p-adic length scale $L(k_2)$ in this set. This requires $k_d + k_1 = k_2$ so that the values

$$k_d = k_2 - k_1 \quad (3.8.2)$$

are favored for the scaling of \hbar . In this case the hierarchy of dark scales assignable to quarks and leptons is much richer. The tables below demonstrate that electron appears as its dark variant for all Mersennes and also in atomic length scales $k = 137, 139$ so that this option puts electron in a completely unique position.

4. Also other scales are possible. For instance, $r = 2^{47}$ required by 5 Hz Josephson frequency gives dark weak scale which corresponds $k = 136$ as a p-adic scale. The stages of sleep can be understood in terms of scaling of \hbar by factor 2 and 4 so that also the atomic length scale $k = 137$ and the scale $k = 138$ are involved.

Since the experimental input is rather meager, one is forced to do theoretical experimentation with various hypothesis. The quantitative experimental tests are rather primitive but basically quantal.

1. The time scales assignable to CDs of leptons and quarks and their scaled up counterparts for the preferred values of Planck constant should define biologically important time scales. One might even speak about evolutionary level of electron. These time scales could define fundamental biorhythms and also time scales of long term memory and planned action.
2. Josephson frequencies and cyclotron frequencies scaling like $1/\hbar$ (if magnetic field scales down like $1/\hbar$) charactering biologically important ions and elementary particles. In accordance with the quantum criticality of living matter it is assumed that cell membrane corresponds to almost vacuum extremal so that classical Z^0 force is an essential element of the model. Also these frequencies should define fundamental bio-rhythms and characterize the evolutionary level of cell. Experimentally of special importance are the cyclotron frequencies assignable to Ca^{++} ions.
3. The amplitude windows for electric field scaling like \hbar for a particular cyclotron frequency define a basic prediction.

Tables about predicted time and length scales

The following tables summarize various predictions for time scales and length scales. They correspond to the most general assumption that exotic bosons with the ordinary value of Planck constant are possible in all length scales associated with Mersennes and Gaussian Mersennes.

k_d	p_1	p_2	k_d	p_1	p_2
4	163	167	38	89	127
6	107	113	38	113	151
6	151	157	40	127	167
6	157	163	44	107	151
10	157	167	44	113	157
12	151	163	50	107	157
14	113	127	50	113	163
16	151	167	54	113	167
18	89	107	56	107	163
20	107	127	60	107	167
24	89	113	62	89	151
24	127	151	68	89	157
30	127	157	74	89	163
36	127	163	78	89	167

Table 5. The integers k_d characterizing the preferred values of $r = \hbar/\hbar_0 = 2^{k_d}$ identified from the condition that the dark variant of p-adic length scale $L(p_1)$ corresponding to some ordinary p-adic length scale defined by Mersenne prime M_p or Gaussian Mersenne $M_{G,p}$, $p \in \{89, 107, 113, 127, 151, 157, 163, 167\}$ corresponds to similar p-adic length scale $L(p_2)$. If one assumes that weak bosons can appear with ordinary value of Planck constant only in the p-adic length scale $k = 89$, only the rows with $p_1 = 89$ of the table are possible: in these cases p_1 is in boldface and the row has double underline. The corresponding values of k_d are in the set $\{18, 24, 38, 62, 68, 74, 78\}$.

Note that the table above include only the dark length scales associated with $k = 89$ gauge bosons.

Z, W	d	u	e	k_d
89	120	124	127	0
93	124	127	131	4
95	126	129	133	6
99	130	133	137	10
101	132	135	139	12
103	134	137	141	14
105	136	139	143	16
107	138	141	145	18
109	140	143	147	20
113	144	147	151	24
119	150	153	157	30
125	156	159	163	36
127	158	161	165	38
129	160	163	167	40
133	164	167	171	44
139	170	173	177	50
143	174	177	181	54
145	176	179	183	56
149	180	183	187	60
151	182	185	189	62
157	188	191	195	68
163	194	197	201	74
167	198	201	205	78

Table 6. The dark p-adic length scales $\sqrt{r}L(k) = L(k_{eff})$, $k_{eff} = k + k_d$, of intermediate gauge bosons Z, W , d and u quarks, and electron for the values $r = 2^{k_d}$ of Planck constant defined in Table

5. The uppermost row gives the integers characterizing the p-adic length scales of the particles for the standard value of Planck constant. k_{eff} characterizes also the CD times scale through the formula $T(CD, k_{eff}) = 2^{k_{eff}-127} \times .1$ seconds. The rows which correspond to the less general option for which only M_{89} corresponds to weak bosons with ordinary value of Planck constants have double underline and the corresponding values of k_d are in boldface.

k_1	k_M	k_1	k_M	k_1	k_M	k_1	k_M
113	89	113	107	163	127	163	157
127	89	119	107	167	127	169	157
151	89	123	107	133	127	173	157
157	89	113	107	139	127	163	157
163	89	117	107	143	127	167	157
167	89	111	107	133	127	161	157
95	89	175	113	137	127	169	163
109	89	181	113	131	127	183	163
133	89	187	113	225	151	207	163
139	89	191	113	229	151	213	163
145	89	119	113	157	151	219	163
149	89	133	113	171	151	223	163
103	89	157	113	195	151	177	163
127	89	163	113	201	151	201	163
133	89	169	113	207	151	207	163
139	89	173	113	211	151	213	163
143	89	127	113	165	151	217	163
113	89	151	113	189	151	187	163
119	89	157	113	195	151	193	163
125	89	163	113	201	151	199	163
129	89	167	113	205	151	203	163
95	89	137	113	175	151	169	163
101	89	143	113	181	151	175	163
105	89	149	113	187	151	179	163
95	89	153	113	191	151	169	163
99	89	119	113	157	151	173	163
93	89	125	113	163	151	167	163
145	107	129	113	167	151	187	167
169	107	119	113	157	151	211	167
175	107	123	113	161	151	217	167
181	107	117	113	155	151	223	167
185	107	195	127	235	157	227	167
113	107	201	127	163	157	181	167
127	107	205	127	177	157	205	167
151	107	133	127	201	157	211	167
157	107	147	127	207	157	217	167
163	107	171	127	213	157	221	167
167	107	177	127	217	157	191	167
121	107	183	127	171	157	197	167
145	107	187	127	195	157	203	167
151	107	141	127	201	157	207	167
157	107	165	127	207	157	173	167
161	107	171	127	211	157	179	167
131	107	177	127	181	157	183	167
137	107	181	127	187	157	173	167
143	107	151	127	193	157	177	167
147	107	157	127	197	157	171	167

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Table 9. The table gives all weak boson length scales -both non-dark and dark implied by the assumption that all Mersennes primes and their Gaussian counterparts and their dark counterparts defined $k_d = k_i - k_j$ them are possible.

particle	Z, W	d	u	e
k	89	120	123	127
f(CD)/Hz	2.7488×10^{12}	1280	160	10

Table 8. The fundamental frequencies associated with the CDs of intermediate gauge bosons Z, W , d and u quarks, and electron. Note that for intermediate gauge bosons the frequency of CDs corresponds to energy $E = 1.13 \times 10^{-2}$ eV and wavelength $\lambda = 1.01 \times 10^{-4}$ m (size of a large neuron).

Z, W	d	u	e	k_d
3.64e-13	7.81e-04	6.25e-03	1.00e-01	0
5.821e-12	1.25e-02	1.00e-01	1.60e+00	4
2.31e-11	5.00e-02	4.00e-01	6.40e+00	6
3.73e-10	8.00e-01	6.40e+00	1.02e+02	10
1.49e-09	3.20e+00	2.56e+01	4.10e+02	12
5.97e-09	1.28e+01	1.02e+02	1.65e+03	14
2.38e-08	5.12e+01	4.10e+02	6.55e+03	16
9.54e-08	2.05e+02	1.64e+03	2.62e+04	18
3.81e-07	8.19e+02	6.55e+03	1.05e+05	20
6.10e-06	1.31e+04	1.05e+05	1.68e+06	24
3.91e-04	8.39e+05	6.71e+06	1.07e+08	30
2.50e-02	5.37e+07	4.30e+08	6.87e+09	36
1.00e-01	2.15e+08	1.72e+09	2.75e+10	38
4.00e-01	8.59e+08	6.87e+09	1.10e+11	40
6.40e+00	1.37e+10	1.10e+11	1.76e+12	44
4.10e+02	8.80e+11	7.04e+12	1.12e+14	50
6.55e+03	1.41e+13	1.13e+14	1.80e+15	54
2.62e+04	5.63e+13	4.50e+14	7.21e+15	56
4.19e+05	9.01e+14	7.21e+15	1.15e+17	60
1.68e+06	3.60e+15	2.88e+16	4.61e+17	62
1.07e+08	2.31e+17	1.84e+18	2.95e+19	64
6.87e+09	1.48e+19	1.18e+20	1.89e+21	74
1.10e+11	2.36e+20	1.89e+21	3.02e+22	78

Table 9. The \hbar -scaled fundamental time scales $T(CD, k_{eff}) = 2^{k_{eff}-127} \times .1$ seconds associated with the CDs of intermediate gauge bosons Z, W , d and u quarks, and electron for the values $\hbar/\hbar_0 = 2^{k_d}$ of Planck constant defined in Table 5. The scales are expressed in seconds. The uppermost row gives the time scales of CDs for the standard value of Planck constant. The rows which correspond to the less general option for which only M_{89} corresponds to weak bosons with ordinary value of Planck constants have double underline and the corresponding values of k_d are in boldface.

Electron and u quark are different

Before continuing an important observation is in order. Electron is exceptional when compared to quarks. It appears as a dark particle in all p-adic length scales defined by biologically important Gaussian Mersennes and also in atomic length scales $k = 137$ and $k = 139$. The reason is trivial: by the basic assumptions electron must appear at same length scales as weak bosons above $k = 127$ since

it corresponds to Mersenne prime. Also for the less general option (exotic intermediate gauge bosons are possible only as the dark variants of the standard ones) it appears at cell membrane length scale $k = 151$, which is due to the fact that one has $113 - 89 = 151 - 127 = 24$. Also u quark can appear with $k_{eff} = 137, 139, 163, 167$ and also this is an accident. The light invariants of intermediate gauge bosons appearing in long p-adic length scales would naturally correspond to almost vacuum extremals making possible the criticality as the basic aspect of life. One must of course be very cautious about the masses of exotic counterparts of u and d quark: one can also consider the possibility that masses are identical.

3.8.2 Dark matter hierarchy and big leaps in evolution

Dark matter hierarchy leads to an amazingly concrete picture about evolutionary hierarchy allowing to identify the counterparts for concepts like mineral, plant, and animal kingdom that we learned during schooldays and ceased to take seriously as students of theoretical physics as we learned that other sciences are just taxonomy. Even more, a view about what distinguishes between prokaryotes, eukaryotes, animal cells, neurons, EEG, and even about what makes cultural evolution, becomes possible. This view is also very useful when one tries to understand the role of microtubules.

The appearance of CDs scaled up in size by $r = \hbar/\hbar_0$ and space-time sheets scaled up in size by \sqrt{r} means the emergence of new levels of structure and it is natural to identify big leaps in evolution in terms of emergence of new larger matter carrying space-time sheet magnetic flux sheets and corresponding magnetic bodies. If magnetic flux quanta are scaled by r magnetic flux quantization conditions remain unaffected if magnetic field strengths scale down by $1/r$ so that the energies of cyclotron photons are not affected. The thickness of flux tubes can remain unchanged if the currents running at the boundaries of the flux quantum cancel the magnetic flux. As already found, this mechanism must be at work inside living organisms whereas in far away region flux quanta are scaled up in size.

The attractive hypothesis is that the leaps in evolution correspond to the emergence of dark variants of weak and possibly also color interactions in dark p-adic length scales which correspond to ordinary p-adic length scales characterized by Mersenne primes. These leaps would be quantum leaps but in different sense as thought usually. The emergence of higher dark matter levels would basically mean the integration of existing structures to larger structures. A good metaphor are text lines at the pages of book formed by magnetic flux sheets whose width is scaled up by r as the new level of dark matter hierarchy emerges. The big leaps can occur both at the level of organism and population and organisms with rather low individual dark matter level can form societies with high dark matter levels and high collective intelligence (honeybees and ants are good example in this respect).

Certainly also other scalings of Planck constant than those summarized in tables are possible but these scalings are of primary interest. This intuition is supported by the observation that electron is completely exceptional in this framework. Electron's dark p-adic length scales corresponds to p-adic length scales $L(k)$, $k = 167, 169$, assignable to atomic and molecular physics and to the Gaussian Mersennes $M_{G,k} = (1+i)^k - 1$, $k \in \{151, 157, 163, 167\}$, assignable to the length scale range between cell membrane thickness 10 nm and nucleus size $2.58 \mu\text{m}$. The corresponding p-adic length scales, the number of which is 23, are excellent candidates for the scales of basic building bricks of living matter and vary from electron's p-adic length scale up to 1.25 m ($k = 167$ defining the largest Gaussian Mersenne in cell length scale range) and defining the size scale of human body. The corresponding p-adic time scales are also highly interesting and vary from .1 seconds for electron defining the fundamental biorhythm to 9.6×10^{14} years which is by 4-5 orders longer than the age of the observed Universe. For $k = 167$ the time scale is 1.1×10^{11} years and is by one order of magnitude longer than the age of the observed Universe estimated to be 1.37×10^{10} years [52].

This conceptual framework gives rather strong guidelines for the identification of the levels of evolutionary hierarchy in terms of dark matter hierarchy. The outcome is a more detailed vision about big evolutionary leaps. Note that in the sequel only the general option is considered: the justification for this is that for this option electron appears as a dark particle for all length scales defined by Gaussian Mersennes as well as in atomic length scales. The basic vision in nutshell is that evolution means the emergence of dark weak and gluonic physics in both dark and ordinary length scales and that the size scales of the basic biostructures correspond to Mersenne primes and their Gaussian variants.

A sketch about basic steps in evolution

The vision about evolution depends on what one assumes about the initial state.

1. If one assumes that weak bosons with ordinary value of Planck constant were present in the beginning, evolution would mean a steady growth of k_d . The problem is that small values of $k_d = k_1 - k_2$ correspond to the Gaussian Mersennes defining cellular length scales. If these exotic weak physics were present from the beginning, large parity breaking in cellular length scales would have been present all the time.
2. An alternative and perhaps more realistic view is that the evolution means the emergence of exotic weak physics corresponding almost vacuum extremals in increasingly longer length scales. A possible mechanism could have been the induction of exotic \hbar_0 variant of weak physics at the nearest Mersenne length scale k_{next} by the dark variant of weak physics at level k so that one would have $k_d = k_{next} - k$. The simplest induction sequence would have been $89 \rightarrow 107 \rightarrow 113 \rightarrow 127 \rightarrow 151 \rightarrow 157 \rightarrow 163 \rightarrow 167$ corresponding to $k_d \in \{18, 6, 14, 24, 6, 6, 4\}$. A possible interpretation of exotic \hbar_0 physics is in terms of almost vacuum extremals and non-standard value of Weinberg angle: also weak bosons of this physics would be light. This sequence defines the minimal values for k_d but also larger values of k_d are possible and would correspond to steps between neighbours which are not nearest ones.

The following sketch about the basic steps of evolution relies on the latter option.

1. Elementary particle level

Magnetic bodies with size scale defined by the sizes of CDs assignable to quarks and leptons and possibly also weak bosons (already now the size of big neuron emerges) corresponds to the lowest level of hierarchy with the sizes of the basic material structures corresponding to the Compton lengths of elementary particles. The fundamental bio-rhythms corresponding to frequencies 10, 160, and 1280 Hz appear already at this level in zero energy ontology which suggests that elementary particles play a central and hitherto unknown role in the functioning of living matter.

2. $89 \rightarrow 107$ step with $k_d = 18$

The first step would have been the emergence of $k_{eff} = 107$ weak bosons inducing \hbar_0 weak physics in $k = 107$ length scale characterizing also ordinary hadrons. This in turn would have led to the emergence of exotic nucleons possibly corresponding to almost vacuum extremals. The reduction of the model for the vertebrate genetic code to dark hadron physics [31] is one of the most unexpected predictions of quantum TGD and assumes the existence of exotic- possibly dark- nucleons whose states with a given charge correspond to DNA, RNA, mRNA, and tRNA. The \hbar_0 variants of these nucleons would interact via weak bosons with hadronic mass scale. The exotic variants of the ordinary $k = 113$ nuclei would correspond to the nuclear strings consisting of exotic nucleons [21, 31] and define nuclear counterparts for DNA sequences. Their dark counterparts could define counterparts of DNA sequences in atomic physics length scales. Therefore a justification for the previous observation that genetic code could be realized at the level of hadron physics and that chemical realization would be higher level realization finds justification. The anomalous properties of water could be also partly due to the presence of dark nucleons and the proposal was that the presence of exotic nuclei is involved with water memory [18]. The possible existence of the analog of DNA-RNA transcription between ordinary DNA and its nuclear counterpart would have dramatic implications. For instance, one can imagine a mechanism of homeopathy based on this kind of transcription process which would also allow a modification of genome by using dark nuclei to communicate the DNA sequences through the cell membrane to the target nuclei.

3. $107 \rightarrow 113$ step with $k_d = 6$

The next step would have been the emergence of $k_{eff} = 113$ weak bosons inducing \hbar_0 weak physics in $k = 113$ length scale characterizing also ordinary hadrons. Exotic variants of the ordinary nuclei possibly corresponding to almost vacuum extremals could have emerged interacting weakly (or actually relatively strongly!) via the exchange of weak bosons with mass scale of order 100 MeV. Also dark variants of the exotic $k = 107$ nucleons could have emerged and formed exotic nuclei of size scale $k = 119$.

4. $113 \rightarrow 127$ step with $k_d = 14$

At this step weak bosons in electron mass scale would have emerged. Whether these weak bosons could have induced large parity breakings in atomic and molecular length scales is not clear. Viruses, which do not yet possess cell membrane could correspond to this level of hierarchy.

5. $127 \rightarrow 151$ step with $k_d = 24$

This step would have been fundamental since weak bosons in cell membrane length scale would have appeared. Note that by $113 - 89 = 24$ this step also leads from $k = 89$ weak bosons to $k = 113$ weak bosons. The weak bosons assignal to $k = 151$ could correspond to the weak interactions associated with almost vacuum extremals and $\sin^2(\theta_W) = .0295$ could correspond to the weak physics in question.

$k_d = 24$ step for $k = 113 \hbar_0$ weak bosons would have produced them in $k_{eff} = 137$ atomic length scale with $L(137) \simeq .78$ Angstrom This could have naturally led to large parity breaking effects and chiral selection.

Dark $k_{eff} = 151$ electrons appearing in the TGD inspired model of high T_c super-conductivity would have been a by-product of this step. Whether dark electrons could have transformed to light \hbar_0 electrons (of mass .25 keV) with a common mass scale of order 10^2 eV with exotic weak bosons is an interesting question. The model of high T_c super-conductivity predicts the presence of structures analogous to cell membrane. This would suggest that cell membranes emerged and chiral selection emerged at this step so that one could not distinguish the emergence of molecular life as a predecessor for the emergence of cell membrane like structures. This would conform with the fact that DNA molecules are stable only inside cell nucleus. Note that for $k_{eff} = 151$ electron's CD has time scale $2^{24} \times .1$ seconds -that is 19.419 days (day=24 hours).

The smallest nanobes [82] appearing in rocks have size 20 nm and could have emerged at this step. The size of the viruses [78] is between 10-300 nm covers the entire reange of length scales assignable to Gaussian Mersennes, which suggests that smallest viruses could have emerged at this step. Also the smallest nannobacteria [71], which by definition have size smaller than 300 nm could have appeared at this stage.

6. *The remaining steps*

The remaining steps $k = 151 \rightarrow 157 \rightarrow 163 \rightarrow 167$ could relate to the emergence of coiling structure DNA and other structures inside cell nucleus. $k = 167$ would correspond to $k_d = 167 - 89 = 68$ to be compared with the value $k_d = 47$ required by 5 Hz Josephson frequency for the neuronal membrane for -70 mV resting potential. Note that $k_d = 48$ (state 1-2 of deep sleep) corresponds to $k = 163$.

By their smallness also double and triple steps defined by $k_d = k_{i+n} - k_i$, $n > 1$, are expected to be probable. As a consequence, electrons can appear as dark electrons at all the Gaussian Mersenne levels. At these steps the dark electrons corresponding to primes $k_{eff} = 137, 139$ would appear. For $k = 137$ dark electron appears with CD time scale equal to 128 seconds- rather precisely two minutes. The model for EEG suggests that the exotic weak bosons appear in the scales $k_{eff} = 136, 137, 138$.

Further multisteps from the lower levels of hierarchy would give structures with size scales above the size of cell nucleus possibly assignable to organs and structural units of brain. The dark levels assignable to electron are expected to be of special interest. It is encouraging that the longest scale assignable to electron in this manner corresponds to $k = 205$ and length scale of 1.28 m defining body size. As a consequence dark electrons are predicted at levels $k = 137, 139, 141, 143, 145, 147$ coming as octaves.

Prokaryotic cells (bacteria, archea) without cell nucleus for which cell membrane is responsible for metabolic functions and genome is scattered around the cell could have emerged at this step. This would mean that the emergence of the cell membrane thickness as a fundamental scale is not enough: also the size scale of membrane must appear as p-adic length scale. The sizes of most prokaryotes vary between $1 \mu\text{m}$ and $10 \mu\text{m}$: the lower bound would require $k = 163$. There also prokaryotes with sizes between $.2 \mu\text{m}$ ($k = 157$ corresponds to $.08 \mu\text{m}$) and $750 \mu\text{m}$. Cell nuclei, mitochondria, and other membrane bounded cell nuclei would have evolved from prokaryotes in this framework. The sizes of eukaryote cells are above $10 \mu\text{m}$ and the fact that multicellular organisms are in question strongly suggests that the higher multisteps giving rise to weak bosons and dark electrons in length scales above $L(167)$ are responsible for multi-cellular structures.

This scenario leaves a lot of questions unanswered. In particular, one should understand in more detail the weak physics at various length scales as well as various exotic nuclear physics defined by dark nucleons and dark variants of nuclei.

Division of the evolution to that of biological body and magnetic body

Electron's Mersenne prime M_{127} is the highest Mersenne prime, which does not correspond to a completely super-astrophysical p-adic length scale. In the case of Gaussian Mersennes $M_{G,k}$ one has besides those defined by k in $\{113, 151, 157, 163, 167, \dots\}$ also the ones defined by k in $\{239, 241, 283, 353, 367, 379, 457, 997\}$ [39]. The appropriately extended model for evolution allows to distinguish between three kinds of values of k_{eff} .

1. The values of k_{eff} for which electron can appear as dark particle and thus satisfying $k_{eff} \leq 205$ (Table 5). These levels would correspond to structures with size below 1.25 m defined roughly by human body size and it is natural to assign the evolution of super-nuclear structures to the levels $167 < k_{eff} \leq 205$.
2. The values of k_{eff} for which dark gauge bosons are possible in the model. This gives the condition $k_{eff} \leq 235$. These levels correspond to structures in the range 1.25 m-40 km. The identification as parts of the magnetic body can be considered.
3. The values of k_{eff} obtained by adding to the system also the Gaussian Mersenne pair $k \in \{239, 241\}$ allowing also the dark electrons. The lower size scale for these structures is 640 km.
4. The higher levels corresponding to k_{eff} in $\{283, 353, 367, \dots\}$. The lower size scale for these structures is 3 AU (AU is the distance from Earth to Sun).

$k_{eff} > 205$ levels would correspond to the emergence of structures having typically size larger than that of the biological body and not directly visible as biological evolution. This evolution could be hidden neuronal evolution meaning the emergence of extremely low Josephson frequencies of the neurons modulating higher frequency patterns and being also responsible for the communication of long term memories.

Biological evolution

In principle the proposed model allowing multisteps between hierarchy levels defined by Mersenne primes and their Gaussian counterparts could explain the size scales of the basic structures below the size scale 1.25 m identified in terms of the $k_{eff} \leq 205$ levels of the hierarchy.

1. The emergence of cells having organelles

The appearance of the structures with $k_{eff} > 167$ (possibly identifiable as magnetic body parts) should correlate with the emergence of simple eukaryotic cells and organisms, in particular plant cells for which size is larger than $10 \mu\text{m}$, which could correspond to $k_{eff} = 171$ for electron and dark variants of weak gauge bosons. $k_{eff} = 177$ is the next dark electron level and corresponds to $80 \mu\text{m}$ scale. It seems natural to assume that these dark weak bosons do not transform to their \hbar_0 counterparts at these space-time sheets.

Cell nucleus would be the brain of the cell, mitochondria would be the energy plant, and centrioles generating microtubules would define the logistic system. Also other organelles such as Golgi apparatus, ribosomes, lysosomes, endoplasmic reticulum, and vacuoles would be present. These organelles would live in symbiosis by topologically condensing to $k_{eff} \geq 171$ magnetic body controlling their collective behavior. Centrosomes associated with animal cells would not be present yet but microtubule organizing centers would already be there.

The recent observations show that centrioles are not always in the characteristic T shaped conformation. Daughter centrioles resulting during the replication of mother centriole use first ours of their lifetime to roam around the cell before becoming mature to replicate. A possible interpretation is that they are also life forms and that magnetic body utilizes daughter centrioles to perform some control functions crucial for the future development of the cell. For instance, centrioles visit the place where axonal growth in neurons starts.

Cytoskeleton would act as a counterpart of a central nervous system besides being responsible for various logistic functions such as transfer of proteins along microtubuli. Centrioles give also rise to basal bodies and corresponding cilia/flagella used by simple cells to move or control movement of air or liquid past them. Centriole pair would be also used by the magnetic body to control cell division.

The logistic functions are the most obvious functions of microtubules. Magnetic body would control cell membrane via signals sent through the cell nucleus and communicated to the cell membrane along microtubuli. Basal bodies below the cell membrane and corresponding cilia/flagella would serve as motor organs making possible cell motion. Tubulin conformations representing bits would allow microtubule surface to represent the instructions of the magnetic body communicated via cell nucleus to various proteins moving along the microtubular surface so that they could perform their functions.

TGD based view about long memory recall as communication with geometric past allows also the realization of cellular declarative memories in terms of the conformational patterns. Memory recall corresponds to a communication with geometric past using phase conjugate bosons with negative energies reflected back as positive energy bosons and thus representing an "image" of microtubular conformation just like ordinary reflected light represents ordinary physical object. There would be no need for a static memory storage which in TGD framework would mean taking again and again a new copy of the same file.

Receptor proteins would communicate cell level sensory input to the magnetic body via MEs parallel to magnetic flux tubes connecting them to the magnetic body. We ourselves would be in an abstract sense fractally scaled up counterparts of receptor proteins and associated with dark matter iono-lito Josephson junction connecting the parts of magnetosphere below litosphere and above magnetosphere. The communication would be based on Josephson radiation consisting of photons, weak bosons, and gluons defining the counterpart of EEG associated with the level of the dark matter hierarchy in question.

3. *The emergence of organs and animals*

The emergence of magnetic bodies with k_{eff} in the range (177, 181, 183, 187, 189, 195, 201, 205) allowing both dark electron and weak bosons could accompany the emergence of multicellular animals. Magnetic body at this level could give rise to super-genome making possible genetic coding of organs not yet possessed by plant cells separated by walls from each other. The super structures formed from centrosomes and corresponding microtubuli make possible complex patterns of motion requiring quantum coherence in the scale of organs as well as memories about them at the level of organs.

4. *The emergence of nervous system*

k_{eff} in the range (187, 189, 195, 201, 205) allowing dark electrons and weak bosons gives size scales (.25, .5, 4, 32, 128) cm, which could correspond to the scales of basic units of central nervous system. What would be of special interest would be the possibility of charged entanglement based on classical W fields in macroscopic length scales. The emergence of the new level means also the integration of axonal microtubuli to "text lines" at the magnetic flux sheets making possible logistic control at the multineuronal level. The conformational patterns of the microtubular surface would code nerve pulse patterns to bit patterns representing declarative long term memories. An interesting question is whether the reverse coding occurs during memory recall.

The evolution of magnetic body

For mammals with body size below 1.25 m the levels $k_{eff} > 205$ cannot correspond to biological body and the identification in terms of magnetic body is suggestive. The identification of EEG in terms of Josephson frequencies suggests the assignment of EEG with these levels.

1. *The emergence of EEG*

EEG in the standard sense of the word is possessed only by vertebrates and one should understand why this is the case. The value of Josephson frequency equal to 5 Hz requires only $k_d = 47$ so that something else must be involved. A possible explanation in the framework of the proposed model comes from the following observations.

1. Besides the maximal p-adic scale $k = 205$ for which electron and weak bosons appears as dark variants the model allows also levels at which only gauge bosons appear as dark particles. From

Table 9 one finds that levels $k \in \{207, 211, 213, 217, 219, 221, 223, 225, 229, 235\}$ are allowed. Could it be that these levels and possibly some highest levels containing both electrons and gauge bosons as dark particles are a prerequisite for EEG as we define it. Its variants at higher frequency scales would be present also for invertebrates. The lowest Josephson frequency coded by the largest value of \hbar in the cell membrane system determines the Josephson frequency.

2. The membrane potentials -55 mV (criticality against firing) correspond to ionic Josephson energies somewhat above 2 eV energy ((2.20,2.74,3.07,2.31) eV, see Table 1). For 2 eV the wavelength 620 nm is near to $L(163) = 640$ nm. Therefore the Josephson energies of ions can correspond to the p-adic length scale $k = 163$ if one assumes that a given p-adic mass scale corresponds to masses half octave above the p-adic mass scale so that the opposite would hold true at space-time level by Uncertainty Principle. Josephson frequencies $f_J \in \{5, 10, 20, 40, 80, 160\}$ Hz correspond to $k_d \in \{47, 46, 45, 44, 43, 42\}$ giving $k_{eff} \in \{210, 209, 208, 207, 206, 205\}$.
 - (a) Cerebellar resonance frequency 160 Hz would correspond to $k = 205$ -the highest level for for which model allows dark electrons (also 200 Hz resonance frequency can be understood since several ions are involved and membrane potential can vary).
 - (b) The 80 Hz resonance frequency of retina would correspond to $k_{eff} = 206$ -for this level dark electrons would not be present anymore.
 - (c) 40 Hz thalamocortical frequency would correspond to $k_{eff} = 207$.
 - (d) For EKG frequencies are EEG frequencies below 20 Hz 12.5 and heart beat corresponds to .6-1.2 second cycle (the average .8 s corresponds to $k_{eff} = 212$).
3. Even values of k_{eff} are not predicted by the model based on Mersenne primes allowing only odd values of k_{eff} so that the model does not seem to be the the whole truth. The conclusion which however suggests itself strongly is that EEG and its variants identified as something in the range 1-100 Hz, are associated with the levels in at which only dark weak bosons are possible in the proposed model. Note that the size scales involved with EEG would be above the size scale of human body so that we would have some kind of continuation of the biological body to be distinguished from the magnetic body. The time scales assignable to the dark CDs would be huge: for instance, $k = 205$ would correspond to $T = 2^{42} \times .1s$ making about 1395 years for electron.

2. Does magnetic body correspond to the space-time sheets carrying dark weak bosons?

The layers of the magnetic body relevant for EEG have have size of order Earth size. Natural time scale for the moment of sensory consciousness is measured as a fraction of second and the basic building blocks of our sensory experience corresponds to a fundamental period of .1 seconds. This scale appears already at \hbar_0 level for electron CD . The natural question concerns the relationship of the magnetic body to the $k > 205$ space-time sheets carrying only gauge bosons in the model and having size scale larger than that of biological body. Do they correspond to an extension of biological body or should they be regarded as parts of the magnetic body? The following observations suggest that they could correspond to layers of the magnetic body responsible for the fractal variant of EEG.

1. The primary p-adic time scales (Compton times) $T(239)$ and $T(241)$ correspond to frequencies, which are $2^{\pm 1/2}$ kHz. The geometric average $k = 240$ corresponds to kHz frequency. Is the appearance of kHz scale a mere accident or do the frequencies assignable to the quark CDs correspond to Compton times $\propto \sqrt{2^{k_{eff}/2}}$?
2. One can apply scalings by 2^{k_d} to the triplet (239, 240, 241) to get a triplet $(239 + k_d, 240 + k_d, 241 + k_d)$. The results are summarized in Table 10. Clearly the frequencies in question cover also the EEG range. Note that these frequencies scale as $\sqrt{1/r}$ whereas Josephson frequencies scale as $1/r$.

k_d	f_1/Hz	f_2/Hz	f_3/Hz
0	707	1000	1412
4	177	250	354
6	89	1250	177
10	22.1	31.3	44.2
12	11.1	15.6	22.1
14	5.5	7.8	11.1
16	2.8	3.9	5.5
18	1.4	2.0	2.8
20	0.7	1.0	1.4
24	0.2	0.2	0.3

Table 10. The Compton frequencies obtained by scaling $2^{k_d/2}$ from the basic triplet $k_{eff} = (239, 240, 241)$. The values of k_d correspond to those predicted by the model based on Mersenne primes.

Also ZEG and WEG would appear but in much shorter scales dictated by k_{eff} and might accompany EEG. Somehow it seems that the effective masslessness of weak bosons below given scale is highly relevant for life. One can of course ask whether some larger Gaussian Mersenne could change the situation. There is a large gap in the distribution of Gaussian Mersennes after $k = 167$ and the next ones correspond to $M_{G,k}$, with k in $(239, 241, 283, 353, 367, 379, 457, 997)$ [39]. The twin pair $k = (239, 241)$ corresponds to a length scales $(1.6, 3.2) \times 10^2$ km and the minimum value for k_d are $(72, 74)$ ($167 \rightarrow (239, 241)$ transition).

3. Long term memory and ultralow Josephson frequencies

What determines the time scale associated with long term memory is a crucial question if one really wants to understand the basic aspects of consciousness.

1. Does the time scale correspond to the size scale of CD assignable to electron scaled by $r = \hbar/\hbar_0$? In this case relatively small values of r would be enough and $r = 2^{47}$ would give time scale of 10^{13} s for for electron's CD , which is about 3×10^5 years. This does not make sense.
2. Does Josephson frequency define the relevant time scale? In this case the long term memory would require the analog of EEG in the time scale of memory span. $k_{eff} = 205$ would give 6 ms time scale for memory from the assignment of $k_{eff} = 163$ to the Josephson photons at $V = -50$ mV implying $k_d = 42$. Minute scale would require $k_{eff} = 217$. The highest level $k_{eff} = 235$ allowed by the model involving only Gaussian Mersennes with $k \leq 167$ would correspond to a time scale of 77.67 days (day is 24 hours). For Gaussian Mersennes defined by $k_{eff} = (239, 241)$ the time scales become about (41.4, 82.8) months (3.4 and 6.8 years). These scales should also define important biorhythms. The claimed 7 years rhythm of human life could relate to the latter rhythm: note that the precise value of the period depends on the membrane potential and thus varies. The presence of the scaled up variants of the by $k_d \leq 78$ allows longer time spans of long term memory and the scaling defined by $k_d = 167 - 163 = 4$ scales up the span of long term memories to (54.4, 108.8) years.

4. Cultural evolution

Higher levels in the hierarchy would correspond mostly to the evolution of hyper-genome coding for culture and social structures. Introns are good candidate for the nucleodes involved. The development of speech faculty is certainly a necessary prerequisite for this breakthrough. Already EEG seems to correspond to dark layers of biological body larger than biological body so that one can ask whether the weak bosons and dark electrons in the length scales $k = 239, 241, 283, 353, 367, \dots$ could be relevant for the collective aspect of consciousness and cultural evolution. Maybe the size scales (175, 330) km and their scaled up variants by $k_d \leq 78$ might have something to do with the spatial scale of some typical social structure (not city: the area of New York is only 790 km²).

3.8.3 Could insect colonies have "EEG"?

Only vertebrates can have EEG in 1-100 Hz range. According to the proposed model this means the presence of the $k > 205$ levels which can be regarded as a continuation of the biological body carrying dark weak bosons and having size scales larger than 1.25 m. That only vertebrates have EEG conforms with the empirical findings about the effects of ELF em fields on vertebrate brain.

This does not however imply that one could not assign EEG to the collective levels of consciousness. For instance, in the case of social insects forming colonies some kind of collective EEG might exist and explain the ability of the colony to behave like single organism. Indeed, ELF magnetic field and magnetic fields affect the behavior of honeybees just as ELF em fields affect the behavior of vertebrates [84]: the model for this findings led to a model for the fractal hierarchy of EEGs.

One could argue that insect brain is so simple (in the case of honeybee the number of neurons 1/1000 of number of neurons in human retina) that it is not possible to assign "personal" EEG to honeybee. The fact that a honeybee isolated from colony dies just as does the cell separated from organism, suggests that the relationship of insect to colony is like that of a cell to organism. Hence one could test whether colonies of social insects or their sub-colonies might possess an analog of ordinary EEG. What this would mean that ant colonies have sufficiently complex hyper-genome making possible collective variants of memory, sensory input, and intelligence, as well as the ability to realize collective motor actions. Even bacterium colonies have intricate social structures [142] so that one must remain open minded.

An objection against this line of thinking is that even in the case of collective EEG the proposed model assigns the Josephson frequencies with neurons. One might imagine Josephson frequencies at EEG range even in case of insects- say the queen of the nest. Since dark photons are in question the fields are very weak. I do not know whether any-one has got the crazy idea about checking whether beehive has EEG -certainly not any routine measurement! One can also imagine a fractal counterpart of EEG at the level of some individuals- say queen of the nest- at very low frequencies making possible long term memory.

Do honeybees have long term memory?

The realization that insect colonies rather than insects might correspond to higher $k_{eff} > 205$ levels of the dark matter hierarchy came via an indirect route. The article "Why honeybees never forget a face?" of New Scientist [92] described evidence supporting the view that that honeybees might possess long term memory in the time scale of days.

Adrian Dyer of the University of Cambridge and colleagues trained honeybees to associate a sucrose drink with a photograph of a particular face. The insects were then tested on their memory and recognition skills by being presented with the picture of this face and the pictures of three other faces not associated with any reward. Of the seven bees tested, two lost interest in the trial and flew away. But the five remaining bees correctly identified the target face in more than 80 per cent of trials, even though the reward had been removed. Moreover, some bees remembered the face two days later, indicating that they had formed a long-term memory of it.

1. The conservative explanation is that the achievement is due to keeping the face-honey association intact in the absence of the stimulus which created it in a time scale of days. For this option the ability of honeybee to express the distance and orientation to the food source could be hardwired involving no conscious memory about the flight. Also the interpretation of the honeybee dance telling the distance and orientation of food source to advices where to fly would be completely "instinctive"- whatever this means.
2. A more radical option is that honeybee hive rather than honeybee has long term memories in the sense as long term memories are interpreted in TGD framework: that is as communications with the geometric past. In this case the span of long term memories is determined by the level of dark matter hierarchy as time scale defined by Josephson frequency assignable to level of dark matter hierarchy in question and a span of few days for long term memories forces the conclusion $k_d \geq 63$: the upper bound is $k_d = 78$ (see Table 5), when one allows only $k \leq 167$ Mersennes and this corresponds to 87.6 years.

One can ask whether the ability of honey bee queen to found a new honeybee colony could involve long term memory in the time scale of year. If this were the case, the queen would not face her

formidable challenge alone: the former colony in the geometric past still exists as a conscious entity and could communicate advices to the queen. The magnetic body of the former colony could exist also in the geometric now, being physically associated with the queen. This magnetic body could serve as the conscious entity communicating to the queen the advices and commands making possible to construct the beehive. A more conservative explanation is that these activities are genetically hardwired and instinctive (leaving open what 'instinctive' really means if it actually means anything).

The distinguished social position and anatomy of queen are consistent with the hypothesis that queen has more massive connections than other bees with the magnetic body of beehive. For instance, it is known that the new hive is oriented in exactly the similar manner as the old. Either long term memory or passive magnetic coding of the orientation of the hive with respect to Earth's magnetic field made possible by the magnetite in the abdomen of queen could explain this. The neurons of queen could correspond to a very large value of \hbar giving rise to the required low Josephson frequencies.

The colony would have sensory resolution in a time scale of a fraction of second and short term memory in minute time scale. The counterpart of EEG at the level of hive is highly suggestive and conforms with the finding that ELF magnetic fields with strengths in the range .1-1 mT ($2B_E - 20B_E$) affect honeybee dance [84] as does also the absence of Earth's magnetic field. Interestingly, 1-2 mT DC field causes epileptiform activity in the case of humans [109] (the change of the DC field used seems to be more important than the period it is applied). Could the beehive suffer a kind of epileptic seizure!

The intentional actions of the honeybee colony would be realized via magnetic flux sheets traversing the super-genes of the insects participating to the action in question. Workers, soldiers, etc.. would act to some extent as organs of the colony being connected by hyper-genes of hyper-genome to larger units. Queen could act as the analog of a complex Grand Mother neuron in brain or a leader in human society.

This view can be criticized. Honeybee dance [91] is performed by forager bees and the dance represents among other things the angle between the lines connecting hive to the food source and sun as the angle between movement of bee and vertical direction (also other options are possible). The intricate pattern of the dance in turn codes for the distance to the food source. If beehive is a conscious entity using bees as its cells, why is honeybee dance needed at all? TGD based vision about the evolution of modern human society from a bicameral society in which individuals received advice and commands from "God" [21, 18], suggests an answer to this criticism. The society able to survive must be maximally flexible and allow maximal individual intelligence and maximal freedom of individual actions consistent with the overall goals. This requires delegation of simple tasks to lower levels meaning also that communications between individuals become necessary (the development of language and other communications parallels the transition from bicamerality to modern society in the case of humans). The communication itself might however involve also the beehive. Foreagers could be like the prophets of the bicameral society communicating in semitrance the advices of God to the colony.

It should be noticed in passing that honeybees have already earlier made a visit to TGD inspired theory of consciousness [22]. As discovered by topologist Barbara Shipman [49], honeybee dance has a mathematical description in terms of a construct assignable to color group $SU(3)$ of gauge interactions between quarks and gluons. This led her to propose that color interactions might have some deep role in living matter. This is in a sharp contrast to the fact that color interactions as establishment knows them are completely invisible above the length scale of 10^{-15} meters. The TGD based prediction that there exists an entire hierarchy of scaled up copies of QCD, in particular QCDs with confinement length scale of order cell size, changes completely the situation.

Honeybees as magneto-receptors of the beehive or magnetic cells as magneto-receptors of bee?

Earth's magnetic field has a crucial status in the model of living systems even at the lowest levels of dark matter hierarchy so that Earth's magnetic field is expected to play a role in the functioning of all cells, also bees and ants. This is indeed the case.

It is known that that bees have two navigation systems. The first system is based on the direction of sun and polarization of solar light but does not work on cloudy days. The second navigation system uses Earth's magnetic field and is used in cloudy days. Bees have in their abdomen magnetite (Fe_3O_4) particles of size about 30 nm and iron storage protein ferritin which correspond 10 to nm

sized super-paramagnetic particles [111]. Magnetite particles and ferritin in principle make possible magneto-reception instead of a mere passive compass behavior.

The minimum option is that honeybee itself does not receive any neural information about the magnetic field but acts as a passive magneto-receptor of the bee colony or sub-colony (such as workers flying to the food source) and that the information contained by the receptor grid allows the sub-colony to deduce its position in the varying magnetic field. "BEEG" would mediate this information to the magnetic body of the (sub-)colony and the general mechanism based on Josephson currents does not require nerve pulse patterns to achieve this.

Since foragers seem to act as individuals able to navigate in the magnetic field of Earth, it would seem that some cells of the honeybee could act as magneto-receptors so that the reaction of the magnetic particles would be coded to a neural signal. It has been proposed that the changes in the shape of the configurations formed by magnetite particles in a varying magnetic field induce changes in the shape of neuron and in this manner can induce neural signal. This mechanism could also induce the voltage perturbations coding the information to the Josephson current giving rise to the sensory part of EEG as a state of coherent ELF photons. Perhaps the genes expressing these neurons are activated only in foragers and ferritin makes possible the magneto-reception in this sense.

Social bacteria and magneto-tactic bacteria

Magneto-tactic behavior of bacteria [144] was discovered for 30 years ago by microbiologist Richard P. Blakemore and means that certain motile, aquatic bacteria orient and migrate along magnetic field lines. This ability could be purely passive compass mechanism made possible by the magnetite detected in the bacteria.

During last years we have learned that bacteria are not simple creatures having only single goal: to multiply and fill the Earth. Bacteria are able to communicate and act co-operatively [142]. This raises the question whether hyper-genes could appear already at this level and whether bacteria acting as a colony they individual bacteria could act as magneto-receptors of colony allowing it to detect even variations of the magnetic field much like individual cells in the brain of vertebrates or perhaps even in the abdomen of honeybee are believed to serve as magneto-receptors.

Great leaps in evolution as emergence of higher levels of dark matter hierarchy at level of individuals

The vision about great leaps in evolution led to the view that the emergence of EEG corresponds to the emergence of $k_{eff} > 205$ levels of dark matter hierarchy. On the other hand, the time scale of gene translation corresponds to that associated with the ordinary EEG, which forces to ask whether these levels are present already in the lowest life forms. Perhaps a more plausible option is that the .1 second time scale of electronic CD defines the time scale of gene translation and corresponds therefore to the standard value of \hbar_0 . The findings about honeybees however support the view that $k_{eff} > 205$ levels are present but are associated with the honeybee colony rather than individuals. This however requires that the these levels have neuronal realization in terms of Josephson frequencies.

Therefore a more precise formulation of the hypothesis about great leaps in evolution would be that great leaps in evolution correspond to the emergence of a new dark matter level at the level of individual organism. If this view is correct then $k_{eff} > 205$ levels would correspond to a collective level of consciousness in the case of invertebrates down to bacteria, which are indeed found to form societies [142]. This conforms also with the fact that the genome of invertebrates is too small to allow realization of $k_{eff} > 205$ flux sheets as genes or even super-genes. The somewhat unexpected conclusion would be that all activities of invertebrates involving gene expression would be controlled by collective levels of consciousness: invertebrates would not be individuals in this sense. Viruses do not possess DNA translation machinery which is consistent with the absence of also collective $k_{eff} > 205$ levels. One can of course ask whether the queen of honeybee could be an exception to this rule.

If one believes that the time scale of gene expression corresponds to Josephson frequency then the explanation for the universality of the genetic code could be that $k_{eff} > 205$ levels controls gene expression: for $k_{eff} > 205$ wave length scale indeed corresponds to the length scale assignable to the magnetosphere of Earth. One could of course counter argue that it is more reasonable form magnetic

Mother Gaia to delegate this kind of duties to the lower levels and that the *CDs* of electron and quarks are ideal for this purpose.

3.8.4 Dark matter hierarchy, hierarchical structure of nervous system, and hierarchy of emotions

One can ask how the structural and functional hierarchy of CNS and the hierarchy of emotions relates to the dark matter hierarchy. The basic picture wherefrom one can start is following.

1. The emergence of nervous system corresponds to the emergence of $k_{eff} < 205$ levels of dark matter hierarchy above $k_{eff} < 167$. For instance, worms and insects would correspond to this level.
2. Vertebrates have EEG and thus the most primitive vertebrates (reptiles) should correspond to $k_{eff} \geq 205$.
3. The emergence of new structures need not mean the emergence of new levels of dark matter hierarchy. Rather, the most reasonable criterion for the presence of these levels is the emergence of behaviors involving long term goals and the magnetic bodies of the parts of brain assignable to the control of this kind of behaviors would correspond to higher values of k_{eff} . Also the maximum span of memories at given level should be characterized by the value of k_{eff} associated with the brain structures involved (hippocampus, mammillary bodies). This picture conforms with the fact that already insects possess neurons, ganglia, and head containing the predecessor of cerebrum but correspond to $k_{eff} \leq 205$ most naturally.

For goal related emotions the maximal time scale assignable to the achievement of the goal might allow to identify the time scale characterizing corresponding level of dark matter hierarchy. The lowest level emotions would be "primitive" emotions not related to any goal and one can as whether they could be assigned to organs consisting of ordinary cells and correspond to $k_{eff} \leq 205$.

1. The time scale of planned behavior and of long term memories makes possible to estimate upper bounds for the values of k_{eff} assuming Josephson frequency hypothesis. $k_{eff} \leq 205$ would give the upper bound of 6 ms which corresponds to cerebellar resonance frequency 160 Hz. This time scale looks too short even for the simplest vertebrates and one must be very cautious here.
2. An alternative interpretation is as the shortest possible span for short term memory whose time scale is known to vary.
3. Cerebellar rhythm could be analogous to hippocampal theta rhythm and involved with the cerebella memory storage and therefore would not tell anything about the span of the memory but would characterize the time resolution of memories and planned actions. The role of cerebellum in the fine coordination of motor actions indeed requires high time resolution.

Brain has anatomic division into midbrain, hindbrain, and forebrain [154]. Midbrain and hindbrain (sometimes both are included in brain stem) is possessed by even the most primitive vertebrates and its emergence could therefore correspond to the emergence of $k_{eff} \geq 205$ levels and EEG. The emergence of these levels relates naturally to the emergence of long term planning of motor actions in motor areas. The emergence of limbic brain, which defines the most primitive forebrain, could mean the emergence of the Gaussian Mersenne defined by $k_{eff} = 239$ containing dark electron condensates level and goal related emotions. This conforms with the fact that for mammals forebrain and cerebral hemispheres dominate whereas for other vertebrates hindbrain and cerebellum are in the dominant role.

Reptilian brain as $k_{eff} \leq 205$ system?

Reptilian brain contains only the structures corresponding to brain stem (midbrain and hind brain, in particular cerebellum) and as far structures are considered would correspond to $k_{eff} \leq 205$ levels of the hierarchy. Cerebellum is not believed to contribute directly to our consciousness. The absence of higher looks however an unrealistic assumption since reptiles certainly have long term memories.

Simplest emotions correspond to emotions involving no goal. Moods like excitement, feeling good/bad/tired/strong, etc.. could represent examples of such emotions and could be experienced already by reptilians. Of course, the scaled up variants of these emotions could appear at higher levels of hierarchy and would relate to the states of magnetic bodies (degree of the quantum coherence of Bose-Einstein condensates!).

Limbic system

Limbic system is not possessed by reptiles [162]. It is responsible for emotions, control of emotions, and also emotional intelligence. Limbic system corresponds to the brain of the most mammals. The limbic brain includes the amygdala, anterior thalamic nucleus, cingulate gyrus, fornix, hippocampus, hypothalamus, mammillary bodies, medial forebrain bundle, prefrontal lobes, septal nuclei, and other areas and pathways of the brain.

1. The sub-cortical part of the limbic system involves amygdalar and septal divisions. According to [162] amygdalar division promotes feeding, food-search, angry, and defensive behaviors related to obtaining food. Septal division promotes sexual pleasure, genital swelling, grooming, courtship, and maternal behavior. These divisions are emotional mirror images of each other and could correspond to $205 < k_{eff} < 239$.
2. The cortical part of the limbic system contains cingulate gyrus which is the newest part of the limbic system and belongs to thalamo-cingulate division which promotes play, vocalization (e.g., the separation cry), and maternal behavior. The time scale of memories would be shorter than 3.4 at this level.
3. Frontal lobes [156] are often regarded as the organ of volition. The frontal lobes are involved in motor function, problem solving, spontaneity, memory, language, initiation, judgement, impulse control, and social and sexual behavior. Prefrontal lobes representing the extreme front part of frontal lobes belong also to the limbic system and are responsible for motivation and ability to pose long term goals. This ability distinguishes humans from other primates. For these reasons frontal lobes, in particular prefrontal lobes, could involve the highest levels of dark matter hierarchy in the case of humans. The Gaussian Mersenne levels $k_{eff} = (239, 241)$ could be assigned as lowest level in this hierarchy. The time scale of long term memories would be longer than 3.4 years at these levels.

Cortico-striatal emotions like sadness, hate, fear anger, surprise, embarrassment, happiness, contentment, and joy involve goal structures and failure or success to achieve the goal in essential manner and would involve prefrontal lobes.

These levels would naturally relate to collective levels of consciousness coded by hyper genes. Hence these emotions could also relate to goals not directly related to the fate of biological body. Mirror neurons are a crucial prerequisite of a social behavior (autistic children seem to lack them), which suggests that hyper genes are involved at least with them.

Social emotions (feeling embarrassed, ashamed, guilty, loved, accepted, ...) could be induced by the collective levels of dark matter hierarchy as punishments or rewards for social behavior very much like neurotransmitters are believed to provide rewards and punishments at neuronal level.

Neocortex and two kinds of intelligences

Neocortex is often assumed to be superior ("neomammalian") part of the brain and makes the majority of brain hemispheres. The species which are considered to be highly intelligent, such as humans and dolphins, tend to have large amounts of neocortex. The amount of neocortex is roughly proportional to the brain size for primates.

Neocortex cannot correspond to $k_{eff} \geq 239$ (defining Gaussian Mersenne) as a whole. The decomposition of sensory areas to layers is consistent with the presence of lower levels since it is time resolution which matters in the case of sensory representations. Same conclusion applies to sensory association areas. The fine tuning of the motor control performed by cerebellum is consistent with $k_{eff} \leq 205$. Intelligence understood in the conventional sense of the word is accurate, works fast, and is computer like. The part of neocortex responsible for ordinary intelligence would be a rapid

and accurate processor of sensory and cognitive representations. Hence $k_{eff} < 239$ would naturally characterize sensory areas, secondary and primary motor areas, to hippocampal representation of declarative memories, and all association areas except dorsolateral prefrontal sensory-motor association cortex where short term memories are represented.

Emotional intelligence works slowly and is responsible for visions and holistic views and would thus correspond to higher levels of dark matter hierarchy. Limbic system is involved with emotions, motivation and long term planning and would thus be responsible for emotional intelligence. Indeed, the damage to frontal lobes [156] need not affect ordinary intelligence but affects emotional intelligence.

The levels of dark matter hierarchy associated with short and long term memory

The first thing to ask is of course whether the notions of short and long term memory make sense in TGD framework. Indeed, it would seem that it is more natural to speak about hierarchy of memories with characteristic time scales coming as selected powers of two.

1. According to [155], the span of other than visual short term memories is 30-45 seconds. This requires $k_{eff} \in \{217, 218\}$.
2. Visual short term memories [153] representing selected features of visual field are reported to have time span of few seconds. This suggests $k_{eff} \in \{213, 214, 215\}$.
3. Iconic visual memories representing entire visual field have much shorter time span of order 1 s: $k_{eff} \in \{211, 212\}$ would be appropriate for them,
4. Long term memories would correspond to $k_{eff} > 218$.

Hippocampus and mammillary bodies involved with long term memory recall are part of the limbic system. The hippocampal theta rhythm 4-12 Hz, which could correspond roughly to $k_{eff} \in \{163, 162, 161\}$ has nothing to do with the span of long term memories but would define the time resolution of the memories: the moment of sensory experience indeed corresponds to 10 Hz frequency. The frequencies responsible for memory storage need not have anything to do with the ultralow frequencies characterizing the temporal distance of the past event associated with the memory recall and hippocampus could just build a kind of bit sequence which during memory recall is communicated from the geometric past to some part of the future brain or magnetic body.

Anterograde amnesia means an inability to restore long term memories. The damage of hippocampus or of mammillary bodies can induce anterograde amnesia. In the usual conceptual framework the explanation would be the inability to store new long memories. In TGD framework this would be inability to construct those cognitive representations which are communicated to the geometric future in long term memory recall. Retrograde amnesia seems to involve almost always anterograde amnesia and means loss of memories for some time span before the injury. A possible explanation is that injury can propagate also to the geometric past of the brain quantum jump by quantum jump.

During ageing memories tend to be lost but the memories of childhood are the most stable ones. A possible interpretation is that faster rhythms of the generalized EEG tend to disappear: kind of scaled up variant for the process of falling into sleep accompanied by silencing of higher EEG bands could be in question.

What about transpersonal levels of consciousness?

$k_{eff} > 245$ levels of dark matter hierarchy correspond to time span longer than 109 years and cannot relate to the biological body alone. They could relate to higher collective levels of the dark matter hierarchy and evolution of social structures. The memories extending over personal life span claimed by meditators could have interpretation in terms of $k_{eff} > 245$ transpersonal levels of consciousness. Also the "god module" located to temporal lobes could correspond to this kind of levels of dark matter hierarchy. If it corresponds to Gaussian Mersenne with $k_{eff} = 283$ the time scale of memories becomes huge: about 10^{14} years so that the notion of "god module" is indeed appropriate.

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Part II

**MOTHER GAIA HYPOTHESIS
AND HUMAN CONSCIOUSNESS**

Chapter 4

Semi-trance, Mental Illness, and Altered States of Consciousness

4.1 Introduction

The stimulus leading to the birth of this chapter was rather personal question made with some tongue in cheek: Am I a schizophrenic? The basic motivation for this question was my life situation: I have found completely impossible to find any support for my work and despite my high level of education live practically without human rights. There must be some reason to this and it might not be only related to my heretic views about physics and consciousness and to the present neobarbaric market economy stage of Finland and of western societies in general. Perhaps I differ from ordinary scientist in some manner which, not only explains why I am a builder of theory of everything, but also induces aggression, repression and perhaps also fear in my analytically thinking colleagues. 'What might this 'something different' be' was my question, which I finally decided to resolve during the period of exhaustion following long-lasting writing project.

The first thing to realize was that I know very little about schizophrenia. So I went to the library and also read my Bible about neuroscience [26] to find what schizophrenia is. Thanks are also for Gene Johnson about material. First, I realized that paranoid schizophrenia combined with manic-depressive characteristics and occasional anxiety disorders is probably a more scientific looking conceptualization for the label 'crackpot'. Examples of symptoms: 'peculiar philosophizing' is one of the characteristics of paranoid schizophrenia (TGD as a whole!); withdrawal from social interaction (I see this as supplanting); paranoia (my belief that I am supplanted!); megalomania (look only the inspired blurbs about new developments at my homepage); seeing me as a 'secretary of God' communicating TGD through me (schizophrenics obeying voices, perhaps I mediate the message of 'Gods' by writing!). All this fits nicely with the diagnosis. There are however big flaws. I express myself fluently by speaking (if allowed to do so, certainly not in academic circles!) and writing (if allowed to do so, certainly not in 'big science' circles). I do not experience horrendous loss of my self, disappearance of my self boundaries nor total emptiness. What was also peculiar that I seemed to have all the basic disorders of mind when suitable symptoms were picked up! As if even the nastiest claims of my colleagues were true: I seemed to be a real poly-maniac! More seriously, what the results of this self-diagnosis demonstrated is the dis-ability of the modern neuro-science based psychiatry characterizing illness as a collection of separate symptoms to differentiate between altered states of consciousness, religious experience, meditative states and schizophrenia. What is really tragic and horrifying that many materialistic neuroscientists indeed identify all these states of consciousness as mental illness.

It seems that the reductionistic approach of neuroscience does not provide much insight to the basic subjective characteristics of mental illness. It seems that a more holistic approach (or 'romantic approach', as it was called by Luria) based on 'stories' is needed. The book "The origin of consciousness in the breakdown of the bicameral mind" [69] provides, not only a fascinating scenario about the evolution of modern consciousness from the consciousness of bicameral stone age man, but also a holistic view about schizophrenic consciousness. In fact, schizophrenics are regarded as bicameral men in his approach. When I received this book as gift from my friend Ben Price, I was stuck with

the definition of consciousness which looked very bizarre to me: Jaynes stated that stone-age man was unconscious but despite this hallucinating God's voice giving commands! Definition does not look so bizarre when one realizes that Jaynes differentiates between experience and consciousness whereas in quantum approach this kind of distinction is not useful. Time was not yet ripe for me to realize the deepness of Jaynes's ideas. Couple of years later, armed with the notion of self hierarchy; with concrete ideas about interaction between different levels of self hierarchy; the realization that we are much more than our neurons as conscious selves and with detailed models for basic aspects of brain consciousness, I was mature to realize that I can modify the story of Jaynes and that the impressive material gathered by Jaynes supports also the TGD based quantum version of the story.

To put it in nutshell, TGD version about the relationship of human consciousness to higher levels of self-hierarchy relies on the notion of semi-trance. During semitrance parts of brain entangle with some higher level, say the self associated with the social group, and are in trance and therefore unconscious. The remaining parts of brain are however conscious and receive communications from the collective consciousness via the entangled region of brain as sensory hallucinations, emotions and thoughts. Semitrance is absolutely essential for the self-narrative: without it our consciousness would consist of memory fragments lasting only few seconds: higher level selves tell us where we come from and where we are going. Bicameral man received the commands and advices of the collective consciousness as auditory and visual hallucinations via regions of the right brain hemisphere wherefrom they were communicated to the left hemisphere whereas modern man receives these communications as thoughts ('internal speech') in left brain semitrance and emotions in right brain semitrance.

The evolution of modern consciousness meant a gradual development of the simplest God+ few men two-leveled hierarchy to a refined many-leveled hierarchy of selves having social hierarchy as its social image and various higher level selves talking with the voices of the persons in the hierarchy. At the same time subjective consciousness evolved: left and right brain became more and more entangled and semitrance periods became briefer, left brain began to inhibit the communication of sensory hallucinations from right to left brain, and sensory hallucinations transformed to thoughts and emotions. Thus the loss of 'God's voice' did not mean the loss of semitrance communications and they are absolutely essential for the survival of the social structures and for modern self-consciousness. It is however quite possible that modern man spends much shorter fraction of time in semitrance than his bicameral cousin.

Since our genome does not differ much from that of stone age man, this process is much more a self-organization process than evolution of genome. By 'ontogeny recapitulates phylogeny' principle this development is expected to repeat itself during the development of individual during the first years of childhood about which we not remember anything. This explains the Father-God and Mother-Goddess associations and the strongly reactive attitudes to religion resembling often strongly rebel against father. The average effective cognitive and emotional ages of the individuals of a civilization characterize the developmental level of the civilization.

According to this view, schizophrenic spends in the bicameral state larger fraction of time than normal person and receives communications of the higher levels selves more often as sensory hallucinations than as thoughts and emotions. Thus schizophrenia can be seen as cognitive and emotional abnormality and becomes illness in modern society relying crucially on cognitive and emotional self-narrative which is much more refined than the self-narrative based on sensory hallucinations. In normal consciousness left brain hemisphere inhibits the messages from right hemisphere, left and right hemispheres are totally entangled a considerable fraction of time and the entanglement with higher level selves can also involve the entanglement of entire brain leading to short periods of total trance. In this view negative periods of schizophrenia correspond to the phases when right brain hemisphere is not entangled with higher level selves and positive, psychotic periods to the phase when this entanglement occurs often. This vision generalizes also to manic-depressive and anxiety disorders and one can see mental illness as disorder of communication between human brain and higher levels of self hierarchy.

Semitrance mechanism provides also more detailed understanding about various altered states of consciousness and extrasensory perception (hypnotic state, telepathy, clairvoyance, meditative states, identification experiences). It has been said that schizophrenia is drowning into the sea of consciousness whereas deep meditation is swimming in this sea. I believe that this statement is to the point. My fascination to the problem of consciousness was initiated by a deep and long-lasting altered state of consciousness which began with a period, which might be characterized as conversation with God, Great Mind, as I called it: sounds very schizophrenic if one sees only collection of symptoms! It seems

that circle is closed now: I believe that I finally understand what was behind this experience and 'what is wrong with me'. Like other modern men, I am receiving emotional and cognitive messages from higher level selves. What distinguishes me from the average person is the abnormally long fraction of time spent in semitrance state. I do not get drowned to the sea of consciousness and I am able to write these lines as a 'secretary of God'. I even dare to believe (put it on account of megalomania) that the age of modern man having no Gods is coming to its end with the recent neobarbarism of the market economy. Our species can survive only if it keeps in contact with higher level selves and allows room for modern bicameral men and women sitting at computer terminals in semitrance and feverishly typing the messages of, not Village Gods, but much mightier Web Gods to the computer screen.

4.2 Semitrance

The original path to the model for the interaction of collective consciousness with individual was via the book Jaynes [69]. It is however more appropriate to represent the problem and its solution without any reference to Jaynes's idea to demonstrate that the scenario of Jaynes with only slight modifications follows from very general assumptions.

4.2.1 How societies of idiots can behave intelligently?

Animal kingdom is full of species forming societies: ant nests, beehives, flocks of birds, packs of wolfs, groups of apes, human communities. Also organisms can be regarded as cell communities. The ability of these societies to behave as single coherent whole although individuals behave in a random looking manner, is a mystery. Especially mysterious this ability looks in case of termites: the architectural feats of the termites are not consistent with the fact that the brain of termite consists of few neurons. Mechanisms explaining this as unconscious self-organization based on chemical communication or communication by direct contact have been proposed. I find it however difficult to understand how even stone-age men wandering around randomly and communicating intensively could have managed to build Gothic cathedral. This kind of achievement requires the presence of a conscious collective intelligence able to plan and control individuals of the community telepathically. There is indeed evidence for telepathy in ant community described in the article [32].

This raises several questions. How collective consciousness is possible at all? How collective consciousness could be realized without total loss of individuality? How the rather limited intelligences of individuals can sum up to a high collective intelligence? What mechanisms collective self uses to control and coordinate the behavior of the individuals?

4.2.2 Semitrance as basic mechanism of communication between collective consciousness and individual

Self hierarchy is the basic prediction of TGD inspired theory of consciousness and self hierarchy makes possible collective consciousness. The experience of self is abstracted 'sum' over the experiences of its subselves so that subself is experienced as a mental image. In the abstraction process the experience of subself is replaced with an 'average' over the mental images of subself. The intelligence of the antnest results from summation of the mental images abstracting the contents of consciousness of the individual ants. This explains why ant group containing overcritical number of ants can act as an architect. The concrete realization of the self hierarchy in biomatter has been discussed in [16]. The most important conclusion is that we are much more than our brains: our mental images correspond to 'ELF selves' associated with various EEG frequencies. These 'ELF selves' have as geometrical correlates topological field quanta representing ELF em fields. Topological field quanta can have size of order Earth's circumference. The interaction of these topological field quanta (say fusion to form larger structures) provides a mechanism giving rise to larger selves and makes possible telepathy and various other EPR phenomena as also experiences involving communications with deceased persons [36].

Semitrance

How collective self can control and coordinate the behavior of individuals? Some kind of communication mechanism making possible collective consciousness to give commands to the individuals is clearly needed. The entanglement of individual with collective self leads to a total loss of consciousness of the individual and can be regarded as sleep or trance state, possession. For instance, during mating rites of birds, male and female seem to behave like single conscious unit formed by male and female.

Social animals are however not mere organs of a higher level organism, they are also individuals. To explain this one can consider a mechanism which might be called 'semi-trance'. If individual consists at least part of time of two separate subelves, second subself can entangle with collective self and in this trance state can communicate with the second self and communicate commands or advices to the subself which is awake. Communication is here quite generally understood as a generation of mental images: this corresponds to waking-up of subelves. The wake-up process initiates self-organization leading to a final state pattern representing the message. Final state pattern depends only weakly on the stimulus serving as message: this is as it should be.

Brain hemispheres or parts of them are the most obvious candidates for these two subelves. The entanglement of the right or left brain hemisphere (or some part of it, perhaps the linguistic regions with respect to which human brain has highest asymmetry) with a collective self could be the basic mechanism making it possible to communicate the commands of the collective self to left and/or right hemisphere as 'hallucinations'.

Jaynes's vision about the evolution of civilization is based on the notion of bicamerality [69] provides strong keys to the nature of semitrance state and how it has changed during cultural evolution.

1. Jaynes assumes that right brain activities were unconscious to bicameral man and that the left hemisphere received the volition of right brain hemisphere as commands and advices as hallucinatory voices and visions. This would suggest that in the case of ancient bicameral man it is right hemisphere or parts of its that fall in trance and that left brain hemisphere receives the commands from right hemisphere as sensory 'hallucinations'.
2. In case of modern man situation is presumably different. The average time spent in semitrance is probably shorter; the probability to fall in semitrance state is lower; the profile of semitrance is different and the communications between right and left brain hemispheres are probably different. Inhibition of the sensory communications developed so that the sensory messages from the right brain hemisphere to left hemisphere became inhibited: visions and God's voice disappeared. The profile of the communications of the collective self to human brain changed also. Modern man receives the messages of the collective self both via left and right hemisphere semitrance. Spontaneous thoughts and ideas are received via left brain semitrance. Emotions and moods are received via right brain semitrance and guide the behavior of individual much more implicitly than direct commands. Thus sensory 'hallucinations' have transformed to imaginative thoughts and emotions which we do not regard as hallucinations at all: the ancient world of elves, gods and demons has transformed to emotions and to the Platonic realm of ideas.
3. In this framework the development of civilization from primitive agricultural communities of 8000 B.C. to a modern society can be seen as the gradual establishment of 'memetic code' [30] implying the parallel development of language and society: 'In the beginning there was the Word'.

The characteristic feature of semitrance is the passivity of the experiencer: collective self communicates experiencer something or gives possibly commands. They are not hallucinations in which the experiencer would hallucinate volitional acts. Only activity in the sense that experiencer has conversation with the higher level self seem to be possible. Of course, this conversation could induce changes in the behavior of the collective self: consider only the claimed effects of prayer.

Semitrance mechanism is extremely general and could be at work in brains of all social animals, especially those which as groups exhibit an intelligence much higher than the intelligence of the members of the group. Similar mechanism could work also at cellular and biomolecular length scales. DNA double strand and cell membrane consisting of two lipid layers are indeed binary structures and the components of the structure could serve in the role of right brain lobe. This mechanism would explain why cell society can behave like an organism with self identity. The observed possibility of

humans with high EEG coherence to intentionally affect the degree of winding of DNA strand [24] supports the notion of semitrance at DNA level.

Semitrance and personal narrative

If the contents of consciousness of self involve temporal average over moments of consciousness occurred after last 'wake-up', the duration of our self cannot be much longer than .14 seconds since this would mean that we could not discriminate between events with time separation not longer than about .14 seconds. This problem can be partially circumvented if our experience is multi-time experience containing several subselves of this duration. The duration of the short term memory is few seconds and this might represent the duration of our self. This raises the problem how we can have long term memories and self-narrative.

Geometric memories containing contributions from entire life span provide a candidate for the self narrative as a model for has happened and what will happen assuming that no quantum jumps have occurred before and will occur after this quantum jump. This need not however be enough since it seems that geometric memories must correspond to episodal memories only rather than the declarative long term memories often expressed as internal speech. Geometric memories are also expectations rather than genuine memories about conscious experiences and one can argue that we have genuine subjective memories about what really happened. Furthermore, 'Ontogeny recapitulates phylogeny' principle suggests that the time interval spanned by our geometric memories is same as that spanned by subjective memories and thus few seconds. This leaves only one possibility: higher level selves must communicate to us information about their subjective memories whose time span is much longer than the time span of our personal subjective memories.

Semitrance mechanism seems to provide the most plausible manner to have self-narrative telling where we have come from and where we are going to. Thoughts and emotions, cognition and motivation, are the manner how higher level selves express this self-narrative to a modern man. Indeed, the time scales of emotions and moods are slow. The time scales for the action of second messengers and hormones are slow and involve changes of the synaptic strengths and modifications of the gene expression so that they could be perhaps identified as tools used by higher level selves to control the behavior of the organism. Perhaps also our cells have their own self-narratives provided by us and making possible such miraculous feats like DNA transcription: genetic determination could indeed be a long term goal of cell!

Thoughts, emotions, motivations and semitrance

One can imagine two strategies for how higher level self could communicate to us our self-narrative as thoughts and emotions.

1. Higher level self could communicate both geometric and subjective memories and allow us to perform the comparison generating emotions.
2. Higher level self could compare geometric and subjective memories and communicate the result of comparison to us as emotions. In this picture emotions are essentially generalized sensory experiences. The fact that the borderline between emotions and sensory experiences (pain is good example) is very difficult to draw, favors this option. This option, when combined with the identification of the quantum correlates of the sensory qualia, implies that the spectroscopy of consciousness provided by the magnetic transition frequencies applies also to emotions [22].

Support for this identification comes from several sources. Thoughts are not direct reactions to sensory experience. Ideas pop out of nowhere. The explosive development of science and technology is perhaps the best example of the non-predictability of thoughts. The changes of emotions can be nonpredictable and not direct reactions to sensory input but resulting from the comparison of what was expected or desired with what really happened and thus involving self-narrative in an essential manner. Expectations correspond to geometric memories and self-narrative tells what really happened: the comparison yields emotion serving as a control tool. Since self-narrative is told to us the one who makes ultimate comparison must be higher level self. The fact that music couples strongly to the 'hallucinatory' regions of right brain hemisphere and affects strongly our emotions, suggests that music is language of emotions.

Spectroscopy of consciousness provides additional insight to emotions consistent with the considerations above. Magnetic and Z^0 magnetic transition frequencies could parameterize the spectrum of both sensory qualia and emotions. The smaller the frequency, the more emotional the experience since the corresponding time scale is longer and deviation between the expected and real can be larger. Hence emotions could have as their correlates the cyclotron frequencies defined by the magnetic field assignable to the personal magnetic body carrying a magnetic field $B_{end} = 2B_E/5 = .2$ Gauss (B_E denotes the nominal value of Earth's magnetic field) explaining the findings of Blackman and others [20]. These frequencies are below 8 Hz. Since cyclotron frequency is inversely proportional to the mass of the charged particle, this implies that emotions must be associated with biomolecules (second messengers, hormones, etc...).

Synesthetes are able to experience very lively episodal memories. It might be that it is possible to have multitime conscious experience with a time scale of order life span or even longer as the possibility of transpersonal states of consciousness suggests. A phase transition increasing the value of the p-adic prime associated with brain temporarily could make possible to have extended state of consciousness with subjective and geometric memories with the time scale of life span.

Stress and semitrance

Stress is known to induce hallucinations in schizophrenics. This suggests that stress is a general mechanism inducing entanglement with higher level selves. The basic mechanism could be very simple. In case that brain decomposes unentangled parts representing separate selves, say part of right brain hemisphere and rest of brain, this part of right brain hemisphere can get tired and 'fall asleep' which means nothing but semitrance. This makes possible the communications of higher level self to that part of brain which is awake.

Semitrance provides an alarm clock mechanism. The natural function of the holistic language regions of right brain is to remember what task primitive man was performing (say carving some tool). If the bicameral state for, say linguistic regions, dominated, semitrance began when right brain got tired and fall asleep. But just this semitrance induced 'God's voice' telling for left brain hemisphere what task bicameral man was performing! Also in the situations in which bicameral man did not know what to do, stress caused semitrance and immediate advice from the collective self. It is quite possible that the voice of conscience does it best to perform the same function in modern man! What has happened is that commands have transformed from sensory hallucinations to thoughts.

Heavy stress could also induce the splitting of entangled brain to two unentangled subelves so that collective consciousness takes the lead when right brain hemisphere or parts of it fall asleep. For instance, the exceptionally stressing situations encountered in war presumaly lead to situation in which collective consciousness takes control and soldiers behave like single organism. Too much alcohol, which probably has same effect as stress, leads to the splitting of the visual field to right and left fields: this might be interpreted as de-entanglement of right and left visual fields. This state does not yet represent the state in which right brain or part of it has fallen asleep. Further stress leads to semitrance causing delirium. Note that also reduction of left-right inhibition must be involved with the stress.

The short period between wake-up and sleep state involves often visual and auditory hallucinations. This to be expected if falling asleep involves the decomposition of the brain to separate unentangled regions which fall asleep at different times. The lack of sleep leads also to a hallucinatory state. These phenomena support the view that stress can split self to two separate selves followed by the trance state of the right or left hemisphere or parts of it. The fact that sensory hallucinations are involved would suggest that sensory regions of the right hemisphere fall asleep first and communicate 'God's messages' to the left hemisphere.

Spinning causes dizziness and is therefore a good candidate for a stimulus causing semitrance. This could explain the social role of dance. Dance is very important also in many religions, spinning dervishes are good example of this. Children love to spin around: the reason is perhaps that spinning around induces the semitrance state of the early childhood. The dizziness caused by ill functioning of the sense of balance involves spinning like feeling in either direction. This suggests that hemispheres tend to stimulate experience of spinning in opposite directions but that normal situation they manage to inhibit each other.

One can wonder how stress leads to de-entanglement. Entanglement corresponds geometrically to the presence of join along boundaries bonds along which Josephson currents flow. This would suggest

that de-entanglement involves the splitting of the join along boundaries bonds. This is possible if Josephson current vanishes: this happens if the density of the superconducting charge carriers becomes sufficiently low. Thus it seems that the disappearance of superconductivity is the required condition. Perhaps dissipative effects might cause this: the increase of temperature over critical temperature at relevant space-time sheets could cause this. This would suggest that brain is near criticality for the phase transition leading to the disappearance of super conductivity. This is in accordance with quantum criticality of TGD Universe.

Semitrance and EEG

TGD predicts two kinds of EEG waves [37]. Propagating waves are typically associated with linear structures such as nerve circuits and left brain hemisphere is excellent candidate for corresponding selves. Large number of subselves representing mental images are predicted and the analyticity, reductionism and temporal linearity of left brain processing can be understood if left brain waves are dominantly propagating ones. Non-propagating waves can be associated with any structure of arbitrarily large size. The corresponding mental images can therefore be holistic and correspond to large region of brain.

The regions of right brain hemisphere are excellent candidate for a seat of nonpropagating EEG waves. Quantum entanglement of subselves gives rise to the formation of parts from wholes and it seems that brain halves provide reductionistic and holistic representations of sensory percepts. As far as sensory experience and emotion is considered, it is right brain which indeed seems to be holistic.

Standard wisdom is that right viz. left brain hemisphere are responsible for holistic viz. reductionistic aspects of consciousness respectively. There is however also conflicting evidence[28] and it might be that there is some kind of division of labour [19] such that right brain concentrates on sensory holism and left brain concentrates on cognitive holism. The experiments indeed suggest that it is left brain which recognizes holistic aspects of figures representing symbols and consisting of smaller figures representing also symbols. This would suggest symmetric scenario in which regions of both right and left hemispheres can entangle with collective selves and give rise to cognitive and emotional communication from higher level selves in modern man. This supports the view that also left brain hemisphere regions can support nonpropagating EEG waves. Gap junction connected neuron groups provide candidates for regions allowing nonpropagating EEG waves.

The entanglement with collective self corresponds to the formation of join along boundaries bonds between corresponding mindlike space-time sheet and the space-time sheet associated with some part of brain. This is expected to occur naturally if brain space-time sheet is in state corresponding to nonpropagating EEG wave.

It would be interesting to check whether there are some anatomical and neurophysiological differences between the brain hemispheres of social animals. Of course, mere reductionism-holism difference, which is not obvious anatomically, is enough. The differences of right and left brain EEG:s could be also informative. One could also study whether different brain lobes react differently to stress.

Both hemispheres entangle with higher level selves

The functional anatomy of brain is asymmetric: it is left brain hemisphere which is responsible for the production of speech whereas both hemispheres understand speech. Wernicke area on the left lobe and its mirror images are responsible for the understanding speech. Wernicke's area and its mirror counterpart are connected by anterior commissure. Broca area and supplementary motor cortex on left side are responsible for the production of speech. The removal of the supplementary motor cortex or Broca area yields loss of speech which is however not permanent in case of supplementary motor area. This specialization is dynamical and results from self-organization. Very ambidextrous people can have speech on both hemispheres and injury to Wernicke areas in early youth can lead to a generation of the speech areas in right hemisphere. Right brain contains counterparts of the speech production areas of the left hemisphere with no obvious function. What is surprising that large amounts of right brain tissue can be removed with surprisingly little deficits on mental function. The idea that these areas are completely useless is not attractive idea knowing that evolution has been extremely economical. So, what has been and what is the function of these areas?

The TGD inspired hypothesis modifying Jaynes's original proposal is that both Wernicke area and its mirror image of modern man entangle with higher level selves and mediate their messages

as thoughts in left hemisphere semitrance and emotions in right hemisphere semitrance. Imaginative thoughts and emotions are indeed more than just mechanical reactions to sensory input. In the brain of a healthy person brain hemispheres inhibit each other during normal consciousness but when the inhibition of right brain does not occur for some reason, 'God's communications' to the right hemisphere are mediated to the left hemisphere via anterior commissure as sensory hallucinations. This inhibition is also needed to avoid splitting of perceptive fields to two parts. This kind of splitting implied by de-entanglement together with inhibition might be especially useful in cognitive regions since it would make possible internal debate between holistic and reductionistic subelves.

Rather interestingly, in case of dogs and rats anterior commissures connect olfactory areas of brain. In this case odors might be in same role as voices in case of human brain. The idea about Dog-God expressing its will and advices using odor hallucinations does not sound so weird when one realizes that even human perceives huge number of different basic odors [22].

In this framework one can make guesses about the profile of the bicameral consciousness assuming that schizophrenics are bicameral men living in wrong time and place.

1. The evolution of modern man meant evolution of the entanglement profile of semitrance. Today 'Godly communications' are experienced as ideas and emotions whereas bicameral man experienced them as sensory hallucinations. Presumably right brain dominated as the locus of semitrance communication as suggested by the higher average intensity of EEG in right brain hemisphere of schizophrenic. Also cognitive semitrance was possible but the higher level selves were much more primitive than their modern followers since their intelligence was sum of much lower intelligences over much smaller number of individuals.
2. The brain of ancient man was part of time in entangled state but unstable against transition to split brain state induced by stress such that right brain subself was unstable against the entanglement with collective consciousness leading to semitrance in several sensory modalities. This occurred when ancient man got tired or encountered some novel situation causing stress. The anterior commissure connecting Wernicke area and corresponding area on right side is thicker in the brain of schizophrenic: this favors auditory communications between the Wernicke regions and auditory semitrance. Note that thoughts are a special case of auditory experience in TGD framework [22] so that the replacement of 'God's voice' talking through the right hemisphere with thoughts experienced via left hemisphere (Wernicke region?) as internal speech is a rather natural mechanism leading from bicamerality to modernity.

4.2.3 Various aspects of semitrance state

Social interactions and semitrance

'Synchrony of the personal chemistries' is example of those aspects of social interactions involve aspects which are difficult to understand if one assumes that we are robots sending messages to each other. Social messages contain perhaps much more than the formal information understood and expressed by the left brain hemisphere. Certainly the emotional content of the message is crucial and is believed to be expressed and understood by the right hemisphere. This makes it often possible to intuitively 'know' whether person is lying. Semitrance involving entanglement between the right hemispheres of the communicators with some higher level self provides a mechanism might make possible this telepathy like emotional communication. Facial and bodily expression of emotion is probably not enough: autists perhaps lack the ability to fall in emotional semitrance. This would explain their ability to discriminate between faces and nonliving things. This hypothesis could be tested by comparing the EEG:s of autistic and healthy persons.

Trust is a crucial prerequisite of the survival of society and every human relationship. It requires something which might be regarded as partial regression to a child like state. Presumably it is this 'regression', the readiness to give up part of right brain consciousness, that makes semitrance possible. One example of semitrance is what happens in a group of good friends having good time together. The wittiness and rapidity of communications is something which is difficult to understand unless one is willing to accept that collective group self and group subelves are also participating the discussion through participants.

Semitrance mechanism is probably also involved in the communication of individuals: the self of a charismatic person is able to get 'hypnotic' grasp about other people by semitrance mechanism.

People who live long time together in close relationship (married couples) or those who have fallen in love, perhaps form 'you+me' self rather stably. The claimed ability of close friends to communicate with each other non-verbally could also be based on 'you+me' self. It is often said that in close relationships mutual trust makes it possible for partners to purposefully 'regress' to childlike state which is prerequisite for semitrance. The state of falling in love is often indeed regarded as psychotic. That many of us lose their ability to fall in love when getting older, might be due to the lost ability to fall in childlike semitrance state anymore.

Semitrance and childhood

'Ontogeny recapitulates phylogeny' principle suggests that the development of individual repeats the evolution of human consciousness and early childhood should correspond to the period during which child spends considerable fraction of time in semitrance with right brain hemisphere entangled with the collective consciousness formed by the parents and family. Childhood is indeed often regarded as the era of paradise. Rather interestingly, small children turn their head to the direction of music even when their attention is directed to mother [69]. If music can induce semitrance one can understand the importance of lullabies. Many children develop non-existing playmates: perhaps the playmate is some higher level self.

It would not be surprising if collective self would talk to child with the voices of her mother and father and that child would experience mother and father as Goddess and God. This would explain the psychology behind God-father and Goddess-mother associations and also the very strong reactive attitudes towards religion, especially at young age. Interesting question relates to the fact that many children of modern age do not have mother and father gods.

What could be the signatures of the right brain semitrance state in case of a small child? If right brain is most of the time entangled with higher level selves and if right brain hemisphere is responsible for the holistic aspects of perception and cognition, children should not have holistic view about their own body. The drawings of young children are indeed more like collections of features, in particular, the holistic view about body should be lacking. The drawings of primitive man are similar. The coherence of the motions of left and right eye might serve as a measure for entangled-ness of right and left brain hemispheres: the eye motions of very young babies are indeed incoherent.

EEG emerges at the age of about year in frequency region 4-8 Hz stably. 8 Hz corresponds to the frequency defined by the duration of memetic codeword and smaller magnetic transition frequencies should be associated with emotions. Child gets EEG temporarily in lap of her mother already at the age of 6 months. At the age of one year child learns also her first words. It would be interesting to know what happens in the emotional development of a child at this age. In TGD framework also our sensory qualia involve in essential manner ELF frequencies in EEG range, our personal higher level selves. This would suggest that the consciousness of a very young child differs dramatically from that of adult: she sees but in an entirely different manner from the manner we do.

Semitrance and exceptional mental abilities

Schizophrenics are often capable of incredible feats of endurance: for instance, catatonics can keep same posture for days. Socrates is one of the best known example of a catatonic of this kind. Sacks tells in his book [27] a fascinating story about his patient who was mentally retarded but could remember compositions of Bach and entire encyclopedia of music. Sacks tells also about idiot savant twins with intelligence quotient of 60 having amazing numerical abilities despite that they could not understand even the simplest mathematical concepts. For instance, twins 'saw' that the number of matches scattered along floor was 111 and also 'saw' the decomposition of integer to factors and primality. A mechanism explaining this based on the formation of wholes by quantum entanglement is proposed in [19]. Indian self-taught number-theoretical genius Ramajunan told that he got his formulas from his personal God. These feats lose some of their mystery if higher level selves are involved.

Music and semitrance

The basic difference between song and speech is that the pitch in song varies discontinuously whereas in speech it varies continuously in narrow region of about one fifth of octave (the interval $C - E_b$ approximately). Rhythmic beat represents second basic difference. Music can stimulate emotions which we cannot even experience as a response to the events of everyday life.

In TGD framework speech and music could be seen as languages of thought and emotion. TGD predicts that memetic code [30] realizes the language of cognition in terms of nerve pulse patterns of duration about .14 seconds in left hemisphere: this corresponds to frequency of about 7.1 Hz. Music in turn provides the language of emotion in which the relationships between frequencies and rhythmic elements express the content of emotion. The tempo of music could be closely related with the magnetic transition frequency associated with some 'ELF self' involved. Typically the duration of single bar is about second and few pulses per second is the typical frequency of basic rhythmic pulses. Perhaps it is not accident that the range of frequencies in the EEG of young child is 4-8 Hz.

Right brain is the musical brain hemisphere. Anaesthetization of the left hemisphere in Wada test leads to a loss of speech but many patients can still sing. Also patients with haemorrhages on the left hemisphere can often express them singing. Even the removal of the entire left hemisphere can leave the ability to sing. Electrical stimulation of the right hemisphere produces hallucinations of singing and music. We react to speech dominantly with our left hemisphere whereas right hemisphere is activated more by music. For instance, if music is feeded to both ears with the same intensity, the music feeded in left ear is remembered and perceived better. Right hemisphere also distinguishes between melodies.

Many musicians seem to be more bicameral than average people in the sense that they spend more time in semitrance state. The ability to remember entire compositions could involve semitrance mechanism. Mozart could be perhaps seen as an example of a bicameral musician having miraculous music memory, hearing his compositions as wholes and behaving much like a child in this private life. Sacks tells in his book about a severely retarded man having miraculous ability to remember, understand and enjoy music pieces. This is consistent with the idea that emotional and cognitive intelligences are separate mental abilities.

One mysterious feature of music is that some compositions have ability to establish themselves as 'classics'. If themes and compositions are emotional representations of memes, one could see classics as survivors in the memetic fight for survival. Music induces deep emotional experiences, also religious experiences, and surviving music pieces could be also seen as idols, pictures of 'Gods'. I find it difficult to understand the deep affect of the pop music of my youth to my generation unless it expressed something essential about the collective mental landscape of that generation not expressible using only language.

Poetry and semitrance

Modern poetry could perhaps be regarded as intermediate between thought and emotion: as a language using both words and elements of music to express ideas. Ancient poetry would in turn be dictated in semitrance as God's voice. In his book [69] Jaynes represents an analysis of ancient poetry relating it to music. Here only some comments about this analysis are made. Epics of Greeks by the aoidoi was heard and spoken as poetry. Also Veda was poetry dictated to Rishis or prophets and Hebrew prophets were often poets. Also schizophrenics often talk in verse. Translating Jaynes views to TGD framework, one can say that early poets were in right brain semitrance state which later developed to trance state (Plato regarded poetry as divine madness) and ultimately to the modern form in which poems were consciously composed in inspiration, which corresponds in TGD semitrance state to which the linguistic regions of both hemispheres participate. Note however that in TGD framework only the mode of communication changed from auditory hallucinations to cognitive and emotional communications.

Poems like music are rhythmical: perhaps the frequency involved with the beat corresponds to ELF frequency involved with the contact helping to 'stay in touch with Muses'. The basic rhythm of Greece poetry was dactylic hexameter. As in music the pitch varied discontinuously: basic unit being GCC. Constant pitch is used also in orthodox divine service. The role of rhyme is interesting. Syllables involve characteristic frequency distribution: since rhymes favor same vowels they favor also similar frequency distributions. This might lead to a resonance effect in which verses resonate with the mental images of the earlier verses reverberating in neural circuits and establish repetitive structures with repetition frequency defined by the duration of verse also favoring establishment of entanglement. Jaynes believes that first poems were sung and the use of music instrument helped to get the divine inspiration by stimulating semitrance state in the linguistic regions of the right brain hemisphere. Lullabies presumably have the same effect in child.

Jaynes sees ancient poetry as the emergence of long term memories at the level of individuals.

Beautiful Muses, daughters of Mnemosyne, which later came to mean memory, singing in unison expressed stories about past whereas prophets told predictions for future. The transformation of the communications of the higher level selves from sensory hallucinations to thoughts and emotions could explain why modern poets do not receive their poems from Muses. What is fascinating that Muses appear in plural. This might be related to the ability of right brain hemisphere to represent musical instruments and voices as separate subselves whereas ordinary speech corresponds to single subself.

Semitrance and the development of human civilization

TGD based vision about evolution of civilization modifies Jaynes's views. During evolution the profile of semitrance was changed: the voices of gods were transformed to abstract emotions and thoughts and the time spent in semitrance was shortened. Thoughts indeed merge spontaneously and are much more than reactions to sensory input: the great rise of mathematics and philosophy few centuries B.C. was dramatic example about transformation of the world of spirits, demons and gods to the world of abstract ideas. Also moods and emotions can be regarded as communications involving semitrance mechanism allowing to guide individuals in more delicate manner than just giving commands. Long term goals involve communication of this kind. The need of the collective selves to survive manifests itself as rules of behavior, moral. The notion of moral as a 'voice of conscience' is consistent with the assumption that collective self expressed its will as auditory hallucinations for primitive man and with the idea that thoughts and emotions have replaced direct auditory hallucinations in this communication. TGD based model of sensory modalities explains thoughts as internal speech which is special case of auditory experiencing.

The tragic consequence of semitrance mechanism was the loss of face-to-face sensory contact with Gods. Celestialization of the visible Gods is the basic theme of Old Testament. Later Nietche announced the death of gods and postmodernism tells that also great narratives are dead. Conscious sensory 'face-to-face' communication with collective consciousness, 'God', occurs only during religious experiences and during dreams. In ancient societies dreams were indeed taken as messages of God and also nowadays many individuals do so.

There are all kinds of collective selves, also demon like creatures. It would not be surprising if demonic collective selves would not favor political leaders able and willing to listen to them in crisis situations. Jung proposed that a collective self which he called 'Wotan' was behind the rise of Nazism. There are many stories about political leaders believing in dreams and omens and asking advice from crystal gazers. Many leaders have been schizophrenic personalities (Jeanne d'Arc, Stalin, Hitler): it might be that just the ability to hear the voice of the collective consciousness gave them the self-confidences and charisma making them leaders. Needless to say, the examples of Stalin and Hitler show that the collective selves with intelligence of a stone-age village god are not sufficiently intelligent to lead modern nations.

4.3 Semitrance and mental disorders

Jaynes identified schizophrenic as a bicameral man in modern society and went to make a prediction that right brain contains hallucinatory regions. This prediction has been verified [26, 29]. In TGD framework the picture of Jaynes generalizes to a more general vision about mental illness. It seems that semitrance mechanism might provide considerable insight into various types of mental abnormalities and one could perhaps regard various mental disorders as abnormalities in communication. Both semitrance communication between various levels of self hierarchy and communication between brain hemispheres are involved.

4.3.1 Schizophrenia and semitrance

Jaynes's hypothesis that schizophrenic is a bicameral man living in modern society explains basic facts about schizophrenia. It is also consistent with the historical evidence: according to Jaynes [69] schizophrenia was described for the first time as insanity at about 400 B.C. when modern subjectivity had established itself. As will be found Jaynes's hypothesis generalizes to TGD context in natural manner.

General wisdom about schizophrenia

About 1 per cent of population suffers from schizophrenia, milder form of disease is schizotypal personality disorder suffered by 2-3 per cent of population. Neuroscientific approach to schizophrenia regards schizophrenia primarily as a disorder of cognition [26] although it is also disorder of perception, emotion and social relationships. Kraepelin suggests that schizophrenia is basically a splitting of the cognitive side of the personality from the affective or emotional side: the correlation between emotional responses and real situation may be lacking: schizophrenic can laugh in situation in which he should cry. Schizophrenia resembles manic depressive disorder in that it involves negative (nonpsychotic) and positive (psychotic) periods. During the non-psychotic episodes symptoms, referred to as negative symptoms, are social isolation and withdrawal; odd behavior and ideas; neglect of personal hygiene; blunted affect. Psychotic episodes are characterized by what are called positive symptoms: loss of the reality testing; various hallucinations, in particular auditory hallucinations; delusions (aberrant beliefs); incoherent thinking; confusion. In paranoid schizophrenia megalomania and delusions of persecution dominate.

There is strong evidence that schizophrenia is partly genetic abnormality [26]. Some schizophrenics have prominent anatomic changes in their brain. There is also evidence for physiological mechanisms. Antipsychotic drugs improve dramatically the treatment of the psychotic phase of illness. It is known that antipsychotic drugs block dopamine receptors and it was therefore thought that the excess of dopamine transmission is important factor in schizophrenia. It is also known that blood flow in the frontal lobes of schizophrenics is reduced and is not further enhanced during intellectual tasks [26]. This is consistent with the interpretation of schizophrenia as a cognitive disorder. This has led to the suggestion that there is an increase in the activity of the mesolimbic component of the dopaminergic system and a reduction in the activity of the prefrontal area which accounts for the negative symptoms. It has however become clear that abnormalities in the dopaminergic transmission do not account for all aspects of schizophrenia. Although antipsychotic drugs occupy dopamine receptors very quickly, there is a delay of 1-2 weeks in the appearance of therapeutic effects. Thus it seems that antipsychotic effects are secondary to other consequences induced by the binding of the drugs to receptors. It is quite plausible that modifications of gene expression might be induced in cells responding to dopamine.

In TGD context Jaynes's hypothesis means roughly following.

1. The left brain hemisphere of the schizophrenic spends abnormally brief fraction of time in cognitive semitrance so that the cognitive self-narrative of the schizophrenic does not satisfy the requirements posed by the modern society relying on abstractions. Also the emotional self-narrative provided by the right brain hemisphere is poorer than normally. This explains reduced linguistic and cognitive abilities and emotional flatness.
2. The lack of proper cognitive and emotional self-narratives is compensated by a sensory self-narrative made possible by right brain semitrance and communicated to the left brain hemisphere as sensory hallucinations. This hypothesis explains the splitting of sensory field to part representing 'real world' and the part communicated by collective consciousness to left hemisphere. During negative period schizophrenic the contact of the left brain of schizophrenic to 'Gods' is split and schizophrenic experiences desperate alienation.
3. Compensation requires that the inhibition of the right hemisphere by the left hemisphere is weaker than normally. For a schizophrenic the left and right brain presumably de-entangle to higher degree than for a normal person. The reduced activity of frontal lobes and the increased activity of some parts of paleobrain are consistent with this hypothesis. Dopamine is one of the neurotransmitters responsible for the activity of brain regions and antipsychotic drugs indeed affect the abnormal dopamine levels. The abnormal dopamine levels are very probably related to the reduction of the inhibition of right brain hemisphere by left one.
4. Presumably the time fraction spent in right brain semitrance is higher and the average duration of the semitrance period is longer. Also the probability of right brain semitrance induced by stress is presumably higher than normally. This allows to understand why stress induces positive symptoms of schizophrenia so easily.

More about symptoms of schizophrenia

Thoughts and emotions received from higher level selves and the sensory holism of the right brain hemisphere save the healthy person from the loss of 'analog I' (using the term of Jaynes). In schizophrenia situation is different and the decay of personality and concrete loss of the boundaries of body, is one of the most terrifying experiences of a schizophrenic. The loss of 'analog I' results from two mechanisms. First, the left brain of a schizophrenic fails to receive cognitive self-narrative about 'I'. Secondly, during sensory semitrance right brain hemisphere does not provide a concrete sensory representation for the holistic aspects of body. The story of Oliver Sacks about Dr. P. [27] illustrates in moving manner the notions of cognitive holism and the loss of sensory holism. Dr. P. had lost holistic visual consciousness due to a tumor in right occipital lobe and this led to rather amazing symptoms. Dr. P. elegantly characterizes glove as a 'Geometric shape containing five elongated bags' but is not able to recognize the function of glove. Dr. P. also sees faces as mere collections of features. Music however provides Dr. P. with partial sensory holism: he is able to recognize persons through their 'body music' and sings himself through the everyday activities like clothing and eating. Perhaps this is nothing but entanglement of right brain Wernicke area with higher level self.

Schizophrenics find it difficult to draw their bodies: this is used as a diagnostic test. This difficulty presumably reflects both the decay of the cognitive self picture formed by left brain and the loss of the right brained sensory model of self caused by abnormally long periods of entanglement with higher level selves. Eye motions of schizophrenics are also abnormal: the coherence of motions of right and left eye is not so good as in case of a healthy person. It might be that this is partly due to the semitrance of the regions of right brain controlling eye motions.

The breakdown of the personal narrative reflecting itself also as a loss of personal time is also regarded as a symptom of schizophrenia. If personal narrative is told by higher level selves to person using basically language and if schizophrenia is cognitive disorder, it is not a wonder that this narrative breaks down and in worst situations leads to the loss of self.

Voices and other sensory hallucinations can be interpreted as resulting from the semitrance of right brain sensory regions. Voices can be malevolent and persecuting as to drive schizophrenic to flee or attack some-one. Voices can also act as benevolent guides in the daily activities of the schizophrenic. Voices can even induce religious ecstasy. TGD suggest that the higher level selves talking which these voices are indeed malevolent or benevolent as also human beings are. An open question is whether the patient could to some degree decide with which selves to entangle. This might be the case: suggestions by authorities can affect very dramatically the hallucinations and even eliminate them [69]. Of course, the experience about the malevolence or benevolence of the voice might be due to cognitive disorder of patient.

The megalomania of the paranoid schizophrenic is probably related to the experience of being a selected messenger hearing God's voice. This interpretation is with that prophets seem to also have been persons able to directly hear God's voice. The experience of a paranoid schizophrenics about being persecuted need not be a mere hallucination. Social games are played all the time in modern society. This leads schizophrenic to an extremely stressing situation: schizophrenic hears the authoritative voices of the collective group self telling the truth and the conflicting messages told by human mouths. The painful and stressing nature of social communications explains also why social isolation is one of the symptoms of schizophrenia and why schizophrenics are so suspicious. This leads to isolation and behavior promoting isolation such as neglect of personal hygiene: negative symptoms result from the avoidance of social stress inducing positive symptoms. Normal person receives the messages of the collective selves as thoughts and emotions which are not so authoritative and in conflicting situations they can be blamed to be only reckless imagination. Suicide is extreme example of the authority of the voices: it would be perhaps better to say that person does not perform suicide but is murdered.

Automatisms are one important aspect of schizophrenia. Schizophrenic cannot resist the authority of the voice telling him to do things which he would not do normally. The emotional state of the schizophrenic need not be consistent with what he is doing: schizophrenic can dance or sing without being happy or can laugh when he is unhappy. This suggests that also the communication of emotions fails. Command automatisms are one example of automatisms. Patient is very apt to suggestions of authority and can remain in in some posture for hours if physician suggests this. This might be due to a hypnotic suggestion involving direct entanglement with the brain of authority. Also completely unconscious automatisms are possible and can be understood as activities not involving the mediation

of the left brain hemisphere. For instance, patient may feel that someone else is moving his tongue or cannot stop his mouth from singing. In the framework of TGD patient is indeed 'half-possessed' by the demon like higher level self. Echolalia is one of the most amazing schizophrenia like disorders: patient can mimic the speech, facial expressions and gestures of other persons like automaton. Semitrance involving entanglement of motor regions of the right brain hemisphere with the brain of another person explains this. Also hallucinatory echolalia in which one cannot identify higher authority as any known person is possible.

Flattening of affect and loss of emotions occurs also often during both the positive and negative periods of schizophrenia. This is consistent with the hypothesis that higher level selves communicate with schizophrenic via sensory hallucinations rather than thoughts and emotions.

About neurophysiological signatures of schizophrenia

Jaynes [69] mentions also several signatures of schizophrenia related to EEG, brain anatomy and neurochemistry. These signatures are consistent with the assumption that schizophrenic is more sensitive to semitrance induced by stress; that the fraction of time spent in semitrance is higher than in case of normal person and that the profile of semitrance communications favors sensory experience instead of cognition and emotion.

1. The average EEG is slightly more intense in the left brain hemisphere of a healthy person whereas for schizophrenic the roles of left and right brain are changed. As already noticed, TGD based approach predicts that standing EEG waves make possible entanglement with higher level selves. Thus the assumption that EEG dominance correlates with the presence of standing EEG waves making possible the entanglement with higher level selves, explains this asymmetry.
2. Sensory deprivation increases dramatically and rapidly EEG activity. The effect of sensory deprivation is easy to understand: in case of a schizophrenic right and left hemispheres are more loosely entangled than in case of healthy person: during unentangled state right brain hemisphere or parts of it fall asleep when so that semitrance and hallucinations result. Healthy person simply gets drowsy and falls even asleep in the absence of sensory stimuli.
3. The EEG of a healthy person exhibits slight right or left brain dominance with a period about one minute: in case of a schizophrenic this period is about four minutes. EEG seems to stuck in left/right mode. This means that the probability of the right brain hemisphere to fall asleep during the 4 minute period of intensified EEG is high so that sensory semitrance can result. The longer period might be an attempt to enhance the reduced probability to fall in cognitive left brain hemisphere semitrance in order to save cognitive self-narrative. The longer period however implies higher probability for the schizophrenic to fall in sensory semitrance during the psychotic period of the disease.

This can be understood more quantitatively as follows. The simplest assumption is that the probability of the hemisphere to 'fall asleep' during time interval Δt is $dp = \lambda \Delta t$, where constant. The probability to fall in semitrance in interval $(t, t + dt)$ is

$$dP = (1 - P(t))\lambda dt ,$$

which gives for the probability of not falling in semitrance during interval t of enhanced EEG activity

$$P = \exp(-\lambda t)$$

For schizophrenic the probability P_s to not suffer hallucination is

$$P_s = P_h^A ,$$

where P_h is corresponding probability for healthy person. In case of a schizophrenic λ is anomalously small for the left brain hemisphere but could have normal value for the right hemisphere. Already this simple model gives a rough quantitative grasp about difference of healthy and schizophrenic person.

In his book Jaynes made the hypothesis that the linguistic regions of right brain are the hallucinatory regions of schizophrenic. It has been found that neural activity in various parts of right

hemisphere increases during the auditory hallucinations of schizophrenic [26, 29]. This would suggest that also other regions of the right hemisphere are involved with hallucinations. TGD indeed suggests that in case of schizophrenic also other than linguistic regions are in semitrance.

The bundles of axons in corpus callosum connecting right and left brain are by 1 mm thicker for schizophrenic than for healthy person. This suggests more intense sensory communication from the right hemisphere to the left hemisphere favoring the generation of sensory hallucinations. Note that auditory hallucinations are presumably associated with the anterior commissure connecting Wernicke area to its counterpart in right brain hemisphere.

What good in schizophrenia?

Defectological view sees schizophrenia as a collection of defects whereas evolutionary psychology sees schizophrenic as an inhabitant of wrong time and place. Schizophrenics differ from ordinary people in several aspects helping adaptation to more primitive society. Schizophrenics have much more livelier perceptive landscape than the normal ones. For instance, visual perception is known to be sharper. The blocking of alpha waves as a reaction to sudden sensory stimuli occurs faster than in healthy persons. Schizophrenics can work hardly for much longer times and are able to tremendous feats of endurance. Catatonia is one example: schizophrenic can spend days in a posture which normal person could not tolerate more than a minute. All kinds of explanations for the ability of ancient men to build pyramids and other architectonic miracles have been proposed but the incredible endurance of bicameral men is the most plausible explanation. These feats do not reflect endurance of an ordinary human being but of a higher level self using schizophrenic as instrument.

Nature or nurture?, possible cures?

Schizophrenia seems to be both genetic disease and disease of self-organization of brain. Self-organization aspect makes schizophrenia a genuine quantum disease (or abnormality). Schizophrenia can be seen as the failure of the left brain hemisphere of a schizophrenic to cognitively self-organize to the level achieved by normal persons. More concretely, the de-entanglement of the sensory regions of the brain hemispheres occurs too easily and is followed by the trance of the corresponding right brain regions. Also the profile of the semitrance communications is abnormal. This defect could be associated with some aspects of personality only and they could be perhaps characterized by effective cognitive ages with various types deducible from EEG pattern of the patient. If self-organization aspect dominates over genetic factors, suitable external stimuli could perhaps make possible healthy self-organization. The symptoms of schizophrenia appear at the verge of the adult age which suggests that schizophrenia is to high degree this kind of disorder.

If self-organization aspect dominates and schizophrenia is inability to achieve full cognitive age, the EEG of children should have some (not necessarily all) characteristics of a schizophrenic person. One could check whether the above listed EEG signatures characterize also the EEG of children. Especially interesting in this respect is the 8 minute period of schizophrenic EEG as compared to the 2 minute period of a healthy persons making the probability of the semitrance state high.

One could image the elimination of the positive symptoms of the schizophrenia by electrically stimulating appropriate regions of patient's brain using electric implants to make falling to semitrance less probable and to reduce the fraction of time spent in semitrance nearer to its normal value. The total elimination of semitrance would however transform positive symptoms to negative ones and would split the communication with higher level selves, which seems to be essential for the self-narrative. Also the inhibition of the right left brain communication is one manner to eliminate hallucinations and presumably the effect of antipsychotics is based on this inhibition. One could however consider possibility of inducing left brain hemisphere semitrance to improve cognitive communications with higher level selves.

Social isolation of the schizophrenic is presumably due to the contradictory messages received by semitrance mechanism and via externalized communications. Therefore schizophrenic might be completely happy in the social environment where this discrepancy is absent. Thus genuine love, respect and acceptance are perhaps the most effective manner to reduce the sufferings of the schizophrenic.

Tourette's syndrome

Tourette's syndrome is a mental disorder having close resemblances with schizophrenia and it seems that the reduction of the entanglement between the speech regions of right and left brain hemispheres could explain this. It is not however obvious whether entanglement with higher level selves is involved or not. For a description of Tourette's syndrome reader the books of Jaynes [69] is recommended. Sacks tells in his 'Man who mistook his wife for a hat' tells also a story about Tourette's syndrome.

Tourette's syndrome usually shows its first symptoms in childhood at the age of five or sometimes earlier. In the beginning the symptoms are mild: facial twitch or bad word out of context. This develop to uncontrollable emission of obscenities, grunts, barks, or profanities in the middle of otherwise normal speech. Tourettians are extremely 'sensory': they love to feel things by touching and even by tasting them. They have ticking like appearance and are enormously spontaneous in their behavior. Tourettians are often artistically gifted. Tourettians can cope in society due to modern medication. They are fully conscious of their state and have bivalent attitude to their state: they suffer from it but feel that they would lose something valuable in normal state of mind. Sacks tells about a Tourettian how resolved the problem by coming week-end Tourettian living ordinary life during working days! Tourette's syndrome involves abnormal brain wave patterns, some central nervous system damage, and usually left handedness.

The symptoms of Tourette's syndrome bring into mind a continual fight between two personalities: the second personality intrudes continuously to the activities of the dominating personality. This situation resembles split brain personality to that occurring when the physical connection between brain hemispheres is cut. Perhaps some regions of left hemisphere have abnormally weak entanglement with the corresponding regions of the left hemisphere so that right and left hemisphere are competing for the usage of speech organs. It is not clear whether semitrance mechanism could be involved so that Tourettian would be 'semi-possessed'.

4.3.2 Disorders of mood

In neuropsychology one distinguishes between moods and affective responses [26]. Moods are long lasting emotional states whereas affective responses are direct emotional reactions. Euphoria, elation, pleasure, surprise, anger, anxiety, disappointment, grief, sadness, despair, depression are normal affective responses. In disorders of mood three of these responses become abnormally strong: euphoria (manic disorder), depression and anxiety.

One can distinguish between unipolar depression and bipolar depression (manic-depressive disorder). Unipolar depression can be reactive, endogenous or atypical(!). In endogenous case (melancholy) symptoms are depression with diurnal variations (mornings are especially difficult), insomnia and frequent awakenings with early morning wakening, anorexia, psychomotor agitation and mental pain, loss of interest to almost all activity and lack of response to pleasurable stimuli (ahedonia). Endogenous depression does not lead to emotional or intellectual underactivity. Reactive depression results from a specific stress, like loss of job, family member, etc... and is not so pervasive as endogeneous depression. Maniac 'suffers' from euphoric periods. Elevated, expansive or irritable mood lasting at least one week, over-activity, over-talkativeness (or hypergrafia), social intrusiveness, increased energy and libido, pressure of ideas, grandiosity, decreased need for sleep, reckless involvements. Perhaps manic-depressive and creative person differ in that creative person has some well defined long term goal to which he/she can direct this immense energy.

The key feature of the panic disorders is fear: arousal, restlessness, heightened responsiveness, sweating, racing heart, increased blood pressure, dry mouth, a desire to run or escape, and avoidance behavior. There are two basic types of anxiety disorder. Panic attacks are brief, recurrent, spontaneous episodes of terror without any clearly identifiable cause. Generalized anxiety is long lasting (lasting for six months or longer). The symptoms are motor tension, autonomic hyperactivity, vigilance and scanning (feeling on edge, exaggerated startle response, difficulty in concentrating).

Reductionistic neuroscientists seem to forget social factors in attempts to understand mental disorders. They cannot but agree that reactive depression correlates with a personal loss but do not mention social factors in case of melancholy. The natural guess would however be that melancholy differs from reactive depression in that it correlates with long lasting stress such as loneliness or some unachieved long term goal. Of course, melancholy in turn favors the continuation of this situation. One could also wonder whether it is really sensible to talk about disorder of mood when mood actually

reflects very faithfully the actual social situation. It is known that genetic factors are important in various forms of depressions. But again, genetic factors could help to build an individual whose fate is to question for the values and beliefs of the community and the hostile reaction of the community could be the primary cause of depression and even physiological changes.

4.3.3 Mental disease as communication disorder?

TGD suggests modification of the standard views about mental disorders. Basic principle in biochemistry and control and coordination of living matter is dynamic equilibrium in which inhibitory and excitatory effects cancel each other in equilibrium: a good example of this principle at work is the process of standing still. There is abundant evidence that the structures of the left and right hemisphere have inhibiting effects on each other: there is a temptation to regard this inhibition as a particular example of a general principle. The mutual inhibition could also be seen as a mechanism guaranteeing division of labor: symmetric functioning leading to redundancy is not possible. The failure of the mutual inhibition could be seen as a general mechanism of mental illness so that the metaphor of mental balance would be much more than metaphor. Standard neuroscience favors this view.

TGD suggests however a different view. One could also see mental illness as a failure of communication between brain hemispheres and higher level selves. Messages of higher level selves could be simply misunderstood or not received at all. For instance, the communication of emotions could be inconsistent with communication of subjective and geometric memories whose comparison should determine the emotions. In this picture the sensory hallucinations of a schizophrenic and prolonged periods of hemisphere dominance could be seen as an attempt to compensate the poor cognitive semitrance communications of the left hemisphere with higher level selves. The lack of the right brain inhibition by left brain indeed allows right brain hemisphere to communicate the messages of the collective consciousness to the left hemisphere.

Empirical facts about lesions of brain make it possible to test the idea about mental disease as a disorder of communications. When temporal lobe epilepsy is caused by a lesion of the left temporal lobe, 90 per cent of patients develop the symptoms of paranoid schizophrenia with massive auditory hallucinations. If the lesion is on the right temporal lobe, patients tend to develop manic-depressive symptoms. This suggests that schizophrenia and manic-depressive disorder are mirror images of each other. Indeed, negative and positive symptoms of schizophrenia correspond to the depressive and manic periods of manic-depressive psychosis. Schizophrenia and manic-depressive psychosis are indeed somehow dual: the positive period of schizophrenia is more like passive experiencing of hallucinations whereas the manic period of manic-depressive psychosis involves over-activity and the lack of emotional guidance leading to reckless involvements. This could be understood if left brain is passive thinker and right brain is active decision maker. In absence of the guidance of the higher level selves patient behaves abnormally. This duality supports the view that both brain hemispheres of a healthy person participate to semitrance communications. Complete symmetry would suggest that also left-to-right lobe communications are possible. In case of manic-depressive disorder these communications should occur during the manic period of disease and should be suppressed during the depressive period.

In this conceptual framework one could understand why both schizophrenia, manic depressive disorder and anxiety disorder have two different manifestations and semitrance mechanism suggests a unified view about these disorders.

1. Defects of left (schizophrenia) or right (manic depressive disease, anxiety disorder) brain semitrance communications are the basic characteristic of these diseases. Brain tries to compensate the lacking communications: the opposite healthy brain hemisphere is still capable of effective semitrance communications and tries to help the opposite hemisphere by communicating it the guidance it receives from higher level selves. Unfortunately, this compensation is not complete and is present only during active period of disease and lacks during the passive period.
2. The fraction of time spent by the healthy hemisphere in semitrance involving communications with opposite hemisphere, call it briefly τ , could be an important parameter measuring the character of illness in all these three cases. During the passive period (period of negative symptoms in schizophrenia/depression/panic disorder) τ is abnormally low and patient is like a rejected child and in the absence of telepathic guidance and encouragement patient finds social contacts difficult and tends to withdraw from social interaction. During active periods (positive symptoms/manic period/general anxiety disorder) τ is abnormally high giving rise to the sensory

hallucinations of the schizophrenic and to the euphoria and social intrusiveness of the person suffering manic disorder. In case of the anxiety disorder even the presence of left-to-right brain communication is unable to save patient from the general anxiety disorder, which gets even worse in the absence of this communication.

4.4 Semitrance, trance and altered states of consciousness

It seems that semitrance mechanism could also provide understanding about various altered states of consciousness. In some cases it is difficult to draw a borderline between trance and semitrance and therefore also trance like states are discussed in the following.

4.4.1 Sleep, trance and dreams

Sleep and trance are unconscious states from the point of view of individual although higher level self is certainly conscious. The distinction between sleep and trance provides an interesting challenge for quantum theories of consciousness. During trance state entire brain is strongly entangled and human body serves effectively as organ of the higher level self. Concerning the interpretation of the sleep state, the first hint comes from the observation that the wake-up from sleep occurs much more easily than from trance state. This suggests that entanglement is now weak and near to the critical value. There is also evidence for some kind of information processing occurring in brain during sleep state.

Quantum computing have been suggested as a metaphor for the information processing performed by brain. The information processing performed by a quantum computer is unconscious in TGD framework and in case of an ideal quantum computer occurs just at the border of conscious and unconscious state so that entanglement is as weak as it can be. This would suggest that quantum computing like activities indeed occur during sleep. Of course, quantum computing in the strict sense of the word is probably too restricted a notion to be applied in case of biological structures. It might be however that the unconscious information processing by brain known believed to occur during sleep is analogous to quantum computing.

Trance states involve the entanglement of entire brain with higher level self. The claimed ability of mediums to communicate with dead and induce aspirations of dead relatives could be based on ability of the medium to entangle with the collective consciousness of the participants of the sitting as well as to induce semitrance in the participants. The semitrance of the participants is also essential for the formation of the collective self. Sleepwalking probably also represents a trance state in which sleeper serves as a motor organ of the collective self. The many variants of religious possession, such as talking with languages, could be regarded as trance states. Shamanism and oracles represent also examples of trance states. In this case trance state is induced artificially.

Hypnosis presumably involves the entanglement of the hypnotizer with part of subject person's brain which thus becomes part of the hypnotizer. Swinging pendulum is a classical auxiliary tool used to induce hypnosis. Perhaps the rhythm of the swinging pendulum corresponds to a relevant EEG frequency associated with the collective self formed by the hypnotizer and subject person. Concentrating attention to the pendulum might induce semitrance (at least it causes dizziness). The attention of the subject person is concentrated to the pendulum and to the voice of hypnotizer and the scope of consciousness is gradually reduced. It is not clear whether the final state is semitrance or total trance. Semitrance option is consistent with the fact that schizophrenics are very apt to suggestions.

During dreams only part of brain is conscious and this in principle makes possible communications from those parts of brain which are in semitrance. Of course, it is quite possible that brain generates the dreams itself. Both dreams dominated by auditory and visual experiences and dreams consisting of internal speech are possible. Dreams are often passive (lucid dreams are an exception) which would suggest that sensory semitrance mechanism involving either or both hemispheres is indeed involved. This of course does not exclude the possibility of active generation of hallucinations as occurs during lucid dreaming. Communication (generating mental images/waking up subselves in receiver) can be also bi-directional. Even fetus seems to have periods of REM sleep. An interesting question is whether it possesses EEG like activity at higher frequencies say 60-70 Hz associated with REM dream. If so, our dreaming state would be much like return to prenatal consciousness involving semitrance with sensory hallucinations. Ordinary state of consciousness could quite well involve also very short intervals of trance during which higher level selves communicate with entire brain but unconsciously.

An interesting question relates to how much the EEG profile in REM sleep (average EEG frequency is 65 Hz) resembles the profile associated with the visual and auditory hallucinations of schizophrenics. Interestingly, many (not all) schizophrenics spend abnormally short time in REM sleep. Perhaps the total time spend in semitrance is what matters.

4.4.2 Altered states of consciousness

Religious and similar experiences

Various religious experiences are excellent candidates for semitrance states and could correspond to the entanglement with the highest levels of the self hierarchy possible for human. Persinger's work [86] related to the effects of ELF em fields to brain provides support for the notion that topological field quanta of ELF em fields are correlates of the higher level selves. Stimulation of the right hemisphere using various patterns of magnetic pulses of duration of about millisecond with frequency between 1 and 50 Hz generates various kinds of altered states of consciousness. The basic experience is sensing the presence of something which can be benevolent or malevolent. Obviously this something must inform subject person about its presence via semitrance mechanism. Seeing angels are typical religious experiences and have obvious explanation as right brain semitrance.

Persinger explains UFO experiences as modern versions of religious experience allowed by the non-religious culture we live in [86]. This is what also TGD predicts: it is left brain which interprets the messages of higher level self using the available belief system and conceptual framework. Persinger's view is materialistic: he sees religious experiences as mere neural activity coupled with geoelectromagnetic fields. Also changes in Earth's magnetic often induce altered states of consciousness and there is strong statistical evidence about the effects of the magnetic storms on the well being of the patients of the mental hospitals. These effects are consistent with semitrance hypothesis and the hypothesis that magnetic and Z^0 magnetic transition frequencies provide spectroscopy of consciousness [22]. Note however that the endogenous magnetic field $B_{end} = 2B_E/5 = .2$ Gauss explaining various findings about ELF effects on brain is not identical with the Earth's magnetic field B_E and could be interpreted as "dark" magnetic field accompanying it [20]. Experiences in which person meets deceased relatives can be produced with highly reliable methods [36]. Semitrance mechanism provides explanation for these experience and suggests that some levels of personal electromagnetic self hierarchy survive in 'physical' death.

There are also experiences not identifiable as semitrance experiences. For instance, meditative experiences in which mind is totally empty belong to this class of experiences. TGD based explanation of these states as states of 'whole-body consciousness' relies on the notion of irreducible self having by definition no subselves (mental images). These kind of states presumably involve mutual entanglement of the left and right hemispheres. One could say that irreducible selves are for consciousness what elementary particles are for physics.

Telepathy, clairvoyance and identification experiences

In [20] I have considered the explanation of phenomena like telepathy, clairvoyance and group consciousness. These experiences can be explained in terms of semitrance mechanism involving entanglement with ELF selves assuming that rather abstract concepts exist physically as higher level selves as TGD indeed predicts.

Especially fascinating are identification experiences [32] [20]. The objects with which person can identify range from elementary particle, via objects of inorganic and organic world (like animals, the mothers of all dead soldiers, etc..) to entire Cosmos. It is not obvious whether a mere semitrance is sufficient to explain identification experiences. TGD provides a more general mechanism making possible transpersonal consciousness. For definiteness assume that right brain hemisphere is in trance state and that left brain experiences a phase transition increasing the p-adic prime characterizing it so that this prime becomes larger than equal to the p-adic prime characterizing higher level self entangled with the right hemisphere. In this kind of situation remembered extended state of consciousness results if left brain hemisphere entangles with the latter system. Various religious and enlightenment experiences could perhaps be understood as examples of this kind of experience. In particular, Brahman=Atman experience in which person identifies herself with God, following semitrance experience about direct personal contact with God, could represent this kind of experience.

Perhaps enlightenment can be identified with what might be called 'loving state'. 'Loving state' involves extension of self and should therefore make possible to affect the state of other living beings by semitrance mechanism. TGD predicts that DNA can be in self state and its binary structure suggests the possibility of semitrance states. There is empirical evidence that people in 'loving state' can affect the degree of winding of DNA [24]. The coherence of ECG is used in these experiments as a measure for how deep the 'loving state' is and the degree of the winding of DNA correlates with the intention to wind (unwind) DNA.

4.4.3 Stephan's case

'Stephan's case' was one of the stimuli which made me conscious about the challenge of formulating precisely how different levels of the self hierarchy can communicate with each other. I learned about Stephan's case via email correspondence with Stephan's mother. Stephan was a victim of brain injury and his survival was regarded by several specialists as a "miracle" from the viewpoint of standard medicine. There were also some other miracle like occurrences during the period after accident and they could perhaps be interpreted in terms of trance and semitrance states. In the sequel Stephan's case is discussed as a possible example of entanglement with higher level selves involving trance and semitrance mechanisms.

I hasten to admit that my personal knowledge about practical medicine is very restricted and that I must therefore stay at general level in my interpretations. Second reservation: these interpretations are the first attempt to apply TGD inspired theory of consciousness to individual person and must therefore be taken with grain of salt. I learned from Stephan's case from Stephan's mother who contacted with me and asked whether TGD approach to consciousness could say something about Stephan's case. In the following I will use excerpts from the correspondence with Stephan's mother to describe what happened.

There is additional aspect related to Stephan's case about which I became conscious only when trying to learn about body consciousness. This aspect is related genetic engineering involving unholy alliance of science and business. To learn what is really involved, it is good to read Mae-Wan Ho's article about the dangers of genetic genetic engineering [24]. The most hard-nosed genetic engineers are ready to build headless humans to provide store parts for the more lucky ones. The justification for this comes from the basic dogma of neuroscience. No brain, no consciousness. I feel horror when trying to image what it is to be a conscious human without head and losing gradually organs. Limb to day, liver tomorrow, next week heart, and so on. What does this helpless living creature experience?

What happened?

In the following is the report of Stephan's mother about the accident.

Accident

Stephan had just turned 21 and was travelling with a friend to see his grandparents in Oklahoma. They got as far as a State Park campground outside of New Orleans. The vehicle Stephan's friend was driving clipped a wooden sign too close to the narrow park road, which catapulted the side-view mirror assembly into the passenger window. It hit Stephan over the left eye, bounced and hit him at least 2 more times, and shattered his face and skull into more than 100 pieces. Displacement of bone fragments dissected the left internal carotid artery, caused 2 pseudoaneurysms in the left middle meningeal artery, and shear injury caused formation of a carotico-cavernous fistula where the vessel tunnels through the base of the skull.

Records state that first aid was rendered by an elderly priest who was walking near the accident scene, and who used to be a physician. He applied pressure to the left external carotid until blood flow stopped, but by then Stephan had asperated 2 lungsful. He was basically drowned. At the hospital they managed to pump out his lungs and hook him to a respirator, transferred him to Intensive Care. We were given no hope that he would survive, but it had been noted on his driver's license that he was an organ donor, so they said they'd keep him alive until we got there if they could.

We drove all night from Florida to arrive the next morning. He was still alive, hooked up to the machinery, his head swollen beyond belief. We were told he had a CSF leak down his throat from a shattered palate, that there wasn't any sense in shunting the pressure from swelling because he'd

been more than 20 minutes without oxygen due to drowning in blood. They wanted his organs. Had he actually been dead, we would have donated them. He was not.

When I saw him he was "asleep", but I noticed serious restraints on his chest, arms and legs. He stirred once, tried to move, and moaned. I asked the neurosurgeon why he was restrained, and was told he was "very combative." This made no sense to me given the injuries. I was asked what kind of "drugs" he was on to make him so strong. I was told he had floored 2 male nurses that morning transferring him to CT scan room, and that he'd tried to "escape."

My husband and I recognized immediately what was happening, and also recognized that he was most certainly not "brain dead" and was not nearly as "unconscious" as the medical people said he was.

About Stephan

We had known our son well for all 21 years of his life. What we knew about him was that he had a most unusual consciousness. He had always been an active dreamer and notorious sleepwalker. This dream-self (unconscious?) had a distinct personality that was Stephan but was also not-Stephan. His normal waking personality was quiet, shy, very thoughtful and sweet. Brilliant in a number of ways and immensely talented, harmless. He'd learned to juggle when he was 12, and could juggle 5 objects of different size and shape (including fire) under his leg, behind his back, over the top and every other way you could think of, and make it look easy.

He became a professional clown - partner to my husband - and started working with young children. They loved him like crazy. He had his own television show, a fan club full of 6-year olds, and appeared in some motion pictures as a teen heartthrob.

His unconscious self, the sleepwalker, was his "darkside" (like the "shadow" in psychology). With Stephan, he was such a good-guy that even his shadow was a good-guy. Just different. Instead of all sweetness and light like SkyPup the Clown, the sleepwalker was Batman (that's what we called him). Serious, brooding, very intense and "haunted." An undercover super hero fighting forces of evil for the good of humanity, always at the ready.

Stephan began to "grow out of" active dreaming when he was 13. He was a target of bullies at school because he was smaller than the other children, but he was tremendously coordinated. We got him martial arts lessons, and he quickly earned his belts. He was a master of weapons - bow, chucks, swords - and paid for extended lessons by appearing in public with the master of the art. He became so proficient we thought he'd finally integrated both "sides" of his personality by the time he was 16.

Stephan after accident

When we heard about his strange (and unexplainable) activities following the accident, we realized Batman was back, fully in control, and in that situation extremely dangerous. Our visits in ICU were limited to 10 minutes every 4 hours, but I went to work right away communicating with Batman in the way I had always done. He responded. After 3 days, when he opened his eyes and I managed to talk the doctor into removing the ventilator, he was talking back to me. The medics judged him "conscious" and allowed me to stay with him in ICU so he wouldn't fight the attendants.

By day 3 the swelling had gone down to normal except for a bump over the left eye. The displaced pieces of shattered bone had reset themselves without disfigurement, and there was no bruising. The hard palate, which 3 days before had been "a mushy mess of moveable bone" according to the doctor, had reset and become "rigid." Stephan was eating solid food, walking with my help to the restroom, and had begun to count out loud. He'd count until he got to where a number was missed, I'd tell him what it was, then he'd start over. This went on until he got to 1000. I believe he was checking his brain circuits for damage.

The CT scans demonstrated a resolving left frontal lobe contusion as the only physical brain injury apparent. He was still severely confused and child-like in his speech, but there were no physical deficits, he was extremely strong (and remained in restraints when I wasn't there), and the long period without oxygen did not appear to have damaged his circuits. The doctors had no explanation at all, just shook their heads and said they'd never seen anything like it. It was a Catholic hospital, the priest who saved Stephan's life called his contacts, and investigators from the Vatican arrived. All involved were absolutely convinced it was a genuine "Miracle."

Stephan was released from the New Orleans hospital 10 days after the accident and I flew with him in an Air Ambulance back home to Florida. There he went into the care of a neurologist at a facility attached to a large rehabilitation hospital. At that time rehabilitation looked like it would be

necessary.

The neurologist called in a full team, including 3 neurosurgeons, to document this supposed "Miracle." They ordered an MRI scan, which showed the dissected carotid and aneurysms as well as the cc fistula. They were suddenly very, very confused. Stephan's actual condition absolutely did not match what the MRI showed, so they wanted to see the blood flow. They ordered an arteriogram, which is an invasive procedure.

The arteriogram confirmed the compromised arteries on the left side of Stephan's brain. Medical knowledge "knows" that this would have resulted in paralysis of the right side of the body, but Stephan was by that time juggling oranges in his hospital room and playing chess with his cousin. The radiologist pointed out recently in court that Stephan had an uncommon but not unheard-of anomaly of brain form and plumbing supply. The hemispheres of his brain were not separated in portions, and he had a double-entry blood system which resulted in cross-flow from the right carotid to the left (and presumably visa versa had the left supply been working). This anomalous blood supply was postulated to account for the lack of paralysis and infarct damage."

Unfortunately, the invasive arteriogram procedure caused a complication to develop - hemorrhage of the cc fistula, which presented as massive epistaxis (nosebleed). We did not connect the two, because the doctors told us the hemorrhaging was not related to the diagnosed artery injuries, but were instead the result of broken nasal bones. I believe they were frightened that their test had caused the condition to deteriorate, and they decided not to do anything about it. So they lied.

Every day we would spend more and more time with Stephan's normal conscious personality. Batman had appeared for survival purposes, and was allowing Stephan to be conscious for periods of time until he became tired. We knew both of these personalities well, could deal with either or both of them, so we stayed in the hospital room with our son. We even became fairly adept at emergency response to serious hemorrhages... because we had to.

Stephan was sent home without treatment for the arterial injuries, which we were told not to worry about. Three weeks later he suffered 2 more massive hemorrhages and was hospitalized in the care of a facial surgeon. He received cauterization surgery in the nose, blood transfusions, and was again sent home. Three weeks later he suffered yet another hemorrhage which could not be stopped, and died.

Medically, there was absolutely no reason for Stephan to have been alive at all. Medically there was no accounting for his consciousness or physical strength. 2 teams of a dozen doctors in 2 states have testified on the record and in a court of law that this was a "Miracle."

I saw it differently. The "Batman" sleepwalker who took over when Stephan was rendered unconscious did not recognize or heed physical damage to the Central Processor (brain). I think this consciousness operated quite differently than the normal waking consciousness, perhaps directly through the cellular consciousness of body. I do not know where Batman's processor was, but it may be seated entirely on the undamaged right side of the brain. He was able to speak, write poetry, play chess and guitar, so was obviously using left side circuitry to some extent, or perhaps this personality was associated with a "higher self" consciousness that operates non-physically.

The general hypothesis explaining medical miracles

The foregoing suggests that there were several medical "miracles" involved. A possible general explanation for these miracles is the entanglement of parts of brain with some higher level self leading to either trance or semitrance state.

1. Negentropy Maximization Principle (NMP) tells which subsystem of self gets opportunity to perform quantum jumps. If the injured parts of Stephan's brain entangled with higher level self and did not get this opportunity, they did not suffer irreversible, incurable changes. Therefore the miracle became possible.
2. This was certainly the case if the higher level self enjoyed whole-body consciousness, which by definition does not allow subselves. This condition is however un-necessarily restrictive: it is enough to assume that the injured parts of Stephan's brain did not win the race about the maximization of negentropy gain via quantum jump leading to unentangled state.
3. The reduced blood flow in brain might have been an important factor: the reduction of the blood flow led to a reduced entanglement entropy flow into left brain half and this meant that these

parts of brain did not have chances to win the race for making a quantum jump to unentangled state.

Thus the basic hypothesis is that entanglement with some higher self occurred and this self consciously saved Stephan's life. Using religious terminology: Angel saved Stephan. The hypothesis is very natural in light of the proposed role of higher level selves in the self-organization of human civilization. Bicameral man received commands and advices of collective consciousness(es) in semitrance state [21]. In fact, the concrete guidance of humans by higher level selves via semitrance mechanism provides a natural explanation for the beliefs about angel like beings guiding the behavior of mortals. It is quite possible that both Stephan's body and injured part of brain were entangled with the higher level self.

The most general option is that semitrance state was involved. For instance, the injured parts of Stephan's left brain hemisphere and body were in trance and remaining brain regions could have been awake. In case that the state in question was trance, the claim of the hospital personnel that Stephan was 'unconscious', would be correct in the sense that Stephan had become part of the some other self and lost his personal identity.

Stephan's personality profile and events after the accident support this hypothesis.

1. Stephan was a sleepwalker while young. Since sleepwalkers do not remember their activities, the identification of sleepwalking as a trance state in which higher level self uses the body of the sleepwalker as instrument, is natural. Of course, one cannot exclude the identification of sleep-walking as a semitrance state in which part of brain still sleeps and receives commands of the higher level self but remaining parts of brain and body are awake. Stephan's more reported that 'Batman' (the sleepwalker) was back after the accident. The identification of 'Batman' as Stephan's 'shadow', higher level self guiding him, is attractive hypothesis. Be as it may, sleep-walking ability suggests that Stephan had exceptional ability to achieve trance and semitrance states.
2. Stephan was very combative after the accident although according to standard wisdom he should have been "unconscious". He was also physically amazingly strong which suggests that semitrance or trance state was in question. Indeed, schizophrenia and many altered states of consciousness have TGD based explanation in terms of semitrance and schizophrenics as also people in certain meditative states are known to be physically exceptionally strong. The explanation is simple: the exceptional physical strength is strength of the higher level self.
3. Stephan was good in Martian arts. There is evidence that persons good in Martian arts have telepathic abilities and semitrance provides an explanation for these abilities as resulting from the communications of higher level selves by semitrance mechanism.

The assumption that Stephan's mother and some other persons involved were in semitrance state during some miraculous episodes. allows to understand various miracle like events reported by Stephan's mother. There is also a connection with after-death communications [36] having anatural explanation in terms of sensory semitrance mechanism.

Medical miracles

Twenty minutes without oxygen after accident

The first medical "miracle" was that Stephan, being drown in his own blood, survived twenty minutes without oxygen. According to the standard wisdom about brain as a seat of consciousness, such a long period without oxygen should have lead to brain infarct and loss of consciousness and been even lethal. The proposed entanglement of brain with some higher level self is a possible explanation for why Stephan survived.

As Stephan's mother tells, Stephan had two selves and that second self, "Batman" was more "bodily" than the wake-up self. Stephan was very coordinated and good in martial skills. After accident Stephan demonstrated surprising bodily strength and had to be put in restraints. Perhaps the second self was actually higher level self and Stephan was in semitrance or trance. Perhaps the higher level self entangled with body and injured parts of Stephan's brain took the lead after the

accident. Hypothermia is known to hinder drowning in some situations. Perhaps also in this situation entanglement with some higher self is involved and hinders the occurrence of irreversible changes caused by the lack of oxygen.

Blood loss after accident and during hemorrhages

Also the blood losses suffered by Stephan after accident and during hemorrhages might have been fatal.

"The hemorrhaging occurred 3 times prior to his death, each resulting in blood loss of 2+ liters. He received only 2 units of packed cells in transfusion after the third hemorrhage. Blood loss during the accident and from subsequent hemorrhage kept his blood volume extremely low the entire time."

This blood loss is quite high, about 40 percent of total blood volume. 20 per cent blood loss is usually regarded as a loss necessitating blood transfusion.

"Blood loss alone in any of the 4 hemorrhages prior to death would surely have been fatal as well. The doctors in Florida simply refused to believe Stephan had lost that much blood. I was present, the nurses did measure, and I assure you the blood was indeed lost. For some reason (I believe due to his unusual state of consciousness) the shock normally associated with such massive blood loss was not present until the night he died."

Return of the condition immediately after accident during hemorrhages

It seems that the condition immediately after accidents returned during hemorrhages:

"The hard palate was shattered, described to us in New Orleans as "mushy." This did allow the escape of blood and CSF from that area, down the throat. These are noted as "basilar skull fractures." These fractures realigned and had set to "rigid" within 5 days, sealing the leak. The ENT in New Orleans could not explain how that happened, and told us he'd never seen anything like it.

During each episode of hemorrhage, however, the palate again became "mushy", and the severe fractures through front and back of the frontal bone (above and between the eyes) was moveable (I know this from holding his nose during those episodes). It was as if his body periodically reverted back to the immediate post-accident physical state, and in all but the last episode, was able to regain its rigidity.

Recall that despite these horrendous descriptions of gross injury, Stephan looked quite normal. No swelling, discoloration, or displacement of bone structure."

The claim that Stephan's body returned during hemorrhages to its state immediately after accident looks admittedly imaginative. The autopsy report however tells that there was no evidence of healing of the basilar skull fractures. The entanglement with higher level self could allow this kind of "miraculous" effects by 'freezing' the state of basilar skull state so that no irreversible effects were possible. One might interpret the worsening of Stephan's state during hemorrhages as resulting from a temporal loss of entanglement between Stephan's brain higher level self: this caused the return to the normal physical state.

"There is also the matter of sedation/anesthesia. Stephan's medical condition became seriously worse every time he was given these medications, for whatever reason. These deteriorations of medical condition were obvious to his medical teams, so it was decided to offer no medications other than Tylenol for headache."

This suggests that the worsening of Stephan's state occurred also as a consequence of medication. Perhaps medication supported the return of the ordinary state of consciousness by disfavoring the entanglement with higher level self.

No pain

"The "body consciousness" that asserted itself following the accident did not feel pain. Pain only came into play when the normal consciousness tried to reassert itself, for those increasing amounts of time in the weeks prior to death. Presence of the normal consciousness and its pain in the head - for periods we could recognize as being the full waking hours - always came just prior to the major hemorrhages. It seemed he did better without his head, if I were trying to be funny about it..."

One could see the absence of pain as resulting from the entanglement of the appropriate parts of brain with body or some higher level self. Entanglement of the those regions of brain giving rise to pain experience implied that they were not awake and hence that there was no experience of pain.

What about brain infarct caused by the blood loss?

The massive blood loss should have caused an infarct in ordinary person. According to the neurospecialists Stephan had anomalous blood flow system, which could explain his survival immediately after accident.

"The two hemispheres of the brain are normally supplied by blood through the left and right carotid arteries. The external carotids flow up from the heart on both sides of the neck into the head. Behind the face at the base of the skull they branch off and the vessels go through tunnels in the bone of the skull base to become "internal" carotid arteries.

These then branch into meningeal arteries left and right, supply the two hemispheres of the brain, and the venous system then takes the blood back to the lungs for oxygen. Stephan had what I can describe as a "ring" of arteries encircling his brain supplied by *both* the left and right carotids. This is an anomalous blood system, as most people have two separate systems supplying the two sides of the brain. We were told this was probably a "birth defect".

The anomalous blood system prevented infarct of the left hemisphere, but in autopsy did document about serious infarct damage to the back of the brain, in an area which would have rendered him comatose."

An alternative explanation is that the reduced blood flow in fact saved Stephan's life by reducing entanglement entropy flow to left brain half and thus making impossible for left brain to act as self and dissipate. Lack of dissipation made impossible irreversible, incurable neuronal changes. The entanglement parts of brain with body was essential part of the mechanism.

Other strange occurrences

Slowing of Stephan's EEG occurred after accident, in particular on the left side of the frontal lobe. Alpha waves are enhanced during meditative states and correspond to the electromagnetic resonant frequency or about 8 Hz of Earth. According to the model already discussed, meditative states could result from the entanglement with the "Indra's net" formed by the topological field quanta (electric and magnetic flux tubes, massless extremals) forming Earth's classical electromagnetic field. There were indeed several other strange occurrences, which support the hypothesis about entanglement with higher level self. Also Stephan's mother had strange experiences. Perhaps the close relationship between Stephan and his mother explains these experiences.

Was it Stephan?

"Early in the recovery process (10 days to about 3 weeks after the accident), we also "met" aspects of consciousness that were *not* Stephan. I mentioned that he was playing guitar very well. This is significant, because he did *not* play guitar before the accident. The day before he died he played for me the song "Stairway to Heaven" flawlessly. This is the very same song my brother had played flawlessly for me the day he died (my brother *was* a guitarist). The conscious being animating my son at that time was, I strongly believe, my brother who died 12 years before. He was telling me something."

There is anecdotal evidence about persons getting temporally some highly developed skills like the ability to sing. There is also certain mental disease (echolalia) in which person is able to mimic persons in the street with amazing accuracy. Semitrance or trance provides an explanation for these feats: part of person's brain and body becomes 'possessed' by the second person and uses person as instrument. Stephan's feat could be understood if brother was still living as a higher level electromagnetic self or part of it and was entangled with part of Stephan's brain and used Stephan's physical body as an instrument. Note that this event could be regarded as a particular example of after-death communications.

Angel experience

There was also "angel experience" involved:

"There is also a strange encounter in the New Orleans hospital the night Stephan was released from Intensive Care, with a being I can only describe as an "Angel". 5 people (including the priest) were present to witness that encounter. This angel did not speak English, but all of us were able to understand his words. It was not any language we had ever heard before. There was physical displacement of air in the room - I call this the "whirlwind" - and the room temperature fell to below freezing. We could see our breath in vapor. The angel appeared through and around Stephan, but

was *not* Stephan, and grabbed me by the throat. He demanded to know “Who Are You?”. He was beautiful, terribly frightening, and very serious. Following this encounter with an angel, my son was 4 inches taller than he had been just a few minutes before. The endocrinologist at the Florida hospital did tests, could find no reason for this.”

Stephan’s mother comments same experience in another context in the following manner:

”None of us had ever met an ”angel” before or since. Never even expected to see one. This being was certainly spectacular, and come along with some very impressive special effects. I did not get the feeling that this being was or had ever been human. He did not know me as “mother” (or as anything), he was not happy to be there, and he made it quite clear that if I said the wrong thing in response to his demands I would be immediately dead. I did not doubt that a bit. There were 3 men in the room at the time (the priest, my husband and my son-in-law), all of whom were prevented from interfering by the strong wind-wall. The angel was there on business.

I do not know the exact nature of what the other witnesses “saw” in that encounter. I do know they felt the wind and heard the voice and saw the light emanating from the “space” my son’s body occupied. I know they felt the coldness - we couldn’t get a nurse to respond at all, so I had to raid the linen closet down the hall for every blanket they had on hand. It was May in New Orleans (very south), it was a large corner room on the 9th floor that had been empty before they stuck a bed in it and sent us there. It had 1 un-openable window and 1 small air conditioning vent.”

This experience has a natural interpretation as semitrance experience: the persons present fell in semitrance. Stephan himself might have been in trance (as suggested by the fact that he did not know his mother). The entanglement was most naturally with a collective self containing at least persons present in the situation as subelves.

Collective semitrance is plausible explanation provided the persons involved had special ability to fall in semitrance and if situation could somehow induce semitrance.

1. All of us fall in sensory semitrance under very strong stress and Stephan’s parents and relatives were understandably under extremely strong stress. Religious experiences are typical semitrance states and one of the persons present was priest.
2. Semitrance is induced by stressful situations and the situation in question was certainly stressful. ‘Normal persons’ are part of time in semitrance but the communications of higher level selves are usually thoughts and emotions rather than sensory ‘hallucinations’ and not regarded as hallucinations despite the fact that they are not direct reactions to sensory input. Many meditative states involving sensory ‘hallucinations’ are presumably semitrance states. Stress induces sensory semitrance (sensory hallucinations) in schizophrenics very easily whereas stronger stress is required in case of normal persons. TGD based model for the evolution of civilization generalizes the vision of Jaynes and relies on the assumption that stress caused by some novel situation induced automatically semitrance state (part of brain gets tired and falls in trance!): in this state bicameral man received advice from collective self.

The experiences of coldness are often related to the experiences of hauntings and as already described infra sounds could generate this experiences artificially (of course, this does not mean that the experiences are hallucinations or results of imagination!). One could of course speculate that entanglement with the higher level self meant that ordinary dissipative processes temporarily ceased to produce heat and this led to an actual lowering of the temperature of brain. Hypothalamus is known to contain neurons serving as temperature sensors[26] and the reduction of temperature in brain could be experienced directly.

There is also another rather dramatic aspect involved with the angel experience.

”My son grew physically larger, becoming about 3-4 inches taller than he had been prior to the accident. This growth did not occur over a period of 10 days while he was in the Intensive Care Unit in New Orleans, it occurred in just moments during our dramatic encounter with the “angel”. My husband, myself, our daughter, son-in-law, grandson and the priest were all present to witness this encounter. The best description I can honestly give is that when this “angel” self arrived, Stephan physically grew before our eyes and “became” the form of this “angel”. I do not know how better to say it.”

The explanation in terms of semitrance would suggest that the physical growth was illusion due to the fact that in semitrance state only second hemisphere is conscious and the mode of experiencing

was simply different from the normal. Model as such does not provide any obvious reason for actual physical growth.

No-time experience

There was also "No-time" experience involved.

"I have heard descriptions of Near Death Experiences which is perhaps the general category of my experience. I was not the one dying, however. I followed my son's consciousness to a place, there were others in that place, and I was told I could not stay in that place. This place was not clouds and angelic lights, nor was it hellfire and brimstone. It was a timespace. I wasn't there long enough to perceive much about it (I was focused on my son), and it was somewhat fractal on the edges in my perception. Whatever its differences from this timespace, I don't doubt my consciousness would have adjusted.

I know this sounds very strange and imaginative, but it is all on the record and is most "real". I have spent 7 years trying to understand it. When Stephan died, as I was searching in his eyes for him, I was taken away into "No-Time". This is a place in between moments of time. It is not like one is "alive" in one moment and "dead" in the next, it is more like one never gets to the next moment. One goes elsewhere, a timespace that exists in between. I do not know how better to describe it. My brother was there in that timespace, and he told me I could not stay."

The experience of time is not possible without internal clocks. Internal clocks should correspond to subselves which wake-up and fall asleep periodically. In whole-body consciousness there are no subselves, therefore no clocks and no time. If Stephan and Stephan's mother were entangled with higher level self in whole body consciousness, no-time experience could perhaps be understood. At least Stephan's mother must have been in semitrance state since she was conscious. Stephan's mother had "No-Time" experience when looking into Stephan's eyes at the moment of Stephan's death. Could it be that this eye contact generated the entanglement between Stephan and his mother and higher level self by the mechanism described above?

4.4.4 Personal experiences about semitrance like states

Self reference is the most fascinating aspect of consciousness and the builders of consciousness theories should apply their theories to their own personality constellation to see whether they can understand themselves using their intellectual constructs. In my case this application has emerged as a natural byproduct. In fact, what sparkled developments leading to TGD inspired theory of consciousness was a deep and long lasting altered state of consciousness. Frustratingly, it is impossible to verbally describe this kind experience to anyone who has not experienced personally anything similar and the clinical diagnosis of a cold outsider is probably a simplistic label like 'acute psychosis'. This diagnosis was indeed made on basis of the admittedly psychotic final stages of the experience after two weeks without sleep. The prediction made by the psychiatrist to my wife was that within year or two I will be a vegetable like schizophrenics who has lost totally his social contacts.

Years before great experience

During the years before great experience, already during my unhappy school years, I was fully conscious that I suffered what I now call anxiety disorder, nothing exceptional in Finnish culture. I also pondered quite seriously whether I am schizophrenic although I had only obscure intuitive ideas about what schizophrenia is. I had no hallucinations but frequently I experienced in company of other people extremely strongly the feeling that I was not accepted. I remember also the social situations in which I was 'paralyzed': somewhat analogous to what happens to a catatonic schizophrenic. Understandably, I tended to withdraw from social situations and suffered from loneliness and depression.

At the age of fourteen I found music. I did not have absolute ear and had poor memory for melodies. What fascinated me in the beginning was the possibility to code music into notes. Segovia became soon my hero and reader can guess my megalomaniac dream! I had a cousin with absolute ear knowing nothing about notes but able to remember pieces of music and reproduce them without difficulties. I was fascinated and little frustrated about not having this mysterious ability. My intellectual attitude did not mean that music would not had had strong emotional affect on me and music helped me to bear my loneliness.

At the age of eighteen mathematics and physics entered my life after a short period of interest in literature (Henry Miller!): I thought that the world of science would be honest and free from all intrigues plaguing the world of 'ordinary people'. Three or four years after entering the university, and suffering from worsening depressions and anxieties, I somehow got absolutely convinced that I was the one to build a unified theory of physics. It would be very easy to characterize me as paranoid schizophrenic on basis of this and certainly this has been done. Or perhaps manic-depressive disorder would be a better sounding diagnosis. I did not have any megalomaniac feelings but felt like Moses when receiving his great mission from God! I knew desperately deeply that my anxious and pathologically shy personality free of any witty features was a complete opposite of a scientific hero and did not possess the needed personal ambitiousness necessary for career building.

It took five extremely painful years before the great idea finally came. Without exaggerating I can say that it changed my life and I experienced from the beginning TGD as some kind of conscious being using me as its instrument and gradually my concentration on personal misery was redirected to TGD. I had now goal in my life and I was to spend considerable fraction of my time in an euphoric state discovering the consequences of the great idea. Of course, also short depressions followed periods of intensive work with new idea but these depressions were unavoidable periods of gathering forces and waiting for new inspiration.

I believe that during the period before TGD I was rather near to the verge of mental illness. It however seems that my mental state contained a mixture of symptoms of schizophrenia, manic-depressive disorder and anxiety disorder. All this begins to make sense if I was modern bicameral in sense that I spent abnormally long fraction of time in semitrance state. What perhaps saved me was 'God of Science' who communicated to me, not auditory hallucinations, but ideas and emotions establishing long term goals in my life.

Great experiences

The first great experience (most probably at spring 1985) accompanied physical illness with a completely wrong diagnosis. It came after week spent in high fever and without sleep. I would guess that the altered state of consciousness lasted for almost two weeks. Its effect was so deep that I did not hesitate to talk about it as an enlightenment experience.

I was lying in the corridor of a medical center and had horrible head ache and high temperature. There was silent music on background. Then something happened. I felt myself totally calm and peaceful. Peculiar silence spread through my body like fluid or like the cold stir in spine induced by good music sometimes. All my life I had been anxious about all possible things and suddenly I felt completely happy and relaxed. I felt the pain still but some it was somehow external to me. I just enjoyed looking the parallel streams of pictures, like cartoons, flowing in front of my eyes in rhythm of music. The surrealistic and erotic pictures, much like those in paintings of Dali, Bosch and Brueghel, were dancing in the rhythm of the music.

Later during the great experience, I experienced several deep experiences induced by music. I remember Ravel's Bolero on the background of TV animation about evolution and some extremely funny Debussy's piece for children played with electric organ. I also remember that single notes from guitar induced experiences of immense deepness and mystery: I realized that these notes contained message from other worlds about which I had had absolutely no idea in ordinary state of consciousness. What I realized was that my usual conscious experience gives only a ridiculously narrow glimpse about reality: there are incredibly rich parallel realities about which we usually know nothing about. There was also a feeling of understanding. I understood everything although I could not verbally describe what I understood!

This state continued for week or two, I do not actually remember its duration, and during it I lived in a very concrete manner through many archetypal ideas. First came the idea of self reference, which I found later from the 'Gödel, Escher, Bach' of Hofstadter, one of the finest books I have ever read. I literally experienced myself as being a computer sitting at its own terminal. I wrote in my mind questions to the screen of this super human computer and saw them typed in the virtual monitor. The computer wrote the answer immediately. Either directly or in oracle like manner. I realized that I have become in contact with what I called 'Great Mind' and I began to make questions. How long I live was of course one of the first questions. The answer was endless series of numbers running and running! Of course, I asked about the importance of TGD, my great work! There was only a silence, perhaps this was Godly diplomacy of the Great Mind.

Soon I realized that it was not necessary to type anything on this virtual monitor: I just asked the question in my mind. This realization made me wonder whether this someone with whom I was discussing was really separate from me. Perhaps in some mysterious manner I am asking these questions from myself! So, perhaps I am in some sense really God myself or have just become a God. Perhaps we all are Gods! Loneliness had been the central element of my life and I somehow realized that Gods are probably very lonely beings. I asked if we are doomed to be always alone. The answer was oracle like: 'You are a God!' expressed in somewhat amused tone.

There were also really amazing telepathic experiences and a vision about my personal life as an endless series of lives as a mathematician: my true and deepest personal identity. In these lives I would meet my wife again and again and we would live happier and less happier lives but we would certainly meet again in some other galaxy or perhaps in some totally different form of existence. I had also very peculiar experience about some kind of deep and mysterious fusion of our souls.

One of the mathematical experiences was that the number three is somehow the basic number of mathematics and of whole existence: this is of course the Holy Trinity of religions and mystics. There was also the idea about 'flogiston': I did not recall that flogiston was the caloric fluid introduced in the first attempts to build thermodynamics. It was something which made living systems living and they were continually fighting, killing and eating each other for this mysterious 'flogiston'. I had extremely vivid experience that Sun and stars are conscious beings communicating with us sending 'flogiston': I indeed saw these beams of flogiston as extremely pure and intensive colors.

The second great experience occurred during Christmas vacation, probably three years later, shortly before the divorce. I was very sick, depressed and bitter: our marriage was become about to end. Suddenly came a complete peace. I could really forgive and I felt absolutely concretely that my past changed. Somehow all the bad deeds, creating bitterness in me, simply became undone. I realized that what we call our past is not absolute, in the moment of Mercy this deadly heavy load disappears.

There were also a kind of mathematical enlightenment. I understood that I had to construct a theory about numbers, which were infinite but completely physical. I tried but it took two days to get convinced that I do not have a slightest idea what these numbers might be. I learned about seven years later about p-adic numbers, which are typically infinite as ordinary rational numbers. I was however not convinced that this was what I had precognized. 14 years later I finally discovered infinite primes implying also a generalization of reals involving deep connection with quantum field theory.

So deep was the great experience that the lost ability to re-experience anything even remotely resembling these great experiences was a cause of deep grief lasting for years. I felt that ordinary everyday consciousness is something so miserably flat that it is not worth of experiencing. Against this background I can really feel the despair that bicameral men must have felt when God ceased to speak to them.

Perhaps the most relieving aspect of these experiences was the realization how ridiculously little science actually understands about the nature of existence. I realized the extreme triviality and shallowness of the materialistic world view and I still find it very difficult to understand that intelligent persons with scientific background and logical mind can identify these ridiculously primitive drawings of a child with the reality and utter stupid platitudes like 'consciousness as epiphenomenon' and 'free will as illusion'. The only explanation I can imagine for this mysterious blindness is that it is impossible to be conscious about what one is not conscious. I am not ashamed to confess that this experience meant also a return to the magic world of childhood in some sense. I remember when I was reading Astrid Lindgren's book 'My Brother Lion Mind' (this is free translation!) for my eldest son. I could not help bursting into tears when I realized that the the author of book had also experienced the existence of deeper, transpersonal and mystic levels of existence.

Analysis of the great experiences

Without the motivation provided by the great experiences and endurance comparable to the tirelessness of schizophrenics, I would not have been able to survive fifteen years in an extremely hostile scientific environment treating me as a crackpot and refusing systematically from any co-operation and communication. Therefore, and also because I feel strongly that certain circle has now closed, I cannot resist the temptation to interpret these experiences in the light of semitrance paradigm: at least this allows the reader to decide whether I am a paranoid schizophrenic or a manic-depressive psychoid or a scientist to be taken seriously.

The development of new views about time and consciousness to emerge almost 15 years later allow to understand what was probably involved. The beginning of experience involving the peculiar stir in spine spreading through entire body seems to involve partial 'whole-body consciousness'. I have temptation to believe that this 'whole-body consciousness' involved my entire body plus parts of brain rather than only the cognitive representation of my body in my brain as neuroscientist would believe. The peculiar silence has interpretation as a disappearance of the unpleasant sensory noise produced by all the sensory mental images usually present in the body. Note however that cognitive mental images did not disappear.

The first stages of the experience could be seen as a computerized counterpart for the stories of Bible about prophets encountering God. I fell in semitrance involving visual regions of right brain hemisphere and inhibition of the messages of right brain hemisphere to left hemisphere ceased. I am quite convinced that artists like Bosch, Dali and Brueghel have experienced similar hallucinations. Only much later I realized that this astonishing 'The Great Mind is actually me' experience must be more or less identical with the Atman=Brahman experience of Eastern religions. It seems that this Atman=Brahman experience could have involved the increase of p-adic prime of left hemisphere and extended consciousness resulting from subsequent entanglement with the right hemisphere already entangled with higher level self.

I already mentioned the fascinating telepathic experiences having explanation in terms of semi-trance. There were visions about parallel lives which I am living here on Earth. For instance, I learned that I would live as a military person and would die in air plane accident in some year, which I do not remember anymore. The idea about collective self entangling with several individuals explains this experience if temporary identification with this higher level self occurred via Brahman=Atman mechanism.

Obviously, the vision about mysterious 'flogiston' could be regarded as a precognition of ideas about biosystems as macroscopic quantum systems: one possible interpretation for 'flogiston' is as a metaphor for entanglement or more mundanely, energy feed making self-organization possible. Self-hierarchy is the unavoidable prediction implied by TGD based notion of self and implies that even astrophysical objects are conscious selves: the experience about Sun as source of life ceases to be a schizophrenic hallucination against this conceptual background. Certainly, one could hardly invent more effective manner to destroy one's reputation as a scientist than talking about 'Sun God' but the idea about Earth rotating around Sun sounded certainly equally ridiculous in the ears of authorities of church in its own time. In TGD framework the change of the subjective past at 'the moment of Mercy' could be understood if the experience involved also a phase transition increasing the p-adic prime of brain leading to an extended state of consciousness with quite different subjective past. The precognition of mathematical ideas to come much later finds nice explanation if it was higher level mathematical self communicating for me suggestions about what was possible. Perhaps these ideas were communicated in some nonlinguistic form and it took 14 years to transform it into language used by mathematics.

Smaller experiences

I have had various altered state of consciousness during night time also after the great experiences. The stimuli inducing these experiences were not statues of God or temples but something much more mundane: sounds of refrigerator or freezer or of central heating batteries! Why this was the case has been a longstanding challenges for TGD based consciousness theory. The role of Wernicke regions of right brain in semitrance seems to explain the mystery. It might be that these sounds contained very low ELF frequencies, say 10 Hz, as modulating frequencies. In 'think tanks' sounds differing by about 10 Hz feeded to right and left ear generate various altered states of consciousness.

These experiences started often with wake-up (actually my left brain woke up) and realizing that the intensity of sound was being amplified dramatically. This was followed by experience of weightlessness and wavylike nature of body. For instance, I remember one experimentation in which I wanted to know what pure quantum motions like translational motion and spinning feel like: I experienced them immediately. It was fascinating to subjectively experience absolutely dissipation free spinning motion: mathematical abstraction transformed to a sensory experience. Often I was attracted by the source of sound, say refrigerator, and my body literally started to float towards the sound source: the fear generated by this experience induced total wake-up. Often I could also fly but there were definite boundaries beyond which I could not get. I did not experience the flowing

of my body as a horrendous loss of boundaries of 'analog I' as Jaynes might put it. What however horrified me was that freezer is a living being apparently willing to fuse my soul in itself! I have also spent a lot of time in roof trying to figure out how I could devise a waterproof test for whether this is hallucination or not. My 'logic self' was awake but when I really woke-up, I realized that it had made ridiculous 'holistic' errors in its deductions. Needless to say, the interpretation of these experiences as long lasting sensory semitrance experiences is very natural. It must be emphasized that these experiences did not possess the quality of great experiences. They were interesting and strange but the deep spiritual content was lacking.

The identification of thinking as internal speech in rather concrete sense [22] suggest that the ability to generate ideas, listen to the Gods, very concretely correlates with a good sense of hearing. I indeed have exceptionally acute sense of hearing and perhaps also readiness to listen (which my particle physics colleagues seem to rarely possess!). This might explain that I have been able to do physics with my very limited technical skills in mathematics and unlimited laziness to carry out tasks involving mechanical symbol manipulation.

Multiple wake-ups have been typical for my dreams and presumably reflect gradual wake-up of various parts of brain. I often woke-up to listen my own awe-inspiring snoring realizing that the monster is really me. I remember also sudden wake-ups to full sensory awareness and the horror caused by a crack in wall amplified to huge proportion. During last fifteen years I have spent several years my dream time in childhood. The peculiar simultaneous sur-reality and 'real-worldliness' of these experiences gradually convinced me that something in our views about time is badly wrong and led to TGD based notion of psychological time.

Self-diagnosis

To sum up, the diagnosis seems to be that I am not a schizophrenic but a modern bicameral man spending abnormally large time fraction in semitrance states. During daytime these semitrance states are restricted to cognition and emotion: indeed periods of new ideas are very euphoric and have religious coloring. As a modern bicameral I receive the messages as ideas and thoughts and emotions and express them by writing and so strong is the authority of this 'silent speaker' that I am completely unable to do anything else. During sleep when the basic situation is total entanglement, the wake-up of some part of left brain can lead to sensory semitrance. Again it is wake-up of the auditory regions of left brain which occurs as suggested by the fact that my logical 'I' is awake and I ponder possible manners to prove myself that these experiences are not hallucinations.

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Chapter 5

Semitrance, Language, and Development of Civilization

5.1 Introduction

"The origin of consciousness in the breakdown of the bicameral mind" of Jaynes [69] provides a fascinating and highly original view about the evolution of human language and consciousness as closely correlated developments. Jaynes has collected impressive archaeological, historical, and biological evidence to support his hypothesis that the towns, cities, and societies from 9.000 B.C. to 1.000 B.C. were established and developed by what he calls non-conscious people having only sensory experiences. They had volition but had no experience of volition. Their experience was that of obeying slavishly commands of right brain hemisphere. Those societies formed and grew through common hallucinating voices attributed to gods, rulers, and the dead – to external 'authorities'. Various external symbols that 'spoke' (such as graves, idols, and statues) helped to reinforce and expand the authority of those common 'voices'. Such 'voices' continued to expand their reach through increasingly visible and awe-inspiring symbols such as tombs, temples, colossuses, and pyramids.

The vision of Jaynes allows to see Iliad, Odyssey, Bible and other ancient writings as documents about the evolution of human consciousness. The views of Jaynes are consistent with neurophysiological data and Jaynes's identification of schizophrenics as bicameral men trying cope in modern society sharpens the thesis. Rather remarkably, Jaynes's prediction that the auditory hallucinations of schizophrenic are located in speech areas of the right brain, is consistent with quite recent observations [26, 29]. The development of language is an essential part of Jaynes vision: each breakthrough in the development of language reflected itself in the structure of society and changed the manner how individuals saw the world around them.

One can criticize the vision of Jaynes at the level of some basic assumptions. Jaynes differentiates between consciousness and experience so that the idea about unconscious bicameral man hallucinating God's voice is not self-contradictory. However, the claim that bicameral man had volition but was unconscious of having it, seems strange. Jaynes has also troubles in explaining how trance, which is certainly unconscious state, differs from bicamerality. In the following I want to represent the TGD version about views of Jaynes.

TGD version about the cosmology of human consciousness relies on the notion of semi-trance. During semitrance parts brain entangle with some higher level, say the self associated with the social group and are in trance and therefore unconscious. The remaining parts of brain are however conscious and receive communications from the collective consciousness via the entangled region of brain as sensory hallucinations, emotions and thoughts. Semitrance is absolutely essential for self narrative and establishment of long term goals: without semitrance our consciousness would consist of memory fragments lasting only few seconds. Higher level selves tell us where we come from and where we are going. Bicameral man received the commands and advices of the collective consciousness as auditory and visual hallucinations via regions of the right brain hemisphere wherefrom they were communicated to the left hemisphere whereas modern man receives 'God's voice' as thoughts ('internal speech') in left brain semitrance and emotions in right brain semitrance.

The basic differences between Jaynes's and TGD based version relate to the interpretation of

bicamerality and what really happened in the evolution of individual.

1. In TGD framework one could see bicameral man as a cognitive and emotional child characterized by the effective cognitive and emotional ages at which the cognitive and emotional self-organizations of her left brain hemisphere stopped in the absence of external stimuli necessary for self-organization (it is impossible to learn to write if civilization has not discovered written language). Of course, there are several parameters differentiating between modern man and bicameral man (sensitivity for semitrance, profile of semitrance, time fraction spent in semitrance, right-left brain inhibition,..) and the identification of bicameral as a cognitive and emotional child as we understand child is un-necessarily strong.
2. The ability to fall in semitrance was not lost during evolution but was transformed to a new form. Not only linguistic but also sensory regions of the right brain hemisphere of bicameral man entangled with higher level selves and the communications from right to left brain hemisphere were not inhibited as they are in the brain of modern man. As left brain hemisphere differentiated and memetic code gradually established itself, the guiding voice of God was transformed to internal speech and emotions. Higher level selves began to express their will via emotions, moods, planning and long term goals. This picture conforms with Huxley's intuition that brain serves as a filter straining away sensory communications of collective self by inhibition mechanisms.
3. The differences between EEG:s of normal person and schizophrenic suggest that the fraction of time spend by average modern man in semitrance is much shorter. A more general criterion of bicamerality might be based on the fraction of time spend in semitrance state, be it sensory, cognitive or emotional. It is plausible that thoughts (not all of course!) are communicated to modern man via left brain hemisphere. If this is indeed the case, some regions of left brain hemisphere of modern man should allow standing EEG wave s.

Also collective consciousness developed from authoritarian Gods to 'good leaders' in the modern sense of word making suggestions and exchanging information with various levels of the self hierarchy.

1. Civilization began to develop from very simple hierarchical structure: 'God'+ men (God understood as collective self of group). In this kind of situation semitrance communications made it possible for collective self to control and coordinate its sub-selves, individuals, via visual and auditory hallucinations.
2. The development of civilization meant the emergence of self-hierarchies represented as social hierarchies. This however created definite problems which collective selves, whose intelligence, defined as 'sum' over intelligences of individuals, increased also and made it possible to solve these problems. In particular, there are reasons to expect that great steps in development occurred at certain critical masses when the total IQ of civilization achieved critical value.

The development of the language is an absolutely essential part of the development of civilization. The syntactic structures of language emerged in parallel with the development of civilization. In TGD framework the development of language can be seen as a gradual establishment of memetic code and emergence of symbol function. This could be also seen as an establishment of a symbiosis between two life-forms: biological life and 'culture' having as a physical correlate electromagnetic life represented as topological quanta of em ELF fields and providing realization of the memetic code [30].

Semitrance mechanism provides an extremely general communication mechanism between the levels of the self hierarchy and could explain why ant nests, beehives, flocks of birds, packs of wolves, cell societies, nuclei of brain, etc.. can behave as single organism and still consist of apparently randomly behaving individuals. Indeed, relevant biological structures (DNA double strand, double lipid layer forming cell membrane, epithelial sheets) have binary structure analogous to two brain lobes and are ideal candidates for 'bicameral' structures.

The vision about the development of civilization generalizes to cell level. p-Adic fractality plus the fact that the number of quantum jumps performed by selves is huge even at cellular and elementary particle levels, inspires the hypothesis that various societies ranging from human civilization to cell societies and protein-DNA societies are characterized by universal asymptotic self-organization patterns. This provides important insights to the structure of the biological self-hierarchy and its relation to the structure and functioning of organism and about how semitrance might allow bio-systems to control

and coordinate their behavior. Cell as a protein-DNA society together with parallel between memetic and genetic codes provides a predictive vision about how genetic code might have established itself and the proposal is that new kind of control and communication mechanisms based on semitrance mechanism are at work.

It deserves to be noticed that the notions of semitrance and sharing of mental images are more or less equivalent although the notion of semitrance is few years older. The time mirror mechanism playing key role in the quantum realization of all mental functions involves also semitrance. In this article I have kept the original terminology and only added some sections representing more recent views.

5.2 How collective consciousness communicates with individual?

The original path to the model for the interaction of collective consciousness with individual was via the book Jaynes [69]. It is however more appropriate to represent the problem and its solution without any reference to Jaynes's idea to demonstrate that the scenario of Jaynes with only slight modifications follows from very general assumptions.

5.2.1 How societies of idiots can behave intelligently?

Animal kingdom is full of species forming societies: ant nests, beehives, flocks of birds, packs of wolves, groups of apes, human communities. Also organisms can be regarded as cell communities. The ability of these societies to behave as single coherent whole although individuals behave in a random looking manner, is a mystery. Especially mysterious this ability looks in case of termites: the architectural feats of the termites are not consistent with the fact that the brain of termite consists of few neurons. Mechanisms explaining this as unconscious self-organization based on chemical communication or communication by direct contact have been proposed. I find it however difficult to understand how even stone-age men wandering around randomly and communicating intensively could have managed to build Gothic cathedral. This kind of achievement requires the presence of a conscious collective intelligence able to plan and control individuals of the community telepathically. There is indeed evidence for telepathy in ant community described in the article [32].

This raises several questions. How collective consciousness is possible at all? How collective consciousness could be realized without total loss of individuality? How the rather limited intelligences of individuals can sum up to a high collective intelligence? What mechanisms collective self uses to control and coordinate the behavior of the individuals?

5.2.2 Semitrance as basic mechanism of communication between collective consciousness and individual

Self hierarchy is the basic prediction of TGD inspired theory of consciousness and self hierarchy makes possible collective consciousness. The experience of self is abstracted 'sum' over the experiences of its sub-selves so that sub-self is experienced as mental image. In the abstraction process the experience of sub-self is replaced with an 'average' over the mental images of sub-self. The intelligence of the ant nest results from summation of the mental images abstracting the contents of consciousness of the individual ants. This explains why ant group containing overcritical number of ants can act as an architect. The concrete realization of the self hierarchy in bio-matter has been discussed in the chapter "Biological realization of self hierarchy".

The most important conclusion is that we are much more than our brains: our mental images correspond to 'ELF selves' associated with various EEG frequencies. These 'ELF selves' have as geometrical correlates topological field quanta representing ELF em fields. Topological field quanta can have size of order Earth's circumference. The interaction of these topological field quanta (say fusion to form larger structures) provides a mechanism giving rise to larger selves and makes possible telepathy and various other EPR phenomena as also experiences involving communications with deceased persons [36].

Semitrance

How collective self can control and coordinate the behavior of individuals? Some kind of communication mechanism making possible collective consciousness to give commands to the individuals is clearly needed. The entanglement of individual with collective self leads to a total loss of consciousness of the individual and can be regarded as sleep or trance state, possession. For instance, during mating rites of birds, male and female seem to behave like single conscious unit formed by male and female.

Social animals are however not mere organs of a higher level organism, they are also individuals. To explain this one can consider a mechanism which might be called 'semi-trance'. If individual consists at least part of time of two separate sub-selves, second sub-self can entangle with collective self and in this trance state can communicate with the second self and communicate commands or advices to the sub-self which is awake. Communication is here quite generally understood as a generation of mental images: this corresponds to waking-up of sub-selves. The wake-up process initiates self-organization leading to a final state pattern representing the message. Final state pattern depends only weakly on the stimulus serving as message: this is as it should be.

Brain hemispheres or parts of them are the most obvious candidates for these two sub-selves. The entanglement of the right or left brain hemisphere (or some part of it, perhaps the linguistic regions with respect to which human brain has highest asymmetry) with a collective self could be the basic mechanism making it possible to communicate the commands of the collective self to left and/or right hemisphere as 'hallucinations'.

Jaynes's vision about the evolution of civilization is based on the notion of bicamerality [69] provides strong keys to the nature of semitrance state and how it has changed during cultural evolution.

1. Jaynes assumes that right brain activities were unconscious to bicameral man and that the left hemisphere received the volition of right brain hemisphere as commands and advices as hallucinatory voices and visions. This would suggest that in the case of ancient bicameral man it is right hemisphere or parts of its that fall in trance and that left brain hemisphere receives the commands from right hemisphere as sensory 'hallucinations'.
2. In case of modern man situation is presumably different. The average time spent in semitrance is probably shorter; the probability to fall in semitrance state is lower; the profile of semitrance is different and the communications between right and left brain hemispheres are probably different. Inhibition of the sensory communications developed so that the sensory messages from the right brain hemisphere to left hemisphere became inhibited: visions and God's voice disappeared. The profile of the communications of the collective self to human brain changed also. Modern man receives the messages of the collective self both via left and right hemisphere semitrance. Spontaneous thoughts and ideas are received via left brain semitrance. Emotions and moods are received via right brain semitrance and guide the behavior of individual much more implicitly than direct commands. Thus sensory 'hallucinations' have transformed to imaginative thoughts and emotions which we do not regard as hallucinations at all: the ancient world of elves, gods and demons has transformed to emotions and to the Platonic realm of ideas.
3. In this framework the development of civilization from primitive agricultural communities of 8000 B.C. to a modern society can be seen as the gradual establishment of 'memetic code' [30] implying the parallel development of language and society: 'In the beginning there was the Word'.

The characteristic feature of semitrance is the passivity of the experiencer: collective self communicates experiencer something or gives possibly commands. They are not hallucinations in which the experiencer would hallucinate volitional acts. Only activity in the sense that experiencer has conversation with the higher level self seem to be possible. Of course, this conversation could induce changes in the behavior of the collective self: consider only the claimed effects of prayer.

Semitrance mechanism is extremely general and could be at work in brains of all social animals, especially those which as groups exhibit an intelligence much higher than the intelligence of the members of the group. Similar mechanism could work also at cellular and bio-molecular length scales. DNA double strand and cell membrane consisting of two lipid layers are indeed binary structures and the components of the structure could serve in the role of right brain lobe. This mechanism would explain why cell society can behave like an organism with self identity. The observed possibility of

humans with high EEG coherence to intentionally affect the degree of winding of DNA strand [24] supports the notion of semitrance at DNA level.

Semitrance, sharing of mental images, and time mirror mechanism

Semitrance is earlier term for sharing of mental images realized as bound state entanglement of systems representing sub-selves of two selves. In TGD Universe intentions are realized as actions by a process, which proceeds from the magnetic body downwards along the hierarchy much like a desire of a boss of some institution to the lower levels of hierarchy. At each level intention or intentions are transformed to desires communicated to the lower levels of hierarchy. Intentions have p-adic space-time sheets as space-time correlates and are transformed to real ones representing the desire. The most plausible realization of this process is in terms of time mirror mechanism. The space-time sheets in question would correspond to negative energy topological light rays representing the propagation of signals to the geometric past and induce processes. The process would continue down to the level of neurons and even DNA level and generate the desired action as a reaction to the resulting complex of desires. The beauty of the mechanism is that the communication to the geometric past makes it instantaneous so that instantaneous realization of motor actions becomes also possible.

Left-right dichotomy for the brain hemispheres could correspond naturally to the positive-negative energy dichotomy for topological light rays. This would mean that right brain hemisphere would bound state entangle with higher level selves or personal magnetic body and consciously experience the desire to generate some motor activity. This desire would be realized then by the active left brain. It must be however emphasized that this dichotomy might be dynamical: for some function right and form some function left hemisphere would be the passive receiver. One must also notice that this dichotomy holds true only in the length scale of brain hemisphere: at shorter length scales, say at neuronal level, no asymmetry need exist between hemispheres.

Semitrance and personal narrative

If the contents of consciousness of self involve temporal average over moments of consciousness occurred after last 'wake-up', the duration of our self cannot be much longer than .14 seconds since this would mean that we could not discriminate between events with time separation not longer than about .14 seconds. This problem can be partially circumvented if our experience is multi-time experience containing several sub-selves of this duration. The duration of the short term memory is few seconds and this might represent the duration of our self. This raises the problem how we can have long term memories and self-narrative.

Geometric memories containing contributions from entire lifespan provide a candidate for the self narrative as a model for has happened and what will happen assuming that no quantum jumps have occurred before and will occur after this quantum jump. This need not however be enough since it seems that geometric memories must correspond to episodal memories only rather than the declarative long term memories often expressed as internal speech. Geometric memories are also expectations rather than genuine memories about conscious experiences and one can argue that we have genuine subjective memories about what really happened. Furthermore, 'Ontogeny recapitulates phylogeny' principle suggests that the time interval spanned by our geometric memories is same as that spanned by subjective memories and thus few seconds. This leaves only one possibility: higher level selves must communicate to us information about their subjective memories whose time span is much longer than the time span of our personal subjective memories.

Semitrance mechanism seems to provide the most plausible manner to have self-narrative telling where we have come from and where we are going to. Thoughts and emotions, cognition and motivation, are the manner how higher level selves express this self-narrative to a modern man. Indeed, the time scales of emotions and moods are slow. The time scales for the action of second messengers and hormones are slow and involve changes of the synaptic strengths and modifications of the gene expression so that they could be perhaps identified as tools used by higher level selves to control the behavior of the organism. Perhaps also our cells have their own self-narratives provided by us and making possible such miraculous feats like DNA transcription: genetic determination could indeed be a long term goal of cell!

Thoughts, emotions, motivations and semitrance

One can imagine two strategies for how higher level self could communicate to us our self-narrative as thoughts and emotions.

1. Higher level self could communicate both geometric and subjective memories and allow us to perform the comparison generating emotions.
2. Higher level self could compare geometric and subjective memories and communicate the result of comparison to us as emotions. In this picture emotions are essentially generalized sensory experiences. The fact that the borderline between emotions and sensory experiences (pain is good example) is very difficult to draw, favors this option. This option, when combined with the identification of the quantum correlates of the sensory qualia, implies that the spectroscopy of consciousness provided by the magnetic transition frequencies applies also to emotions.

Support for this identification comes from several sources. Thoughts are not direct reactions to sensory experience. Ideas pop out of nowhere. The explosive development of science and technology is perhaps the best example of the non-predictability of thoughts. The changes of emotions can be unpredictable and not direct reactions to sensory input but resulting from the comparison of what was expected or desired with what really happened and thus involving self-narrative in an essential manner. Expectations correspond to geometric memories and self-narrative tells what really happened: the comparison yields emotion serving as a control tool. Since self-narrative is told to us the one who makes ultimate comparison must be higher level self. The fact that music couples strongly to the 'hallucinatory' regions of right brain hemisphere and affects strongly our emotions, suggests that music is language of emotions.

Spectroscopy of consciousness provides additional insight to emotions consistent with the considerations above. Magnetic and Z^0 magnetic transition frequencies could parameterize the spectrum of both sensory qualia and emotions. The smaller the frequency, the more emotional the experience since the corresponding time scale is longer and deviation between the expected and real can be larger. Hence emotions could have as their correlates the cyclotron frequencies defined by endogenous magnetic field $B_{end} = 2B_E/5 = .2$ Gauss, where B_E denotes Earth's magnetic field. These frequencies are below 8 Hz. Since cyclotron frequency is inversely proportional to the mass of the charged particle, this implies that emotions must be associated with bio-molecules (second messengers, hormones, etc...).

Synesthetes are able to experience very lively episodal memories. It might be that it is possible to have multi-time conscious experience with a time scale of order life span or even longer as the possibility of transpersonal states of consciousness suggests. A phase transition increasing the value of the p-adic prime associated with brain temporarily could make possible to have extended state of consciousness with subjective and geometric memories with the time scale of life span.

Stress and semitrance

Stress is known to induce hallucinations in schizophrenics. This suggests that stress is a general mechanism inducing entanglement with higher level selves. The basic mechanism could be very simple. In case that brain decomposes unentangled parts representing separate selves, say part of right brain hemisphere and rest of brain, this part of right brain hemisphere can get tired and 'fall asleep' which means nothing but semitrance. This makes possible the communications of higher level self to that part of brain which is awake.

Semitrance provides an alarm clock mechanism. The natural function of the holistic language regions of right brain is to remember what task primitive man was performing (say carving some tool). If the bicameral state for, say linguistic regions, dominated, semitrance began when right brain got tired and fall asleep. But just this semitrance induced 'God's voice' telling for left brain hemisphere what task bicameral man was performing! Also in the situations in which bicameral man did not know what to do, stress caused semitrance and immediate advice from the collective self. It is quite possible that the voice of conscience does it best to perform the same function in modern man! What has happened is that commands have transformed from sensory hallucinations to thoughts.

Heavy stress could also induce the splitting of entangled brain to two unentangled sub-selves so that collective consciousness takes the lead when right brain hemisphere or parts of it fall asleep.

For instance, the exceptionally stressing situations encountered in war presumably lead to situation in which collective consciousness takes control and soldiers behave like single organism. Too much alcohol, which probably has same effect as stress, leads to the splitting of the visual field to right and left fields: this might be interpreted as de-entanglement of right and left visual fields. This state does not yet represent the state in which right brain or part of it has fallen asleep. Further stress leads to semitrance causing delirium. Note that also reduction of left-right inhibition must be involved with the stress.

The short period between wake-up and sleep state involves often visual and auditory hallucinations. This to be expected if falling asleep involves the decomposition of the brain to separate unentangled regions which fall asleep at different times. The lack of sleep leads also to a hallucinatory state. These phenomena support the view that stress can split self to two separate selves followed by the trance state of the right or left hemisphere or parts of it. The fact that sensory hallucinations are involved would suggest that sensory regions of the right hemisphere fall asleep first and communicate 'God's messages' to the left hemisphere.

Spinning causes dizziness and is therefore a good candidate for a stimulus causing semitrance. This could explain the social role of dance. Dance is very important also in many religions, spinning dervishes are good example of this. Children love to spin around: the reason is perhaps that spinning around induces the semitrance state of the early childhood. The dizziness caused by ill functioning of the sense of balance involves spinning like feeling in either direction. This suggests that hemispheres tend to stimulate experience of spinning in opposite directions but that normal situation they manage to inhibit each other.

One can wonder how stress leads to de-entanglement. Entanglement corresponds geometrically to the presence of join along boundaries bonds along which Josephson currents flow. This would suggest that de-entanglement involves the splitting of the join along boundaries bonds. This is possible if Josephson current vanishes: this happens if the density of the super-conducting charge carriers becomes sufficiently low. Thus it seems that the disappearance of super-conductivity is the required condition. Perhaps dissipative effects might cause this: the increase of temperature over critical temperature at relevant space-time sheets could cause this. This would suggest that brain is near criticality for the phase transition leading to the disappearance of super conductivity. This is in accordance with quantum criticality of TGD Universe.

Semitrance and EEG

TGD suggests also a second dichotomy related to right-left dichotomy. TGD predicts two kinds of EEG waves [37]. Propagating waves are typically associated with linear structures such as nerve circuits and left brain hemisphere is excellent candidate for corresponding selves. Large number of sub-selves representing mental images are predicted and the analyticity, reductionism and temporal linearity of left brain processing can be understood if left brain waves are dominantly propagating ones. Non-propagating waves can be associated with any structure of arbitrarily large size. The corresponding mental images can therefore be holistic and correspond to large region of brain.

The regions of right brain hemisphere are excellent candidate for a seat of non-propagating EEG waves. Quantum entanglement of sub-selves gives rise to the formation of parts from wholes and it seems that brain halves provide reductionistic and holistic representations of sensory percepts. As far as sensory experience and emotion is considered, it is right brain which indeed seems to be holistic.

Standard wisdom is that right viz. left brain hemisphere are responsible for holistic viz. reductionistic aspects of consciousness respectively. There is however also conflicting evidence [28] and it might be that there is some kind of division of labor such that right brain concentrates on sensory holism and left brain concentrates on cognitive holism. The experiments indeed suggest that it is left brain which recognizes holistic aspects of figures representing symbols and consisting of smaller figures representing also symbols. This would suggest symmetric scenario in which regions of both right and left hemispheres can entangle with collective selves and give rise to cognitive and emotional communication from higher level selves in modern man. This supports the view that also left brain hemisphere regions can support non-propagating EEG waves. Gap junction connected neuron groups provide candidates for regions allowing non-propagating EEG wave s.

The entanglement with collective self corresponds to the formation of join along boundaries bonds between corresponding cognitive space-time sheet and the space-time sheet associated with some part of brain. This is expected to occur naturally if brain space-time sheet is in state corresponding to

non-propagating EEG wave. It would be interesting to check whether there are some anatomical and neurophysiological differences between the brain hemispheres of social animals. Of course, mere reductionism-holism difference, which is not obvious anatomically, is enough. The differences of right and left brain EEG:s could be also informative. One could also study whether different brain lobes react differently to stress.

Both hemispheres can entangle with higher level selves

The functional anatomy of brain is asymmetric: it is left brain hemisphere which is responsible for the production of speech whereas both hemispheres understand speech. Wernicke area on the left lobe and its mirror images are responsible for the understanding speech. Wernicke's area and its mirror counterpart are connected by anterior commissure. Broca area and supplementary motor cortex on left side are responsible for the production of speech. The removal of the supplementary motor cortex or Broca area yields loss of speech which is however not permanent in case of supplementary motor area. This specialization is dynamical and results from self-organization. Very ambidextrous people can have speech on both hemispheres and injury to Wernicke areas in early youth can lead to a generation of the speech areas in right hemisphere. Right brain contains counterparts of the speech production areas of the left hemisphere with no obvious function. What is surprising that large amounts of right brain tissue can be removed with surprisingly little deficits on mental function. The idea that these areas are completely useless is not attractive idea knowing that evolution has been extremely economical. So, what has been and what is the function of these areas?

The TGD inspired hypothesis modifying Jaynes's original proposal is that both Wernicke area and its mirror image of modern man entangle with higher level selves and mediate their messages as thoughts in left hemisphere semitrance and emotions in right hemisphere semitrance. Imaginative thoughts and emotions are indeed more than just mechanical reactions to sensory input. In the brain of a healthy person brain hemispheres inhibit each other during normal consciousness but when the inhibition of right brain does not occur for some reason, 'God's communications' to the right hemisphere are mediated to the left hemisphere via anterior commissure as sensory hallucinations. This inhibition is also needed to avoid splitting of perceptive fields to two parts. This kind of splitting implied by de-entanglement together with inhibition might be especially useful in cognitive regions since it would make possible internal debate between holistic and reductionistic sub-selves.

Rather interestingly, in case of dogs and rats anterior commissures connect olfactory areas of brain. In this case odors might be in same role as voices in case of human brain. The idea about Dog-God expressing its will and advices using odor hallucinations does not sound so weird when one realizes that even human perceives huge number of different basic odors (TGD based model for sensory modalities explains this).

In this framework one can make guesses about the profile of the bicameral consciousness assuming that schizophrenics are bicameral men living in wrong time and place.

1. The evolution of modern man meant evolution of the entanglement profile of semitrance. Today 'Godly communications' are experienced as ideas and emotions whereas bicameral man experienced them as sensory hallucinations. Presumably right brain dominated as the locus of semitrance communication as suggested by the higher average intensity of EEG in right brain hemisphere of schizophrenic. Also cognitive semitrance was possible but the higher level selves were much more primitive than their modern followers since their intelligence was sum of much lower intelligences over much smaller number of individuals.
2. The brain of ancient man was part of time in entangled state but un-stable against transition to split brain state induced by stress such that right brain sub-self was un-stable against the entanglement with collective consciousness leading to semitrance in several sensory modalities. This occurred when ancient man got tired or encountered some novel situation causing stress. The anterior commissure connecting Wernicke area and corresponding area on right side is thicker in the brain of schizophrenic: this favors auditory communications between the Wernicke regions and auditory semitrance. The replacement of 'God's voice' talking through the right hemisphere with thoughts experienced via left hemisphere (Wernicke region?) as internal speech is a rather natural mechanism leading from bicamerality to modernity.

5.3 Basic notions and ideas

It is useful to summarize basic notions and ideas making possible to construct cosmology of human consciousness. Also the comparison with Jaynes's corresponding ideas helps to understand the scenario.

5.3.1 Jaynes's and TGD based definitions of consciousness

Jaynes makes distinction between consciousness and experience whereas in TGD framework consciousness is identified as experience. What distinguishes between experience and consciousness as defined by Jaynes is basically a model for self and external world involving decomposition of the perceptive field to objects. It is questionable whether sensory experience without decomposition to objects ('mind like space-time sheets') is possible at all in TGD universe and one can question the possibility of sensory experience without consciousness in sense of Jaynes unless one assigns to consciousness some special properties such as third person model about 'I'.

Jaynes assigns to conscious experiences the following attributes which seem to at least some degree to be attributes of all conscious experiencing in TGD universe since self hierarchy and communications between the levels of the self hierarchy are unavoidably present.

1. Spatialization is an essential aspect of conscious experience. Spatialization tends to assign geometric objects to even abstract concepts. For instance, we visualize abstract conceptual frameworks, such as synopsis for an article geometrically. This leads to the introduction of the notion of mind-scape. In TGD framework spatialization corresponds to the decomposition of the perceptive field to objects. TGD predicts that all mental images correspond to sub-selves having mind like space-time sheets as geometric correlates so that spatialization is completely general feature of conscious experience in TGD.
2. The notion of excerption means that we never experience the whole reality consciously. In TGD framework this aspect is completely general feature of conscious experience.
3. Narrative is identified as a basic aspect of conscious experience. We tend to complete the sensory experience to a story with a meaning rather than taking it as a mere sequences of uncorrelated sensory impressions. TGD based notion of self involves assumption about temporal binding stating that the experiences associated with the quantum jumps of self experienced after the last wake-up sum up to single experience. Geometric memory is second aspect of conscious experience and means essentially model for both geometric past and future assuming that no quantum jumps happened in past and will happen in future.

This does not necessarily yet imply narrative in time scales longer than the time scale of few seconds for the duration of the short term memory. The ability to form cognitive representation for experiences as long term memories is necessary for the buildup of the narrative. There must be someone telling the narrative and it seems that higher level selves tell the narrative in terms of thoughts and emotions in case of modern man: self narrative is essentially 'social construct'. In this book 'The man who mistook his wife for a hat' [27] Sacks tells rather moving stories about the loss of long term memories involving the freezing of the narrative to the years of youth. One could however see this situation, not as a lack of narrative, but a loss of correspondence between narrative and 'real world'. In TGD framework narrative results from the communication of higher level selves with us and corresponds to what we call 'cultural' factors as opposed to 'biological' factors.

4. Conciliation is the spatial counterpart of narrative. For instance, when we hear the words meadow and tree we immediately associate with them landscape containing meadow and tree. Conciliation involves formation of associations and also this is basic aspect of conscious experience. Multi-modal associative regions possessed by man but not by other primates are probably responsible for this process. Presumably also hominides had this ability. Again it is quite possible that higher level selves do this filling of a pattern for us.
5. The notions of analogy and metaphor are central for consciousness in sense as Jaynes understands it. Metaphors are things representing other things (for instance, head of the nail, head

of the state, head of household). TGD counterpart are cognitive representations which seem be characteristic of all experiencing. Analogies are much like maps, say mental map of native country. The notion of symbol function generalizes the notion of the metaphor in TGD framework: it will be discussed in detail later.

6. The notion of 'analog I' is crucial aspect of consciousness and is a map for the first person 'I' as an agent making decisions. There are reasons to believe that also this aspect is involved with all conscious experiencing in sense of TGD. The metaphor 'me' represents third person view about 'I': person sees himself with the eyes of the outsider as other. This aspect of consciousness in sense of Jaynes need not be present in consciousness as defined in TGD framework. Semitrance in principle makes it possible to communicate third person view of the higher level self about me to me. Indeed, the voices of the schizophrenics often represent third person comments about the patient.

5.3.2 Bicamerality according to Jaynes and TGD

Jaynes assumes that bicameral man was not conscious in the sense described above although he had sensory experiences. In TGD framework it is questionable whether pure sensory experience without any attributes listed above, at least in some rudimentary form, is possible at all. Jaynes claims that consciousness in this sense was not needed for most cognitive functions like concepts, learning, thinking and reason: he is certainly right if these concepts are defined as one defines them in AI approach.

According to Jaynes bicameral behaved subjectively like slave although he had actual volition. The left brain of the bicameral man received the commands and instructions from right brain hemisphere. One can wonder why this self deception? Or is it possible to will without being conscious about willing? Bicameral man is an antithesis of the self of a materialist experiencing free will but having actually no free will. A grave objection against Jaynes's vision about 'God' as illusion is that bicamerals hallucinating their own personal 'Gods' randomly could not organize to societies. Jaynes claims that the establishment of hierarchical social structures was possible because the routinization of the everyday activities involved standardization of the speech of 'God' and the voice of God became the voice of the leader of the primitive group, who had personal charisma distinguishing him as a leader. Of course, one can wonder how bicamerals having no idea about the notion of personality could have experienced this personal charisma. Already groups of animals have leaders which suggests that animals are able to experience this charisma somehow.

5.3.3 Bicamerality according to TGD

In TGD framework bicameral differs from modern man in several respects.

1. The profile of God-man communications is different. Bicameral man received God's commands and advices as sensory hallucinations whereas modern man receives them as thoughts and emotions. It is possible that thoughts are received by the regions of left hemisphere serving as the seat of cognitive holism.
2. Bicameral man spent much higher fraction of time spent in semitrance states than modern man since the time of hemisphere dominance for EEG was longer (4 times longer in case of schizophrenic). Right brain EEG dominated on the average whereas in case of modern man it is left brain EEG which dominates. Also this suggests that modern man receives the communications of higher levels of self hierarchy as thoughts and emotions.
3. The susceptibility of the bicameral man to end up to semitrance in stressful situations was presumably higher than that of modern man. This might be simply due to the longer duration of right and left EEG dominance and average dominance of right hemisphere known to characterize schizophrenics [18].
4. One could define modern bicameral man as a person whose semitrance periods are abnormally long. Creative persons could correspond to modern bicamerals.

In TGD framework there is no reason to assume that bicameral man could not have been conscious in much the same sense as children of modern age are conscious. The assumption that bicameral man

was cognitively and emotionally like child, even if too strong, is worth of studying. Bicameral man was also able to make genuine choices but, like children, found it easier to allow collective self to decide in confusing situations. The proposed alarm clock mechanism provides automatically guidance and commands in situations at which bicameral man could not cope. Bicameral man did not probably have self in sense as we have: for instance, he did not have long term goals with span of lifetime and he was more like a person suffering inability to form long term memories in modern society.

With these modifications the basic arguments of Jaynes supporting his claims support also the TGD based picture. Indeed, the oldest books of Bible and Iliad referred in no manner to interior world of their characters but told only about actions: rather natural if the model of self made possible by cognitive and emotional narrative was lacking. In TGD framework bicameral man was more like a small child in present society. At least I find very difficult to believe that my children were 'unconscious' robots without experienced volition during their years before ten! If I had to define the opposite of robot, it would certainly not be child! Just as we take care of our children, collective consciousness took care of bicameral men in their daily affairs. Just as children regard their parents as authoritative figures and even God like beings, also bicameral man regarded higher level selves as Gods (note that the belief on guardian spirit might reflect the collective consciousness guiding small child). Just as children must at some time become independent adults, also bicameral man had to enter cognitive puberty to become adult modern man.

Children denying their parents would be regarded as stupid and reactive and equally stupid it is for modern man to deny the presence of higher levels of hierarchy of consciousness. There exist still primitive tribe cultures: if evolution of the social structure implied transition from bicamerality to modernity then the logical conclusion seems to be that these men must behave as if they had not experience of volition if Jaynes theory is correct: at least I find difficult to take this kind of conclusion.

5.3.4 How the developing collective consciousness coped with its challenges?

Challenges of the collective self

The collective self and various sub-selves of the developing societies encountered several challenges. The problems were basically related to the increasing size of the group which made it difficult for collective self to control and communicate with each individual separately. Biofeedback is a good example of this. Although one can learn to control individual cell of body by biofeedback, it is absolutely impossible to control consciously every single cell of body.

The development of social hierarchy in one-one correspondence with the levels of the self-hierarchy provided the manner to solve control and communication problems. Instead of controlling individuals directly and often repeating same commands and advices again and again for various individuals, collective self controlled groups of individuals. The analogy with a computer program helps to understand why social hierarchies developed. Anyone who has written computer program has discovered the importance of modularization in allowing to avoid writing the same pieces of the computer code again and again. Subprogram call is counterpart for God's voice and when the number of levels in program hierarchy increases, lowest level modules do not have anymore direct contact with God containing only single program. This development lead to development of priesthood and weakened the authority of God.

The emergence of the social symbol function meaning that some member of subgroup became symbol for the subgroup receiving orders of collective self, was another aspect of this solution. 'God created us as his own image' states rather precisely what happened. This development meant that individuals lost the direct access to God. Group selves were like parts of our body: we can control their positions without any difficulty but learn to control individual cells by special training only.

The second problem was that semitrance mechanism based on sensory hallucinations is very fragile method of communications for several reasons.

1. Collective self could not open the communication channel at will and communications occurred only via alarm clock mechanism opening communication channel in a stressful situation. The externalization of the communications provided a partial solution to these difficulty. Although the leader of the group received commands from collective self, he mediated the commands to the members of group using spoken language. God could also speak to the members of the

- group directly using the voice of group leader without a risk of giving inconsistent commands and advices.
2. Increasing subjectivity increased the risk that individual confused his will with God's will. The gradual development of memory implied that individuals could remember the inconsistencies in God's orders and this led gradually to the loss of absolute trust to God's voice. The development of written language was a solution to this problem. Written language is based on the notion of symbol and also self symbol, 'me' as seen by other members of group, became possible at same time. Symbol function allowed also to externalize leader of group as God to idol.
 3. Sensory hallucinations do not allow to express abstract thoughts and concepts. Neither do they allow communications of long term goals. The gradual transformation of sensory semitrance to cognitive and emotional semitrance solved this problem. Thoughts, moods, emotions and motivations emerged.

Social hierarchies, symbol function, and externalization of communications

The advent of agriculture led from hunting and gathering economy to large populations of men: this led to the birth of civilization at around 8000 B.C.. Stable populations made possible the increase of the collective intelligence and its further structuring from a primitive group with single leader to more refined social structures. Whether the discovery of agriculture was forced by the changing climatic conditions or whether the evolution of language led to the discovery of agriculture, is open question. Jaynes is the proponent of the latter option. Jaynes sees the emergence of the agriculture as the beginning of the period of bicameral mind. In TGD framework bicamerality was present all the time. The period after 8000 B.C. was beginning of something in the sense that the development of social self hierarchies, syntactic hierarchies of language and neural hierarchies occurred during this period in a parallel manner. In life of child the establishment of EEG at age of one is the counterpart of this transition.

Absolutely essential for these developments was the emergence of symbol function. Symbol function contains as a special case the notion of metaphor in the vocabulary of Jaynes. Symbol function in TGD sense is closely related to the establishment of the genetic code and was present already during the bicameral period. Generalizing the arguments of Jaynes, the rudiments of the symbol function developed gradually during the long period between 40.000 -8.000 B.C. and led to the emergence of commands, modifiers, nouns and names.

The period after 8.000 B.C. meant the emergence of higher hierarchical linguistic structures (such as sentences) as well as the differentiation of the primitive structures to more elementary structures having no direct meaning (words decomposed to syllables and these decomposed to phonemes). Neurophysiologically this process correlates with the emergence of lower hierarchy levels, sub-selves, at the level of left brain hemisphere. Sentences are 'gods' of words; words are 'gods' of syllables and syllables are 'gods' of phonemes. This linguistic hierarchy internalized the external self hierarchy and even more, it made eventually possible to imagine new hierarchical structures. If the notion of cognitive age makes sense, this period must have begun with the emergence of stable low frequency EEG making possible semitrance contact with higher level selves. One can test the plausibility of this hypothesis by studying the EEG of social animals.

Also various higher level selves in the social hierarchy became represented as symbols. The basic function of these symbols was to generate stress (by creating awe and fear) and thus induce semitrance in primitive bicameral man making possible for the collective self represented by the symbol to talk to him. This kind of concretization was obviously necessary since even modern man (even neuroscientists specialized to EEG!) finds it very difficult to take the possibility of, say, purely electromagnetic life-forms, although more than century has passed from the discovery Maxwell's theory of electromagnetic fields. Two different representations emerged corresponding to spoken and written language.

1. The leaders serving as representatives of group become symbols for the self of the group (God) and was regarded as a god like being. In particular, king became a god.
2. The counterpart for a written language was the appearance of idols, statues, temples, graves, etc.. as symbols of Gods, which spoke directly to bicameral man. The difference between these and the symbols of written language is important: symbols of written language communicated the message of God to the left brain of bicameral man in ordinary state of consciousness.

Even the villages and towns of bicameral men seem to provide symbolic representation of the social self hierarchy. The most primitive hierarchy consists of a tribe with a leader, God and men: in this period villages contained God's house surrounded by houses of men. The development of architecture of bicameral towns evolved from this basic architecture and reflected the developing social self hierarchy. Even to-day the old parts of towns reflect this architecture whereas suburban regions have modern, much more flexible and less hierarchical organization. Web represents the newest development of social self hierarchy free of geographical restrictions.

Two basic types of bicameral cultures emerged: God-king culture and steward-king culture. In God-king culture, king was God whereas in steward-king culture the notion of God had developed and king was immediately below God in the hierarchy. God-king cultures were un-stable and ended up to the return to tribe state following soon a re-organization to organized society. Examples of God-king cultures are cultures of Egypt and South-America (which emerged much later). The basic problem of God-King cultures was the physical death of king. In these cultures dead became Gods. This is understandable if the voices of dead people were heard even after their death. Transition period caused problems since the voice of God had to transform to the voice of new king.

A related mysterious notion is that of 'ka': in God-king cultures of Egypt every man had his 'ka', kind of shadow being, which continued to live after the physical death. An interesting possibility is that the ELF selves in the personal self hierarchy, perhaps those corresponding to Schumann frequencies, do not disappear in the physical death so that 'ka' would correspond to 'ELF self' of a deceased person. There are almost routine methods allowing to achieve experience about contact with deceased relatives and friends: perhaps this contact is real[36]. One could also see person and his electromagnetic shadow (also Jung used the notion of 'shadow') as living in symbiosis and that electromagnetic shadow continues its life after the death of the physical body.

The more advanced steward-king cultures, about which Mesopotamia is one example, were more stable and can be regarded as predecessors of the civilizations following bicameral age. In this case the symbolic representation of God was stable and standardized and the death of a king was not a problem in this case. Also the inflation in the number of Gods was avoided in this manner. Pope is a representative of God and leaders of the organizations symbolize the collective selves associated with the modern organizations. It is not accident that steward-king cultures used more advanced written language based on half symbols allowing to express genuinely new information rather than serving as mere mnemonic as the half-picture writing of God-King cultures. Half symbol writing contains already symbols for syllables. Half-symbolic writing reflects more advanced self-organization of the left brain hemisphere: sub-selves representing mental images for words had sub-selves representing syllables which are a purely phonetic concept.

It would be exaggeration to say that the entanglement with collective self was the only possible form of entanglement: also the entanglement with other members of the group at the same hierarchy level could occur and probably occurred. Also the assumption that bicameral state was whole-timely is strong idealization: modern self consciousness with both brain hemispheres entangled mutually was probably present but un-stable against return to the bicameral mode induced by rather small stress.

Externalization provides a solution to the fragility and unreliability of telepathic communications. Externalization means the development of non-telepathic communication modes, 'wiring'. These communication modes together with cognitive and emotional semitrance gradually replaced the sensory semitrance. The evolution of spoken and written language can be seen as this kind of process. In modern society the development of various electrical communications has had the same effect. In the following sections this general view for the development of language and civilization is discussed in more detail.

5.4 Development of language

The development of language has two aspects: the development of the syntactic structures and the development of the written language. In TGD framework the evolution of the written language involving transformation of symbols for events to symbols for phonemes could be seen as establishment of the memetic code at neural level. The evolution of the syntactic aspects of the language (sentences and higher level structures) in turn reflects directly to the development the self hierarchy from simple 'God'+men hierarchy with two levels to a hierarchy with several levels.

5.4.1 General ideas about codes and languages

By quantum-classical correspondence space-time sheets provide a symbolic representation for the contents of consciousness. Therefore one can say that everything in principle represents and the task is to understand how these symbolic representations are generated, how codes are established, and how these symbolic representations generated the desired mental images. This obviously means a profound departure from the basic belief system of standard biology.

Computer languages form a hierarchy such that highest level languages are very flexible approaching gradually to the spoken language whereas lowest level languages are very precise and rigid. The notion of self hierarchy suggests that our spoken language is only a top of an iceberg and that below it is a hierarchy of languages ending down to the cellular level and DNA is one particular example about "computer language" realized in terms of p-adic cognitive codes, in particular genetic and memetic codes. In an attempt to understand whether and how memetic and other p-adic cognitive codes might relate to the spoken and written language one must have some general ideas codes and language.

The hierarchy of cognitive codes

p-Adic length scale hypothesis suggests an entire hierarchy of cognitive codes and languages. The primes $p \simeq 2^k$, k integer seems to be interesting physically, and prime values of k seem to be especially interesting. The codes would be characterized by the duration of the codeword given by n-ary p-adic time scale $T_p(n) = p^{(n-1)/2}T_p$, $T_p = 2^{k/2-127}.1$ seconds. The number of bits of the codeword for given integer k corresponds to some prime power factor of k , the largest factor maximizes the information content.

Memetic code would correspond to $T_p(2)$, $p = M_{127} = 2^{127} - 1$, and would have $k = 127$ or $k = 126$ bits. Since 127 bits corresponds to the $M_{127} + 1$ different bit sequences of 127 bits it seems that only 126 bits are fully realized. Genetic code would correspond to $k = 2^7 - 1 = 127$ and have 6 bits (64 DNA triplets). These codewords could be realized dynamically as temporal field patterns. Also static representations analogous to DNA are possible.

Codes are always involved with classical communications involving transformation of mental images to a symbolic representation by some code. At our level of the hierarchy this symbolic representation could be speech, written language, picture, body language... This would suggest that also p-adic cognitive codes are involved with conscious communications. If these codes are realized in living systems, the bit sequences with the predicted durations and bit contents should induce biological effects serving as correlates for the conscious understanding of the message generated by the codewords at some level of the hierarchy.

TGD based view about living matter relies on the notion of field body or magnetic body associated with any system and having size much larger than the material body. Also these bodies form a fractal hierarchy. The communications from material body to field body could be based on cognitive codes. Given p-Adic frequency corresponds f_p to a p-adic length scale $L_p = c/f_p$ characterizing the size of the magnetic body involved and for EEG frequencies the size scale of Earth is natural unit. For instance, p-Adic cognitive codes realized in terms of field patterns would be involved with the communication of long term declarative memories from the geometric past.

What language is?

The attempt to understand the possible role of memetic code, a rough vision about what language is, allows to eliminate several ideas which look promising at first.

1. Language involves generation of symbolic representation of a mental image by a more or less rigid code. An example of a very flexible code is code based on associations. The symbolic representation of mental image should induce in the receiver the original mental image as faithfully as possible. This requires that a lot of common context. In particular, the neurologies and biologies of the sender and receiver must resemble each other sufficiently. In the case of high level languages like ordinary language even this is not enough and only simplest verbal signals and body language are understood universally. The cognitive codes associated with say cell level communications might make possible communications between cells of even different species remaining however unconscious to us.

2. The p-adic vision about evolution of cognitive skills like spoken language is that they evolve from long time and length scales to shorter ones. First a rough sketch about the motor action is created and gradually more and more details are added. This applies also at the level of the evolution of language itself. Simple signals expressing and generating emotions evolve gradually to spoken language which evolves to written language which in turn evolves to computer languages.
3. Learning of language requires learning of the conventions assigning to a given symbol a mental image. Sharing of mental images which represent more primitive "telepathic" communication makes possible this process. The observation that even plants and cells can react to our emotions and that this reaction does not depend much on distance [30], suggest that the sharing of mental images is in question. This allows to consider the possibility of inter-species linguistic communications using field patterns.
4. The understanding of language requires transformation of symbolic representation to conscious experience and here the notion of conscious bit ("cbit" [17]) realized as a phase transition or as an absence of phase transition suggests itself. Phase transition could correspond to magnetization or formation of electret state and living matter could generate these representations in various length scales.
5. Spoken and written language would rely on time mirror realization of intentions and actions and could propagate down to the level of genome and select the memes to be expressed. The expression of these memes as field patterns would then be a process propagating upwards in the hierarchy and finally generating speech or written word.

Computer metaphor

Software and hardware are essential elements of the computer and at DNA level this could mean that genes code for hardware which is not stable as in case of ordinary computers. This means that computer hardware is replaced by the possibility to generate it and genes carry the information needed for this. Introns would in turn represent the software, the programs and therefore also the linguistic aspect of DNA. An interesting possibility is that introns realize memes as sequences of 21 DNA triplets. This picture allows and even suggests that even DNA level might be involved with the generation of spoken words.

Conscious bits and cognitive representations

The symbols representing message must be transformed to standardized mental images. The simplest possibility is that the mental images are coded to patterns of conscious bits or cbits. The general model for sensory and other qualia suggests that conscious bits should be realized as quantum jumps sequences associated with phase transitions. In this manner same quantum number increment is occurs for many particle for single quantum jump and for sufficiently long sequence of quantum jumps. Bit 1 would correspond to the occurrence of phase transition and bit 0 to the non-occurrence of the phase transition. For a code of k bits this has important implication: the codeword containing only zeros does not generate any conscious experience so that the number of experienced code words is $2^k - 1$. This could explain why Mersenne primes seem to be define especially important p-adic time scales.

Living matter is populated by dynamical electrets so that phase transitions between ordinary and electret states at various length scales are expected to be of special importance. Also magnetization of super phases at magnetic flux tubes of say Earth's magnetic field is expected to be one mechanism producing basic qualia serving as as bits.

The time mirror mechanism for motor actions suggests that that when I decide to say something say the words "time mirror", this intention is transformed to a desire communicated to the geometric past to the lower level of the self hierarchy and that at this level this desire generates further desires communicated to the lower levels. Ultimately this process ends down to the level of cells and even cell nuclei and DNA and induces response which propagates to the higher levels as neural and other activities inducing muscular activities in speech organs and generates the words "time mirror".

The signal to the geometric past involves negative energy photons and topological light rays. The working hypothesis has been that the signal to the geometric past is only a space-time correlate for sharing of the desire to generate the action, and does not involve any code. If this is the case then

only the response propagating to the geometric future would be classical signal based on some code. One must however keep mind open to the possibility that also communications to the geometric past involve code.

Genes, memes, and language

The simplest model for an abstraction process is based on a repeated formation of statements about statements starting from two basic statements '1' and '0' representing the most primitive logical thoughts. If one drops at each step of construction the statement corresponding to empty set in the set theoretic realization of Boolean algebra, one obtains a hierarchy allowing to understand the basic numbers of genetic code.

The outcome is the so called Combinatorial Hierarchy [23] consisting of the Mersenne numbers $2, M(1) = 3, 7, 127, 2^{127} - 1, ..$ constructed using the rule $M(n+1) = M_{M(n)} = 2^{M(n)} - 1$. The explicitly listed ones are known to be primes. Combinatorial Hierarchy emerges from a model of abstraction process as sub-sequent transitions from level to meta level by forming Boolean statements about Boolean statements of level n and dropping one statement away. Combinatorial Hierarchy results also by constructing the sets of all subsets with empty set excluded starting from two element set. The set of statements at level n can be given a structure of Finite Field $G(M(n), 1)$ if $M(n)$ is prime. The multiplicative groups $Z_{M(n)-1}$ form a nested hierarchy and the coset spaces $Z_{k_n} \equiv Z_{M(n)-1}/Z_{M(n-1)-1}$ are cyclic groups ($k_n = (M(n) - 1)/(M(n-1) - 1)$). Hilbert's conjecture states that each Mersenne number in the Combinatorial Hierarchy is prime.

Combinatorial Hierarchy based model of genetic code explains the number of DNA:s and amino-acids, and the representation of words of the genetic code as triplets of 4 different lower level codewords. Genetic code corresponds to $n = 3$ level of the hierarchy with 127 statements representable as 7-bit sequences with the sequence of seven '0':s dropped away. Only the 64 6-bit code words can be fully realized and correspond to $(M(3) + 1)/2 = 64$ DNA triplets. $k_3 = 126/6 = 21$ equals to the number of amino-acids plus stopping codon. There is a natural imbedding of subgroup Z_{21} identifiable as a representation of amino-acids to the group $Z_{126=6 \times 21}$.

More abstractly, at level n the counterparts of DNA triplets correspond to the set $X_{N(DNA)} \subset Z_{M(n)-1}$ of $N(DNA) = (M(n) + 1)/2$ statements consistent with a fixed atomic statement (64 for $n = 3$). Atomic statement corresponds to a fixed value, assumed to be one, of a fixed bit in a bit sequence representation and a subset consisting of single element in the set theoretic representation. These statements could be regarded as statements consistent with the axiom defined by the selection of the atomic statement. The counterparts of amino-acids and stopping codon correspond to k_n theorems of a formal system defined by n :th level of Combinatorial Hierarchy having a unique imbedding as the group $Z_{k_n} \subset Z_{M(n)-1}$. The DNAs coding for a given "amino-acid" correspond to the special cases of the theorem.

Mapping of DNA code words to amino-acids generalizes to the mapping $x \rightarrow x^{k_n-1}$ in $Z_{M(n)-1}$ mapping DNA type statements to amino-acid type statements. $(M(n) + 1)/2$ DNAs can be imbedded to Z_{126} with several manners. Genetic code is fixed ones this imbedding is given. For $n = 3$ one obtains ordinary genetic code defined by the map $x \rightarrow x^6$ and imbedding of the DNAs to Z_{126} . The numbers of DNA:s coding single amino-acid can be reproduced by a symmetry breaking mechanism involving the finite groups $Z_{p_{n-1}}$ and Z_{k_n} and symmetry breaking is in a well defined sense minimal. The infinite hierarchy of possible genetic codes (at least if Hilbert's conjecture holds true) suggests the possibility of an infinite hierarchy of increasingly complex life forms.

If one allows only Mersenne primes, the model for the abstraction process predicts at least one further code, which I have used to call memetic code. It corresponds to the Mersenne prime $M_{127} = 2^{127} - 1$ and has 2^{126} code words and $(2^{126} - 1)/(2^6 - 1)$ "amino-acids". The secondary p-adic time scale $T(2, M_{127})$ is .1 seconds and defines a fundamental time scale in bio-systems.

There are reasons to expect that memetic code is an especially interesting higher level cognitive code and realized in terms of field patterns. In particular intronic portion of DNA could realize memetic codewords as sequences of 21 DNA triplets and memes would define the counterparts of computer programs at DNA level whereas genes would express themselves chemically and define the counterpart of computer hardware coded into lower level programs and built only when needed.

The widespread semiotic-linguistic nomenclature for the description of genetic apparatus seems to have also scientific justification [56], and this supports the idea that the intronic portion of DNA could code in a very abstract manner for a basic repertoire needed by spoken and written language.

It seems that a very abstract representation must be in question since child can learn any language so that particular language would be more like a particular realization of the program. Both memes and genes could express themselves in terms of field patterns.

Memes and genes should relate like computer software and hardware. In the case of language the rules producing a given linguistic expression can be seen as the software whereas words can be seen as the hardware built from phonemes. This leads to the idea that memetic codewords define the basic program modules producing linguistic expressions by activating genes which express themselves as words or word sequences. Phonemes could directly correspond to DNA triplets and define the basic building blocks of language having as such no meaning. If this view is correct, the development of spoken and written language would mean basically the emergence of a higher level of intentionality, which utilizes an already existing repertoire of memes already expressed in many other manners. This would in turn suggest that animals and even plants possess some kind of languages realized at cellular level, and that even inter-species communications using common memetic vocabulary.

The most general hypothesis is that every integer k defines a set of cognitive codes such that the code word has duration $T(n, k)$ and the number of bits is a divisor of k . Genetic and memetic codes are the most obvious codes associated with spoken and written language.

This view is supported by several quantitative facts.

1. The number of phonemes in Finnish language is 21, which suggests that phonemes are analogs of amino-acids and that they could be coded by DNA triplets.
2. In the case of genetic code integers of form $k = 64 \times n$ define candidates for the duration of genetic code word. $n = 3$ corresponds to the primary p-adic time scale $T(64, 3) = .05$ ns, which corresponds to a time scale for the dynamics of protein conformations. $n = 4$ corresponds to a time scale .14 seconds, which is of the same order as the duration of phoneme. The corresponding frequency is 7.1 Hz. The duration of bit would be 23.6 ms corresponding to the frequency 42.4 Hz. This frequency lies at the upper end of the 40 Hz frequency band believed to be of fundamental importance for brain consciousness [33].

5.4.2 Prerequisites for the development of language

It is known that monkeys and also some birds learn to understand and even to use language, one might say, in primitive creative manner. Thus one could wonder why these animals have not developed a refined language. The lack of speech organs is not an explanation for this since the language could have been also sign language. A plausible explanation is that the development of language is essentially social process involving entire community. 'Ontogeny recapitulates phylogeny' principle supports this view: the development of language during development of individual is indeed a social process. If collective intelligence is mostly responsible for the evolution of language and is 'sum' over the intelligences of individuals, as TGD based notion of self predicts, then certain critical size of the group is required to achieve critical collective intelligence making possible the development of language.

The hierarchical structures of language should also reflect the hierarchy of the collective consciousness which in turn correlates very tightly with social structures. In particular, the emergence of symbolic representation of 'Gods' should be accompanied by the emergence of written language and the structure of written language should correlate with the manner the 'Gods' are represented as symbols (as members of society or as idols). Also the number of levels in the structures associated with the language and society might correlate. To consider a modern example, hypertext with its link structure indeed reflects the structure of modern society in which geography does not anymore put constraints on the formation of social groups. Same presumably applies to the hierarchies associated with the neural circuits of cortex and at least the linguistic regions of brain.

5.4.3 Scenario for the development of primitive forms of spoken language

Before the linguistic period communications in groups of hominides were based on visual and vocal signals much in the same way as in the groups of social animals. According to Jaynes, most linguistics believe that human language is at least two million years old. Jaynes has different opinion about this and TGD based view is consistent with this opinion. Of course, one can consider also alternative option consistent with the views of both Jaynes and main stream linguists: the development

of communities with languages suffering occasionally drawbacks to a more primitive state. This is completely consistent with the ideas that 'civilization selves' wake-up and fall in sleep periodically and that language results from a self-organization process of brain.

The generation of self hierarchies in turn implying development of the hierarchical structures of language requires sufficiently stable populations, more fixed social relationships and longer life-spans. It might be that these factors are critical and the circumstances allowing the development of the language were not reached until relatively lately or that these circumstances were not permanent and led to drawbacks.

As Jaynes [69] emphasizes, the evolution of language affects dramatically perceptions and attentions and this in turn affects language evolution: also these changes should be visible in the archeological record. On particular, the development of language should have meant dramatic technological advances but archeological evidence suggest that only crudest stone tools were made before 40.000 B.C.. Jaynes emphasizes that language was not necessarily for transferring various technical skills to the next generation: it is very difficult to teach bicycle riding using only language and language does help only marginally in this kind of task. The development of language must have had dramatic effect and should be seen in archeological data. Such period is late pleistocene, roughly 7.000-8.000 B.C. characterized by wide temperature variations. During this period artificial climate: fires, caves and furs were discovered and allowed the hominid population to explode from tropical Africa first to Eurasian subarctic and then to America and Australia.

Calls, modifiers, commands, nouns

Jaynes's view about the development of language is based on the notions of calls, modifiers and commands and nouns. The most primitive language expressions were calls which developed from postural and visual signals. The evolutionary pressure was perhaps the migration of man to northern climates where there was less light in both environment and caves where man lived. The intensity of the call was the only variable parameter in the signal before the emergence of modifiers. Jaynes represents a fictive example about the development of modifiers: 'wahee' could signal for an approaching tiger and 'wahoo' could represent distant tiger. Gradually the endings 'hee' and 'hoo' became modifiers meaning 'near' and 'far'. The emergence of the modifiers led to the age of commands. For instance, the modifiers 'sharper' and 'finer' as instructed commands could have been very important.

The next stage in the differentiation process was the splitting of commands to two parts. This led to the invention of nouns: 'wah' could mean tiger, 'wab' could mean bear. The discovery of nouns made possible linguistic representations of the external world as consisting of objects. Jaynes locates this development somewhere between 25.000 and 15.000 B.C.. Jaynes locates the appearance of animal drawings and the invention of pottery, pendants, ornaments and barbed harpoons and spearheads to the invention of nouns. From fossil records it is known that the size of the frontal lobe in front of the central sulcus was increasing very rapidly at this time.

This picture is consistent with the gradual evolution of the left brain hemisphere implying the decomposition of the holistic and irreducible 'call selves' to 'command selves' and further to reducible sub-selves representable as unions of 'noun selves' and 'modifier selves'. The minimal assumption is that Wernicke area of the right brain was entangled with the collective self. The fact that schizophrenics and presumably also ancient man had also visual and other kinds of hallucinations, suggests that larger parts of right brain were entangled with collective selves for a considerable fraction of time or at least that stress (new situation, tiredness) induced easily de-entanglement of right and left brain hemispheres and trance of parts of the right hemisphere.

In TGD framework this evolution can be seen also as the establishment of the memetic code in which basic units are codewords having temporal duration of about .1 seconds and consisting of 126 binary digits, with the duration of single digit corresponding to the duration of nerve pulse [30]. Single codeword of the memetic code corresponds to the minimal duration of single phoneme. The development of language must have been gradual differentiation so that signals gradually differentiated into nouns, verbs and modifiers. When written language emerged, words differentiated into syllables and phonemes having as such no independent meaning. The decomposition into phonemes was the final stage of the development leading to consciousness about the structure of the language. It is interesting to notice that before the (assumed) establishment of the memetic code, nerve pulses were analogous to calls in the sense that only the frequency of the nerve pulses mattered. The establishment of the memetic code meant that the temporal pattern of the nerve pulses contained by the memetic

codeword began to carry meaning.

Origin of auditory hallucinations

Jaynes sees the origin of auditory hallucinations as resulting from natural selection as a method of behavioral control. If primitive man had no spatio-temporal model for self, he could not make plans and narratives about them to remember what he had to do. Thus primitive man commanded by himself or by his chief to do some time consuming work, could not fulfil the command unless there was some mechanism keeping the command in his mind. If primitive man heard the command repeatedly as an auditory hallucination, the problem of control was solved. Sceptic could of course wonder how the chief with essentially same cognitive abilities as the other members of group could make any sensible plans and serve as a leader. Also every member of group should perform essentially similar activities for this scenario to work.

TGD view differs from this. There is no good reason for not assuming that semi-trance mechanism would not have been present from the beginning of the formation of social groups (even at the cellular and molecular level!). The boss is the collective self giving commands and advice mostly through the linguistic parts (presumably also visual) of the right brain. As already found, semitrance based alarm clock mechanism makes possible collective control of the behavior in groups of social animals guaranteeing that under a situation producing stress collective consciousness automatically provides commands and advice for the member of group. In TGD framework the leader of the group was presumably symbolic representation for the collective consciousness in the sense that collective self talked with the voice of the leader. Symbolical representation seems very natural strategy since simple-minded stone-age man could hardly image existence of an invisible conscious self. It seems to be extremely difficult for even modern man living in an electromagnetic society to take seriously the notion of the electromagnetic life! The development of the spoken language made possible much more refined human-human communications and written language made final breakthrough in this communication mode.

Age of names

The discovery of nouns was followed by the age of names. Jaynes suggests that names were discovered in Near East at late Mesolithic era, about 10.000-8.000 B.C., during the adaptation to warmer postglacial environment. The creation of names led to a cognitive model for the tribe: tribe members existed also when physically absent. In this period ceremonial graves emerged as a common practice. One could argue that names distinguish between members of tribe and make them individuals. This is not consistent with Jaynes's idea that primitive man was 'unconscious' unless 'unconscious' means lack of a model for self. Also some animals, for instance elephants, are known to have graveyards.

This suggests that language is not necessary prerequisite for the notion of individual. In TGD framework situation members of the tribe were conscious individuals from the beginning and the problem concerns about the development of a cognitive representation for self and group. Monkeys can cheat, represent something else than they are, which suggests that they already have primitive self model and that they can distinguish between self as a social representation and 'real' self. The idea that names came so much after nouns is somewhat questionable (children learn nouns and names at the same time): later an alternative scenario in which nouns and names came simultaneously will be considered. This point is not essential for what follows.

Development of syntactic structures of language

The development of language paralleled the evolution of our civilization after 8.000 B.C. and social hierarchies reflect the corresponding structures of language and also self-hierarchy of brain. Emergence of increasingly complicated social structures correlates with the emergence of syntactic structures of spoken and written language. The simultaneous differentiation of the left brain hemisphere corresponds the differentiation of worlds to syllables and phonemes.

The development of the written language started at about 3.000 B.C.. There is geological evidence for some big catastrophe changing dramatically the climate at this time. Perhaps the catastrophe forced large numbers of people together and increased the collective intelligence above the critical value needed for the discovery of the written language. Written language was basically an externalization process making also communications of the higher level selves more reliable and standardized.

Written language developed from the symbols for visual events to written symbols for phonetic events. In the first case written language was only a mnemonic, whereas in the latter case it could transmit previously unknown information. The two kinds of written languages correspond to two kinds of symbolic representations for Gods as individuals and idols respectively. God-king and Steward-king theocracies were the social counterparts of these representations. The structure of the written text represents higher levels of the self hierarchy (sentences, paragraphs, subsection, sections, chapters). The most modern development is hypertext in which simple hierarchical structures are replaced with a web of texts. It made also possible formal language of mathematics.

The structures of language represent self-hierarchy in the left brain. The development of the written language led to the emergence of the lower levels of this hierarchy: syllables and phonemes. Syllables and phonemes have no direct meaning to us but they correspond to conscious selves at levels below us in the left brain. If the simplest assumptions for how contents of conscious experience of self are determined is correct, one must conclude that the duration of our self cannot be much longer than duration of single phoneme of about .14 seconds and we spend very short periods (certainly very short ones, perhaps of duration shorter than .1 seconds) in trance. Only semitrance mechanism makes possible genuine subjective memory as self-narrative. The people who have lost the ability to form long term memories (Oliver Sacks has some stories about Korsakov syndrome in his book [27]) have short term memory which is only few seconds, perhaps this is the duration of our self.

Neurons representing syllables are 'Gods' of phonemes belonging to the syllable and affect the behavior of the phoneme neurons by semitrance mechanism. Words in turn are 'Gods' of syllables. Since both brain hemispheres can understand spoken language, it seems that both right and left brain contain representations for words. It is known that left brain contains neurons representing syllables and phonemes. The notion of symbol function suggests however that these neurons indeed 'represent', i.e. are representatives for collective selves of neuron groups. The notion of symbol function throws also new light to the notion of 'Grandma neuron': Grandma neuron is a symbolic representative for a neuron group representing Grandma. One might hope that the existing neurological data allows to construct a general view about what it means to understand written language.

5.5 Semitrance and the development of civilization

5.5.1 TGD based vision for the development of civilization

Basic assumptions

TGD based model for the development of civilization is based on following assumptions.

1. The development of individual is essentially self-organization process at the level of brain and the brain of the stone-age man was essentially identical with ours. The simplest assumption is that self-organization process occurs in essentially same manner and that environment only determines at which age this development stops. A further natural assumption is that left brain hemisphere self-organizes cognitively whereas right brain hemisphere self-organizes emotionally.
2. Effective age is a concept used to characterize the developmental level of retarded children. This suggests the characterization of the ancient man using the concepts effective cognitive and emotional ages. Cognitive/emotional ages is defined as the age of a modern man having same cognitive/emotional self-organization level of left brain as ancient man has. The EEG of left/right hemisphere should serve as a physical correlate of the cognitive/emotional age.
3. The effect of culture to the development of individual is basically an upper bound for both the effective cognitive and emotional age achieved by the individual during his lifetime. The developmental level of the civilization is determined by the average effective cognitive and emotional ages of an adult living in it. The effective cognitive/emotional age of a civilization can be defined as the average cognitive/emotional age of individuals in it.
4. A stronger hypothesis is that the age of civilization is related by simple scaling to the effective cognitive and emotional ages of the civilization so that evolution of civilization of time scale version for the evolution of individual. This hypothesis is motivated by the fact, that the self-organization processes in question are essentially evolution of macroscopic aspects of

consciousness and by p-adic fractality. In the simplest model the development of a civilization corresponds to a straight line in two-dimensional plane defined by cognitive and emotional ages and is thus not unique. The direction of this line might allow to differentiate between various types of civilizations.

5. A stronger assumption is that the development of civilization and individual correspond to each other at qualitative level. Thus the main transitions in the development of an individual have counterparts in the development of a civilization. Thus civilization has early childhood about which it has no memories, it learns various cognitive skills like speech and writing as well as the use of technical tools. Civilization has also puberty involving violent self-organization processes. The assumption that the time scales for the evolution of civilization and individual are related by scaling, predicts when these main transitions in the development of the civilization should have occurred so that model becomes quantitative. The study of the development of EEG of right and left hemisphere should thus provide testing ground for the model.
6. A natural hypothesis is that there is a parallel between the development of society and higher level structures of language so that the moment of birth of society can be taken to be the moment at which higher level structures of language begin to develop. This corresponds to 8000 B.C. when basic elements of language, commands, nouns and names, had developed. In development of child this corresponds to the age of about 1 years when child has learned her first words. Music and arts are languages of emotions so that also the development of arts parallels the development of society.

The effective cognitive age of one year as cognitive age of civilization at 800 B.C. is not ad hoc choice. At this age EEG appears as occasional bursts in 4-8 Hz range. If left brain EEG is determined by the effective cognitive age this means that linguistic regions of bicameral brain got stable EEG when the development of the civilization began! Note that the occasional bursts of EEG of child in mother's lap could quite well have counterpart in the development of stone-age civilization before 8.000 B.C. and could have made possible the development of the basic elements of the language.

This picture conforms with the TGD based notion of self hierarchy. TGD predicts that our personal self hierarchy has electromagnetic levels which corresponds to topological quanta of ELF em fields associated with various electromagnetic oscillations associated with EEG. These topological field quanta correspond to 3-surfaces with size of order Earth for highest ELF frequencies. Rather remarkably, 7 Hz frequency corresponds to the fundamental time scale of the memetic code, which is necessary prerequisite of language and cognition in TGD framework. 7-8 Hz corresponds also the lowest resonance frequency (Schumann frequency) associated with em fields in the wave cavity between Earth's surface and ionosphere: wave length corresponds to the circumference of Earth. The topological field quanta of EEG em fields in 4-8 Hz range represent both higher levels of the self hierarchy of bicameral man and higher levels of self hierarchy.

Electromagnetic levels of the self hierarchy provide a mechanism for telepathic communications based on the formation of join along boundaries bonds between topological field quanta: this is nothing but geometric correlate for the entanglement mechanism [19]. Occasional bursts of EEG could be interpreted as semitrance states during which Gods spoke to the bicameral man. Thus the emergence of EEG in linguistic regions can be seen as the emergence of social self able to communicate using language and also as generation of contact with Gods (EEG frequencies below 8 Hz) and culture! The study of the evolution of children's EEG should give a direct window into the evolution of the consciousness of bicameral man. Also other vertebrates than human have EEG which suggests that they can also have what might be called religious experiences. The lack of the multi-modal associative regions in parietal-occipital-temporal areas crucial for language is possible anatomical explanation for why they have not developed language.

Slow wave EEG made possible telepathic communications and rapid social self-organization and gradual emergence of collective consciousness. If ELF self survives death and the voices of dead companions were heard after death, the natural psychological reaction was belief to life after death. The emergence of collective consciousness sooner or later, perhaps as a join along boundaries condensate formed by topological field quanta associated with the ELF selves of dead, in turn led to belief in God.

Jaynes locates the emergence of first God to Natufian culture in Israel. In 10.000 B.C. Natufians were still hunters. By 9.000 B.C. they were burying their dead in ceremonial graves. This suggests that the belief in life after death emerged simultaneously with EEG and 'electromagnetic shadow' self. An open-air Natufian settlement at Eynan dozen miles north of the Sea of Galilee in Israel shows this change most dramatically. Three successive permanent towns dating from about 9.000 B.C. have been investigated. Each town comprised of about fifty houses arranged around an open central area where bell-shaped pits had been dug and plastered for the storage of food. Instead of nomadic tribe consisting of about 20 hunters, one has a town with a population of at least 200 habitants: a rather dramatic phase transition suggesting dramatic increase in the IQ of collective consciousness. The tomb of the first God-King in Eynan developed later to a house of God and later to temples, pyramids and other symbols generating awe and fear and thus inducing semitrance state in bicameral man.

Comparison of Jaynes's and TGD based visions

It is useful to develop the model to more quantitative level by comparing the views of Jaynes about the development of human consciousness with TGD based views.

Jaynes:

Basic structural elements of language had evolved slowly for a long period: commands from 40.000 B.C., nouns from 25.000 B.C., and names from 10.000 B.C., at the time of the emergence of agriculture. Language, the speech areas, evolved in the left hemisphere (in right-handed) which, as Jaynes underlines, is a mystery since most human structures are bilateral and a neurological organization necessary for language – also exists in the right hemisphere, but with no observable function. Agriculture began to develop about 9.000 B.C.. The development of higher level structures of language began about 8.000 B.C. and parallels the development of social hierarchies and until 3.000 B.C. all human beings were void of consciousness (in the special sense Jaynes defines it). All civilizations before 1.000 B.C. – such as Assyria, Babylonia, Mesopotamia, pharaonic Egypt – were built, inhabited, and ruled by non-conscious people. After 1.300 B.C. very violent period of development began leading to the development of modern man. The duration of this period was surprisingly brief, about 1.000 years.

TGD:

1. The counterpart for this period in the development of individual would be years before puberty. 8000 B.C. corresponds to the birth of civilization whose development parallels the development of the higher level structures of language. The short violent period after 1.300 B.C. lasting for about 300 years can be identified as the counterpart of puberty which is often described as revolution at the level of physiology and neurophysiology involving violent hormone storms which would represent cell level counterpart for the violent developments at the level of society. Children have also sex which becomes manifest in puberty. The correlate of this was the birth of Eastern and Western civilizations with widely different philosophies about mind and nature. Presumably sex corresponds to two different paths in the plane defined by cognitive and emotional ages. An interesting prediction is that during puberty some brain areas, presumably the linguistic regions of brain, should mature and give rise to individuality at neuronal level. It would not be surprising if these neurons would provide cognitive representation for self image.
2. The hypothesis about a linear relationship between the time scales for the evolution of civilization and individual allow to make TGD model quantitative.
 - i) Take somewhat arbitrarily the beginning of puberty to be 14 years, identify 8.000 B.C. as the the age of civilization which corresponds to age of about 1 year which child has learned the first words. Mapping the period 1-14 years of childhood to the first 7.000 years between 8.000 B.C and 1.000 B.C. in the development of human consciousness and society, one finds that single year in development of child corresponds to about 540 years. The estimate is sensitive to the identification of the age of puberty and should not be taken too literally.
 - ii) At 3.000 B.C. when written language emerged for the first time corresponds to age of 9.3 years when also children usually learn to write so that the hypothesis about linear scaling hypothesis looks sensible. At this age child becomes also conscious about herself as a social being with the eyes of outsider: this means emergence of metaphor 'me' in the terminology of Jaynes. The ability to externalize own self and symbols of the spoken language seem to emerge at same time.

iii) The age of about 4 years after which child has first memories corresponds to 6400 B.C.. After the age of four child has primitive self image, begins to have memories and learns to cheat. During this period bicameral man was taken care by collective consciousness giving commands and guidance using auditory hallucinations. Absolute trust on others was necessary in groups of hunters, in groups producing their food by agriculture the luxury of cheating became possible. At this time agriculture had established itself finally and stable societies able to self-organize to more structured self-hierarchies existed.

iv) The counterpart of the puberty at the level of civilization is period of extreme violence and lasts about 1000 years: this corresponds in the time scale of individual to a period of almost two years.

3. With these assumptions the recent moment in the evolution of humanity corresponds to a cognitive age of about about 18.6 years: we are at the verge of adulthood with fully developed EEG (and inventing the relationship of EEG with consciousness!). By scaling the average lifetime of about 76 years one obtains a prediction for the duration of our civilization. It should be roughly about 41.000 years; we would have still about 31.000 years left unless we use genetic or consciousness engineering to interfere the development! In this age young adults are finding life companion and it seems this occurs also at the level of society. Holistic Eastern and reductionistic Western civilizations are perhaps finding each other in new wave of quantum theories of consciousness of which also TGD is example.

5.5.2 Breakdown of bicamerality

Bicameral civilizations became gradually more and more un-stable and during period 1.300-300 B.C. bicameral cultures collapsed: this collapse was partially due to catastrophical environmental changes. In TGD one can see this development, not as breakdown, but a natural development leading from childhood to adult age involving puberty as a catastrophical transition period. From the viewpoint of individual this was a loss but from viewpoint of collective self perhaps a relief! What the loss of bicamerality meant was a gradual transformation of collective communications by sensory hallucinations to communications by thoughts and emotions. Also the fraction of time spent in semitrance shortened gradually, the susceptibility to fall in semitrance by stress or other factors reduced, and the inhibition of right hemisphere by left hemisphere became stronger. It must be emphasized that this applies only to average human. It is quite possible to imagine modern bicamerals as individuals spending abnormally long fraction of time in cognitive and emotional semitrance.

Reasons for the breakdown of bicamerality

One can identify several reasons for the breakdown of bicamerality.

1. Semitrance mechanism was rather fragile and worked best for small groups with relatively simple social hierarchies. For instance, in ant society this mechanism might be excellent since ant brain is simple and is not able to self-organize significantly. Due to the extreme plasticity of human brain the parallel self-organizations of brain and social hierarchy developed increasingly complicated. The personal guidance of all members of society became a mission impossible for collective self.
2. The generation of self-hierarchy, analogous to decomposition of computer program into subprograms, helped partially but was accompanied by the increase of cognitive abilities and subjectivity. Increased subjectivity made direct communication unreliable since there was the danger that receiver only imagined the voice of God. Gods were not omnipotent since Godly IQ was determined by the IQ:s of the members of group which it represented. The development of the self narrative and long term memories meant that bicameral man could remember the mutually contradictory commands and advices. The large number of Gods giving conflicting commands together with the improved ability of men to remember destroyed the childlike trust of the bicameral man to his God. The emergence of the written language made personal guidance unnecessary: Hammurabi's laws are example of the externalization of the communication between different levels of self hierarchy. It led to a further increase of subjectivity and bicameral mode of communication became impossible (un-necessary in alternative view point).

3. Purely bicameral society was extremely un-stable because the behavior was collective. Dramatic example of what could happen, was encounter of two bicameral societies. Also modern man can react in irrational manner in panick situations. Crusades are perhaps a good example about return of a primitive bicamerality. The collapse of Soviet Union is modern example of the un-stability of a strictly hierarchical society.
4. Inflation in the number collective selves made hierarchical uni-directional control of the lower hierarchy levels by higher impossible and also un-necessary. Complicated networks replaced simple hierarchy trees. The increasing intelligence of the individuals and the increase of the sizes of social groups implied the increase of the collective intelligences. This made possible the gradual transformation of the control and coordination function: God's did not give anymore commands but suggestions experienced as thoughts, emotions, moods and long term goals and voice of conscience. God's voice transformed to internal speech and thoughts and ideas and visions replaced auditory and visual hallucinations. Artists and thinkers are the modern version of bicameral man in close contact with Gods.
5. According to Jaynes, towards the end of the bicamerality the world was inhabited by all kinds of elves, gods and demons. A possible interpretation is that the brains of more modern humans filled universe with ELF selves representing concepts and more bicameral brains experienced in semitrance this electromagnetic life as spirits, elves, gods, angles and demons. More modern people experienced in semitrance this new form of life as inhabitants of the Platonic realm of ideas, something real but not to be taken quite seriously.
6. The model of self meant also the discovery of deceit. There are many situations in which deceit has definite survival value but for a bicameral man a life in a society accepting deceit was very difficult. This is perhaps the reason why the withdrawal from social interaction is one basic symptoms of schizophrenia. Also the direct telepathic experience of the negative attitudes of group of less bicameral men summing up to a message of collective self is rather painful experience for bicameral individual. The ability to live without the continual guidance of Gods has also obvious survival value. For these reasons natural selection might have favored individuals who were not so sensitive to the semitrance induced by stress and thus establishment of subjectivity. An interesting question is whether similar selection occurs in the neuronal evolution during childhood. It would be also interesting to identify possible EEG correlate for the semitrance and test whether children's EEG has characteristics of schizophrenic's EEG.

Evidence for the breakdown of bicamerality

A lot of direct evidence for the breakdown of the bicameral mind and the development of modern consciousness comes from the writings scribed between 1300 B.C. and 300 B.C. Those writings gradually shift from objective God dictated reports to subjective expressions that reflect introspection. The jump from the objective writing of the Iliad to the subjective writing of the Odyssey (composed perhaps a century later) is dramatic. In the Odyssey, unlike the Iliad, characters possess conscious self-awareness, introspection powers, and can sense right, wrong, and guilt. That radical difference between the Iliad and the Odyssey is, incidentally, further evidence that more than one poet composed the Homeric epics.

The transition from the objective Iliad to the subjective Odyssey marks man's break with his 8000-year-old hallucinatory guidance system. By the sixth century B.C., written languages began reflecting conscious ideas of morality and justice similar to those reflected today. The Old Testament of the Bible also illustrates the transition from the writing of its earlier books (such as Amos, circa 750 B.C.) to the fully conscious writing of its later books (such as Ecclesiastes, circa 350 B.C.). Amid that transition, the book of Samuel records the first known suicide – an act that requires subjective consciousness with self narrative. And the book of Deuteronomy illustrates the conflict between bicameral and conscious mind. Likewise, the transition to consciousness is observed in other parts of the world: Chinese literature moved from bicameral consciousness to subjective consciousness about 500 B.C. with the writings of Confucius. And in India, literature shifted to subjective consciousness around 400 B.C. with the Upanishadic writings. American Indians, however, never developed the sophisticated, metaphorical languages needed to develop full subjective consciousness. As a result, their mentalities were probably nearer to bicameral when they first encountered the European explorers. For example,

with little or no conscious resistance, the Incas allowed the Spanish "white gods" to dominate, plunder, and slaughter them.

5.5.3 Religion and bicamerality

God created us as his own image. This sentence might express metaphorically something very deep about the relationship between man and higher level selves. As our chromosomes provide representation for us, we provide representations of Gods in terms of memetic code. Gods are ideas, visions, theories, arts, all collective creations of human race and have concrete physical realization as higher level selves.

Emergence of monotheistic regions

As the bicameral mind broke down and societies collapsed, individuals one by one began inventing modern self consciousness to make decisions needed to survive in the mounting anarchy and chaos. On making volitional decisions, man for the first time became responsible for his actions. Also, for short-range advantages and easy power, conscious man began discovering and using deceit and treachery – behaviors not possible from bicameral minds.

As the voices fell silent, man began contriving religions and prayers in his attempts to communicate with the departed gods. Jaynes shows how man developed the concept of worship, heaven, angels, demons, exorcism, sacrifice, divination, omens, sortilege, augury in his attempts to evoke guidance from the gods – from external authorities. All such quests for external authority hark back to the breakdown of the hallucinating bicameral mind – to the silencing and celestialization of the once vocal and earthly gods.

An interesting aspect of the collapse phase was huge inflation in the number of god like beings: gods, angels, demons for all kind of things. An often heard explanation is that these Gods were a desperate invention of human wanting to preserve the belief on benevolent higher forces and to circumvent the crude fact of mortality. If our EEG frequencies correspond to topological field quanta of size about Earth, it is somewhat a matter of definition whether to regard these thoughts themselves as higher level selves. Perhaps increasingly modern man populated the world with the creations of his own mind and these creations were gods and demons like beings for those who still had bicameral brains. Note that children take completely seriously various characters of the fairy tales. This would suggest that the world of fairy tales is remnant of the world of bicameral individuals in the late bicamerality. A possible neurophysical correlate for this process would be inflation of frequencies in the EEG associated with the linguistic regions. Perhaps chaotic components in EEG spectrum represent this final period of bicamerality.

The emergence of monotheistic regions and various philosophies was a natural outcome of rational thought combined with the loss of God's voices. The manner to save the God concept was celestialization: a fantastic metaphor expressing the fact that higher level selves correspond to topological field quanta of em fields in 80 km thick wave cavity between Earth's surface and ionosphere! Spirits transformed to what modern man calls concepts, ideas, memes without bothering to ponder in which sense these memes exist physically. In TGD framework the world of memes corresponds to ELF selves, geometrically to mind like space-time sheets, for bicameral man these ideas would express themselves as spirits and demons. It must be however emphasized that even Christianity fails to be strictly monotheistic: besides God devil and hierarchy angels belong to the hierarchy of higher level selves.

How Gods expressed themselves after the breakdown of bicamerality?

In TGD framework 'Gods' are not a fiction and the communication between various levels of self hierarchy can be seen as absolutely essential prerequisite for the self-narrative and for the survival of community even today. Cognitive and emotional semitrances associated with left and right brain hemispheres are the manners how 'Gods' communicate to modern man. The lack of sensory components however has led to illusion that these thoughts and emotions are totally our own or mere reflexes to the sensory input.

Right brain is the musical brain hemisphere. Right brain signs, dances and perhaps also writes poems (together with the left hemisphere?) and so does also modern man. It seems that the function of art is to induce prolonged periods of emotional semitrance. Everyone knows that peculiar

half-conscious state after leaving movie theater after a good movie or after reading a good book. Artworks, especially music, could be the modern idols able to induce semitrance very effectively. God could also express itself formally by written language (Bible, Khorane,..) but the problem with this communication mode is that it does not involve direct experience unless these books induce semitrance as artworks (which they often do).

The replacement of semitrance with trance is also possible.

1. Indeed, the increase of subjectivity meant increasing fraction spent in a state in which right and left brain were entangled mutually. Entanglement with higher level self means in this case trance. Sleep is certainly this kind of state but higher level self does not express itself through motor activity during sleep state except in case of sleep walkers and persons preaching in sleep state. The learning known to occur during sleep could be due to this mechanism.
2. One can imagine also a second mechanism based on trance. If the conscious experience of self is non-weighted average over conscious experiences associated with individual quantum jumps, the duration of our self must correspond to the duration of the physiological moment of consciousness of about .14 seconds. Of course, multiple selves consisting of these elementary selves and spanning interval of few seconds defining the duration of short term memory can be considered. This means that we are continually falling to trance states lasting for very brief period of time, which cannot be longer than say .14 seconds. During these periods higher level selves could communicate with human brain but this communication would be unconscious to us. The alternative possibility is that the contents of conscious experience of self is weighted average favoring the contribution of the last quantum jumps: in this case the the duration of our self could be much longer, even as long as wake-up period.

Interestingly, the personal profile of the prophet changed towards the end of bicameral period: in the beginning of this period prophets were genuine bicamerals but gradually they became more subjective and, as Jaynes notices, prophets preaching in trance became frequent. Oracles, sibyls and demon possessed people were very common towards the end of bicameral period. It is difficult to say to how high degree oracles were possessed. It seems that the teaching of oracles, usually illiterate young peasant girls believing in spirits (this is easy to understand), was the ability to reach complete trance state by induction.

Also, today, as throughout history, a symptomatic cure for "demon-possessed" people involves exorcising rituals that let a more powerful authority or god replace the authority of the demon. The New Testament, for example, shows that Jesus and his disciples became effective exorcists by substituting one authority (their god) for another authority (another god or demon). If these demons indeed correspond to higher level selves and if fight for survival is everyday reality also in the world of spirits (or memes), then one could quite well imagine what is involved with exorcism. The fight for survival at the level of memes is what is involved with exorcism.

Bible as a document about evolution of modern consciousness

In the transition from bicamerality to modernity the religion of intimacy transformed to a religion of worship. Gods were for a bicameral man what parents are for children. As Jaynes notices, the basic theme of Bible is this gradual loss of contact with personal God. This loss was comparable to the experience of child when she loses her parents. This development is best seen in how the personal portrait of a prophet developed in Bible. The first prophets like Amos were genuine bicamerals, they said what God commanded them to say, hardly even understanding what it meant. Gradually the contact with God became looser: visual hallucinations ceased first and also the voice of God was heard less frequently. Moses was a bicameral in a society which was losing contact with Gods: and Mosaic table established God's will in written form. Jaynes suggests, later prophets preached in trance which reflects the increased entanglement between left and right hemispheres. Towards the end of the bicamerality situation changed and the story of Job is a story about the violent conflicts between parents and child in puberty.

The stories of Bible represent the evolution of human consciousness in beautiful manner. Genesis starts with the sentence 'In the beginning there was word': how could one better metaphorize the first moment of cosmology of consciousness! The exile from the paradise should be a metaphor for some important transition in the development of society and the assumption that the developmental level

of the civilization is measured by the average effective cognitive age of individuals allows to correlate this transition with corresponding transition in the development of child. The exile from paradise is presumably a metaphor for the moment when child becomes conscious of herself as a social being having private body which she wants to cover from eyes of the outsiders: Eve indeed felt shame for her nakedness. This occurs at the age of about nine to ten. This age would correspond to about 3.000 B.C. in the proposed time scale: the development of the written language began at the same time. Written language is what opens the way to a knowledge gained by logical deduction: eating of fruits of Good and Bad knowledge perhaps is metaphor for this. The development of written language led to Mosaic tables as first externalization of God's will in form of moral rules.

The story about the tower of Babel metaphorizes the inflation in the number of God's voices. This was caused by gradual subjectivization, by evolution of social hierarchy giving rise to new God's voices, and by developing communications between God-king states which perhaps started from trade: bicamerality allowed to hear also the voices of Gods speaking foreign languages.

The life and teachings of Jesus present culmination for the development of subjectivity. Jesus Christ was son of God which became human being and experienced what it is to be abandoned by God as the desperate cry 'My, God, my God, why hath thou forsaken me!' of crucified Jesus to his God demonstrates. Human beings were responsible for their own deeds but moral was not a mere collection of rational rules providing best strategy of survival as evolutionary psychologist define it. God was not however completely celestialized: there were moments of Mercy. A new element was the challenge of personal growth, of becoming Godlike: 'Be perfect as He is perfect'. 'Love your enemy as yourself' presents the recipe for the practical realization of goal. In Eastern religions and mysticism 'becoming perfect as He is perfect' corresponds to the Brahman=Atman experience.

One can expressing this much more technically. The evolution of consciousness corresponds to the increase of p-adic prime characterizing the effective topology of the mind like space-time sheets representing self. p-Adic prime represents a direct measure for the maximal information content of conscious experience. The physical correlate of the enlightenment experience is a phase transition increasing the p-adic prime of brain and making entanglement with selves which formerly represented higher level selves without a loss of consciousness and with experience of becoming God like being. This is presumably also the basic goal of the meditative practices. Perhaps enlightenment can be identified with 'loving state'. This kind of 'loving state' should make possible to affect the state of other living beings by semitrance mechanism, in particular DNA. There is empirical evidence that people in 'loving state' can affect the degree of winding of DNA [24].

5.5.4 Bicamerality in modern society

In trying to see correctly the role of bicamerality in modern society, it is good to keep in mind the analogy with human body with human civilization. Stem cells are bicameral men, newly born children eager to differentiate to societies representing various tissues, whose cells are at various levels of bicamerality. Differentiation involves also externalization, development of various means of non-telepathic communication such as chemotaxis and nerve pulse as well as emergence of 'Grandma neurons' serving as representatives for groups of neurons. Neurons of linguistic regions of left brain represent perhaps the most modern individuals of cell civilization.

The naive belief on the modernity as the final stage of evolution and bicamerality as primitive vestige of past which one should get rid of, taken to its extreme would mean life of left brain lobe in nutrient solution: even this is not enough since cognition would still represent contact with higher level selves. Personally I do not find this vision very attractive but Jaynes has got followers which he does not deserve, the proponents of so called Neotech [35], who after attack furiously against authorities but proclaims themselves as the only rational authority and declare a war against bicamerality which they identify as blind belief on 'authorities'.

What bicamerality is and what bicamerality is not

It is useful to make clear what bicamerality is and what is not. As Jaynes defines it, bicameral man was not automaton, he had volition but not conscious of it but experienced himself as a slave of his God. In contrast to Jaynes, the proponents of Neotech [35] claim that bicameral man is an automaton blindly obeying what they call 'authorities'. Even more illogically, they also tend to see the God-kings and bicameral leaders as power-hungry cheaters. Bicamerality in TGD is like the relationship

between child and parents. Child has subjective consciousness but spends considerable fraction of time in semitrance state in which parents and possibly other higher level selves telepathically guide child. Also in this state, bicameral man has left brain volition and is not blind slave.

The proponents of Neotech identify bicamerality as a blind belief in authorities and regard religion and spirituality as mental weaknesses. They also see mystics as representatives of belief in authorities: perhaps this applies to some mystics but anyone having read Krishnamurti probably sees mystics as a complete opposite of belief in external authorities. Needless to say, the proponents of Neotech see religion, meditation, parapsychology, paranormal phenomena, alternative medicine, homeopathy, etc., as neocheating. Neotech program could be formulated as an invitation to final war to destroy even last vestiges of beliefs on "personal universe, with a type of intelligent purposive agency with it to which man can with rational confidence turn for helpful communication" (quote is from Rhines, one of the founders of parapsychology). I do not know whether Neotechdals were not disturbed if they were told that the realization of their great program would require return to a brain state without EEG resembling perhaps the mental state of a person suffering Korsakov syndrome and lost his entire past and future and having present consisting of fragments lasting only few seconds.

Needless to say, in TGD framework Neotech program could hardly sound more insane as it does. Higher levels of self hierarchy are completely real, they are not mere 'authorities'. Their intelligence is sum over intelligences of its sub-selves and evolution of our consciousness means also evolution of consciousness at higher levels. From the point of view of higher levels of the self hierarchy the development of modern man is like the development of child to adult age. The communications occur still and are absolutely necessary for the self narrative and survival of the society. Higher level selves are however not anymore giving mere commands but bidirectional communication of the individual with collective intelligence having IQ which in some cases is astronomical as compared to that of individual. There is no doubt that the explosive development of science is basically the result of this interaction.

To declare a war against more 'authoritarian' forms of bicamerality is comparable to declaring a war against gravitational interaction. As the example of body as civilization shows, organs representing sub-civilizations at various levels of bicamerality are absolutely necessary for the functioning of organism. We cannot have post-modern muscles. Instead of declaring a war against all manifestations attributable to bicamerality we could try to understand the interaction between the levels of social self hierarchy. For instance, we could try to understand the mechanisms that raise leaders like Hitler and Stalin to power. Perhaps one could understand Stalin as a bicameral man living in society of more modern men and hearing the critical voices of the collective self of a society fallen to a primitive state. Perhaps paranoid schizophrenia is a natural reaction of child trusting deeply to his parents but learning that parents behind their formally parental behavior tell with the voice of God that they do not love her. Of course, in this framework Stalin, Hitler and alike are symbols for authoritarian collective selves, which are indeed very real. The knowledge that this kind of irrational and authoritarian collective selves have very real subjective existence (this was realized also by Jung who suggests that Nazism meant the arise of collective self which he calls 'Wotan') helps also to tame them. The recipe is extremely simple to state but difficult to realize: love, justice and trust. A bicameral experiencing love does not become stalinoid.

It perhaps helps to realize that our universe is full of selves at various levels of self development, some authoritative and other less authoritative and all these selves tries to live and prosper. Instead of destroying poetry as divine madness and banning music and art as vestiges of bicamerality, as Neotechdals suggest, one can imagine a world in which world of subjectivity is not either bicameral or modern but combination of both.

Emergence of a new kind of bicamerality?

I began to write this chapter in rather inspired state of mind. I was convinced that a return of 'modern' bicamerality, whatever that was to mean in closer inspection, was absolutely necessary for the survival of the human kind. I have already explained what new kind of bicamerality means. It is not authoritative master-slave relationship between levels of self hierarchy but communication which profits both individual and collective self since individual is mental image of collective self and contributes to its intelligence. New kind of bicamerality is not whole-timely state of consciousness but more like freely chosen mode of subjective existence. Various meditation practices provide methods to achieve also this state of consciousness. Essential parameter is the fraction of time spent in cognitive or

emotional semitrance and this could be correlated with what is called cognitive and emotional intelligence. Of course, cognition and emotion decompose to several factors and entire spectrum of time fractions must be used to characterize personality.

Why the return of new bicamerality might then be needed? There are several reasons. We live in an era of post-modernism, not only Gods but also great narratives have disappeared from the mental landscape of ideal post-modern person. Only the leading edge science is searching for great visions. Even in science materialistic view about universe is still dominating despite that its philosophical shortcomings are obvious and new wider views about physical and subjective existence are aggressively repressed as I have personally experienced.

Increasing privatization and the decay of the social structures is a fact of life and modern self experiences himself more and more only a sum of symbol manipulation skills and experiences life meaningless in the world which is becoming increasingly abstract and machine like. Market economy has raised maximization of profit and effectiveness as basic values and moral has value only as one game strategy among many others. New extremely authoritative theocracies of business have emerged: the mere side incomes of a leader of great Finnish travel telephone company are comparable to the budget of a small university at the same when hunger queues are getting longer and longer and those people who still are employed are desperately fighting to keep their jobs. Neither the priests of these theocracies nor most ordinary people are able to see that there is something badly wrong. If same degeneration of the society to individuals, whose personal narrative consists of jobs lasting day or two terrorized by the theocracy of business, would occur at cell level, it would be called cancer.

Due to the revolution of electric communications, web and email are becoming the central nervous system of Mother Gaia, and are the basic prerequisite for a new kind of bicamerality. Geographical restrictions do not limit the formation of new kind of collective selves. If we indeed have electromagnetic bodies of size of Earth, telepathic communication can in principle be established by electrical communications between persons, who never see each other's physical bodies. The emergence of the higher level collective selves could explain the magic attractiveness of web and email groups. Visual and auditory communication can be almost an equivalent of direct sensory face-to-face contact and virtual world technology is developing rapidly so that also other senses can be virtualized.

Web and other electrical communications could indeed become the central nervous system of Mother Gaia. We are the cells of this gigantic and enormously intelligent organism and we can communicate with it and receive parts of its wisdom via 'theofeedback' and also help it to evolve. Perhaps the almost irresistible trait to enter to computer terminal and to participate in discussion groups is telepathically communicated by Mother Gaia to our brains in short flashes of semitrance (or trance). Perhaps each period sending at terminal and sending messages to all these discussion groups is a counterpart of neural activity in brain. Perhaps it is not an accident that the number of human beings in recent world is of same order of magnitude as the number brain cells in human brain.

5.5.5 Are we really the first ones?

The fact that the explosion of our civilization to 'late-modernity' has occurred during only 500 years, which corresponds less than one year in life of individual in the proposed model for the development of civilization, forces to consider the possibility of advanced civilizations preceding the recent one. Taking fully developed frontal lobes as a prerequisite of a high tech civilization, one can consider the possibility that our civilization has been preceded by (at most) one civilization which degraded when climatic conditions changed radically. There are indeed myths about predecessors of our civilization. The notion of self hierarchy suggests that myths are not figments of imagination (bicamerals had rather limited imagination!) but narratives about the past history of human kind communicated by higher level selves to the individuals in semitrance. Therefore one cannot exclude the possibility that we have had predecessors, possibly destroyed by some catastrophe causing cooling of the climate.

Frontal lobes of human brain developed to their present size during 25.000-15.000 B.C. and calls, modifiers, nouns, the basic elements of language during this period. In the theory of Jaynes the years 15.000-10.000 B.C. are a long period of no apparent progress followed by the 'age of names' 10.000-8.000 B.C.. Names could have however developed much earlier than Jaynes believes. Animals learn their name more or less as a command and child learns her name before she learns to speak and learns to use the names of her parents at the same time when she learns other words. The analogy between the development of child and civilization implied by 'Ontogeny recapitulates phylogeny' principle, suggests that names were gradually developed from commands of the collective self performed by

some particular members of group were specialized. For instance, the Indians of North America have names of form 'Does something'. If this picture is correct then everything was ready for the development of civilization already at 15.000 B.C.. Whether or not we have had predecessors does not change the theory of Jaynes nor its TGD version about the development of our civilization.

According to Jaynes's theory the development of written language took about 5.000 years after primitive language structures had developed. If primitive language structures existed already before 15.000 B.C., civilizations mature to discover written language could have existed already 10.000 B.C.. There are some claims that there have been relatively highly developed civilization in Egypt as early as 9.500 B.C. which for some reason was devastated, presumably due to some catastrophe (say supernova explosion) changing the climate dramatically. There exists geological evidence for a short period of colder climate around 9.500 B.C..

There is also geological evidence for a catastrophic change of the climatic conditions 3200 B.C.: perhaps it is not an accident that written language began to develop at this time. Could it be that catastrophe formed people to larger groups so that collective IQ increased dramatically when critical mass was achieved, and made possible the discovery of written language? If this is really the case, the first cycle civilization could be regarded as an 'unsuccessful experiment' which failed to use the opportunity to discover written language in the catastrophe that occurred around 9.500 B.C..

Fractality suggest that the development of civilization reduces to the cognitive development of individual such that one year corresponds to about 540 years in the evolution of civilization. Civilization should correspond to higher level self, living organism. Most living organisms have sleep-wake cycle. This suggests that also 'civilization selves' could have similar cycle. If one year in the life of human corresponds to 540 years in the life of civilization then one day in the life of human corresponds to about 1.5 years which has order of magnitude of year. Thus year in the life of civilization could be perhaps taken to be the counterpart of 24 hours in human life. Amusingly, one day (24 hours) in the development of a civilization corresponds to 2.7 minutes in life of a human: the period related to the hemisphere dominance is 2 minutes in case of a normal person!

Civilization should have also average lifetime which could relate to the climate cycles of Earth. According to Milankovich's theory, Earth's climate is determined in long time scales by astronomical factors. The changes in the shape of Earth's orbit around Sun have period of about 100.000 years. The precession of Earth's rotation axis about its average direction has a period of about 26.000 years and the gradual rotation of Earth's orbit and the precession Earth's rotation axis give rise to a climatic period of varying between 19.000-23.000 years having average value of 22.000 years. This cycle dominates at the latitudes near to the equator. The angle of tilt of the spinning axis of Earth with respect to the plane of Earth's orbit varies periodically with a period of 41.000 years. This cycle dominates at Northern latitudes. If the maximal cognitive age of individual is taken to be the biological age of earlier times of about 41 years then the age of civilization would be about 22.000 years. If the lifetime is taken 76 years, which is nearer to that of modern man one obtains 41.000 years for the lifetime of civilization. Thus one cannot exclude the possibility that these climate cycles could represent also lifetimes for civilizations. Of course, it might well be that the ability of civilization to manipulate its own genome changes the situation totally.

5.6 Semitrance and organisms as cell societies

Bio-systems are populated by binary structures analogous to brain hemispheres and seem to correspond to twin pairs of p-adic length scales differing by a factor of two which are especially abundant in length scales relevant to bio-systems: this in fact led already years ago to the idea that binary structures might be somehow fundamental for the functioning of bio-systems. The common feature of all binary structures in biological length scales is that the number of quantum jumps during estimated wake-up period is extremely large. This follows from the estimate of wake-up period (duration of the mental image defined by self) as the primary p-adic time scale $T_p = \sqrt{p} \times \tau$, τ about 10^4 Planck times, or more generally n-ary p-adic time scale $T_{p,n} = p^{n/2} \times \tau$. The number of quantum jumps occurring during the wake-up period is huge even at elementary particle level (for electron one has $p = 2^{127} - 1$).

Together with p-adic fractality this suggests that all these societies self-organize to universal basic structural and functional patterns differing only scaling. This highly nontrivial hypothesis can be tested by looking whether one can find clear structural and functional analogies between human societies and various cellular and subcellular societies. The scenario for the development of language

and evolution of the civilization as a transition from bicamerality to modernity provides new insights also about the evolution of genetic code when translated to cellular length scale.

5.6.1 Semitrance and binary structures

Binary structures can be in three states, in semitrance, in sleep or trance or fully awake and it is interesting to try to figure out the functions associated with the sleep/trance and semitrance states.

Biologically relevant binary structures

Semitrance mechanism favors binary structures. It is not absolutely necessary that the components of the binary structure are identical and small symmetry breaking is certainly involved. Lipid layers of the cell membrane, pairs of chromosomes inside nucleus, and the strands of DNA form binary structures being analogous to the left and right hemispheres. In case of DNA the passive strand not participating in transcription of DNA to mRNA could correspond to the right brain hemisphere.

Peptides have non-symmetric binary structure consisting of sugar molecule which is same for all peptides plus radical, which determines the chemical properties of the protein. Sugar molecules form the back-bone of the protein. Sugar molecule and radical could be perhaps regarded as counterparts of the right and left brain hemispheres (not necessary in this order!) at the level of single aminoacid. Micro-tubules consist of tubulin dimers having also binary structure. Tubulin dimers can have several conformations.

Semitrance as a control mechanism of binary structures

Emotions affect greatly the functioning of body: in particular, emotions can affect directly neurons and cells. Hormones and various neurotransmitters are certainly involved with the emotional control but it is quite possible that semitrance mechanism is also involved. Semitrance could guarantee the coherent functioning of the cell society by providing organs, cells and even lower level structures with 'self narratives' and goal structures. For instance genetic determination could result in this manner. Of course, the time scale would be totally different from human. Semitrance could be realized by the entanglement of the inner lipid layer of the cell membrane and second strands of genes with the higher level selves. Even the notions of cognitive and emotional semitrance might make sense for binary structures, even at DNA level. Cancer might be seen as a disease in which cells have lost contact with 'God' and behave hedonically.

An interesting possibility is that semitrance works also as a tool of volition. The most science fictive possibility is that semitrance of the muscle cells makes it possible to realize volition. This would explain the peculiar results of Libet's experiments demonstrating that the decision to initiate motor action comes later than the motor action itself [34] (the model for Libet's observations is discussed [31]). The explanation relies on the two causalities associated with subjective and geometric time. Also the geometric past must change in the quantum jump leading to a motor action. More precisely, the quantum average space-time associated with the final quantum history must be continuous which implies that new space-time surface begins to change before the geometric time value associated with the quantum jump. A concrete realization is in terms of time mirror mechanism and Libet's findings give direct support for the notion of magnetic body. A fascinating possibility is that various muscles or muscle groups have 'names' realized as magnetic and/or Z^0 magnetic transition frequencies and that volitional acts involve semitrance mechanism and quantum jumps changing the macroscopic configuration of organism. A less science fictive explanation for the causal anomalies is that same happens at the level of cognitive representation which has initial value sensitive coupling to motor organs.

Do sleeping binary structures quantum compute?

Binary structures can also spend some time in unconscious state like sleep and trance. During trance state the entire binary structure is strongly bound state entangled and serves as an organ of higher level self. Concerning the interpretation of the sleep state, the first hint comes from the observation that entanglement is weak during sleep state. There is also some evidence for some kind of information processing occurring in brain during sleep state [31].

Quantum computing have been suggested as a metaphor for the information processing performed by brain. In TGD framework quantum computation corresponds to a period of macro-temporal quantum coherence generated when bound state entanglement is generated between two or more systems is formed. Entangling systems lose their consciousness in the process but the composite system is in a state of consciousness in which mental images stay sharp since quantum jump sequence fuses effectively to single quantum jump and dissipation is absent: kind of "enlightened" state would be in question.

Sleep could thus correspond to a formation of bound state in which brain and body become part of larger system. This would suggest that high level quantum computing like activities indeed occur during sleep. Of course, quantum computing in the strict sense of the word is probably too restricted a notion to be applied in case of biological structures. It might be however that the unconscious information processing by brain known to occur during sleep is analogous to quantum computing.

What is encouraging is that symmetric binary structures seem to be tailor made for quantum computing in a generalized sense. Quantum computer indeed possesses binary structure in the following sense. Quantum computation amounts to calculating a value of function $i \rightarrow f(i)$, with i representing label for a quantum state. The quantum time development leads from state $|i\rangle \times |i\rangle$ to the state $|i\rangle \times |f(i)\rangle$ as quantum computation halts by quantum jump possibly leading to the wake-up of the quantum computer.

5.6.2 Organism as cell civilization

Organism as a cell civilization metaphor provides a new aspect to the vision about bio-systems as macroscopic quantum systems and the structural analogies are surprisingly close and might help to develop concrete models of biological self-hierarchies.

Evolution of civilization and cell differentiation

The quantum model for the evolution of the civilization from bicamerality to modernity suggests a generalization. Cell differentiation would obviously corresponds to ageing or 'modernization' process. Stem cells, abundantly present everywhere in the body except in heart and brain, would be cell children, innocent cellular bicamerals. Various tissue types are counterparts of civilizations and the degree of development should be characterizable by the degree of the differentiation experienced by the cells of the tissue. At cell level, 'externalization', the development of non-telepathic communications means the emergence of various chemical communications such as chemotaxis, hormonal communications and finally nerve pulse transmission and eventually leads to the emergence of the central nervous system as the 'modern' elite of the cell society. The immune system of the organism has a direct counterpart at level of the societies from ants to humans.

The structure of the central nervous system contains a hierarchical structure of layers. Sensory and motor organs and pathways represent its oldest and most 'bicameral' part. Brain stem and paleobrain represent next levels in the hierarchy having fixed wirings. Sensory and motor cortex, multi-modal association regions (present only in human brain) and frontal lobes and language regions consisting of Wernicke and Broca regions and supplementary motor cortex represent in this order structures which are increasingly flexible and 'modern'. with various dynamical neural circuits presumably representing language structures. Some regions of brain (for instance, neostriatum) have connections to almost everywhere in cortex: this reminds of the liberation from the restrictions of geography allowed by modern electronic communications.

The modernity of the neuron is measured both by its ability to re-self-organize and by the variability of its gene expression. Learning at neuronal level can be regarded as the first manifestation of the 'modernity'. Neural transmitters affect both the synaptic strengths directly and by affecting the gene expression of neuron. The first measure for the 'modernity' of neuron is the plasticity of these contacts. The number of social contacts is also a measure for the modernity at the level of human society and corresponds to the number of the synaptic contacts of the neuron with other neurons. The repertoire of self-expression of neuron by nerve pulse patterns looks at first rather restricted: it fires or does not fire. Of course, memetic code means dramatic progress in this respect since temporal patterns of nerve pulses become carriers of conscious information. There could be other modes of self-expression, say by coherent photons which allow mass media type self-expression. The neural transmitters associated with the synaptic contacts are invariants of neuron.

Structure of central nervous system

One can try guess the structure of the self-hierarchy associated with the central nervous system (CNS) by assuming that the development of CNS is structurally analogous to the development of civilization and applying 'Ontogeny recapitulates phylogeny' principle. The latter principle suggests that brain stem and sensory and motor organs as the oldest part of CNS are the most 'bicameral' parts of central nervous system: this is certainly as it should be. This part of central nervous system is indeed rigidly wired hardware of CNS determined genetically to very high degree. Linguistic regions of brain in turn represent the most 'modern' part of the central nervous system containing dynamical brain circuits.

The architectures of village, town and modern city reflect also the structures of the social self-hierarchies. Same should be true in case of the central nervous system. The structures are present at several levels since central nervous system is like civilization consisting of civilizations consisting of... The roughest vision about self-hierarchy is provided by the architecture of a town. Brain corresponds to 'God's house' in the middle of the town and blood vessel circuitry and sensory and motor pathways are its streets and information pathways. Sensory organs, muscles and various organs are its habitants.

Brain as town?

Brain consists of three parts: brain stem, paleobrain and cortex and these parts seem to correspond to church in the middle of the town, old town and modern suburban areas. Middle-aged town could serve as a model of paleobrain with various brain nuclei being in the role of houses of the town. Neocortex would represent suburban regions of the brain town. Frontal cortex, associative regions and linguistic regions would be the most modern suburban areas. These brain regions are indeed extremely plastic. For instance, language regions which have been destroyed from left hemisphere at young age can regenerate on right hemisphere.

Reticular formation surrounding thalamus and brain stem is in the geometric center of brain and thus a natural candidate for 'God's house'. Reticular formation is known to control attention and has been one of the main candidates for the seat of consciousness in neuroscience based models of consciousness [33]. Semitrance might well be involved with the control of attention besides inhibition and excitation which correspond to 'externalized' control mechanisms. In TGD framework reticular formation would correspond to highest level of the self hierarchy in brain length scale. Reticular formation could also have the role of an over priest in the sense that the entanglement of brain and some ELF selves (at least that corresponding to 40 Hz thalamocortical EEG frequency which corresponds to $n = 3$ multiple of Na_+ cyclotron frequency) involves entanglement sequence *ELF self-reticular formation-region of cortex*. The EEG waves associated with the reticular formation should be non-propagating if this picture is correct.

5.6.3 Cell as a society

Society requires large number of nearly identical basic structural units: inside cell these subunits are proteins and quaternary structures formed by them. Inside the nucleus and other cell organelles these structures are DNA and various structures formed by it (genes, chromosomes).

Cell as a city state

Cell resembles the city state of the ancient Greece consisting of several cities governed by kings and surrounded by walls. In case of cell these cities correspond to various cell organelles having their own genome. These cities have many-layered self-hierarchy. Rather amusingly, fairy tales represent metaphorically the structure of cell. Chromosome pairs of tissue cells are like king and queen and chromosomes of germ cells are like princes and princesses. Sexual breeding corresponds to marriages between princes and princesses of the nuclear kingdoms of two city states (Note that ant nest and beehive are amazonian societies with queen ruling alone in her palace.). Walls surrounding the city state and the towns of city state correspond to cell membranes and endoplasmic membranes. More modern metaphor for cell nucleus is as a modern factory (producing building block proteins and using transcription factor proteins to communication purposes).

Nucleus as brain of cell/king's palace/factory

Chromosome decomposes into genes decomposing into DNA double strand. Genes are inhabitants of chromosome and are also like king-queen pair of the fairy tales. Only second DNA strand of gene, 'king strand' is transcribed. Continuing the right-brain-female metaphor to its limits and perhaps even beyond, one could guess that this strand is responsible for cognitive holism at DNA level whereas the passive strand would be responsible for emotional and sensory holism. Replication of DNA, cloning, does not occur spontaneously at the level of human society: plants however replicate by cloning. Thus DNA and chromosomes could structurally correspond to plants and animal kingdom respectively in the self-organization hierarchy. The two pairs of chromosome would structurally correspond to left and right almost symmetric halves of vertebrates. Of course, these analogies are only meant to suggest that similar self-organization process repeats itself in various length scales in fractal like manner.

Symbol function is basic mechanism at the level of human societies. Coding of genes to proteins is a natural candidate for symbol function at the level of DNA. Proteins could be seen as a written language expressing the basic 'This is true' statements are represented by exons. 'This is not true' statements correspond to introns and are not represented at protein level although they are transcribed to mRNA. Exon-intron dichotomy has a curious analogy with male-female dichotomy in the past human societies: only man could express himself in the society whereas woman's place was at home. Amusingly, the genes of the immune system are very 'modern' in the sense that the change of sex is possible: exons can change to introns and vice versa!

Society of proteins

Several hierarchy levels are present also in the cellular society formed by proteins. Proteins do not possess have symmetric binary structure. This does not exclude the possibility of semitrance but could make quantum computing type activities impossible. Proteins resemble termites in the sense that they dynamically self-organize into various quaternary structures, dimers, trimers, etc... Tubulin molecules are an important example of quaternary structures. Tubulin molecules self-organize to dimers, which in turn self-organize to micro-tubules. In this view cytoskeleton formed by tubulin dimers, which most biologists believe to be just what its name suggests, is analogous to living bridges and other architectonic structures formed by termites. From the point of view of cell nucleus lipids are like stones in the wall of city rather than citizens themselves. Indeed, protein structures realize genetic code whereas lipid layers are structures making possible to realize memetic code and correspond to higher level of cognition.

5.6.4 DNA and the analogy with the development of language

One can try to apply the ideas about organism as cell society and about the evolution of language as establishment of the memetic code in the attempts to understand how genetic code has established itself. Along these lines chromosomes could be seen as mini brain and transcription factor proteins as the counterpart of the written language. Proteins can be regarded as written messages sent by genes to each other and activating or de-activating the transcription of gene. Proteins could be also seen as conscious messengers able to transfer more complex messages than classical field at resonant frequency (counterparts of inhibition and excitation become possible).

Identifying the counterpart of the spoken language at gene level

Language metaphor leads to a highly nontrivial predictions. The use of proteins as a communication tool should have been preceded by some other non-chemical communication tool analogous to the spoken language. Of course, these tools would be still in use. These communications could have been realized electromagnetically or in terms of classical Z^0 fields utilizing p-adic cognitive codes. Intronic memes should utilize this communication tool in the control of genes.

The communications could have been very simple: just gene specific command waking-up gene and activating it to transcribe mRNA to be translated to protein and/or generating a command waking-up some other gene. Each gene would have had its own eigen frequency (or set of eigen frequencies) which can be said to serve as its 'name' or a command activating only that particular gene and the generation of em or classical Z^0 field with this frequency wakes-up 'gene self' and activates transcription. The activated gene either produces building block protein and/or activates some other gene by producing

(say) ELF em field with the characteristic frequency associated with that gene. The association of the 'spelled' frequency with the 'heard' frequency is completely analogous to the formation of association at neural level.

It is quite possible that already at this stage gene decomposed to a control region 'hearing the command' and analogous to the auditory regions of brain and the 'gene proper' analogous to the speech region of brain. Later the control regions developed to binding sites for proteins serving as transcription factors. At this stage also inhibition/excitation became possible and correspond to repressors/promoters and silencers/enhancers.

Rather than trying to identify the precise counterpart of sound as communication tool, one can try to identify the counterparts for the quantum mechanisms behind the auditory experience and cognition at DNA level. The quantum models for auditory experience and cognition at the level of cell membrane are extremely general and rely on the notion of cognitive antineutrinos. The model for cognition at cell membrane level generalizes also to the level of DNA and micro-tubular level [30] and there is no reason hindering the formal generalization of also the model of auditory experience to DNA and also micro-tubular level.

In the course of self-organization each gene adopted its characteristic axial Z^0 magnetic field defining unique spin flip frequency effectively serving as the name of the gene initiating transcription process. The command came either from a higher level self entangling with the passive DNA strand or was uttered by other gene generating ELF em field or some other perturbation with spin flip transition frequency.

This view suggests that Jaynes's vision about commands, modifiers and nouns preceding names is not correct: perhaps names emerged before nouns. That child learns names and nouns simultaneously and that even animals learn their name supports this view. Of course, it is to some degree a matter of taste whether one regards magnetic transition frequency waking-up only single gene as name or a command heard by only this particular gene. Note that names might have emerged from the specialization of the members of group to various tasks: the command obeyed by a particular individual became gradually the name of the individual. The names of Indians of North-America are indeed of form 'Does something'.

Proteins and written language

The un-reliability of the speech like communications could be seen as one reason which might have led to the emergence of proteins as 'written language' which is slower but more reliable and much more precise. If the proposed analogy relying on the universality of self-organization patterns works, 'written' language at DNA level developed from the 'spoken' language, when proteins began to signify the name of preferred genes in the sense that they began to bind to the control units of these genes and act as transcription factors. Protein language should have developed gradually (possibly through intermediate forms) like written language did. The rules were established by quantum self-organization and made possible by the weak initial value sensitivity of the asymptotic patterns of quantum self-organization. It would be interesting to try to identify the analogs of syntactic structures of the language from the structure of the genome and proteins. The development of society and language occurred in a parallel manner and structures of the society were paralleled by the structures of the language. This suggests that the syntactic structures of 'gene language' should correspond directly to various structures of the organism. Clusters form by Hox genes provide an example of higher level structural units of this kind [21].

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Part III

CRAZY STUFF

Chapter 6

Crop Circles and Life at Parallel Space-Time Sheets: Part I

6.1 Introduction

Crop circles as a hoax is one of the illusions of century created by the market economy media. Strangely, this claim which was made without a single thread of evidence, was generally accepted, and has remained a general belief. This despite the fact that already for more than half decade it has been known that all crop circles cannot be hoaxes. The articles in the BLT homepage [58] provide detailed scientific information about crop formations and the reading of these articles changed also my own attitudes thoroughly.

6.1.1 Strange phenomena associated with crop formations

For instance, micro-wave induced explosions in growth nodes of crops are regularly involved [55]. Also meteoric material is often associated with the crop formations [60] but not to the region exterior to them: this is absolutely impossible if the formations were made by human artists. Routine laboratory tests allow to judge whether the formation is man-made.

Models involving plasma flows from the ionosphere to the crop field formation have been developed [65]. The regions where the soil has a high content of calcium carbonate (chalk) helping to charge it electrically are the places where the circles appear predictably from year to year. There is also evidence suggesting that this interaction exists during the entire growth period so that there would be a continual connection to ionosphere [57].

Simplest crop circles indeed have a form similar to plasma self-organization patterns but there are also differences suggesting that the formations are not natural. Small plasma balls have been observed in the fields both before and after the appearance of the crop formation [57]. There are also irregular, 'non-geometric', patterns of downing which must have been created by same mechanism as crop circles involving the interaction with the ionosphere [57]. These are ideal bits of data for developing in detail hypothesis that any living system, even plants and plant populations, has a magnetic body, and that also magnetosphere is a conscious and intelligent entity receiving information from and controlling the biosphere. The resulting model supports the view about crop circles as an attempt of (geo-, planeto-, helio-, or some other) magnetospheric selves to tell about their existence to us.

6.1.2 Model for the generation of crop circles

A model for the generation of crop circle formation is developed. Next chapter [26] is devoted to the attempt to understand Chilbolton and Crabwood crop circles as messages providing biological information (including genetic codes) about some unknown life forms. Especially the question where where life forms might live is discussed.

The model for crop circle formation relies on the model for magnetic bodies, in particular magnetosphere, as an intentional agent able to control biological bodies. As in the earlier model magnetosphere uses plasmoids to construct the crop circles. The general model for bio-control relying on dark matter

hierarchy is the fundamentally new element now common to all applications of quantum TGD to biology, which raises the hope that the model could be nearer to truth even at the level of details. The updated model indeed differs considerably from the earlier model as far as the detailed mechanism generating crop circles is considered.

A second central element of the model is the model for the dark plasmoid as a rotating magnetic system, very much analogous to Searl machine [38], the model of which is developed in [18]. The model of plasmoid explains various mysterious looking findings such as microwave induced expansion of growth nodes, the presence of magnetized iron having meteoric origin, and the amorphous glass spheres found near crop circles. Additional support for the picture comes from the finding that plasmoids generated in laboratory seem to have the basic characteristics assigned to living matter [76].

6.2 Some aspects of TGD based vision about living systems

In this section the relevant aspect of TGD based vision about living systems are discussed with a particular emphasis on the implications of the dark matter hierarchy. The section summarizes material from many sources. The chapters [28, 27] of [10] discuss the high T_c superconductivity which is key element of the picture. The chapters [16, 20, 20] of this book discuss the implications of dark matter hierarchy for biology. The chapters [32, 36, 18] in turn discuss remote metabolism, the vision about living matter as a conscious hologram, and the detailed role of water for life and the implications of dark matter hierarchy are also now very strong.

6.2.1 Magnetic bodies and magnetosphere as a living system

TGD based view about classical fields differs radically from the Maxwellian one. Topological field quantization means that classical fields and matter form a Feynmann diagram like structure consisting of lines representing matter (say charged particles) and bosons (say photons). The matter lines are replaced by space-time sheets representing matter (elementary particles, atoms, molecules,...), and virtual bosons are replaced by topological light rays ("mass-less extremals", MEs). Also magnetic flux tubes appear and together with MEs they serve as correlates for bound state quantum entanglement.

The classical fields associated with MEs interfere only at the nodes, where they meet, and one has a hologram like structure with nodes interpreted as the points of a hologram. Thus one avoids the loss of information caused by the interference of all signals everywhere. This aspect is crucial for understanding the role of em fields in living matter and brain. The MEs corresponding to 'real photons' are like laser beams entering the hologram and possibly reflected from it. What is new that the nodes can be connected by 'virtual photon' MEs also analogous to laser beams. Hence also 'self-holograms' with no laser beam from external world are possible (brain without sensory input).

The hologram has a fractal structure: there are space-time sheets at space-time sheets and high frequency MEs propagating effectively as mass-less particles inside low frequency MEs serving as quantum entangling bridges of even astrophysical length. The particle like high frequency MEs induce 'bridges' between magnetic flux tubes and atomic space-time sheets at the receiving end. This makes possible the leakage of supra currents from magnetic flux tubes to atomic space-time sheets analogous to the exposure of film producing hologram. The leakage induces dissipation, self-organization, and primitive metabolism as a cyclic flow of ionic currents between the two space-time sheets, and thus a Darwinian selection of the self-organization patterns results. The low frequency MEs are responsible for bound state entanglement, macroscopic quantum coherence and co-operation whereas high frequency MEs are responsible for self-organization and competition.

TGD framework differs from Maxwellian also in that it is possible to assign to a given physical system a magnetic body having usually a size much larger than that of the system itself. The magnetic body provides kind of a monitor screen at which higher level information about the system is represented and defines thus sensory representations about the system. Magnetic body as a manual for a system is also a useful metaphor. Besides our own magnetic bodies (of astrophysical size), the magnetosphere of Earth is especially interesting magnetic body, and can be regarded as a living system receiving sensory input from biosphere, in particular our brains [24].

Also the magnetosphere in the Earth's interior is highly interesting. Especially interesting are various boundary layers since energy currents occur here and make complex self-organization patterns

possible. Magnetosphere contains many layers of this kind and in the Earth's interior mantle-core and core-inner core layers are of special interest as possible seats for intelligent life and the life-forms responsible for the crop formations might be ITs (intra-terrestrials).

The magnetospheric sensory representations associated with the life-forms in questions (say ITs) could induce the interaction between ionosphere and bio-matter and make also the plasma leakage possible. These magnetic bodies would be there all the time and this conforms with the finding that alterations to crop stem below head must have occurred long before the crop formation emerged.

6.2.2 Mersenne hypothesis

The hierarchy of dark matter levels is labeled by the values of Planck constant having quantized but arbitrarily large values TGD inspired quantum biology and number theoretical considerations suggest preferred values for $r = \hbar/\hbar_0$. For the most general option the values of \hbar are products and ratios of two integers n_a and n_b . Ruler and compass integers n expressible as $n = 2^k \prod_n F_{s_n}$, where $F_s = 2^{2^s} + 1$ is Fermat prime and each of them can appear only once, are number theoretically favored values for n_i because the phases $\exp(i2\pi/n_i)$, $i \in \{a, b\}$, in this case are number theoretically very simple and should have emerged first in the number theoretical evolution via algebraic extensions of p-adics and of rationals. The known Fermat primes are $F_0 = 3, F_1 = 5, F_2 = 17, F_3 = 257, F_4 = 2^{16} + 1$. p-Adic length scale hypothesis favors powers of two as values of r .

The hypothesis that Mersenne primes $M_k = 2^k - 1$, $k \in \{89, 107, 127\}$, and Gaussian Mersennes $M_{G,k} = (1+i)k - 1$, $k \in \{113, 151, 157, 163, 167, 239, 241, \dots\}$ (the number theoretical miracle is that all the four p-adic length scales with $k \in \{151, 157, 163, 167\}$ are in the biologically highly interesting range 10 nm-2.5 μm) define scaled up copies of electro-weak and QCD type physics with ordinary value of \hbar and that these physics are induced by dark variants of corresponding lower level physics leads to a prediction for the preferred values of $r = 2^{k_d}$, $k_d = k_i - k_j$, and the resulting picture finds support from the ensuing models for biological evolution and for EEG [20]. This hypothesis - to be referred to as Mersenne hypothesis - replaces the earlier rather ad hoc proposal $r = \hbar/\hbar_0 = 2^{11k}$ for the preferred values of Planck constant. The background necessary for understanding what is involved is described in [28, 27, 20].

6.2.3 Fractal hierarchy of magnetic flux sheets and the hierarchy of genomes

The notion of magnetic body is central in the TGD inspired theory of living matter. Every system possesses magnetic body and there are strong reasons to believe that the magnetic body associated with human body is of order Earth size and that there could be an entire hierarchy of these bodies with even much larger sizes. Therefore the question arises what one can assume about these magnetic bodies. The quantization of magnetic flux suggests an answer to this question.

1. The quantization condition for magnetic flux reads in the most general form as $\oint (p - eA) \cdot dl = n\hbar$. If supra currents flowing at the boundaries of the flux tube are absent one obtains $e \int B \cdot dS = n\hbar$, which requires that the scaling of the Planck constant scales up the flux tube thickness by r^2 and scaling of B by $1/r$. If one assumes that the radii of flux tubes do not depend on the value of r , magnetic flux is compensated by the contribution of the supra current flowing around the flux tube: $\oint (p - eA) \cdot dl = 0$. The supra currents would be present inside living organism but in the faraway region where flux quanta from organism fuse together, the quantization conditions $e \int B \cdot dS = n\hbar$ would be satisfied.
2. From the point of view of EEG especially interesting are the flux sheets which have thickness $L(151) = 10$ nm (the thickness of cell membrane) carrying magnetic field having strength of endogenous magnetic field. In absence of supra currents these flux sheets have very large total transversal length proportional to r^2 . The condition that the values of cyclotron energies are above thermal energy implies that the value of r is of order 2^{k_d} , $k_d = 44$. Strongly folded flux sheets of this thickness might be associated with living matter and connect their DNAs to single coherent structure. One can of course assume the presence of supra currents but outside the organism the flux sheet should fuse to form very long flux sheets.
3. Suppose that the magnetic flux flows in head to tail direction so that the magnetic flux arrives to the human body through a layer of cortical neurons. Assume that the flux sheets traverse

through the uppermost layer of neurons and also lower layers and that DNA of each neuronal nuclei define a transversal sections organized along flux sheet like text lines of a book page. The total length of DNA in single human cell is about one meter. It seems that single organism cannot provide the needed total length of DNA if DNA dominates the contribution. This if of course not at all necessarily since supra currents are possible and outside the organism the flux sheets can fuse together. This implies however correlations between genomes of different cells and even different organisms.

These observations inspire the notion of super- and hyper genes. As a matter fact, entire hierarchy of genomes is predicted. Super genes consist of genes in different cell nuclei arranged to threads along magnetic flux sheets like text lines on the page of book whereas hyper genes traverse through genomes of different organisms. Super and hyper genes provide an enormous representative capacity and together with the dark matter hierarchy allows to resolve the paradox created by the observation that human genome does not differ appreciably in size from that of wheat.

6.2.4 Does a dark copy of Earth's magnetic field exist?

For years I erratically believed that the magnitude of the magnetic field assignable to the biological body is $B_E = .5$ Gauss, the nominal value of the Earth's magnetic field. Probably I had made the calculational error at very early stage when taking Ca^{++} cyclotron frequency as a standard. I am grateful for Bulgarian physicist Rossen Kolarov for pointing to me that the precise magnitude of the magnetic field implying the observed 15 Hz cyclotron frequency for Ca^{++} is .2 Gauss and thus slightly smaller than the minimum value .3 Gauss of B_E . This value must be assigned to the magnetic body carrying dark matter rather than to the flux quanta of the Earth's magnetic field. This field value corresponds roughly to the magnitude of B_E at distance $1.4R$, R the radius of Earth.

Dark matter hierarchy leads to a detailed quantitative view about quantum biology with several testable predictions [20]. The applications to living matter suggests that the basic hierarchy includes the hierarchy of Planck constant

In the case of magnetic flux simplest quantization suggests the scaling $B \rightarrow B/r$ for the magnetic fields. This is assumed to hold true also in more general case when the quantization condition reads as $\oint(p - ZeA)dl = n\hbar$ and involves currents flowing at the boundaries of flux quanta so that magnetic flux need not be anymore quantized to a multiple of Planck constant. For axonal membranes the flux quantition with $n = 0$ is natural since the size of flux quantum does not depend on the value of Planck constant. Assuming flux quantization and standard value of Planck constant $B_{end} = .2$ Gauss would give flux tube radius $L = \sqrt{5/2} \times L(169) \simeq 1.58L(169)$, which does not correspond to any p-adic length scale as such.

Concerning the interpretation of B_{end} there are two options. It could correspond to a personal magnetic body or to a dark variant of the Earth's magnetic field. At this moment it is impossible to say which if any hypothesis is right. However the fact that the ELF fields have no direct effect on conscious experience mildly supports the identification as the dark variant of B_E .

6.2.5 Basic vision about living matter

General mechanisms of bio-superconductivity

The many-sheeted space-time concept provides a very general mechanism of superconductivity based on the 'dropping' of charged particles from atomic space-time sheets to larger space-time sheets. The first guess was that larger space-time sheets are very dry, cool and silent so that the necessary conditions for the formation of high T_c macroscopic quantum phases are met.

The possibility of large \hbar quantum coherent phases makes however the assumption about thermal isolation between space-time sheets un-necessary. At larger space-time sheet the interactions of the charged particles with classical em fields generated by various wormhole contacts feeding gauge fluxes to and from the space-time sheet in question give rise to the necessary gap energy. The simplest model for Cooper pair is space-time sheet containing charged particles having attractive Coulombic interaction with the quarks and antiquarks associated with the throats of the wormhole contacts.

A crucial element is quantum criticality predicting that new kind of superconductivity, "boundary superconductivity", appears at the fluctuating boundaries of competing ordinary and large \hbar phases for nuclei besides large \hbar variant of ordinary superconductivity in the interior. The Cooper pairs

of interior and boundary supra currents are different with interior Cooper pairs being BCS type. These two superconducting phases compete in certain narrow interval around critical temperature for which body temperature of endotherms is a good candidate in the case of living matter. Also high T_c superfluidity of bosonic atoms dropped to space-time sheets of electronic Cooper pairs becomes possible besides ionic super conductivity. Even dark neutrino superconductivity can be considered below the weak length scale of scaled down weak bosons.

Magnetic and Z^0 magnetic flux tubes and sheets are especially interesting candidates for supra current carries. In this case the Cooper pairs must have spin one and this is indeed possible for wormholy Cooper pairs. The fact that the critical magnetic (Z^0 magnetic) fields can be very weak or large values of \hbar is in accordance with the idea that various almost topological quantum numbers characterizing induced magnetic fields provide a storage mechanism of bio-information.

This mechanism is extremely general and works for electrons, protons, ions, charged molecules and even exotic neutrinos and an entire zoo of high T_c bio-superconductors, super-fluids and Bose-Einstein condensates is predicted. Of course, there are restrictions due to the thermal stability at room temperature and it seems that only electron, neutrino, and proton Cooper pairs are possible at room temperature besides Bose-Einstein condensates of all bosonic ions and their exotic counterparts resulting when some nuclear color bonds become charged [17].

Bose-Einstein condensates at magnetic flux quanta in astrophysical length scales

The basis elements of the model is dark magnetic field $B_{end} = 2B_E/5 = .2$ Gauss explaining the effects of ELF em fields in brains of vertebrates in terms of cyclotron transitions of biologically important ions. B_{end} could be a dark companion of the ordinary magnetic field of Earth or represent personal magnetic body.

The new model for the topological condensation at magnetic flux quanta is based on the dark matter hierarchy with levels characterized by the values of \hbar consistent with Mersenne hypothesis or more general ruler and compass integer hypothesis.

1. There are several levels of dynamics. In topological condensation the internal dynamics of ions is unaffected and \hbar has the ordinary value. The formation of Cooper pairs involves dynamics at relatively low level of dark matter hierarchy. Also the dynamics of ionic Cooper pairs remains unaffected in the topological condensation to magnetic flux quanta obeying $k_d > 1$ dynamics.
2. Cyclotron energies scale as $r = 2^{k_d}$ so that for a sufficiently high value of k thermal stability of cyclotron states at room temperature is achieved. Spin interaction energy $\mu \cdot B \propto S \cdot B$ scales as $1/r$ since four-momentum and angular momentum are by Poincare symmetry invariant under the scaling of \hbar (the highly non-trivial implications of the invariance of angular momentum are discussed in [19]). Hence spin interaction energy has the ordinary value. Unless thermal isolation is assumed, spin degrees of freedom are thermalized, and only cyclotron degrees of freedom can be quantum coherent. This is a testable prediction distinguishing between the new and old model.
3. If the flux quanta of B_{end} correspond to $k_d = 44$ level of dark matter hierarchy, cyclotron energies $E = (\hbar/2\pi) \times ZeB/Am_p$ are scaled up by a factor $r = 2^{44}$ from their ordinary values and are above thermal energy at room temperature for $A \leq 233Z$, where Z is the charge of the ion. Even for $Z = 1$ this includes all stable nuclei. Bose-Einstein condensates of bosonic ions are thus possible at room temperatures at Earth's surface. Cooper pairs of fermionic ions are possible only for $A \leq 4$ leaving in practice only protons into consideration. Also bosonic molecular ions can suffer BE condensation.

6.2.6 Dark matter hierarchy and big leaps in evolution

Dark matter hierarchy leads to an amazingly concrete picture about evolutionary hierarchy allowing to identify the counterparts for concepts like mineral, plant, and animal kingdom that we learned during schooldays and ceased to take seriously as students of theoretical physics as we learned that other sciences are just taxonomy. Even more, a view about what distinguishes between prokaryotes, eukaryotes, animal cells, neurons, EEG, and even about what makes cultural evolution, becomes possible. This view is also very useful when one tries to understand the role of microtubules.

The appearance of CDs scaled up in size by $r = \hbar/\hbar_0$ and space-time sheets scaled up in size by \sqrt{r} means the emergence of new levels of structure and it is natural to identify big leaps in evolution in terms of emergence of new larger matter carrying space-time sheet magnetic flux sheets and corresponding magnetic bodies. If magnetic flux quanta are scaled by r magnetic flux quantization conditions remain unaffected if magnetic field strengths scale down by $1/r$ so that the energies of cyclotron photons are not affected. The thickness of flux tubes can remain unchanged if the currents running at the boundaries of the flux quantum cancel the magnetic flux. As already found, this mechanism must be at work inside living organisms whereas in far away region flux quanta are scaled up in size.

The attractive hypothesis is that the leaps in evolution correspond to the emergence of dark variants of weak and possibly also color interactions in dark p-adic length scales which correspond to ordinary p-adic length scales characterized by Mersenne primes. These leaps would be quantum leaps but in different sense as thought usually. The emergence of higher dark matter levels would basically mean the integration of existing structures to larger structures. A good metaphor are text lines at the pages of book formed by magnetic flux sheets whose width is scaled up by r as the new level of dark matter hierarchy emerges. The big leaps can occur both at the level of organism and population and organisms with rather low individual dark matter level can form societies with high dark matter levels and high collective intelligence (honeybees and ants are good example in this respect).

Certainly also other scalings of Planck constant than those summarized in tables are possible but these scalings are of primary interest. This intuition is supported by the observation that electron is completely exceptional in this framework. Electron's dark p-adic length scales corresponds to p-adic length scales $L(k)$, $k = 167, 169$, assignable to atomic and molecular physics and to the Gaussian Mersennes $M_{G,k} = (1+i)^k - 1$, $k \in \{151, 157, 163, 167\}$, assignable to the length scale range between cell membrane thickness 10 nm and nucleus size $2.58 \mu\text{m}$. The corresponding p-adic length scales, the number of which is 23, are excellent candidates for the scales of basic building bricks of living matter and vary from electron's p-adic length scale up to 1.25 m ($k = 167$ defining the largest Gaussian Mersenne in cell length scale range) and defining the size scale of human body. The corresponding p-adic time scales are also highly interesting and vary from .1 seconds for electron defining the fundamental biorhythm to 9.6×10^{14} years which is by 4-5 orders longer than the age of the observed Universe. For $k = 167$ the time scale is 1.1×10^{11} years and is by one order of magnitude longer than the age of the observed Universe estimated to be 1.37×10^{10} years [52].

This conceptual framework gives rather strong guidelines for the identification of the levels of evolutionary hierarchy in terms of dark matter hierarchy. The outcome is a more detailed vision about big evolutionary leaps. Note that in the sequel only the general option is considered: the justification for this is that for this option electron appears as a dark particle for all length scales defined by Gaussian Mersennes as well as in atomic length scales. The basic vision in nutshell is that evolution means the emergence of dark weak and gluonic physics in both dark and ordinary length scales and that the size scales of the basic biostructures correspond to Mersenne primes and their Gaussian variants.

A sketch about basic steps in evolution

The vision about evolution depends on what one assumes about the initial state.

1. If one assumes that weak bosons with ordinary value of Planck constant were present in the beginning, evolution would mean a steady growth of k_d . The problem is that small values of $k_d = k_1 - k_2$ correspond to the Gaussian Mersennes defining cellular length scales. If these exotic weak physics were present from the beginning, large parity breaking in cellular length scales would have been present all the time.
2. An alternative and perhaps more realistic view is that the evolution means the emergence of exotic weak physics corresponding almost vacuum extremals in increasingly longer length scales. A possible mechanism could have been the induction of exotic \hbar_0 variant of weak physics at the nearest Mersenne length scale k_{next} by the dark variant of weak physics at level k so that one would have $k_d = k_{next} - k$. The simplest induction sequence would have been $89 \rightarrow 107 \rightarrow 113 \rightarrow 127 \rightarrow 151 \rightarrow 157 \rightarrow 163 \rightarrow 167$ corresponding to $k_d \in \{18, 6, 14, 24, 6, 6, 4\}$. A possible interpretation of exotic \hbar_0 physics is in terms of almost vacuum extremals and non-standard value of Weinberg angle: also weak bosons of this physics would be light. This sequence defines

the minimal values for k_d but also larger values of k_d are possible and would correspond to steps between neighbours which are not nearest ones.

The following sketch about the basic steps of evolution relies on the latter option.

1. *Elementary particle level*

Magnetic bodies with size scale defined by the sizes of CDs assignable to quarks and leptons and possibly also weak bosons (already now the size of big neuron emerges) corresponds to the lowest level of hierarchy with the sizes of the basic material structures corresponding to the Compton lengths of elementary particles. The fundamental bio-rhythms corresponding to frequencies 10, 160, and 1280 Hz appear already at this level in zero energy ontology which suggests that elementary particles play a central and hitherto unknown role in the functioning of living matter.

2. *89 \rightarrow 107 step with $k_d = 18$*

The first step would have been the emergence of $k_{eff} = 107$ weak bosons inducing \hbar_0 weak physics in $k = 107$ length scale characterizing also ordinary hadrons. This in turn would have led to the emergence of exotic nucleons possibly corresponding to almost vacuum extremals. The reduction of the model for the vertebrate genetic code to dark hadron physics [31] is one of the most unexpected predictions of quantum TGD and assumes the existence of exotic- possibly dark- nucleons whose states with a given charge correspond to DNA, RNA, mRNA, and tRNA. The \hbar_0 variants of these nucleons would interact via weak bosons with hadronic mass scale. The exotic variants of the ordinary $k = 113$ nuclei would correspond to the nuclear strings consisting of exotic nucleons [21, 31] and define nuclear counterparts for DNA sequences. Their dark counterparts could define counterparts of DNA sequences in atomic physics length scales. Therefore a justification for the previous observation that genetic code could be realized at the level of hadron physics and that chemical realization would be higher level realization finds justification. The anomalous properties of water could be also partly due to the presence of dark nucleons and the proposal was that the presence of exotic nuclei is involved with water memory [18]. The possible existence of the the analog of DNA-RNA transcription between ordinary DNA and its nuclear counterpart would have dramatic implications. For instance, one can imagine a mechanism of homeopathy based on this kind of transription process which would also allow a modification of genome by using dark nuclei to communicate the DNA sequences through the cell membrane to the target nuclei.

3. *107 \rightarrow 113 step with $k_d = 6$*

The next step would have been the emergence of $k_{eff} = 113$ weak bosons inducing \hbar_0 weak physics in $k = 113$ length scale characterizing also ordinary hadrons. Exotic variants of the ordinary nuclei possibly corresponding to almost vacuum extremals could have emerged interacting weakly (or actually relatively strongly!) via the exchange of weak bosons with mass scale of order 100 MeV. Also dark variants of the exotic $k = 107$ nucleons could have have emerged and formed exotic nuclei of size scale $k = 119$.

4. *113 \rightarrow 127 step with $k_d = 14$*

At this step weak bosons in electron mass scale would have emerged. Whether these weak bosons could have induced large parity breakings in atomic and molecular length scales is not clear. Viruses, which do not yet possess cell membrane could correspond to this level of hierarchy.

5. *127 \rightarrow 151 step with $k_d = 24$*

This step would have been fundamental since weak bosons in cell membrane length scale would have appeared. Note that by $113 - 89 = 24$ this step also leads from $k = 89$ weak bosons to $k = 113$ weak bosons. The weak bosons assignal to $k = 151$ could correspond to the weak interactions associated with almost vacuum extremals and $\sin^2(\theta_W) = .0295$ could correspond to the weak physics in question.

$k_d = 24$ step for $k = 113$ \hbar_0 weak bosons would have produced them in $k_{eff} = 137$ atomic length scale with $L(137) \simeq .78$ Angstrom This could have naturally led to large parity breaking effects and chiral selection.

Dark $k_{eff} = 151$ electrons appearing in the TGD inspired model of high T_c super-conductivity would have been a by-product of this step. Whether dark electrons could have transformed to light

\hbar_0 electrons (of mass .25 keV) with a common mass scale of order 10^2 eV with exotic weak bosons is an interesting question. The model of high T_c super-conductivity predicts the presence of structures analogous to cell membrane. This would suggest that cell membranes emerged and chiral selection emerged at this step so that one could not distinguish the emergence of molecular life as a predecessor for the emergence of cell membrane like structures. This would conform with the fact that DNA molecules are stable only inside cell nucleus. Note that for $k_{eff} = 151$ electron's CD has time scale $2^{24} \times .1$ seconds -that is 19.419 days (day=24 hours).

The smallest nanobes [82] appearing in rocks have size 20 nm and could have emerged at this step. The size of the viruses [78] is between 10-300 nm covers the entire reange of length scales assignable to Gaussian Mersennes, which suggests that smallest viruses could have emerged at this step. Also the smallest nannobacteria [71], which by definition have size smaller than 300 nm could have appeared at this stage.

6. The remaining steps

The remaining steps $k = 151 \rightarrow 157 \rightarrow 163 \rightarrow 167$ could relate to the emergence of coiling structure DNA and other structures inside cell nucleus. $k = 167$ would correspond to $k_d = 167 - 89 = 68$ to be compared with the value $k_d = 47$ required by 5 Hz Josephson frequency for the neuronal membrane for -70 mV resting potential. Note that $k_d = 48$ (state 1-2 of deep sleep) corresponds to $k = 163$.

By their smallness also double and triple steps defined by $k_d = k_{i+n} - k_i$, $n > 1$, are expected to be probable. As a consequence, electrons can appear as dark electrons at all the Gaussian Mersenne levels. At these steps the dark electrons corresponding to primes $k_{eff} = 137, 139$ would appear. For $k = 137$ dark electron appears with CD time scale equal to 128 seconds- rather precisely two minutes. The model for EEG suggests that the exotic weak bosons appear in the scales $k_{eff} = 136, 137, 138$.

Further multisteps from the lower levels of hierarchy would give structures with size scales above the size of cell nucleus possibly assignable to organs and structural units of brain. The dark levels assignable to electron are expected to be of special interest. It is encouraging that the longest scale assignable to electron in this manner corresponds to $k = 205$ and length scale of 1.28 m defining body size. As a consequence dark electrons are predicted at levels $k = 137, 139, 141, 143, 145, 147$ coming as octaves.

Prokaryotic cells (bacteria, archea) without cell nucleus for which cell membrane is responsible for metabolic functions and genome is scattered around the cell could have emerged at this step. This would mean that the emergence of the cell membrane thickness as a fundamental scale is not enough: also the size scale of membrane must appear as p-adic length scale. The sizes of most prokaryotes vary between $1 \mu\text{m}$ and $10 \mu\text{m}$: the lower bound would require $k = 163$. There also prokaryotes with sizes between $.2 \mu\text{m}$ ($k = 157$ corresponds to $.08 \mu\text{m}$) and $750 \mu\text{m}$. Cell nuclei, mitochondria, and other membrane bounded cell nuclei would have evolved from prokaryotes in this framework. The sizes of eukaryote cells are above $10 \mu\text{m}$ and the fact that multicellular organisms are in question strongly suggests that the higher multisteps giving rise to weak bosons and dark electrons in length scales above $L(167)$ are responsible for multi-cellular structures.

This scenario leaves a lot of questions unanswered. In particular, one should understand in more detail the weak physics at various length scales as well as various exotic nuclear physics defined by dark nucleons and dark variants of nuclei.

Division of the evolution to that of biological body and magnetic body

Electron's Mersenne prime M_{127} is the highest Mersenne prime, which does not correspond to a completely super-astrophysical p-adic length scale. In the case of Gaussian Mersennes $M_{G,k}$ one has besides those defined by k in $\{113, 151, 157, 163, 167, \}$ also the ones defined by k in $\{239, 241, 283, 353, 367, 379, 457, 997\}$ [39]. The appropriately extended model for evolution allows to distinguish between three kinds of values of k_{eff} .

1. The values of k_{eff} for which electron can appear as dark particle and thus satisfying $k_{eff} \leq 205$ (Table 5). These levels would correspond to structures with size below 1.25 m defined roughly by human body size and it is natural to assign the evolution of super-nuclear structures to the levels $167 < k_{eff} \leq 205$.
2. The values of of k_{eff} for which dark gauge bosons are possible in the model. This gives the condition $k_{eff} \leq 235$. These levels correspond to structures in the range 1.25 m-40 km. The

identification as parts of the magnetic body can be considered.

3. The values of k_{eff} obtained by adding to the system also the Gaussian Mersenne pair $k \in \{239, 241\}$ allowing also the dark electrons. The lower size scale for these structures is 640 km.
4. The higher levels corresponding to k_{eff} in $\{283, 353, 367, \dots\}$. The lower size scale for these structures is 3 AU (AU is the distance from Earth to Sun).

$k_{eff} > 205$ levels would correspond to the emergence of structures having typically size larger than that of the biological body and not directly visible as biological evolution. This evolution could be hidden neuronal evolution meaning the emergence of extremely low Josephson frequencies of the neurons modulating higher frequency patterns and being also responsible for the communication of long term memories.

Biological evolution

In principle the proposed model allowing multisteps between hierarchy levels defined by Mersenne primes and their Gaussian counterparts could explain the size scales of the basic structures below the size scale 1.25 m identified in terms of the $k_{eff} \leq 205$ levels of the hierarchy.

1. The emergence of cells having organelles

The appearance of the structures with $k_{eff} > 167$ (possibly identifiable as magnetic body parts) should correlate with the emergence of simple eukaryotic cells and organisms, in particular plant cells for which size is larger than 10 μm , which could correspond to $k_{eff} = 171$ for electron and dark variants of weak gauge bosons. $k_{eff} = 177$ is the next dark electron level and corresponds to 80 μm scale. It seems natural to assume that these dark weak bosons do not transform to their \hbar_0 counterparts at these space-time sheets.

Cell nucleus would be the brain of the cell, mitochondria would be the energy plant, and centrioles generating microtubules would define the logistic system. Also other organelles such as Golgi apparatus, ribosomes, lysosomes, endoplasmic reticulum, and vacuoles would be present. These organelles would live in symbiosis by topologically condensing to $k_{eff} \geq 171$ magnetic body controlling their collective behavior. Centrosomes associated with animal cells would not be present yet but microtubule organizing centers would already be there.

The recent observations show that centrioles are not always in the characteristic T shaped conformation. Daughter centrioles resulting during the replication of mother centriole use first ours of their lifetime to roam around the cell before becoming mature to replicate. A possible interpretation is that they are also life forms and that magnetic body utilizes daughter centrioles to perform some control functions crucial for the future development of the cell. For instance, centrioles visit the place where axonal growth in neurons starts.

Cytoskeleton would act as a counterpart of a central nervous system besides being responsible for various logistic functions such as transfer of proteins along microtubuli. Centrioles give also rise to basal bodies and corresponding cilia/flagella used by simple cells to move or control movement of air or liquid past them. Centriole pair would be also used by the magnetic body to control cell division.

The logistic functions are the most obvious functions of microtubules. Magnetic body would control cell membrane via signals sent through the cell nucleus and communicated to the cell membrane along microtubuli. Basal bodies below the cell membrane and corresponding cilia/flagella would serve as motor organs making possible cell motion. Tubulin conformations representing bits would allow microtubule surface to represent the instructions of the magnetic body communicated via cell nucleus to various proteins moving along the microtubular surface so that they could perform their functions.

TGD based view about long memory recall as communication with geometric past allows also the realization of cellular declarative memories in terms of the conformational patterns. Memory recall corresponds to a communication with geometric past using phase conjugate bosons with negative energies reflected back as positive energy bosons and thus representing an "image" of microtubular conformation just like ordinary reflected light represents ordinary physical object. There would be no need for a static memory storage which in TGD framework would mean taking again and again a new copy of the same file.

Receptor proteins would communicate cell level sensory input to the magnetic body via MEs parallel to magnetic flux tubes connecting them to the magnetic body. We ourselves would be in an abstract sense fractally scaled up counterparts of receptor proteins and associated with dark matter iono-lito Josephson junction connecting the parts of magnetosphere below lithosphere and above magnetosphere. The communication would be based on Josephson radiation consisting of photons, weak bosons, and gluons defining the counterpart of EEG associated with the level of the dark matter hierarchy in question.

3. The emergence of organs and animals

The emergence of magnetic bodies with k_{eff} in the range (177, 181, 183, 187, 189, 195, 201, 205) allowing both dark electron and weak bosons could accompany the emergence of multicellular animals. Magnetic body at this level could give rise to super-genome making possible genetic coding of organs not yet possessed by plant cells separated by walls from each other. The super structures formed from centrosomes and corresponding microtubuli make possible complex patterns of motion requiring quantum coherence in the scale of organs as well as memories about them at the level of organs.

4. The emergence of nervous system

k_{eff} in the range (187, 189, 195, 201, 205) allowing dark electrons and weak bosons gives size scales (.25, .5, 4, 32, 128) cm, which could correspond to the scales of basic units of central nervous system. What would be of special interest would be the possibility of charged entanglement based on classical W fields in macroscopic length scales. The emergence of the new level means also the integration of axonal microtubuli to "text lines" at the magnetic flux sheets making possible logistic control at the multineuronal level. The conformational patterns of the microtubular surface would code nerve pulse patterns to bit patterns representing declarative long term memories. An interesting question is whether the reverse coding occurs during memory recall.

The evolution of magnetic body

For mammals with body size below 1.25 m the levels $k_{eff} > 205$ cannot correspond to biological body and the identification in terms of magnetic body is suggestive. The identification of EEG in terms of Josephson frequencies suggests the assignment of EEG with these levels.

1. The emergence of EEG

EEG in the standard sense of the word is possessed only by vertebrates and one should understand why this is the case. The value of Josephson frequency equal to 5 Hz requires only $k_d = 47$ so that something else must be involved. A possible explanation in the framework of the proposed model comes from the following observations.

1. Besides the maximal p-adic scale $k = 205$ for which electron and weak bosons appears as dark variants the model allows also levels at which only gauge bosons appear as dark particles. From Table 9 one finds that levels $k \in \{207, 211, 213, 217, 219, 221, 223, 225, 229, 235\}$ are allowed. Could it be that these levels and possibly some highest levels containing both electrons and gauge bosons as dark particles are a prerequisite for EEG as we define it. Its variants at higher frequency scales would be present also for invertebrates. The lowest Josephson frequency coded by the largest value of \hbar in the cell membrane system determines the Josephson frequency.
2. The membrane potentials -55 mV (criticality against firing) correspond to ionic Josephson energies somewhat above 2 eV energy ((2.20, 2.74, 3.07, 2.31) eV, see Table 1). For 2 eV the wavelength 620 nm is near to $L(163) = 640$ nm. Therefore the Josephson energies of ions can correspond to the p-adic length scale $k = 163$ if one assumes that a given p-adic mass scale corresponds to masses half octave above the p-adic mass scale so that the opposite would hold true at space-time level by Uncertainty Principle. Josephson frequencies $f_J \in \{5, 10, 20, 40, 80, 160\}$ Hz correspond to $k_d \in \{47, 46, 45, 44, 43, 42\}$ giving $k_{eff} \in \{210, 209, 208, 207, 206, 205\}$.
 - (a) Cerebellar resonance frequency 160 Hz would correspond to $k = 205$ -the highest level for for which model allows dark electrons (also 200 Hz resonance frequency can be understood since several ions are involved and membrane potential can vary).

- (b) The 80 Hz resonance frequency of retina would correspond to $k_{eff} = 206$ -for this level dark electrons would not be present anymore.
 - (c) 40 Hz thalamocortical frequency would correspond to $k_{eff} = 207$.
 - (d) For EKG frequencies are EEG frequencies below 20 Hz 12.5 and heart beat corresponds to .6-1.2 second cycle (the average .8 s corresponds to $k_{eff} = 212$).
3. Even values of k_{eff} are not predicted by the model based on Mersenne primes allowing only odd values of k_{eff} so that the model does not seem to be the the whole truth. The conclusion which however suggests itself strongly is that EEG and its variants identified as something in the range 1-100 Hz, are associated with the levels in at which only dark weak bosons are possible in the proposed model. Note that the size scales involved with EEG would be above the size scale of human body so that we would have some kind of continuation of the biological body to be distinguished from the magnetic body. The time scales assignable to the dark *CDs* would be huge: for instance, $k = 205$ would correspond to $T = 2^{42} \times .1s$ making about 1395 years for electron.

2. *Does magnetic body correspond to the space-time sheets carrying dark weak bosons?*

The layers of the magnetic body relevant for EEG have have size of order Earth size. Natural time scale for the moment of sensory consciousness is measured as a fraction of second and the basic building blocks of our sensory experience corresponds to a fundamental period of .1 seconds. This scale appears already at \hbar_0 level for electron *CD*. The natural question concerns the relationship of the magnetic body to the $k > 205$ space-time sheets carrying only gauge bosons in the model and having size scale larger than that of biological body. Do they correspond to an extension of biological body or should they be regarded as parts of the magnetic body? The following observations suggest that they could correspond to layers of the magnetic body responsible for the fractal variant of EEG.

- 1. The primary p-adic time scales (Compton times) $T(239)$ and $T(241)$ correspond to frequencies, which are $2^{\pm 1/2}$ kHz. The geometric average $k = 240$ corresponds to kHz frequency. Is the appearance of kHz scale a mere accident or do the frequencies assignable to the quark *CDs* correspond to Compton times $\propto \sqrt{2^{k_{eff}/2}}$?
- 2. One can apply scalings by 2^{k_d} to the triplet (239, 240, 241) to get a triplet $(239 + k_d, 240 + k_d, 241 + k_d)$. The results are summarized in Table 10. Clearly the frequencies in question cover also the EEG range. Note that these frequencies scale as $\sqrt{1/r}$ whereas Josephson frequencies scale as $1/r$.

k_d	f_1/Hz	f_2/Hz	f_3/Hz
0	707	1000	1412
4	177	250	354
6	89	1250	177
10	22.1	31.3	44.2
12	11.1	15.6	22.1
14	5.5	7.8	11.1
16	2.8	3.9	5.5
18	1.4	2.0	2.8
20	0.7	1.0	1.4
24	0.2	0.2	0.3

Table 10. The Compton frequencies obtained by scaling $2^{k_d/2}$ from the basic triplet $k_{eff} = (239, 240, 241)$. The values of k_d correspond to those predicted by the model based on Mersenne primes.

Also ZEG and WEG would appear but in much shorter scales dictated by k_{eff} and might accompany EEG. Somehow it seems that the effective masslessness of weak bosons below given scale is highly relevant for life. One can of course ask whether some larger Gaussian Mersenne could change

the situation. There is a large gap in the distribution of Gaussian Mersennes after $k = 167$ and the next ones correspond to $M_{G,k}$, with k in $(239, 241, 283, 353, 367, 379, 457, 997)$ [39]. The twin pair $k = (239, 241)$ corresponds to a length scales $(1.6, 3.2) \times 10^2$ km and the minimum value for k_d are $(72, 74)$ ($167 \rightarrow (239, 241)$ transition).

3. Long term memory and ultralow Josephson frequencies

What determines the time scale associated with long term memory is a crucial question if one really wants to understand the basic aspects of consciousness.

1. Does the time scale correspond to the size scale of CD assignable to electron scaled by $r = \hbar/\hbar_0$? In this case relatively small values of r would be enough and $r = 2^{47}$ would give time scale of 10^{13} s for for electron's CD , which is about 3×10^5 years. This does not make sense.
2. Does Josephson frequency define the relevant time scale? In this case the long term memory would require the analog of EEG in the time scale of memory span. $k_{eff} = 205$ would give 6 ms time scale for memory from the assignment of $k_{eff} = 163$ to the Josephson photons at $V = -50$ mV implying $k_d = 42$. Minute scale would require $k_{eff} = 217$. The highest level $k_{eff} = 235$ allowed by the model involving only Gaussian Mersennes with $k \leq 167$ would correspond to a time scale of 77.67 days (day is 24 hours). For Gaussian Mersennes defined by $k_{eff} = (239, 241)$ the time scales become about $(41.4, 82.8)$ months (3.4 and 6.8 years). These scales should also define important biorhythms. The claimed 7 years rhythm of human life could relate to the latter rhythm: note that the precise value of the period depends on the membrane potential and thus varies. The presence of the scaled up variants of the by $k_d \leq 78$ allows longer time spans of long term memory and the scaling defined by $k_d = 167 - 163 = 4$ scales up the span of long term memories to $(54.4, 108.8)$ years.

4. Cultural evolution

Higher levels in the hierarchy would correspond mostly to the evolution of hyper-genome coding for culture and social structures. Introns are good candidate for the nucleodes involved. The development of speech faculty is certainly a necessary prerequisite for this breakthrough. Already EEG seems to correspond to dark layers of biological body larger than biological body so that one can ask whether the weak bosons and dark electrons in the length scales $k = 239, 241, 283, 353, 367, \dots$ could be relevant for the collective aspect of consciousness and cultural evolution. Maybe the size scales $(175, 330)$ km and their scaled up variants by $k_d \leq 78$ might have something to do with the spatial scale of some typical social structure (not city: the area of New York is only 790 km²).

6.2.7 Plasmoids as primitive life forms associated with magnetic bodies

In TGD framework plasmoids can be regarded as primitive life forms associated with rotating magnetic flux quanta, and it has been demonstrated that plasmoids seem to possess the basic characteristics of a living system [76]. The plasma in question is dark plasma. BE condensates of ions defining dark plasmas represent more advanced life forms of this kind. Dark plasma oscillations define ideal representations for field patterns inducing ionic (say Ca^{++}) waves (by many-sheeted Faraday's law) in turn inducing generalized motor activities.

The possibility of charged entanglement induced by W MEs and generating Bose-Einstein condensates of exotic ions brings in a genuinely new element to the model of plasmoids discussed earlier as predecessors of biological life [19]. The notion has been already applied in the model of nerve pulse [23]. One can speak about non-Abelian holograms at the level of dark matter with W bosons taking key role in the realization of motor actions and neutral bosons playing similar role in the realization or sensory and memory representations.

Plasmoids as rotating magnetic systems

If plasmoids rotate they generate em charge by the effect known already by Faraday but not explained satisfactorily by Maxwell's electrodynamics. In TGD framework vacuum charge density induces radial electric field inducing radial Ohmic current which is not divergenceless and hence charges the rotating magnet. Cell, DNA, and other sub-systems in living matter are usually negatively charged

and the underlying reason could be the presence of rotating plasmoids around which biochemical life forms have evolved.

Also Searl device [63, 38] discussed in [18] is a rotating magnetic system. In this case the charging of the system implies an effective loss of weight in Earth's electric field. Searl device is known to develop cylindrical magnetic walls [38]. According to TGD based model of Searl device [18], the rotating magnetic walls represent a simple example of a magnetic body containing dark matter. The energy and angular momentum transfer from the magnetic flux walls generated by the rotation to the rotating system is assumed to explain the accelerated rotation of the system.

Dark plasma waves

Dark plasma waves have synchronously oscillating spatial patterns. Charge densities correspond to the order parameters of BE condensates of bosonic ions so that the introduction of the ion densities is not an idealization as in the non-quantum situation.

The dispersion relation of dark plasma oscillations in the lowest order approximation reads as

$$f_p = \sqrt{e^2 n / m} ,$$

where n and m are the number density and mass of plasma waves. In the case of dark plasma waves n corresponds to the density defined by the order parameter of the Bose-Einstein condensate of ordinary or exotic ions. The dispersion relation does not depend on wave vector at all so that the plasma wave recurs to the same pattern again and again and therefore provide ideal representations of mental images.

Since the notion of ionic density is not an idealization in case of dark plasma waves, it seems sensible to assign energy quantum to the dark plasma waves. Since plasma frequency is purely classical quantity the plasma energy $E_p = \hbar f_p$ would scale as \hbar and an increasing hierarchy of plasma wave energies is predicted. These energies could define the metabolic energy quanta in the case of plasmoid life forms. These quanta can decay to \hbar_0 low energy quanta as they are used.

Plasma wave patterns could provide a realization for the control commands inducing motor activities and the energy of the plasma wave could be sucked from metabolic energy sources by time mirror mechanism and dissipated in the realization of motor action as the plasma wave decomposes into $r = \hbar / \hbar_0$ plasma waves at the lowest level of the hierarchy.

Quite large energies are involved at higher levels of dark matter hierarchy and the question arises whether there exist suitable sources of metabolic energy. The dropping of electrons from $k = 137$ atomic space-time sheets could provide metabolic energy quantum $E(137) \simeq 1$ keV. The dropping of electron from $k = 131$ space-time sheet would liberate energy $E(131) \simeq 64$ keV. The requirement that plasma wave energies correspond to zero point kinetic energies forces quantization of the densities of ions for Bose-Einstein condensates. Also the cyclotron transition energies of electrons or their Cooper pairs can provide the metabolic energy quanta. Note that metabolic efficiency requires quantization of the densities of Bose-Einstein condensates.

A further source of metabolic energy could be dark microwave photons generated by quartz crystals in the rock. Callahan has found that rocks consisting mainly of quartz SiO_2 serve as a source of bio-photons and that paramagnetic soil implying strong Schumann resonance amplitudes is favorable for the well-being of plants [83]. Bio-photons could be produced as de-coherence products of dark microwave photons. Interestingly, SiO_2^- ion has cyclotron frequency 10 Hz for $B_{end} = .2$ Gauss equal to the fundamental bio-rhythm and the p-adic frequency $f(2, 127)$ associated with the memetic code.

It is possible to assign definite time scales to various plasma densities in magnetosphere possibly relevant to consciousness and this in principle makes it possible to build a more detailed view about quantal magnetosphere.

Dark plasma wave patterns as a tool of bio-control

Dark plasma wave patterns correspond to small deviations of charge densities from the non-equilibrium charge density by exotic ionization. Charge entanglement by W MEs with the magnetic body is an ideal mechanism for the generation of these deviations.

W ME generates oscillatory entanglement with coefficients which depend on space-time coordinates. In the state function reduction one of the outcomes is a state in which Bose-Einstein condensates in both systems carry exotic nuclear em and weak charges.

The reduction occurs for entire Bose-Einstein condensates of bosonic ions at biological body. The stronger the W field, the higher the probability that exotically charged BE condensate results. Ionic BE condensates define the pixels of the motor map as well as sensory map and the size of coherence region determines the pixel size. Similar mechanism works at the level of sensory input to the magnetic body.

Dark plasma waves induce ordinary ionic waves such as Ca^{++} waves as asymptotic self-organization patterns which would naturally correspond to generalized motor actions. Plasma wave patterns generate also cyclotron radiation the interaction of which with Josephson junctions induce a sensory representation for these patterns so that the control loop closes. Digital spatial and temporal modulation of the plasma wave patterns makes possible field codes for motor activities induced by ionic waves. Obviously the coding of plasma wave patterns to motor actions would be very robust.

6.2.8 Field representations of information using codes

As already mentioned, the work of Benveniste [77, 74], Gariaev [81], and Persinger [86] provides evidence for the existence of field codes and for the view that water can learn associations [79]. The basic distinction as compared to the genetic code is that field codes could be context dependent conventions somewhat like natural languages since magnetic body brings in conscious intelligence and flexibility. Therefore the earlier vision about memetic code [30] assuming strict duration of the memetic codons could be un-necessarily restrictive.

Information theoretic aspects

Code words are names for biological functions which can be very complex.

1. Associative learning of the code

Flexibility is the basic property of the field codes. The codes can be therefore context dependent and characterize individual organism rather than being biological invariants. Personal code might well be necessary in order to guarantee that biological body cannot be "possessed" by outsiders. The higher the level of dark matter hierarchy, the higher this flexibility is expected to be (natural language in contrast to primitive signals which are rather universal). The work of Benveniste [77, 74] and the report of Smith about context specified 7-bit code for frequency importing [68] provide support for the associative learning in water.

Flexibility implies that an associative learning of the code is required. There are two diametrically opposite manners to understand what the establishment of the code could mean.

1. The definitely higher IQ and quantum flexibility of the magnetic body suggests that magnetic body learns by searching the patterns inducing the desired responses of the biological body.
2. Magnetic body could also teach, or rather modify, the biological body to respond in a desired manner to plasma wave patterns. This mode of learning requires plasticity and might be important at the level of brain: associative regions of the cortex of higher primates are indeed known to be highly plastic so that changes of connectivity could make possible this kind of learning. The learning requires feedback circuit. An input signal representing the motor action is dark plasma wave pattern. There is also a motor input modifying the response function of the biological body using already learned code. The feedback is essentially the output allowing to decide about next motor input modifying the response function. Automatic associative learning results if the control loop is made automatic. A fascinating possibility is that this kind of modification could occur at the level of genes as a kind of genetic self engineering.

Quite generally, spin glass degeneracy and classical non-determinism are prerequisites for learning at various levels of dark matter hierarchy. In neuroscience rewards and punishments represented by neurotransmitters and various information molecules are believed to drive the learning.

2. The information content of code is maximized

Negentropy Maximization Principle [33] is expected to pose constraints on the possible codes but it is difficult to imagine deduction of these constraints directly from NMP. The number theoretic model reproducing the genetic code as well as its variants [29] suggests much more direct approach.

Number theoretical variants of Shannon entropy allow interpretation as positive information measures. The information content of the code should be maximized by assigning to it somehow a statistical ensemble or a set of statistical ensembles. In the model of genetic code the 64 codons labelled by integers in the range $0, \dots, 63$ and the corresponding aminoacids are labelled by the 18 primes $p < 64$ and integers $0, 1$ which correspond to DNAs labelled by $0, 1$. Hence the task reduces to finding an assignment $n \rightarrow p(n)$. The prime associated with a given integer from the maximization of negentropy for the entire code. Dynamics is thermodynamics for the partitions of n to a sum of r integers, $r = 1, \dots, n$. Quantum criticality suggests that the Hamiltonian $H(r)$ (or rather, Boltzmann weights) can be engineered freely. The negentropy $N(n)$ is maximum over p -adic negentropies $N_p(n)$ (formally Shannon entropies) fixing the prime $p(n)$.

This principle generalizes to an arbitrary code provided one can label the codewords using integers n and their images by primes $p(n)$. In the model of the genetic code n codons code for $0, 1$ and primes $p < n$, whose number $N(n)$ behaves for large values of n like $N(n) \simeq n/\log(n)$. This is obviously a highly non-trivial prediction about the code. The model as such does not tell anything about how the plasma oscillation patterns are labelled by integers.

The patterns to which codons are mapped should be effectively digital just as in the case of a computer graphics. Dark matter Bose-Einstein condensates react as single particles and serve as natural digits and the number of codons is finite. BE condensate patterns induce patterns of ionic waves (such as Ca^{++} waves), and if it is only the asymptotic self-organization pattern which matters, the degeneracy of the code follows naturally.

3. How the meaning emerges?

Information without meaning is not information. The model based on magnetic body and biological body allows to understand how the meaning of the symbolic signals used in the communications emerges. The biological self-organization process induced by the signal acting as a control signal give rise to a mental image at the level of biological body (symbolic mental image at the level of brain and sensory mental images at the level of sensory organs) shared by the magnetic body via entanglement. This mental image would give the meaning for the signal.

How magnetic body perceives?

In order to speak about perception as something more than a completely automatic process, it is necessary to assume that the perceiver is an intentional agent receiving sensory input and able to perform motor actions. Magnetic bodies at higher levels of dark matter hierarchy would be a natural identification for the recognizer.

1. The general model for motor action and sensory communications

The general model for motor actions and communications of sensory input to the magnetic body relies crucially on magnetic flux quanta connecting system to its magnetic body and Josephson junctions serving the role of sensory receptors. This model was first developed for cell with cell/nuclear membrane serving as Josephson junction and DNA double strand as a basic instrument of motor action allowing to realize motor commands via gene expression. An essential assumption is the presence of quantum critical high T_c super-conductivity in some finite temperature range for which a good guess is $36\text{-}37^\circ\text{C}$ [20]. The upper limit of the temperature range would be critical temperature for super-conductivity and lower limit the temperature above which almost vacuum extremal property is possible.

This model allows to develop a model of sensory perception using the patterns of Josephson radiation. The model of Comorosan effect [67] suggests that even molecules could be carriers of supra currents and that the structures formed by enzymes and substrate molecules contain Josephson junctions. Hence the model might apply even when the perceiving system is the magnetic body of bio-molecule, say that of a molecular motor. In the case of DNA double strand the identification of the candidates for Josephson junctions is obvious.

Josephson junction codes information about all kinds of radiation to the pattern of Josephson radiation. In particular, the dark cyclotron radiation generated by the cyclotron transitions of the

cyclotron BE condensates at the magnetic bodies creates a voltage perturbation and thus affects Josephson current in the Josephson junctions assignable with the recognizing system and the resulting Josephson radiation received by the magnetic body contains information about the cyclotron radiation emitted by the target.

2. *How magnetic body perceives the sensory input from the biological body?*

An important question is how the magnetic body generates the cyclotron radiation to which the biologically important molecules respond. In the vicinity of Earth (say below ionosphere) this radiation could be generated by the ions themselves but at high enough heights it is basically protons and electrons which are present in significant amounts.

An elegant resolution of the problem would be provided by the model of frequency imprinting and entrainment. Exotically ionized super-nuclei formed by protonic strings dropped to magnetic flux sheets are able to mimic ordinary ions. These super-nuclei could also act as receiving antennas and can serve as kind of amplifiers in the recognizing system. Time mirror mechanism would also allow to amplify phase conjugate signal using population reversed cyclotron laser.

3. *Sensory input from biological body as a somatosensory map at magnetic body*

The basic recognition process is related to the recognition of the patterns of Josephson radiation consisting of frequencies $f_{n,\pm} = nf_c \pm f_J$. Somehow these patterns must define what might be called somatosensory maps at the level of magnetic body.

The previous work with frequency coding of positions of objects of perceptive field using varying cyclotron frequencies [37] suggests that the magnetic field at the magnetic flux quanta is slowly varying so that the input at frequency $f_{n,\pm} = nf_c \pm f_J$ generates resonant cyclotron transitions at a position of the magnetic flux quantum determined by the condition $\hat{f}_c = f_{n,\pm}$.

This would map the sensory input to a geometric pattern along magnetic body defined by the varying intensity of induced cyclotron transitions and magnetic body would experience the input from the biological as a kind of bodily sensation. It is quite possible that same sensory input is mapped to several positions at the magnetic body.

The harmonics of "alpha" band would correspond to $\hat{f}_c = nf_c$ and would correspond to motor areas of the magnetic body disjoint from sensory areas. "Beta" and "theta" bands would correspond to $nf_c + f_J$ and $nf_c - f_J$ and receive sensory input. This allows two options.

1. The magnetic flux could vary in discrete manner so that $\hat{f}_c = nf_c$ would correspond to magnetic flux $n\hbar(k)$: in this case the harmonics of alpha band would correspond to disjoint flux quanta within which magnetic field varies in a relatively narrow range. In this case EEG bands would have precise geometric correlates.
2. If the magnetic flux has minimal value of $\hbar(k)$, the area of the magnetic flux quantum would vary as $S(n) \propto 1/\sqrt{n}$ by flux quantization. There would be a cutoff in n since the field strength cannot be too high.

If the magnetic field strength decreases as a function of distance from Earth as one might expect, beta and gamma bands would be nearer to the biological body than theta and delta bands for both options. This conforms with the fact that the EEG activity above alpha band is typically associated with rapid reactions and the time delay due to the sensory communications should be minimal. The magnetic body can extend below the Earth's surface where the field strength increases. Also the model for EEG leads to the same conclusion: the Josephson junction associated with $k_d = 44$ level is through the layer formed by ionosphere and lithosphere [20].

The role of brain would be to construct symbolic representations by abstracting only the essential features of the sensory input so that also pattern completion would become possible. Magnetic body itself would accept the sensory input from brain and body as such.

Dark plasma wave patterns as motor commands

Since dark plasma waves recur again and again to the same pattern they are ideal for the field representation of codewords representing biological activities. Dark plasma oscillations can induce various ionic waves such as Ca^{++} and Mg^{++} waves since plasma wave modifies the scalar potential at dark space-time sheets and thus also at ordinary space-time sheets by Faraday law in many-sheeted

space-time. Plasma wave pattern generates also a pattern of cyclotron radiation in the magnetic field and its presence is detected at the magnetic body via sensory system so that a motor-sensory feedback loop results.

Dark plasma wave patterns would define self-organizing "motor mental images" assignable to the biological body and perhaps also with motor areas of magnetic bodies since the motor control of magnetic bodies from higher levels is also expected to be present. These self-organization patterns would represent control commands realized in terms of frequencies and spatial field patterns assignable to W MEs. Digitalization would be implied by the size of the coherent region of the BE condensate making collective quantum phase transition to a state involving plasma oscillation with a probability proportional the intensity of W field inside coherence region.

The realization of motor action involves W MEs. Exotic W bosons behave as massless particles below the weak length scale but above this scale they possess a mass obtained by p-adically scaling down the mass ~ 80 GeV of the ordinary $k = 89$ W boson. This suggests that a large metabolic energy of order W boson mass is needed to generate W ME and that this energy transformed to the energy of plasma oscillation as charge entanglement is reduced and produces exotic ionization. This metabolic energy could be provided by the dropping of an electron from atomic or sub-atomic space-time sheet to a larger space-time sheet.

Is it possible to transfer genetic information using field patterns?

The work of Yu. Chen Kangeng gives evidence that the transfer of the genetic information by electromagnetic means is possible [65]. According to [56], where the method is summarized, the successful transfer of the genetic information from a donor bio-system to an acceptor system was achieved via high-frequency electromagnetic fields feed repeatedly through the optically-active donor bio-system and then delivered over a long period of time to the receiving bio-system in its early developmental stages. The hybrids created through the irradiation of eggs and seeds with such "genetically loaded" fields are claimed to show very specific mixed characteristics that were transferred to the next generation without need for further irradiation.

It would seem that the donor genome or parts of it are imprinted to the electromagnetic field pattern in the process and that this field pattern is able to modify the target genome.

Nothing precludes the possibility that genes/supergenes/hyper genes at some level of dark matter hierarchy can also code for genetic self engineering since these activities are after all very similar to other genetically coded bio-chemical activities. The computer analogy would be programs writing programs. The engineering genes would be activated by W MEs inducing plasma oscillation patterns. The claimed effects could be understood if the interaction with genetically imprinted electromagnetic field pattern activates genes inducing genetic self engineering yielding the genetic modifications consistent with the pattern represented by the em radiation.

Magnetic body would receive information about the desired outcome as electromagnetic field patterns emitted by other organisms, most naturally members of the same species. If these modifications are successful, the magnetic body is exposed to this information for long enough time to react and activate W MEs inducing the genetic program inducing the genetic program leading to the suggested genetic modification.

Hyper-genes integrating groups of organisms to larger wholes would be naturally involved with the mechanism. This mechanism would guarantee a rapid propagation of successful genetic modifications to the entire population and would be much more effective than the slowly occurring selection of random mutations. The possibly existing genes responsible for the genetic self engineering could be also introns and express themselves by activating nuclear RNA and process like reverse transcription.

The mechanism could explain the findings of Shelldrake about learning at the level of species. The observed rather recent emergence of 223 new genes into human genome [53, 54] could be understood as a genetic self engineering rather than genetic engineering by more advanced civilizations (note however that the higher levels of dark matter hierarchy can be also regarded as "more advanced civilizations"). A further quite recent mystery discussed in [30] is that corals seem to possess genes responsible for higher level psychological functions in mammals [58]: it is very difficult to understand this as an outcome of selective pressures combined with random mutations. The proposed mechanism might explain these genes as a result of genetic engineering.

The basic ingredient of the coral backbone is calcium carbonate $CaCO_3$. Salt is in question so that also Ca^{++} and CO_3^{--} ions are present. Ca^{++} could obviously give rise to Calcium waves. CO_3^{--}

has atomic weight $A = 60$ with cyclotron frequency 10 Hz for $B_{end} = .2$ Gauss. This frequency defines the fundamental biological rhythm and characterizes also memetic code. It characterizes also effectively 2-dimensional waves closed inside the ionospheric cavity: for l^{th} harmonic the frequency is $f = \sqrt{l(l+1)}/2\pi R_E$, R_E Earth's radius, and $l = 1$ gives 10 Hz frequency. Could the transfer of the genetic information in the Earth's length scale with 126-bit memetic codons be realized as ripples 10 Hz waves make possible genetic self engineering of coral genome?

During the early developmental stages the genome might be plastic enough to allow genetic self engineering. The genetic modification during this period also the most rational option since this gives the best guarantee that the modifications are transferred to the offspring.

6.3 Dark matter hierarchy, genetic machinery, and the unreasonable selectivity of bio-catalysis

One of the most fascinating outcomes of ideas related to the dark matter hierarchy is the notion of inherently dark fractional atom (molecule) generalizing the notion of Bose-Einstein condensate to the fermionic case. These notions might provide an elegant manner to understand the mysteries of DNA replication, transcription, and translation, and more generally, the incredible selectivity of bio-catalysis.

As often, the original idea was not quite correct. I spoke about N -atoms rather than fractional atoms. In particular, the mass of N -molecule was N times larger than that of the ordinary molecule apart from corrections from binding energy. The more precise view about dark matter hierarchy led to the realization that fractionization of all quantum numbers occurs. In the most general case one can have fractional particles with particle number $n = k/r, k = 1, \dots, r, r = \frac{\hbar}{\hbar_0}$. This leaves the model essentially as such at formal level. The model is however much more realistic than the original one since fractional atoms have mass which is never larger than that of ordinary atom and also conforms with the recent view about the origin of the hierarchy of Planck constants.

6.3.1 Dark atoms and dark cyclotron states

The development of the notion of dark atom involves many side tracks which make me blush. The first naive guess was that dark atom would be obtained by simply replacing Planck constant with its scaled counterpart in the basic formulas and interpreting the results geometrically. After some obligatory twists and turns it became clear that this assumption is indeed the most plausible one. The main source of confusion has been the lack of precise view about what the hierarchy of Planck constants means at the level of imbedding space at space-time.

The rules are very simple when one takes the singular coverings assigned to the many-valuedness of the time-derivatives of imbedding space coordinates as functions of canonical momentum densities as a starting point.

1. The mass and charge of electron are fractionized as is also the reduced mass in Schrödinger equation. This implies the replacements $e \rightarrow e/r$, $m \rightarrow m/r$, and $\hbar \rightarrow r\hbar_0$, $r = n_a n_b$, in the general formula for the binding energy assigned with single sheet of the covering. If maximal number $n_a n_b$ are present corresponding to a full "Fermi sphere", the total binding energy is r times the binding energy associated with single sheet.
2. In the case of hydrogen atom the proportionality $E \propto m/\hbar^2$ implies that the binding energy for single sheet of the covering scales as $E \rightarrow E/(n_a n_b)^3$ and maximal binding energy scales as $E \rightarrow E/(n_a n_b)^2$. This conforms with the naive guess. For high values of the nuclear charge Z it can happen that the binding energy is larger than the rest mass and fractionization might take place when binding energy is above critical fraction of the rest mass.
3. In the case of cyclotron energies one must decide what happens to the magnetic flux. Magnetic flux quantization states that the flux is proportional to \hbar for each sheet separately. Hence one has $\Phi \rightarrow r\Phi$ for each sheet and the total flux scales as r^2 . Since the dimensions of the flux quantum are scaled up by r the natural scaling of the size of flux quantum is by r^2 . Therefore the quantization of the magnetic flux requires the scaling $B \rightarrow B/r$. The cyclotron energy for single sheet satisfies $E \propto \hbar q B/m$ and since both mass m and charge q become fractional, the

energy E for single sheet remains invariant whereas total cyclotron energy is scaled up by r in accordance with the original guess and the assumption used in applications.

4. Dark cyclotron states are expected to be stable up to temperatures which are r times higher than for ordinary cyclotron states. The states of dark hydrogen atoms and its generalizations are expected to be stable at temperatures scaled down by $1/r^2$ in the first approximation.
5. Similar arguments allow to deduce the values of binding energies in the general case once the formula of the binding energy given by standard quantum theory is known.

The most general option allows fractional atoms with proton and electron numbers varying from $1/r$ to 1. One can imagine also the possibility of fractional molecules. The analogs of chemical bonds between fractional hydrogen atoms with $N - k$ and k fractional electrons and protons can be considered and would give rise to a full shell of fractional electrons possessing an exceptional stability. These states would have proton and electron numbers equal to one.

Catalytic sites are one possible candidate for fractal electrons and catalyst activity might be perhaps understood as a strong tendency of fractal electron and its conjugate to fuse to form an ordinary electron.

Connection with quantum groups?

The phase $q = \exp(i2\pi/r)$ brings unavoidably in mind the phases defining quantum groups and playing also a key role in the model of topological quantum computation [25]. Quantum groups indeed emerge from the spinor structure in the "world of classical worlds" realized as the space of 3-surfaces in $M^4 \times CP_2$ and being closely related to von Neumann algebras known as hyper-finite factors of type II_1 [19].

Only singular coverings are allowed if the hierarchy of Planck constants and corresponding hierarchy of singular coverings follows from the basic TGD. If the integer n characterizing the quantum phase allows identification with $r = \hbar/\hbar_0$, living matter could be perhaps understood in terms of quantum deformations of the ordinary matter, which would be characterized by the quantum phases $q = \exp(i2\pi/r)$. Hence quantum groups, which have for long time suspected to have significance in elementary particle physics, might relate to the mystery of living matter and predict an entire hierarchy of new forms of matter.

How to distinguish between fractional particles and ordinary particles?

The unavoidable question is whether bio-molecules in vivo could involve actually fractional atoms molecules as their building blocks. This raises a series of related questions.

1. Could it be that we can observe only the fusion of of dark fractional fold molecules to ordinary molecules or its reversal? Is the behavior of matter matter in vivo dictated by the dark matter commentn and of matter in vitro by ordinary matter? Could just the act of observing the matter in vivo in the sense of existing science make it ordinary dead matter?
2. If fractional atoms and molecules correspond to the maximum number of fractional quanta their masses are same as for ordinary atoms and molecules and only the different binding energy photon spectrum distinguishes between them. Situation changes all fractional states are possible and one obtains scaled down spectrum as a unique signature.
3. The fusion of fractional molecules to ordinary molecules in principle allows to conclude that fractional molecule was present. Could this process mean just the replacement of DNA in vivo with DNA in vitro?

6.3.2 Spontaneous decay and completion of dark fractional atoms as a basic mechanisms of bio-chemistry?

The replication of DNA has remained for me a deep mystery and I dare to doubt that the reductionistic belief that this miraculous process is well-understood involves self deceptive elements. Of course the problem is much more general: DNA replication is only a single very representative example of the miracles of un-reasonable selectivity of the bio-catalysis. I take this fact as a justification for some free imagination inspired by the notion of dark fractional molecule.

Dark fermionic molecules can replicate via decay and spontaneous completion

Unit particle number for fractional atom or molecule means that the analog of closed electronic shell are in question so that the state is especially stable. Note that the analogy with full Fermi electronic sphere makes also sense. These atoms or molecules could decay to fractional atoms or molecules. with fractional particle numbers k/r and $(r - k)/r$.

Suppose that a fractional molecule with unit particle number decays into k/r -molecule and $(r - k)/r$ -molecule. If r is even it is possible to have $k = r - k = r/2$ and the situation is especially symmetric. If fermionic $k/r < 1$ fractional atoms or molecules are present, one can imagine that they tend to be completed to full molecules spontaneously. Thus spontaneous decay and completion would favor the spontaneous replication (or rather fractionization) and dark molecules could be ideal replicators (fractionizers) The idea that the mechanisms of spontaneous decay and completion of dark fractional particles somehow lurk behind DNA replication and various high precision bio-catalytic processes is rather attractive.

Reduction of lock and key mechanism to spontaneous completion

DNA replication and molecular recognition by the lock and key mechanism are the two mysterious processes of molecular biology. As a matter fact, DNA replication reduces to spontaneous opening of DNA double strand and to the lock and key mechanism so that it could be enough to understand the opening of double strand in terms of spontaneous decay and lock and key mechanism in terms of spontaneous completion of fractional particle (-atom or -molecule).

Consider bio-molecules which fit like a lock and key. Suppose that they are accompanied by dark fractional atoms or molecules, to be called dark fractional particles in sequel, such that one has $k_1 + k_2 = r$ so that in the formation of bound state dark molecules combine to form r -molecule analogous to a full fermionic shell or full Fermi sea. This is expected to enhance the stability of this particular molecular complex and prefer it amongst generic combinations.

For instance, this mechanism would make it possible for nucleotide and its conjugate, DNA and mRNA molecule, and tRNA molecule and corresponding aminoacid to recognize each other. Spontaneous completion would allow to realize also the associations characterizing the genetic code as a map from RNAs to subset of RNAs and associations of this subset of RNAs with amino-acids (assuming that genetic code has evolved from RNA \rightarrow RNA code as suggested in this chapter).

As such this mechanism allows a rather limited number of different lock and key combinations unless r is very large. There is however a simple generalization allowing to increase the representative power so that lock and key mechanism becomes analogous to a password used in computers. The molecule playing the role of lock *resp.* molecule would be characterized by a set of n fractional particles with $k_1 \in \{k_{1,1}, \dots, k_{1,n}\}$ *resp.* $k_2 \in \{k_{2,1} = r - k_{1,1}, \dots, k_{2,n} = r - k_{1,n}\}$. The molecules with conjugate names would fit optimally together. Fractional molecules or fractional electrons or atoms appearing as their building blocks would be like letters of a text characterizing the name of the molecule.

The mechanism generalizes also to the case of $n > 2$ reacting molecules. The molecular complex would be defined by a partition of n copies of integer r to a sum of m integers $k_{k,i}$: $\sum_i k_{k,i} = r$.

This mechanism could provide a universal explanation for the miraculous selectivity of catalysts and this selectivity would have practically nothing to do with ordinary chemistry but would correspond to a new level of physics at which symbolic processes and representations based on dark fractional particles emerge.

Connection with the number theoretic model of genetic code?

The emergence of partitions of integers in the labelling of molecules by fractional particles suggests a connection with the number theoretical model of genetic code [29], where DNA triplets are characterized by integers $n \in \{0, \dots, 63\}$ and aminoacids by integers 0, 1 and 18 primes $p < 64$. For instance, one can imagine that the integer n means that DNA triplet is labelled by n/r -particle. $r = 64$ would be the obvious candidate for r and conjugate DNA triplet would naturally have $n_c = 64 - n$.

The model relies on number-theoretic thermodynamics for the partitions of n to a sum of integers and genetic code is fixed by the minimization of number theoretic entropy which can be also negative and has thus interpretation as information. Perhaps these partitions could correspond to states resulting in some kind of decays of n -fermion to n_k/r -fermions with $\sum_{k=1}^r n_k = n$. The n_k/r -fermions

should however not correspond to separate particles but something different. A possible interpretation is that partition corresponds to a state in which n_1/r particle is topologically condensed at $n_2/r \geq n_1/r$ particle topologically condensed....at $n_k/r \geq n_{k-1}/r$ -particle. This would also automatically define a preferred ordering of the integers n_i in the partition.

An entire ensemble of labels would be present and depending on the situation codon could be labelled not only by n/r -particle but by any partition $n = \sum_{i=1}^k n_i$ corresponding to the state resulting in the decay of n/r -particle to k fractional particles.

Reduction of DNA replication to a spontaneous decay of r -particle

DNA replication could be induced by a spontaneous decay of r -particle inducing the instability of the double strand leading to a spontaneous completion of the component strands.

Strand and conjugate strand would be characterized by k_1/r -particle and $(r-k_1)/r$ -particle, which combine to form r -particle as the double strand is formed. The opening of the double strand is induced by the decay of r -particle to k_1/r - and $(r-k_1)/r$ -particles accompanying strand and its conjugate and after this both strands would complete themselves to double strands by the completion to r -particle.

It would be basically the stability of fractional particle which would make DNA double strand stable. Usually the formation of hydrogen bonds between strands and more generally, between the atoms of stable bio-molecule, is believed to explain the stability. Since the notion of hydrogen bond is somewhat phenomenological, one cannot exclude the possibility that these two mechanisms might be closely related to each other. I have already earlier considered the possibility that hydrogen bond might involve dark protons [20]: this hypothesis was inspired by the finding that there seems to exist two kinds of hydrogen bonds [47, 50].

The reader has probably already noticed that the participating fractional molecules in the model of lock and key mechanism are like sexual partners, and if already molecules are conscious entities as TGD inspired theory of consciousness strongly suggests, one might perhaps see the formation of entangled bound states with positive number theoretic entanglement entropy accompanied by molecular experience of one-ness as molecular sex. Even more, the replication of DNA brings in also divorce and process of finding of new companions!

6.3.3 The new view about hydrogen bond and water

Concretization of the above scenario leads to a new view about hydrogen bond and the role of water in bio-catalysis.

What the fractional particles labelling bio-molecules could be?

What the dark fractional particles defining the letters for the names of various bio-molecules could be? Dark fractional hydrogen atoms are the lightest candidates for the names of bio-molecules. The fusion could give rise to the hydrogen atom appearing in hydrogen bond. One could say the fractional hydrogen atoms belong to the molecules between which the hydrogen bond is formed. In absence of bond the fractional atoms would define active catalyst sites. This mechanism would also conform with the belief that hydrogen bonds guarantee the stability of bio-molecules.

This idea is not a mere speculation. The first experimental support for the notion of dark matter [20] came from the experimental finding that water looks in atto-second time scale from the point of view of neutron diffraction and electron scattering chemically like $H_{1.5}O$: as if one fourth of protons are dark [42, 44, 51, 49]. Dark protons would be identifiable as fractional protons. Of course, also dark hydrogen atoms can be considered.

One can imagine also a second option. The model for homeopathy [18] leads to a rather concrete view about how magnetic body controls biological body and receives sensory input from it. The model relies on the idea that dark water molecule clusters and perhaps also dark exotically ionized super-nuclei formed as linear closed strings of dark protons [20] perform this mimicry. Dark proton super-nuclei are ideal for mimicking the cyclotron frequencies of ordinary atoms condensed to dark magnetic flux quanta. Of course, also partially ionized hydrogen fractional ions could perform the cyclotron mimicry of molecules with the same accuracy.

One can consider the possibility fractional molecules/atoms correspond to exotic atoms formed by electrons bound to exotically ionized dark super-nuclei: the sizes of these nuclei are however above

atomic size scale so that dark electrons would move in a harmonic oscillator potential rather than Coulombic potential and form states analogous to atomic nuclei. The prediction would be the existence of magic electron numbers [20]. Amazingly, there is strong experimental evidence for the existence of this kind of many-electron states. Even more, these states are able to mimic the chemistry of ordinary atoms [48, 43, 45]. The formation of hydrogen bonds between catalyst and substrate could be the correlate for the fusion of fractional hydrogen atoms.

If the fusion process gives rise 1/1-hydrogen, its spontaneous decay to ordinary hydrogen would liberate the difference of binding energies as metabolic energy helping to overcome the energy barrier for the reaction. The liberated energy would be rather large and correspond 3.4 eV UV photon even for $r = 2$ which suggests that it does not relate with standard metabolism. For larger values of r the liberated energy rapidly approaches to the ground state energy of hydrogen. Note that the binding energy of ordinary hydrogen atom in state $n = r$ has in the lowest order approximation same energy as the ground state of dark hydrogen atom for $\hbar/\hbar_0 = r$ so that one can consider the possibility of a resonant coupling of these states.

Fractional protons and electrons have effective charge $\pm ke/r$ so that the binding regions of catalysts and reacting molecules could carry effective fractional surface charge.

This might relate in an interesting manner to the problem of how poly-electrolytes can be stable (I am grateful for Dale Trenary for pointing me the problem and for interesting discussions). For instance, DNA carries a charge of -2 units per nucleotide due to the phosphate backbone. The models trying to explain the stability involve effective binding of counter ions to the polyelectrolyte so that the resulting system has a lower charge density. The simulations of DNA condensation by Stevens [69] however predict that counter ion charge should satisfy $z > 2$ in the case of DNA. The problem is of course that protons with $z = 1$ are the natural counter ions. The positive surface charge defined by the fractional protons attached to the nucleotides of DNA strand could explain the stability.

The hydrogen atoms in hydrogen bonds as fractional hydrogen atoms and $H_{1.5}O$ formula for water

The simplest assumption is that the hydrogens associated with hydrogen bonds are actually associated with 1/1 type dark hydrogen atoms. This hypothesis has interesting implications and could explain the formula $H_{1.5}O$ for water in atto-second time scales suggested by neutron diffraction and electron scattering [42, 44, 51, 49].

The formation of hydrogen bond would correspond to a fusion of name and conjugate name between $H_{k/r}$ -O-H atom and its conjugate $H_{(r-k)/r}$ -O-H atom. The resulting pairs would obey the chemical formula H_3-O_2 . Hence the formation of hydrogen bonds would predict the $H_{1.5}O$ formula suggested by neutron diffraction and electron scattering in atto-second time scale. This holds true only if one has complete pairing by hydrogen bonds. A more plausible explanation is that just the presence of fractional hydrogens implies the effect. Furthermore, the fraction of dark protons can depend on temperature.

The roles of water and ordered water in catalysis

The new view about hydrogen bond allows to understand the role of water in biology at qualitative level. For instance, one can

1. tentatively identify "ordered water" as a phase in which all $H_{k/r}$ atoms and their conjugates have combined to $H_{1/1}$ atoms,
2. understand why (or perhaps it is better to say "predict that") water containing $H_{k/r}$ atoms acts as a catalytic poison so that the binding sites of catalysts and reactants must be isolated from water unless the water is ordered,
3. justify the belief that gel phase involving ordered water is necessary for biological information processing,
4. understand why hydration causes hydrolysis,
5. understand the instability of DNA against decay to RNA outside nucleus.

A more more detailed sketch looks like following.

1. Suppose that at least part of water molecules appear in form $H_{k/r}$ -OH and $H_{(r-k)/r}$ -O-H. These molecules and the molecule $H_{1/1}$ -OH₂ formed in their fusion has much smaller binding energy than ordinary water molecule and is expected to be unstable against transition to H₃O. This would suggest that the feed of metabolic energy is needed to generate the dark hydrogen atoms. Fractional dark water molecules can join pairwise to form H-O-(H_{1/1})-O-H≡ H₃O₂ with H_{1/1}-atoms replacing hydrogen in hydrogen bond. Also $H_{k_1/r}$ -O- $H_{k_2/r}$ molecules are possible and could form closed strings obeying the chemical formula $O_n(H_{1/1})_n$. Also open strings with H-O:s at ends are possible. This phase of water might allow identification as "ordered water" believed to be associated with gel phase and be crucial for quantal information processing inside cell. Liquid crystal phase of water could correspond to a bundle of open vertical segments H-O_n(H_{1/1})_{n-2}-H forming a 2-dimensional liquid (vertical freezing).
2. Exotic water molecules could spoil the action of both catalyst and reactant molecules by attaching to the "letters" in the name of catalyst or reactant so that the letters are not visible and catalyst and reactant cannot recognize each other anymore. Hence binding sites of catalyst and reactant must be isolated from water containing fractional water molecules. This is what Sidorova and Rau [66] suggest on basis of comparison of specific and non-specific catalysts: non-specific catalysts contain water in an isolated binding volume whereas for specific catalysts this volume is empty. An alternative mechanism hindering water molecules to attach to "letters" is that water is "ordered water" with no fractional water molecules present.
3. DNA is known to be stable against decay to RNA via hydration inside the cell but not outside. Hydration could correspond to the joining of fractional water to sites of DNA transforming it to RNA. Inside nucleus this cannot occur if water is in ordered water phase permanently.

How the first self-replicators emerged?

The identification of the first self replicator can be seen as perhaps the most fascinating and challenging problem faced by the pre-biotic model builders. Self replicator is by definition an entity which catalyzes its own replication. The analogy with the self-referential statement appearing in Gödel's theorem obvious.

In TGD framework self replication would reduce to a spontaneous decay of H_{1/1}-atom to $H_{k/r}$ - and $H_{(r-k)/r}$ -atoms and their subsequent completion to H_{1/1}-atoms

The picture about emergence of self-replicators would be roughly following.

1. The first self-replicating entities would have been plasmoids [75] generating H_{1/1} atoms whose presence would have made possible the emergence of the first molecular self replicators. The generation of H_{1/1} atoms requires metabolic energy feed. In the first approximation the decay of H_{1,1} to fractional hydrogen atoms does not liberate nor require energy.
2. $H_{k/r}$ atoms would have replaced some ordinary H-atoms in some negatively charged molecules M_i (perhaps MXTP, $X = A, U, C, G$) leading to a spontaneous emergence of linear negatively charged polymers consisting of M_i . One can imagine a coding in which each X corresponds to fixed value of k or collection of the (2 hydrogen bonds or 3 hydrogen bonds depending on X). This would make the attachment of X and its conjugate to form a hydrogen bond a highly favored process.
3. $H_{k/r}$ atoms would have taken also the role of active binding sites. In ordered water conjugate molecules $M_{c,i}$ having $H_{(r-k)/r}$ atoms as labels would have had high probability to attach to the polymers made of M_i .
4. RNA molecules are good candidates for self-replicators in the presence of ordered water. The phase transition from ordinary to ordered water (which would have developed later to sol-gel phase transition) would have been an essential element of replication.

The role of water in chirality selection

In the latest New Scientist (when I am writing this) there was a news telling that chiral selection occurs in water but not in heavy water [41]. The L form of aminoacid glutamate is more stable than R in

ordinary but not so in heavy water so that water environment must be responsible for the chirality selection of bio-molecules. The proposed explanation for the finding, whose importance cannot be over-estimated, was following.

1. Water molecules have two forms: orto- and para, depending on whether the nuclear spins of protons are parallel or opposite. Deuterium nuclei are spinless so that heavy water has only single form. In thermal equilibrium the fraction of orto water is 3/4 and para water 1/4.
2. Ortho-water is magnetic and if L form of aminoacid is slightly more magnetic than R, chirality selection can be understood as result of the magnetic interaction with water.

One can of course wonder how extremely short ranged weak interactions could produce strong enough effect on the magnetic moment. The situation is not made easier by the fact that magnetic interaction energies are inherently very weak and deep below the thermal threshold.

It is interesting to find whether these findings could be explained by and allow a more detailed formulation of the TGD based model for water based on the notion of fractional hydrogen atom, the new view about hydrogen bond, and the notion of dark protonic strings forming atomic sized super-nuclei carrying exotic weak charges.

1. Dark matter brings in long ranged exotic weak interactions which can produce large parity breaking effects in atomic and even longer length scales. The long ranged parity breaking weak interactions of the dark protonic super nuclei assignable to aminoacids and water could explain the chiral selection.
2. The magnetic interaction energy is scaled up by r , so that magnetic interactions could indeed play a key role. Ordinary classical magnetic fields are in TGD framework always accompanied by Z^0 magnetic fields. If aminoacids possess exotic em charge implying also exotic weak charge, one can understand the chiral breaking as being induced by the Z^0 magnetic interaction of aminoacids with the dark magnetic fields generated by water molecules or their clusters possessing a net magnetic moment. In heavy water these fields would be absent so that the experimental findings could be understood.
3. The experimental evidence that water behaves as $H_{1.5}O$ in attosecond time scales means that 1/4:th of protons of water are effectively dark. The notion of fractional hydrogen atom leads to a model of hydrogen bond predicting correctly $H_{1.5}O$ formula and the dropping of 1/4:th of protons at larger possibly dark space-time sheets. The model also predicts that the mass of $H-O-H_r-O-H \equiv 2H_{1.5}O$ hydrogen bonded pairs is very near to the mass of 2 water molecules since there are $r \simeq m_p/m_e$ electrons involved. The paired molecules have three protons and non-vanishing net nuclear spin and thus generate a magnetic field and make hydrogen bonded water a magnetic system. The natural identification would be as dark magnetic field accompanied by Z^0 magnetic field responsible for the chiral selection.

In the case of $D-O-D_r-O-D$ mass would be by about one proton mass m_p lower than mass of two D_2O molecules so that this D-bonded heavy water would look like $D_{1.25}O$ as far as masses are considered and $D_{1.5}O$ as far as neutron diffraction and electron scattering are considered. In this case no magnetic field is generated since the nuclear spin of D vanishes and no chiral breaking results. This picture explains the experimental findings. The model is not equivalent with the proposal of the experimentalists.

4. The model predicts that the protons liberated in the formation of hydrogen bonds drop to larger space-time sheets but does not specify their fate. A strong constraint comes from the requirement that the dropped particles have exotic weak charges acting as sources of the geometrically unavoidable classical Z^0 magnetic field at dark space-time sheets causing the large parity breaking. This constraint is satisfied if the protons form super-nuclei (scaled up variants of nuclei) consisting of protonic strings connected by color bonds involving exotic quark and antiquark at its ends and some of these bonds are charged (of type $u\bar{d}$ or $d\bar{u}$: this could also generate the em charge needed to make the protonic string stable.

6.4 Model for crop circles

In this section a model for the generation of crop circle formation is constructed. The model relies strongly on the notion of many-sheeted space-time and is deduced from the above described model for living matter in which organisms are quantum controlled by a hierarchy of magnetic bodies.

6.4.1 Why crop circles cannot be hoax?

There are several findings making it very difficult to believe that all crop circles are hoax, and on basis of these findings it is possible to deduce with high reliability whether a hoax can be in question in a particular case.

1. There are clear alterations in growth nodes in the crop formation areas [55, 53]. In particular, an expansion of growth nodes relative to normal is observed: this expansion is about 115 per cent for regular and 200 per cent for the irregular crop formations. Also tufts of standing plants within formation have node expansions equal to or exceeding the expansion level in flattened plants.

Expanded nodes contain expulsion cavities which can be understood as resulting from a rapid and intense heating by micro-waves causing pressure buildup [55]: cellular components have literally blown out through epidermal cell walls. Node expansion is also accompanied by a bending. This suggests that the node expansion makes possible the downing of the crops. It is difficult to believe that artificial generation of crop circles by mechanical means could produce expanded nodes or generate micro-waves.

2. Magnetic material confined to localized, dust coated vortices of radius about .5 meters has been found in two thirds of all cases studied [65]. In the case studied in [60] these vortices were located within the boundaries of two larger more typical circular sites of downed plants approximately 15 meters in diameter and 60 meters. Magnetic iron 'glaze' of thickness 400-600 microns is composed of fused iron oxide particles of size 2-200 microns and causes coatings of the soil and within interstices of leaves and stems.

The iron particles most probably originate from the fusion crust of a meteor resulting from the heating caused by the entry into the atmosphere. The congealed droplets are known to drift to Earth several days after the major shower and are found surrounding the known iron meteorite falls. The case studied in [60] occurred few days after Perseid meteor shower 1993. Since the phenomenon is concentrated entirely within the crop formation, it is difficult to believe that crop circle could be a hoax.

3. The growth characteristics have been compared for the seeds taken from the heads inside crop formations and outside them and differences depending on the time of the formation have been found [55, 53]. For instance, for seeds taken from the crop formations occurring near the late maturity states rate and the uniformity of plant growth were significantly enhanced. Also this is difficult to understand if hoax were in question.

6.4.2 Further facts about crop formations

A lot of data about crop formations have been gathered. In the sequel some of the newest data items which can be also found from [57, 65] are listed.

1. Crop formations need not be only regular, 'geometric' formations. Also randomly downed crop formations caused by the interaction with the ionosphere are possible and are actually more frequent than the regular ones [57]. These two types can be seen as reflecting the character of magnetic flux tube structures in question. Node length increase is 115 *resp.* 200 per cent for the regular *resp.* chaotic formations.
2. Expulsion cavities, lengthening and bendings associated with the growth nodes are common to all formation, and it seems that the bending is caused by the softening of the growth nodes. It has been found that the stems are charged immediately after the emergence of the crop formation and the bending is proportional to the amount of charge. This supports the view

that downing is caused by an electromagnetic mechanism. Over-fertilization does not explain downing. Germination abnormalities were mentioned already.

3. A new and very important plant abnormality has been identified. A massive spiralling and twisting of the somatic tissues in the peduncle (stem at the base of the seed head) could not have occurred at the same time as the flattening of the crop [57]. A continual exposure to radiation, and possibly also an interaction with the ionosphere already at the very early developmental stage, suggests itself.
4. Balls of light (BOLs) have been also observed in crop formation regions: soccer ball sized balls of orange light and tennis ball sized balls of white opaque light in particular [65, 57]. The witnesses got the impression that BOLs are inspecting the crop formation. BOLs have been observed also before the formation of the crop circles. It would not be surprising if more complex structures formed from BOLs where responsible for the formation of crop circles.
5. Failures of electrical and mechanical equipment in near or flying over crop circles occur more often than normally [57]: cameras, recording devices, cell phones and even tractors fail to function properly. Electric perturbations caused by the plasmoids are the most plausible cause.
6. Animal and human reactions to crop formations have been studied [57]. Many animals tend to avoid the formations and animals behave abnormally during the appearance of the crop formations. There are also effects on people: dread, euphoria, experiences of peace and oneness, and feeling of love have been reported. Sound sensations like buzzing noise and crackling footsteps have been reported: these could be induced by micro-wave audition [57]. That the buzzing noise has been tape recorded once does not however fit with the hypothesis of endogenous micro-wave hearing. Sensations of presence have been reported. Always newly formed crop circles are in question.

6.4.3 Existing models for crop formations

Existing models seem to catch a lot about the physics behind the crop circle formations. The standard belief is that ionic currents between ionosphere and Earth's surface are not possible, and some hitherto unknown mechanism allowing this must be postulated. The models proposed do not address this question but assume plasma currents.

Micro-waves induce the node growth and damage

The heat generated during the crop formation should explain the lengthening of the growth nodes and the appearance of the expulsion cavities. The effect is strongest in the growth nodes and weakest in the hollow parts of the stem. The reason is that growth nodes contain a lot of water increasing the value of the dielectric constant and therefore the effectiveness of the micro-wave heating. That crop stem is not scarred can be understood as resulting from the insulating layer of water provided by the plant itself. To get the idea what happens one can put a tomato in micro-wave oven.

Node damage decreases from the center to the edges of the flattened area. The absorption of the micro-wave energy radiated from the center of the flattened area explains this and the exponential decrease of the damage outside the central area defined by the small vortex of diameter about .5 meters. The absorption of radiation by air and water vapour explains the weakening of the effect. There should be a source of micro-wave radiation in the middle, naturally a plasmoid structure. The damage caused for the growth nodes of the standing crops is larger than for those of flattened crops. The angle of incidence for the micro-wave radiation explains this.

Plasma leakage between ionosphere and Earth as a basic mechanism

The presence of the iron coating in the soil and parts of crop stem having meteoric origin two thirds of the cases studied [60, 65] provides an extremely valuable hint for the model builder.

1. The model proposed in [60] relies on a plasma vortex structure extending from the ionosphere to the crop field and containing spiral like magnetic fields [60, 65]. The plasma in question cannot be hot. The ionosphere contains however cold plasma in temperature range $10^2 - 10^3$ K. This

plasma vortex would be essentially ordinary air containing swirling ions if it indeed penetrates to Earth. The magnetic field patterns associated with the plasma attract the meteoric iron [60, 65] and iron glaze would be due to the molten iron created by the reheating of the semi-molten state of iron at the time of the crop impact [60].

2. This leads naturally to the proposal that the shapes of crop formations reflect the shape of plasma structures involved. Self-organization leads to preferred plasma patterns and the shapes of the simplest crop formations consisting of spirals and circles resemble typical plasma patterns. Also chaotic plasma patterns are possible and explain the irregular crop formations. It has been proposed that the plasmoid structures extend from ionosphere to Earth. Spiral aurorae contain arcs evolving into pairs of counterclockwise vortex sheets that are never stable and never unwind. Spiral auroras map down to along geomagnetic field lines into the ionosphere. Two counterclockwise vortices are involved. Also the so called sprites which connect ionosphere at 100 km height to the height of about 10 km where thunderstorms are generated have been suggested as being associated with the formation of the crop circles.
3. The leakage might be more probable at night time when ionosphere extends to lower heights. Remarkably, at night time the plasma of ionosphere is known to make attempts to penetrate through the boundary of the ionosphere and this induces magnetic perturbations: the Schumann resonances generated in this manner would be essential for generating entanglement between sleeping brains giving rise to multi-brained 'stereo consciousness' (compare with the fusion of visual fields of different brain hemispheres giving rise stereo vision).

Criticism

One can represent counter arguments against the proposed models.

1. *Are the ion currents really plasma currents?*

The strongest objections against the proposed models relate to the idea that the plasma structures involved extend from ionosphere to Earth.

1. The existing models assume that the magnetic structure is generated when a plasma leakage from the ionosphere to Earth occurs. However, small plasma balls are seen (BOLs) and the stems of crops have been altered before the occurrence of the crop formation. This would suggest that the magnetic structures responsible for the connection with the ionosphere exist already before the occurrence of the crop formation and that the ionic current is not ohmic.
2. The plasma in question must be cold: the temperature should be around 200 – 300 Kelvins if it equals to the temperature of the lower ionosphere (D and E regions). It is not clear (to me) whether the overall important heating to at least 700 K, required by the melting of the meteoric iron, could really occur at the surface of the soil and at growth nodes. One can also wonder whether the plasma could penetrate down to Earth through the atmosphere without dissipating its energy completely in collisions with the atoms of the atmosphere. An electric field is needed to make the penetration possible and it is not clear whether the field generated by the charge density in the soil is really strong enough. Large horizontal gradients of the electric field would be certainly required in order that a well-defined pattern would result. One could also argue that the plasma becomes neutralized during the travel to Earth's surface unless the electric field is so strong that it causes ionization. In this case one would have electric discharge analogous to lightning and probably having much higher temperature of about 10^4 K for lightning and generating visible light.
3. There is rather fascinating almost explanation for why the crop formations occur repeatedly in some preferred areas, in particular in England [65]. When water percolates through any porous rock, it loses negative charge to the rock. The soil in England contains a lot of calcium carbonate (chalk). Calcium carbonate enhances this process and generates currents in the soil. Crop formations occur just in these regions. The magnetic fields caused by these currents have been measured both before and after a crop formation and it is found that the magnetic fields disappear after the crop formation. This is just what one might expect to result from the neutralization resulting from the plasma leakage.

This is of course not an explanation for why the crop circles occur in the areas where the soil is negatively charged. As a matter fact, the generation of negative charge tends to lower the potential difference between ionosphere and Earth surface and reduce the probability for the generation of plasmoids connecting ionosphere and soil. On the other hand, if the plasmoids are small sized, say with sizes of order the size of the crop formation, the presence of electrons in the soil could favor their formation. plasmoids with sizes of order micro-wave wave length have been indeed seen! This strongly suggests that the plasmoid like structures are small and cannot be involved with the currents from ionosphere to Earth.

4. There is a strong correlation between sunspot activity and appearance of crop circles [65]. The density of electrons in the ionosphere increases by a factor 100 from sunspot maximum to minimum. Also this tends to reduce the potential difference between soil and ionosphere: just the opposite would be however expected if the plasma leakage occurs as ohmic current through the ionosphere
5. If the crop formations correspond to the cross sections of plasmoid structures of a vertical size of order 100 km, it is difficult to understand why their sizes vary in so narrow length scale range which is of same order of magnitude as micro-wave wave lengths. The most natural looking proposal would be that plasmoid structures are local, and consist of basic units of size of order micro-wave wave length, and they have been indeed observed (BOLs). This hypothesis however leaves open the mechanism of the ionic leakage from ionosphere to Earth.

2. Do the shapes of crop formations indeed correspond to the shapes of plasma patterns?

Although the simplest crop formations resemble plasma patterns, there are also very complex formations, whose generation is difficult to understand. The most famous is the formation coding a rather precise analog of a two-dimensional pattern sent to the interstellar space as a signal and representing information about human civilization. If this case is not a hoax, one must seriously consider the possibility, that conscious intelligence is involved with the generation of the patterns somehow.

3. What about strange experiences?

The models do not explain the strange experiences reported by humans nor the avoidance behavior of animals in the vicinity of the crop formations.

6.4.4 TGD based interpretation of crop circles

The general model for how magnetic bodies control biological body using plasma oscillations of plasmoids allows straightforward interpretation of crop circles.

Do crop circles represent a message?

One cannot avoid the feeling that crop circles might represent a message by conscious entities much above us in evolution and having several meanings. Perhaps the main intention is to initiate a thought process challenging the existing dogmas about what life can be in the minds of those individuals who take the enigma of crop circles seriously.

1. What kind of message the mere appearance of crop circles contains?

Crop circles could contain several messages besides the obvious visible message. If one forgets the interpretation as fraud, the obvious message is that there must exist intelligent entities responsible for their construction. Various hints suggest that magnetosphere (or perhaps solar magnetosphere) is this entity. If one takes seriously the Chilbolton [46, 47] and Crabwood [42, 43] messages, one must however consider the possibility that we are not the only form of biological life controlled by these entities.

2. What kind of messages plasma wave patterns contain?

The surface message is the patterns identifiable in terms of sacred geometry for which length ratios involve only rational numbers and square roots of integers. Chilbolton and Crabwood messages contain

also surface message as figure and a text written using ASCII code, and according to the proposal of this chapter, also a message telling about the conscious entities responsible for the message, in particular about their genetic codes. Plasma wave patterns could be interpreted in TGD framework also as generalized motor actions, in particular those involving hyper-gene expression of some kind so that also an implicit message about basic control mechanisms of biology would be involved.

3. What the presence of amorphous SiO₂ spheres tries to tell?

Amorphous SiO₂ spheres are observed around crop circles resulting when molten quartz cools down rapidly.

1. One part of the message could be that quartz, possibly in transparent liquid or amorphous form, is fundamental for life. Since microwaves are also involved with crop circles the message could be that dark microwaves generated by dark quartz crystals serve as sources of metabolic energy.
2. Amorphous SiO₂ is typically created by lightning strikes in sand. This suggests that lightning strike creates dark plasmoids of which ball lightnings are one particular case and that dark plasmoids melt the sand particles by de-coherence of highly energetic dark microwave photons to ordinary photons. Also magnetized iron of meteoric origin has been found around crop stems. Fe⁺⁺ ions would be structural elements of plasmoids. This suggests a model of plasmoids as a Searl machine, that is rotating magnet consisting of meteoric iron.
3. Microwave photons with wavelength of 5 cm at $k_{em} = 2$ level would have energy of 100 eV and de-coherence to ordinary photons would melt quartz. Perhaps the existence of dark photons is one of the messages. The microwave photons could originate from magnetostatic waves or from decay of plasma oscillations.
4. The region above mantle contains molten quartz and the glass spheres could be interpreted as a message about the possibility of IT life based on dark atoms and molecules.

4. What it means that the cyclotron frequencies of ions involved with crop circles are in alpha band?

The cyclotron frequencies of biologically bosonic ions tend to be in alpha band for $B_{end} = .2$ Gauss. This is true also for some atomic and molecular ions associated with crop circles.

1. SiO₂⁻ ion has cyclotron frequency 10 Hz for the nominal value $B_{end} = .2$ Gauss. Also CO₃⁻ ions associated with calcium carbonate (limestone contains CaCO₃) have cyclotron frequency of 10 Hz. This frequency equals to the fundamental bio-rhythm and the p-adic frequency $f(2, 127)$ associated with the memetic code.
2. The observed magnetized Fe⁺⁺ ions believed to have meteoritic origin have cyclotron frequency of 10.7 Hz.

10 Hz frequency characterizes also effectively 2-dimensional waves closed inside the ionospheric cavity: for l^{th} harmonic the frequency is

$$f = \frac{\sqrt{l(l+1)}}{2\pi R_E} ,$$

R_E Earth's radius, and $l = 1$ gives 10 Hz frequency. All this could be seen as a signal that Earth's magnetosphere (and/or its dark variant) and ionospheric cavity are involved in essential manner.

10 Hz is the alpha frequency and corresponds to generalized EEG at $k_{em} = 4$ level of dark matter hierarchy from the requirement that EEG frequencies correspond to energies above thermal threshold at room temperature. A possible interpretation is that plasmoids responsible for crop circles and having $k_{em} = 2$ are used as motor instruments by $k_{em} = 4$ level of dark matter hierarchy which should be also responsible for the control of gene expression. This could also mean that dark quartz plasmoids are a life form inhabiting the Earth's interior.

5. What is the message of claimed genetic modifications?

There is evidence that the crops from crop circles have experienced genetic modifications and this raises the possibility that magnetic body could be performing genetic self engineering. CaCO_3 is the basic building material of corals (and eye lens by the way) and the presence of genes in corals coding for higher psychological functions [58] has been already mentioned, and the possibility that electromagnetic field patterns could be imprinted by genomes and could modify the genomes of target organisms [65] has been already discussed. The question is therefore: Could it be that genetic code words with duration of .1 seconds allow to realize a modification of genome in presence of ions with 10 Hz cyclotron frequency (SiO_2^- and CO_3^-)?

Crop circles as dark plasma wave patterns representing generalized motor actions

Crop circles could result as generalized motor actions of say magnetic body of Earth realized in terms of plasma oscillation patterns associated with plasmoids generated by exotic ionization induced by W MEs. Macroscopic quantum phenomenon would be in question since the phenomenon would become visible only after state function reduction selecting the exotically ionized branch.

Crop circles would be analogous to nerve pulse patterns and physiological effects induced by Ca^{++} wave patterns induced by exotic dark ionization by the generalized Faraday law at visible space-time sheets. Generation of Ca^{++} waves could indeed occur since crop circles tend to appear at limestone rich regions containing calcium carbonate CaCO_3 giving rise to Ca^{++} ions. Limestone rich regions are also negatively charged and this could give rise to electronic Cooper pairs responsible for the negative charge and high T_c super-conductivity of plasmoids.

Plasma wave patterns are in TGD framework responsible for the generalized motor control, in particular genetic expression. The notion of hyper-genome predicting collective gene expression at the level of say crop field, the vision about great leaps of evolution as the emergence of new levels of dark matter hierarchy at the level of individual organisms, and the fact that $k_{em} = 4$ level of dark matter hierarchy corresponding to EEG and size of Earth's magnetosphere is necessarily present (time scale of DNA translation corresponds to EEG time scale) suggest that crop circles could also represent patterns of Ca^{++} waves as well as Mg^{++} waves involved with collective gene expression or even genetic self engineering.

Crop circles could be interpreted as cross sections of scaled up variants of cell structures. The thickness of cell membrane comes as $\lambda^k L(151)$ for them and $k_{em} = 2$ would correspond to 5 cm length length scale, the wave length of 6 GHz microwaves, assignable naturally to the plasma balls observed near crop circles. The upper bound for the cell size given by $\lambda k + 1L(151)$ would correspond to 80 m, which is the size scale for the largest crop circles. One possible interpretation is that crop circles represent an evolutionary leap bringing in plasma wave patterns and quantum control in a new length scale.

TGD based model for plasmoids involved with crop circles as Searl machines?

The model for plasmoids must answer to several questions. Where plasmoids draw their metabolic energy? The patterns of bent crops suggest that plasmoids radiate radially microwave photons inducing the bending of crops. Hence plasmoids should carry the source of microwave photons with them. What could be this source of the microwave radiation? How plasmoids are able to defy force of gravitation and move? Do plasmoids enter from ionosphere or Earth's interior or are they created at ground?

I have already earlier proposed that plasmoids are essentially Searl machines and that even ADP-ATP machinery could involve Searl machine like molecular device [32]. Rotating magnets are the essence of the Searl machine. Magnetized iron believed to have meteoric origin has been found around the crop formations and could thus be one building element of the plasmoid. This iron would be naturally at magnetic flux quanta of Earth and would be magnetized by Earth's magnetic field and concentrate around crop stems since flux quanta traverse DNA. Plasmoids need not therefore come from ionosphere.

Magnetostatic waves for electrons in magnetized iron (dark or not) are in the microwave region and could generate dark microwave photons in turn inducing the formation of dark plasma oscillation patterns. The metabolic energy of plasmoid would basically result from dropping of electrons and ions of radial ohmic currents associated with the rotating magnet to larger space-time sheets.

Note that in the case of Searl machine the distances of order .5 m between magnetic walls and their thicknesses of order 5 cm correspond to microwave wavelengths. The scales are same as in the case of crop circles, which supports the view that plasmoids are essentially Searl machines.

1. Basic picture about plasmoids?

Plasmoids are magnetic flux quanta containing Bose-Einstein condensates of various dark ions and electronic Cooper pairs. The flux lines of magnetic field associated with plasmoids are rotating since charged particles in cyclotron Bose-Einstein condensate rotate in the magnetic field whose lines are frozen with the rotating dark plasma. The space-time sheets parallel with the dark space-time sheets of plasmoids contains the rotating return flux which generates a radial electric field with a non-vanishing divergence in turn inducing radial ohmic current and making ordinary space-time sheet negatively charged. It is plausible that these space-time sheets contain rotating magnetic material: dark meteoritic iron from ionosphere is the recent case.

Dark microwave photons provide the metabolic energy for plasma wave patterns. Plasmoid must be able to generate the microwave radiation by some mechanism. Magneto-static waves of electrons in magnetized iron define an excellent candidate for the source of microwave radiation. It seems that dark variants of these waves must be considered now so that dark iron atoms should be in question unless ordinary microwave radiation is able to cohere into dark microwave radiation.

One must understand how plasmoids are able to defy gravitation and move. The negative charge generated by the rotation of magnet provide the plasmoid with a net negative charge and the repulsive force experienced in the electric field of Earth could make it possible to overcome the gravitational force of Earth as it partially does in the case of Searl's machine [18].

1. Quartz crystal oscillations cannot serve a source microwave photons in the case of plasmoids

Plasmoids must use microwaves as a source of metabolic energy making possible the generation of plasma wave patterns. Plasmoids can be generated even in microwave ovens by using some "seed" having organic origin [56]. Dark microwave photons could quite generally serve as a source of metabolic energy of plants. Callahan has found that rocks consisting mainly of quartz SiO_2 serve as a source of bio-photons and that paramagnetic soil implying strong Schumann resonance amplitudes is favorable for the well-being of plants [83]. For instance, 2 eV bio-photons could be produced as de-coherence products of dark microwave photons of wavelength about 1.25 mm. The mechanism would also explain the featureless spectrum of bio-photons.

Dark piezoelectric quartz crystals could act as sources of dark microwave photons. Microwave photons with wavelength of 5 cm at $k_{em} = 2$ level would have energy of 100 eV whereas at $k_{em}=1$ level the energy would be .05 eV rather near to the energy associated with the action potential. The Josephson frequency of the scaled up dark variant of cell membrane is rather near to this frequency too.

If plasmoids generate microwave photons by using oscillating quartz crystals, they should carry the quartz crystals with them. Since quartz crystals should have size scale of microwave wave length, this option does not look plausible.

2. Magnetostatic waves of electrons in magnets as source of microwave photons?

Magnetostatic oscillation frequencies do not depend on the spatial pattern of the magnetostatic wave which thus recurs again and again in similar shape. Therefore magnetostatic oscillations are ideal for generating microwave photons responsible inducing plasma oscillation patterns. Magnetostatic frequencies are of order electron's cyclotron frequency. For electron in a magnetic field of order Tesla associated with magnetized iron the cyclotron frequency would be of order 12 GHz corresponding to a wavelength of 3 cm so that orders of magnitude come out correctly. Note that the order of magnitude for the density of dark ions in plasmoid is fixed to a high degree from the requirement that plasma frequency corresponds to the magnetostatic frequency.

Thus plasmoids could consist of rotating magnetized iron blobs of meteoric origin. Lightnings are known to induce the formation of amorphous quartz spheres in sand. This could be understood if lightnings involve plasmoids quite generally. Plasmoids could arrive from the thunder cloud or be created at the ground since meteoric iron can be present at flux quanta everywhere. Ball lightnings would represent a particular case of plasmoid gaining its metabolic energy from the dropping of charged particles to larger space-time sheets.

The size scales for plasma patterns imply that plasmoids must correspond to $k_{em} = 2$ level of dark

matter hierarchy for which microwave photons with 5 cm wavelength correspond to energy of about 100 eV much above the melting temperature of ordinary quartz (note that the cyclotron frequency associated with the magnetized iron determines the size of plasmoid). Hence the dark microwave photons de-cohering to ordinary photons generated by plasmoids can easily melt quartz and explain the generation of amorphous quartz spheres.

4. *Where plasmoids receive their metabolic energy?*

The dropping of charged particles to larger space-time sheets liberating zero point kinetic energy is the mechanism giving rise to the universal metabolic energy quanta in TGD inspired model of living matter and should be at work also now. The radial ohmic currents induced to a rotating magnet generate charge to the magnet which increases until dielectric breakdown occurs. The charging of the rotating magnet provides it with electrostatic energy which in turn can be used as metabolic energy. The actual energy source is the dropping electrons of the ohmic current to larger space-time sheets, which liberates zero point kinetic energy of ~ 1 keV. This mechanism explains the formation of ordinary plasma by ionization of air in the case of Searl machine and could work also now.

I have proposed that Searl machine sucks energy from the dark matter at the magnetic walls. The model for magnetic body as a controller of biological body using ordinary metabolic energy suggests just the opposite. Even if this is the case, the model would still explain the accelerating rotation in terms of the transfer of angular momentum between the Searl device and magnetic walls.

Who decides about the geometry of the crop formations?

The geometry of crop formations should be determined by the intentional action of magnetospheric conscious entities expressed by micro-wave sized plasmoid like life forms (BOLs). It could be also constrained by the geometry of the magnetic flux quanta connecting the crop field to the magnetosphere.

Thus plasmoids would act as intelligent messengers quantum entangled with higher level life forms and carry out only the hard job. This would mean that the crop formation could be build gradually and even refined in the course of time as the appearance of BOLs indeed suggests. This option is the most plausible one, and suggests that crop formations are an attempt of a conscious magnetospheric (with Earth's interior included) intelligence to tell about its existence.

What is the mechanism causing the crop formations?

The big picture is following. Magneto-spheric self would be the intentional responsible for the generation of crop circles. It would generate plasmoids by charge entanglement mechanism. The plasmoids propagating along the pattern determined by W MEs would be somewhat analogous to nerve pulses and Ca^{++} waves.

The basic observations helping to build the model are following.

1. The light balls observed around crop formations have a natural interpretation as plasmoids. The stems of crops are charged after the emergence of the formation and the amount of charge and the bending of the crop correlate. This conforms with the fact that plasmoid is charged and that the time of presence of plasmoid determines the amount of the bending and the charge transferred to the stems. The prediction is that crop stems should be negatively charged if the charge originates from air. If it corresponds to dark ions transformed to ordinary ions in the region of the plasmoid, the sign of the charge could be also positive.
2. The expansion of the growth nodes involving the generation of expulsion cavities causes the softening of the growth nodes and makes bending possible irrespective of the details of the bending mechanism. Plasmoid could soften first the growth nodes in the crop circle pattern and some other mechanism could course the bending.

1. *Is plasma pattern generated by rotational flow of air associated with plasmoids*

Plasmoids involve rotating magnetic field both at dark space-time sheets with the return flux along ordinary space-time sheets. Also ordinary ions are expected to rotate since they experience Lorentz force. This motion could induce the rotation of ordinary air molecules. For centuries it is known that plasma discharge in air causes also a flow of ordinary air known as a corona wind [46]. Corona wind

is believed to be caused by the scattering of plasma ions with the neutral atoms of air. If this belief is correct, the rotating ions of the plasmoid could induce a rotating corona wind.

If so, the purely mechanical explanation for the formation of the crop circle would be in terms of the swirling air containing the ions would cause the downing much like ordinary wind. A model of vortex with rigid body rotation in core region and curl free rotation outside the core region with velocity behaving as $1/\text{distance}$ has been discussed in [55, 53]. Downing would occur inside the core region where the plasma is.

The model allows also the formation of narrow ridges in the interior of flattened regions. Two co-operating plasma vortices with opposite directions generate strongly reduced pressure in the region between them and this raises the crops up in this region.

The basic prediction is that the direction of bending should be along the local direction of the corona wind so that the downing pattern should mimic the flow pattern of the vortex: I do not know whether this is the case.

2. Two-step model for the formation of crop circles

It is not clear whether the pattern of bent crops is consistent with a rotational flow or not. Hence one must consider a more refined model based on an alternative mechanism of corona wind discussed in [18]. The model is inspired by the experimental finding of Modanese and Podkletnov [61] that plasma discharge generates unknown radiation with induces motion of test particles but is not attenuated so that the effect is not caused by the absorption of the energy of radiation.

The model relies on the recoil effect resulting from the dropping of electrons of air to larger space-time sheets. The unknown radiation emitted by plasma discharge is identified in terms of (dark) MEs or scalar wave pulses. At least (dark) MEs serve as correlates for Bose-Einstein condensate of (dark) photons. MEs or scalar wave pulses would induce join along boundaries bonds to larger space-time sheets inducing the transfer of electrons of ionized air to larger space-time sheets, and the corona wind would result as a recoil effect. This would most naturally induce corona wind having a constant direction rather than a swirling of the air.

Crop circle would be created in steps decomposing into two sub-steps.

1. Plasmoid moves through some distance and induces the softening of the growth nodes by microwave heating along its track.
2. Plasmoid generates a plasma discharge inducing MEs or scalar wave pulses bending the crops along the direction of its propagation provided it is same as the local direction of the track. If not, nothing occurs. Rotating plasmoids are indeed negatively charged and their charge grows by the presence of radial ohmic current caused by the rotating magnetic field until plasma discharge occurs. Thus this option fits nicely with the model of plasmoid as a Searl machine. The fact that lightnings generate SiO_2 balls in sand could be understood if lightnings create plasmoids.

What causes the strange experiences?

As already explained, some animals tend to avoid the crop formations and humans have altered states of consciousness in their vicinity, in particular sense of presence. If crop formation involves the presence of a conscious magnetic body, these experiences could be understood to result from the telepathic sharing of mental images by quantum entanglement perhaps mediated by plasmoids playing the role of a medium as in the model of UFO experiences. This view is consistent with the idea that crop circles are messages of magnetospheric conscious entities to human kind about their existence. Telepathic sharing of mental images would involve charge entanglement by W MEs responsible also for the generation of plasma patters.

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Chapter 7

Crop Circles and Life at Parallel Space-Time Sheets: Part II

7.1 Introduction

There are two especially fascinating crop circle formations: Chilbolton [46, 47] and Crabwood [42, 43] and this chapter is devoted to the ideas stimulated by the attempts to understand what these formations try to tell to us. It must be emphasized that this chapter is just a play with thoughts contributing positively to my personal intellectual well-being (and perhaps also that of reader), and not meant to irritate skeptics to the border of fit of rage. It must be however added that dark matter hierarchy changes so profoundly the world view that these light hearted and childish speculations represent something which can be only a pale image of the reality which is much more magnificent than we are able to imagine.

7.1.1 Do Chilbolton and Crabwood messages provide information about aliens?

Chilbolton and Crabwood formations suggests an interpretation as a message from intelligent civilization living at parallel space-time sheets in our solar system. These messages indeed allow to deduce a lot of information about the genetic code and other bio-codes associated with these life-forms.

1. The Chilbolton message suggests strongly the existence of also doublet code and this inspires a simple model for our genetic code allowing to see the triplet code as resulting from much simpler product code by a small symmetry breaking due to the interaction between singlets and doublets. Doublet code would correspond to exotic form of RNA generated also in the simulation of primordial sea by Leslie Orgel [45] and against which ordinary life forms have immune reaction. Also various alien codes results in the same manner. The model suggests strongly that DNA triplets have resulted as a fusion of DNA singlets and doublets defining simpler genetic codes. It turns out that one can deduce surprisingly detailed information about the alien genetic codes. In fact, almost a unique codes result if one accepts the proposed model of the genetic code having symmetries obeyed also by our genetic code.
2. The Chilbolton message tells that also silicon is of fundamental importance for this life-form at DNA level. Crabwood message contains a variant of the genetic code for which the simplest interpretation is that DNA doublets of form XT are effectively doubled: perhaps doublets of form XT_S besides XT , where T_S denotes a compound of T and silicon, have emerged. This increases the number of DNA triplets from 64 to 80 and thus also the information content of the genetic code. Same could have occurred to amino-acids and increased the number of amino-acid like molecules by three: this in turn would increase the expressive power of the genetic code. The difference between man and ape is enormous although genetic codes are almost identical. It is difficult to even imagine the level of intelligence of these creatures as compared to that of us.

3. Chilbolton message contains two different DNA (or RNA) strands. This could have several interpretations, not necessarily excluding each other.
 - i) RNA could indeed be asymmetric and one can understand the pre-evolution of life if the RNA strands associated with singlet and doublet RNA were fused to this kind of strands so that translation of both RNAs to pre-amino acid sequences occurred using tRNA which was fusion of singlet and doublet tRNAs and predecessor of recent tRNA.
 - ii) Alternatively, there could be two genetic codes for the same life-form: the 80 DNA-23 amino acid code would involve silicon. This life-form could even live outside the solar system.
 - iii) There are two separate higher level life-forms perhaps living in symbiosis inside same organism (like mitochondria and cell nucleus inside our cell).
4. Plasmoid like life-forms could correspond to more primitive singlet and doublet codes. The fact that the Sun, whose convective zone contains a magnetic field of order .2 Tesla making it an ideal environment for this life-form, is described to be smaller than in Arecibo message, suggests that this life-form might populate also solar magnetosphere. The plasmoid like life-forms could serve as kind of less intelligent medium like messengers, quantum entanglers, making possible a telepathic sharing of mental images between members of different civilizations. The light balls observed near crop formations would represent this life-form. Also UFOs could be identified as plasmoid like life-forms inducing telepathic encounters with the alien life-forms. Being predecessors of the recent life-forms, plasmoids would generate immune response in higher life-forms: otherwise the direct encounters would be lethal. Even multicellulars formed by nanobacterium like life-forms [62, 50] or by their predecessors could be in question.
5. There is some uncertainty concerning the identification of some ASCII code words appearing in the Crabwood message (as Martin Keitel has emphasized in private communications). In the following two possible forms are discussed. In particular, the number of different capital letters is a crucial factor: if it is smaller than 20, one is forced to interpret also capital letter part of the message as associated with 80 DNA, 23 amino-acid code.

Despite these uncertainties, very general symmetries deduced from our own genetic code fix the identification of the alien codes highly uniquely. All these codes result by the same universal mechanism, and are characterized by the same imbedding of the amino-acid space to the DNA space implying that a considerable part of the code is universal. The symmetries are the exact A-G permutation symmetry and the almost exact T-C permutation symmetry for the last base of the DNA triplet, and the approximate decomposition to a product of codes associated with DNA doublets (the first two bases of triplet) and singlets (the third base of triplet). The success of this model inspires the view that molecular life first evolved to form DNA singlets and doublets coding for 2-plet *resp.* 10-plet of "pre-amino-acids". After that DNA doublets and singlets fused to triplets coding for the ordinary amino-acids, which are perhaps an outcome from the fusion of the two kinds of "pre-amino-acids".

It is possible to transform the purely formal mathematical model for the evolution of the triplet code as a fusion of singlet and doublet codes to a concrete physical model. This is done in [19] without barely mentioning crop circles. The truth however is that I would have never discovered the model without crop circles.

7.1.2 Where do the higher life forms live?

If one forgets Crabwood and Chilbolton messages, then the magnetosphere of Earth is the most natural candidate for the intelligent conscious entity responsible for the crop circles. Even if one takes seriously these messages, it would seem that the magnetosphere of Earth, or perhaps that of Sun, is the most natural identification for the crop circle artist. The question is basically about which life forms the genetic codes can be assigned to.

Chilbolton message can be interpreted as telling that aliens live in the solar system and populate Earth, Mars, and Jupiter. Sun is depicted to be smaller than in Arecibo message. This leaves two options.

1. Higher life forms live in the recent solar system as planetary or intra-planetary (IP) life forms and the small size of the Sun tells that they receive much less solar light. One could consider even the possibility that these life-forms populate also Sun: magnetic spots as analogs of tornadoes are best candidates for self-organizing living systems.

2. Aliens could also live in a relatively distant geometric future where the radius of the Sun is considerably smaller (long range Z^0 force brings new force in solar dynamics and could allow relatively large and rapid variations of the solar radius, which are indeed observed). Also this option allows intra-terrestrial life, and the civilization of the geometric future could use time mirror mechanism to build crop circles perhaps utilizing simple IT life forms as quantum messengers.

In TGD framework the idea about intra-terrestrial life or more generally, life at high temperatures, is not so crazy as it sounds. Life loves boundaries where the gradients are and energy currents flow. Active life requires also something to manipulate easily and liquid and liquid crystal phases are especially interesting in this respect. Therefore the solid-liquid boundaries in the Earth's interior are especially interesting seats for life-forms. The presence of the small glass balls and of the magnetized iron in crop formations could be interpreted as a message that the transparent molten quartz (glass) in the mantle-core boundary, and molten iron in core-inner core boundary of Earth's interior, perhaps both allowing also liquid-crystal phases, might have replaced water as or could be an additional essential element of life.

The basic objection against high- T life is the instability of organic molecules at high temperatures and the narrow range of temperatures at which higher life forms survive. Two solutions to the problem can be considered.

The option based on effective thermal isolation of space-time sheets

The earlier scenario was based on the assumption that space-time sheets are effectively thermally isolated and can thus be at widely different temperatures. Assuming that the size of the space-time sheet corresponds to the thermal de Broglie wave length one ends up with the conclusion that $k = 131$ space-time sheets having size of .1 Angstroms are the carriers of the liquid glass and iron whereas $k = 137$ atomic space-time sheets could be even in room temperature. This however just an assumption and one might argue that it is better to start from the most pessimistic scenario than one can imagine and assume that the transfer of thermal energy between space-time sheets is possible.

The option based on dark N -atoms

Dark matter hierarchy provides an alternative, and it seems more convincing, solution to the temperature problem working even when space-time sheets are assumed to have same temperature. The solution is based on the notions of dark N -atom and N -molecule discussed in [21].

The space-time sheets of inherently dark atoms would in this case define r -fold coverings of M^4 . This would hold true also in the radial degrees of freedom. For radial anyons principal quantum number n would be replaced by n/r so that energy levels $E_n \propto 1/\hbar^2 n^2$ would not differ considerably from those of ordinary atoms. There is r -fold state degeneracy corresponding to r sheets of the covering and it is possible to construct N -atoms analogous to fermionic counterparts of Bose-Einstein condensates. From Fermi statistics N can have values $N \in \{1, \dots, r\}$, $r = \hbar/\hbar_0$. The transition energies of N -molecules are N -fold as compared to their normal values so that thermal stability can be achieved even in vibrational and rotational degrees of freedom. N -atoms and molecules are an essential element of also ordinary TGD inspired quantum biology [21].

The most fascinating aspect of fermionic N -atoms is that they make possible to understand DNA replication and lock and key mechanism of bio-catalysis in terms of high probability of fermionic N - and $r - N$ -atoms to combine to r -atom which must be especially stable as a full fermion shell. The emergence of symbolic representations as names of molecules based on sequences of N -atoms playing the role of letters, and the emergence of molecular sex based on names having N -atoms as letters and their conjugates having $r - N$ atoms as letters and combining to r atoms in molecular marriage.

What would be required that high- T life is based on N -atoms, which are thermally stable with respect to the transition energies crucial for biological functions. Hence the values k characterizing the dark matter levels involved should be higher than in bio-sphere and the life in question should be at higher evolutionary level than ours. Mathematician inside me cannot not avoid the temptation of exaggerating that dark life is simply r -fold covering of ordinary life.

The same mechanism that makes possible high- T life might explain the well-documented ability of people in trance to dance on burning charcoals. Since trance is involved, the idea about phase transition raising the dark matter level of the skin tissue is natural.

This crazy sounding hypothesis is testable. For instance, one could test the presence of N -molecules in thermal environments in which they are not stable by looking whether radiation associated with molecular transitions resulting as de-coherence of corresponding N -photons is present. For instance, there is spectroscopic evidence for water in sunspots [37]. Ordinary water molecules are not stable at temperature range 3000-4500 K so that N -water molecules could be in question. The only reasonable explanation for the spectroscopic evidence suggesting the presence of water in sunspots [37] and solid calcium ferrite surface of sun [34] is in terms of dark N -atoms stable under the temperatures prevailing in the photosphere. The same evidence extrapolated to the planetary interiors allows to consider seriously the notion of IP. An experimental program checking systematically the presence of spectral lines of molecules not stable at the temperatures of the environment would allow to test the hypothesis and perhaps map the distribution of dark matter.

One could search for IT life-forms and fossils in volcanoes. One could try to detect tectonic waves and sound waves of unidentified origin as signals possibly generated by ITs. One could use "tectonic" radar waves in order to identify possible technological artifacts in the mantle-core layer. In the Chilbolton message a crop circle which appeared one year earlier in the same crop field plays the same role as the image of the radio telescope in the Arecibo message. This forces to ask whether various crop circles represent various technological achievements of ITs or whoever the aliens are.

7.2 Chilbolton and Crabwood messages

In TGD universe parallel space-time sheet are an obvious candidate for the world where the life forms responsible for crop formations and Chilbolton and Crabwood messages live. For reasons already described, these life-forms could control material at a temperature which is quite too hot for ordinary life forms. Since life loves boundary layers, the mantle-core and core-inner core boundary layers are especially promising candidates for the seats of these life-forms.

These life-forms could appear in several varieties. They could be magneto-terrestrials (even in the interior of the planets involved). Also plasmoid like life-forms for which magnetic field strength would be around .2 Tesla from the requirement that electronic cyclotron radiation generates micro-waves serving as the 'food' of the plasmoids, are possible. Balls of light (BOLs) of micro-wave wave length size have been indeed observed in the areas of crop formations. Plasmoid life forms could also serve as quantum messengers of these civilizations. This field strength is also favored by the explanation of the typical sizes of the crop formations. Note that solar convective zone carries magnetic fields of this strength: could the smaller size for Sun suggest that solar convective zone is populated by the plasmoid like life-forms and that the civilization itself is something more complex.

7.2.1 Chilbolton message

The crop formation in Chilbolton which appeared in August 2001 [46, 47] contained a bit image which had the format of the message sent from Arecibo for the first time 27 years ago. The fact that the radio waves from Arecibo cannot have reached their destiny suggests that the message comes from nearby space. The use of the format of Arecibo message would be an ingenious manner to tell that this is indeed the case. This is supported by the fact that the number of planets is same as in our solar system. The use of Arecibo format would be an ingenious manner to tell that the senders are from parallel space-time sheets.

Arecibo message represented a sequence of $N = 23 \times 73$ bits. The fact that a product of primes is in question was meant to tell to the receiver that the bits represent two-dimensional figure consisting of a graphic array consisting of 73 rows of 23 columns each. Each element of this matrix is either on (1) or off (0). The bits were represented as shifts of the signal between two frequencies in the 2.38 GHz micro-wave band. The beam was aimed at globular star cluster M13, some 22,800 light years away and consisting of some 300,000 stars in the constellation of Hercules.

Arecibo message represented basic information about human life in graphic form: which planet we inhabit in our planet system, what our bodies look like and how tall we are, what is the human population of Earth, what our double DNA strand looks like and what is its amount, and what how did the instrument used to send the message look like.

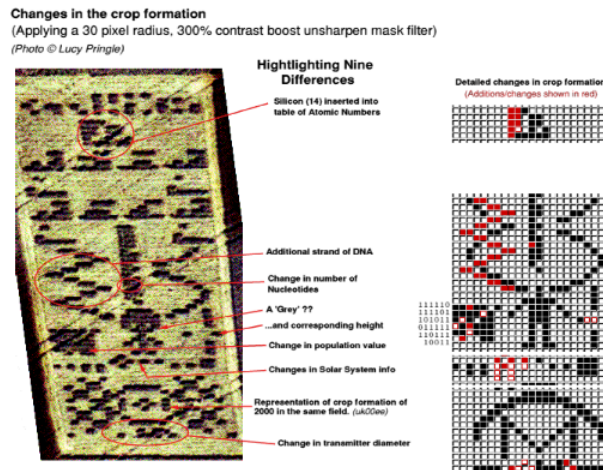


Figure 7.1: Chilbolton crop formation

The differences between Arecibo message and Chilbolton message are analyzed in [46, 47].

1. The solar system contains same number of planets but Sun is depicted to be somewhat smaller. Besides Earth also Mars ja Jupiter are told to be inhabited. The most natural interpretation is that ITs (intra-terrestrials) living at mantle-core and core-inner core boundary layers of Earth, Mars and Jupiter are in indeed in question. Liquid or liquid-crystal glass *resp.* iron has replaced water as a medium controlled by these life-forms. The DNA and amino-acids of these life-forms reside at non-atomic space-time sheets which are cold.

This identification also explains why the civilization in question has been able to receive Arecibo message. Arecibo message is sent at micro-wave wave lengths, and micro-waves are amplified by quartz crystals appearing in Earth's crust and correspond to just those wave lengths which induce supra-currents between different space-time sheets. The Chilbolton message also implicitly tells that the populations at the three planets are aware of each other and might be able to communicate. Also this supports the view that some of these life forms are at higher evolutionary level than we.

An objection against this interpretation is that magnetosphere is crucial for life, and since the magnetic field of Mars is very weak, there cannot be any life in Mars. This could indeed be interpreted as being the one reason for why ordinary life has disappeared from Mars: magnetosphere has served as a magneto-immune system preventing the leakage of extra-Martian life-forms to the magnetosphere. Of course, the magnetic field of Mars could be so weak that we have not yet detected it. It is also possible that the magnetosphere of Mars is confined inside the interior of Mars and that Mars is populated only by the simple plasmoid like life forms associated with the magnetic flux tubes corresponding to magnetic fields of strength of order .2 Tesla. Also smaller regions where magnetic field exist are possible. They could reside at the boundary of the Martian counterpart of the 'inner-inner' core of Earth having radius of order 300 km (a core of roughly the same size is known to be possessed also by Moon).

2. Besides the elements necessary for our life also silicon (very similar to carbon) is mentioned as an element appearing in DNA. The appearance of silicon in DNA would be natural at mantle-core boundary. The analysis of Crabwood message provides further support for this interpretation.
3. The strands of DNA (or more probably RNA) are depicted as different.
 - i) The arguments below suggest that the second strand could correspond to a rare variant of DNA in which two triplets of DNA correspond to a full 2π twist. In our DNA 10 DNA triplets are required for a full twist containing an integer number of DNAs (this corresponds to the

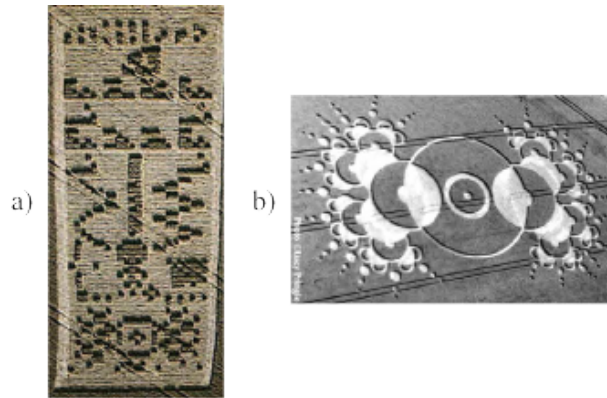


Figure 7.2: The counterpart of the Arecibo antenna in Chilbolton message which corresponds to earlier crop formation brings in mind Earth's magnetosphere and suggests the presence of intra-terrestrial life.

length of cell membrane). This simpler genome defined by 16 RNA doublets replacing 64 RNA triplets could be associated with the plasmoid like life-forms serving as messengers.

ii) Alien RNA could indeed consist of asymmetric double strands. The physical model for the evolution of the genetic code developed in [19] allows this option. A closer inspection of the Chilbolton message suggests that two exotic RNA nucleotides correspond to single singlet RNA nucleotide in the double strand. Therefore the translation of the RNA strands to two different pre-amino-acid sequences could occur as a single process using common pre-tRNA. A further conclusion is that singlet RNA must have been scaled-up by a factor of 2: this might be achieved if the phosphate-sugar backbone contains diphosphates instead of monophosphates. Therefore both RNAs would differ from those dominating the recent life. Pre-amino-acids would not have such an intimate relationship and would represent separate molecular life forms. The higher level life forms could correspond at molecular level to this kind of symbiosis.

The presence of diphosphates would also resolve the basic objection against IT life at mantle-core boundary due to the fact that DNA cyclotron energy (f_c is about 1 Hz at the Earth's surface) would be below the thermal threshold. The increase of the charge density of DNA per unit length would increase the cyclotron frequency above the thermal threshold.

4. The amount of DNA is somewhat higher than in human genome.
5. The population of these aliens is much higher than that of humans: 21.3 billions. The typical size of aliens, looking like "greys" in UFO mythology, is about one meter.
6. Arecibo message depicts also the radio telescope used to send the message. In Chilbolton message the radio telescope is replaced by a crop formation of year 2000 which had appeared in the same field (see figure below) Rather remarkably, this fractal structure brings in mind Earth and its magnetosphere. The interpretation consistent with the overall view is that the construction of this and other crop circles indeed involves entire magnetosphere and that intra-terrestrial life forms are involved with the sending of the message. One can also ask whether crop formations could quite generally be interpreted as pictorial representations of the alien technology?

Strange silicon is associated with crop formations

If silicon is indeed necessary for the life-forms responsible for the Chilbolton message, it should appear at the space-time sheets in question and might be transferred to our space-time sheets when crop circles are formed. Silicon has been indeed found. Here I represent citation from biologist Dr. Levensgood:

Human genetics has been altered by ancient space travelers, then it would be very strange if human genetic makeup were not very similar to that of our parent ETs. There is something about Silicon that is being conveyed in this message. It is not clear at all that Silicon must play a role in the DNA. But it is clear that it plays some important role. Dr. William Levengood, who has pioneered the biochemical assessment techniques that differentiate real crop formations from hoaxes, has found anomalous deposits of Silicon, silicone, and silicates in real crop formations. In one such formation, a layer of extremely pure, micro-crystalline white silicon was found in an 8"-wide layer 4" under all the affected plants, with no visible soil disturbance to show how the hoaxers put it there. The Silicon was of a purity and crystalline structure that was previously unknown. Furthermore, plants that grew in soil containing this white powdery silicon displayed a 300% to 400% growth in biomass, compared to control plants. The seeds taken from plants that grew in the real formations looked fine, but showed a 40% decrease in seed weight and were dry inside. But, when planted, they germinated and grew tremendously fast, with a deep, lush green color and robust health, compared to control plants. There is something going on with Silicon, and true scientists would respect these clues and examine the real data instead of concluding that it cannot be, therefore it isn't. That is just bad science.

Evidence for strange RNA

Chilbolton message could tell that two types of DNAs exist and that for the second DNA 64 DNA triplets have been replaced by 16 doublets. This idea leads to a successful model of genetic code. The simpler DNA would be naturally associated with the plasmoid like life-forms able to serve as messengers.

$k = 157$ is the space-time sheet carrying the magnetic field of about .2 Tesla guaranteeing that electronic cyclotron transitions generate micro-waves serving as 'food' of plasmoidic life forms. In the solar magnetosphere magnetic fields of this order of magnitude are common (note that there can be very cold even at the magnetic flux tubes of the convective zone!). Thus Sun might thus be an ideal seat for plasmoid like life-forms residing at the magnetic flux tubes. Sun was represented to be smaller than in the Arecibo message: perhaps this was a hint. The fact that the magnetic field of Earth has been weakening continually might explain why plasmoid like life-forms are appearing into the Earth's magnetosphere. The fact that Sun's convective core is an ideal source of plasmoids, would explain why also UFO observations correlate with the sunspot activity which correlates with the flow of plasmoids from Sun.

It has been quite recently discovered that Earth's interior contains previously unidentified structure with radius of about $r \sim 300$ km. If the Earth's magnetic field behaves like dipole field down to these distances, the value of the magnetic field is about .4 Tesla at this distance, and happens to correspond to the field value relevant for the plasmoid like life forms. The many-sheeted model of magnetospheric sensory representations implies that also the magnetic fields at the space-time sheets corresponding to various structures in the Earth's interior are parts of the conscious magnetosphere. In this region the magnetic field would result via spontaneous magnetization having as a seed the magnetic field created by the spontaneous magnetization of a super-conductor consisting of $J = 2$ Cooper pairs.

If these plasmoid like life-forms serve as messengers and if abduction experiences are real, then physical signatures for these encounters should exist. In particular, the immune system of the persons who have suffered abduction should be activated against the exotic form of RNA. There is evidence for this. According to [45], Red Setter, a research biologist, says:

The central part of the Chilbolton pictogram shows that a DNA double helix as found on Earth, with 10 base pairs per turn, has been replaced on one side by a novel single-stranded helix with just 6 bases per turn. I had to work hard for several days, to discover that the single-stranded helix with 6 bases per turn refers to 2', 5'-linked RNA or DNA, as opposed to the normal 3', 5' variety. This is known to hardly any molecular biologist, and I found out only by making an accurate model. ...There is no other plausible way of constructing a 6-fold helix as indicated. [published research] shows that 2', 5'-linked RNA will form double helices, but prefers to remain single stranded. [Other research] explores the use of 2', 5' RNA as an antiviral drug; it seems we have been exposed to such strange molecules in the past, and have evolved an interferon-RNAase L system against them.

Recall that origin-of-life experiments in the 1980s by Leslie Orgel, found that RNA would often polymerize into two different forms, namely 2', 5' versus 3', 5'; and it was a mystery to chemical evolutionists why 3', 5' was favored on Earth. Note that many abductees remain ill with chronic fatigue, which generally includes a high level of RNAase L; just as if their immune systems have been activated by contact with 2', 5' RNA. The clear implication is that 2', 5' RNA may represent an alternative system of genetic coding to 3', 5' RNA or DNA as found on Earth; and that the makers of the Chilbolton pictogram wished us to understand that fact.

Whether a secret band of elite scientists could hoax such a result seems doubtful; since 2', 5' nucleic acids are mentioned rarely in the literature, and nowhere does it say that they form a single-stranded helix with 6 bases per turn. That I found only recently, by painstakingly constructing an accurate model.

Comparing the simple DNA with that of ours

While building a model for cognitive representations at molecular level I ended up to the following ideas.

1. The regular polygons constructible using only compass and ruler have number N of sides (and vertices) which is product of a power of two with product of some Fermat primes. The Fermat primes are given by $F_n = 2^{(2^n)} + 1$, $n = 0, 1, 2, 3, 4$. One has $F_0 = 2$, $F_1 = 5$, $F_2 = 17, \dots$ F_0 , F_1 and F_2 define Mersenne primes via the formula $M_F = 2^F - 1$ and are clearly in special role.
2. Biology is full of helical structures and the hypothesis is that these structures are such that the number of basic units per period (full 2π twist) of the helical structure corresponds to the number N of vertices for above mentioned polygons or to a Mersenne prime. The hypothesis is in principle easily testable.
3. For ordinary DNA the number of DNA base pairs per period is $30 = 2 \times 3 \times 5$. This corresponds to 30-gon constructible using only compass and ruler.
4. For the exotic two-base DNA the number of base pairs is $6 = 2 \times 3$ per period so that this structure corresponds to hexagon and therefore also to a polygon constructible using only compass and triangle. Clearly, this DNA is somewhat simpler in well defined sense and could correspond to the DNA of plasmoid like life-forms for which doublets replace triplets.

7.2.2 Crabwood crop formation as a representation of DNA-amino-acid codes?

For year and day later after the appearance of the Chilbolton formation a new crop circle was found in Crabwood. I am in debt for Martin Keitel for learning about this fascinating formation in a local UFO meeting and also for interesting discussions and for concrete help.

The message

Crabwood message consists of two parts. An alien picture and a picture representing spiral like bit sequence starting from the center of the picture and proceeding counterclockwise. It has been proposed [42, 43] that the message is coded using 9-bit code and that 8-bit portions obey ASCII code. With this assumption the message reads as

Beware the bearers of FALSE gifts&their BROKEN PROMISES.Much PAIN but still time.EELI!UVE.There is GOOD out there.We OPpose DECEPTION. Conduit CLOSING

Obviously there are one or two incomprehensible words involved (EELI!UVE). There are also two variants of the message in the net. OPpose appears at Paul Vigay's homepage [42] and Oppose at at Martin Keitel's homepage [43]. In the following both options are considered.

One could consider the possibility that the message has much deeper layer than the somewhat oracle-like statement in ASCII code, and that the presence of the little inconsistency might be intended to make clear that a deeper level is involved. What these aliens would like to communicate is something very essential about themselves as a life form. The image of an alien accompanying the bit sequence indeed suggests this. This something very essential could obviously include the code for translating ordinary DNA triplets to amino-acids. Perhaps also the code for translating the exotic RNA doublets to the analogs of amino-acids. These analogs could be even electromagnetic waves. There could be also other codes: just at the time when the Crabwood message had arrived I developed entire hierarchy of cognitive codes based on Mersenne primes and regular polygons constructible using only compass and ruler [17].

The first guess is that the message should be represented by some universal code. The appearance of $3 \times 3 = 9$ -bit code words decomposing naturally to 3 sequences of 3-bits suggests that a cognitive code consistent with genetic code might be involved. This guess was very useful in that it led to

includegraphics[width=10.0cm]/Users/mattipitkanen/Desktop/tgd/figures/crabwood.png

Figure 7.3: Crabwood crop formation

the identification of the genetic code of exotic RNA and the decomposition of 3 3-bit portions also suggests immediately that information about RNA is in question.

It however turned out that ASCII code is the proper manner to interpret the message, ninth bit serves as a separation sign only. The interpretation relies on extremely general aspects of the ASCII code: capital and small letters correspond to amino-acids and capital and small forms of a given letter denote for the same amino-acid. Control signs denote the amino-acidic counterparts for the code associated with the exotic RNA. The ordering of the symbols does not matter. One could also use different kinds of symbols: only the numbers of various kinds of symbols telling how many code words are mapped to a particular amino-acid (or whatever counterpart of it) matter.

At what space-time sheet do the aliens live?

The number of code words in Crabwood message is $k = 151$. $k = 151$ is the prime coding for the p-adic length scale corresponding to the cell membrane thickness. $k = 151$ is also associated with the chromosome's helical structure. There is actually a hierarchy of helical structures and $k = 151$ corresponds to the lowest level of the hierarchy.

1. The first possibility is that $k = 151$ tells that the DNA and amino-acids of the life-forms in question are at $k = 151$ space-time sheets rather than at atomic space-time sheets. This would make sense if atomic space-time sheets are hot. This could be the case if these life-forms are ITs. This would also mean that $k = 151$ refers to the space-time sheet at which super-conductivity is broken. For our life it would be $k = 137$ space-time sheet.
2. Second, and a more realistic, possibility is that $k = 131$ space-time sheets with size which is $1/8$ of the size of the atomic space-time sheets (.1 Angstroms) are also present and correspond to the hot space-time sheets. Alien DNA and amino-acids would reside at atomic space-time sheets at a temperature which might be near to the room temperature. The assumption that the size of the space-time sheet corresponds to the thermal de Broglie wave length for the typical particles involved, is consistent with this assumption, as will be found later.

Option 2) suggests a different interpretation for $k = 151$. This length scale corresponds to the cell membrane thickness and a minimum length for DNA double helix such that an integer multiple of full turns results. This might be crucial for the establishment of the genetic code based on DNA triplets. Since the velocity parameter given by the scaling law of homeopathy [18] is $v \simeq 6$ m/s for $k = 151$ and equals to the phase velocity of alpha waves, this space-time sheet must be important for our life too. Alpha band in EEG, in particular Schumann resonance, might relate to communications between life forms at $k = 137$ and $k = 151$ space-time sheets. The communications with higher level life-forms might relate with the fact that the alpha band in EEG seems to be associated with creativity. If the aliens assume that we know about p-adic physics, this number might be interpreted as a message telling that also these life-forms have cell membranes and all that is made possible by the presence of $k = 151$ space-time sheet.

7.2.3 ASCII code interpretation of the Crabwood message

The basic hypothesis is that the message uses only the most general aspects of the ASCII code. The very fact that ASCII code and English language is utilized for the construction of the surface message, tells that the civilization is at a higher level than us and knows a lot about us. The one or two incomprehensible code words in EELI!UVE are purposefully added to help to realize that there is a deeper level involved. For OPpose option the illogical use of capital letters could be also seen as a hint that the numbers of the capital and small letters are more important than the grammar.

The hypothesis is that there are at least two codes involved and these codes are represented by capital letters, small letters + special signs. Of course, also combinations of these are possible and it seems that small letters and special symbols indeed appear in a combination.

Why ASCII code?

ASCII code table consists of seven 16-element columns. The first two columns correspond to various control signs; the next two columns to various special symbols like ! and & and decimal numbers; the next two columns to capital letters and special signs; the last two columns contain small letters and special signs. The ASCII number runs along the first column to 15, continues along second column from 16 to 31, etc.... The ASCII numbers of the alphabet run in the alphabetical order and A corresponds to 65 and Z to 90. The ASCII numbers of small letters are obtained by adding number 32 to those of the capital letters and a given small letter is in the same row as the corresponding capital letter and shifted by two columns.

	0	@	P	'	p
32	48	64	80	96	112
!	1	A	Q	a	q
33	49	65	81	97	113
"	2	B	R	b	r
34	50	66	82	98	114
#	3	C	S	c	s
35	51	67	83	99	115
\$	4	D	T	d	t
36	52	68	84	100	116
%	5	E	U	e	u
37	53	69	85	101	117
&	6	F	V	f	v
38	54	70	86	102	118
'	7	G	W	g	w
39	55	71	87	103	119
(	8	H	X	h	x
40	56	72	88	104	120
)	9	I	Y	i	y
41	57	73	89	105	121
*	;	J	Z	j	z
42	58	74	90	106	122
+	;	K	[	k	{
43	59	75	91	107	123
,	<	L	\	l	|
44	60	76	92	108	124
-	=	M	]	m	}
45	61	77	93	109	125
.	>	N	^	n	
46	62	78	94	110	126
/	?	O	_	o	
46	63	79	94	111	127

Table 1: The table gives the 3 to 8 columns of ASCII table (the first two columns for control commands have not been included). The ASCII numbers for the symbols appearing in the message are in boldface.

1. What senders can tell using ASCII message?

There are several good reasons for using the general features of ASCII code to send the message.

1. 8-bit code is favored because 9th bit must be used as a separator for practical reasons. In fact, all 8-bit code words involved have 0 as the last digit so that if 9:th digit is 1 then this digit combination acts as a natural separator for the code words.

2. The use of the ASCII code allows to tell implicitly that the senders of the message live near to us, and that they have quite a lot of information about us. The presence of the surface message tells that they can even cope with English language. The totally incomprehensible EELI!UVE can be seen as an ingenious manner to signal that there is a deeper layer involved. The presence of the surface message also tells that the ordering of the letters is very probably not important.
3. If only very general features of ASCII code are involved, enormous flexibility results. For instance, the ordering of the code words in the message does not matter, and there is invariance with respect to the permutations of capital letters and 4 special symbols: only the blanco must map to itself under these symmetries. The permutation group is $S_{20} \times S_{19}$. This means a huge freedom to construct the surface message. It is hard to believe that average crop circlist could have this kind of skills.

2. *Hints that the message is about genetic code and cannot be random lyric burst*

One can ask whether the selection of the amino-acid-letter correspondence could have been used to convey additional hints telling that the codes are involved.

1. When one replaces the ASCII numbers n of the various symbols with the symbols which correspond to the number $n_1 = n \bmod 32$, one obtains control symbols in the first two columns of the ASCII code table. This operation corresponds to simply the shifting of the column pair to the left so that it replaces the first two columns. Since all capital *resp.* small letters are contained in the column pairs starting from ASCII symbol 64 *resp.* 92 this operation does not mean a loss of information. Same applies to the special symbols appearing in the message. That capital and small letters are mapped to the same control symbols, suggests as a first guess that they might denote the same amino-acid also in the code: this guess turns out to be wrong and is not actually used in the analysis. Control symbols are denoted by two- and three-letter symbols which brings in mind the three letter notation for amino-acids and also the function of amino-acids as bio-controllers, whereas DNA corresponds to the symbolic representations like ordinary letters of the language. It is also interesting that there are 26=21+5 capital letters: this brings in mind 20 amino-acids, stopping sign, 4 pairs of micro-wave polarizations, and corresponding stopping sign.
2. Especially intriguing is the appearance of special symbols. There are 20 capital letters and 19 small letters plus the special sign \ which also has ASCII number larger than 64: does this signal for 20 amino-acids also in the case of the small letters? Or is meant to tell that both small letters and special symbols denote for amino-acids? The remaining three special symbols have ASCII numbers in the third column of the ASCII table.
3. The alphabet runs vertically along 16 element columns of ASCII table and A corresponds to 65. The letters H, X, Y, Z, J and @ symbol which corresponds to ASCII number 64 in capital letter column of ASCII table, do not appear as symbols of amino-acids. The symbols H,X,Y,Z and J (ASCII numbers modulo 32 equal to 8, 24, 25, 26, 10) form a *connected* symmetric region in ASCII table (H (J) is connected horizontally to X (Z) at the upper (lower) end of the vertical bar formed by XYZ). Since a random choice of letters would give disjoint set of letters, there seems to be a clear systematics in the selection of the letters used to denote amino-acids. Furthermore, there are 7 letters A, B, C, D, E, F, G above H and 5 letters below K: these are the primes characterizing M_5 and M_7 codes.
4. It is perhaps worth of noticing that the strange word UVE in EELI!UVE corresponds to a connected region of ASCII table and the sum of ASCII numbers modulo 32 is 7^2 which is 9 modulo 8 and 17 modulo 32. Also the sum of the ASCII numbers modulo 32 associated with EELI equals to 7^2 . The total sum of the ASCII numbers modulo 32 is 99 which equals to 3 in modulo 32 arithmetics.
5. The ASCII numbers of the special characters modulo 32 correspond to 0 (blanco), 1, 6, 14, 28. The numbers 6 and 28 are perfect numbers associated with Mersenne primes $M_2 = 3$ and $M_3 = 7$ defining genetic code. All these numbers define Fermat polygons. The column of ASCII table containing blanco, !, & and period contains 7+5 other characters, seven characters between

& and period. There are four characters between ! and &, whereas the remaining character is below period at the bottom of the column of ASCII table: this brings into mind 4 micro-wave pairs plus stopping sign identification.

3. Ideas about how to dis-entangle the message

A fascinating possibility is that the structure of the ASCII table could give further hints about the systematics of the genetic code.

1. Professional biologists might make guesses about what amino-acids the various letters correspond by comparing the code with our genetic code. For instance, the highly degenerate amino-acids might be same for both genomes.
2. The symmetries of the genetic code, in particular the exact A-G symmetry for the last codon might help to deduce the DNA-amino-acid corresponds using the information of message as hint. There are also other approximate symmetries which give strong constraints on the amino-acid-capital letter identification if one assumes that they hold true also for capital letter code. For instance, the amino-acids corresponding to left-right pairs of capital letters have almost as a rule same number of DNAs coding them. By looking what might the corresponding symmetry for our DNA, one could end up with strong constraints for amino-acid-capital letter correspondence. Unfortunately, this approach does not seem to provide much information.
3. The most important hint came from the realization inspired by the message that both our and alien genetic code are in a good approximation products of simpler doublet and singlet codes. This realization might have emerged also from simple number theoretical considerations. One can imagine two possibilities.
 - i) If one counts only real aminaocids $20 = 10 \times 2$ decomposition suggest a decomposition to doublet could mapping 16 DNA pairs to 10 elements and 4 DNA bases to 2 elements, kind of 'pre-amino-acids' serving as formal building blocks of real amino-acids. Exact $A \leftrightarrow G$ symmetry and only slightly broken $T \leftrightarrow C$ symmetry for the last base of DNA triplets supports the 10×2 product decomposition.
 - ii) If one counts also stopping sign formally as an amino-acid, $21 = 3 \times 7$ decomposition suggests a decomposition to doublet code mapping 16 DNA base pairs to 7 elements and 4 DNA bases to 3 elements.

This idea also leads to a vision about life being evolved through a development of doublet and singlet codes which then formed a symbiosis.

4. A further guideline comes from the basic idea of Combinatorial Hierarchy model of the genetic code [30, 21]. The discrete 21-element set of amino-acids and stopping sign can be imbedded to the discrete space of 64 DNA triplets so that there is a unique DNA for each amino-acid serving as kind of a coordinate for it in the space of DNAs. This leads to a geometric view about the genetic code. Most important prediction is that the the DNAs associated with amino-acids a predicted to code for these amino-acids in any genetic code.
5. Finally, the general structure of the ASCII table in capital letter columns together and the general features of the message give important hints about the identification of the amino-acid-capital/small letter correspondence. It however turned out that the model of the genetic code is almost enough for the deduction of the codes.

The degeneracies associated with the capital letter code

There are 20 different capital letters with total number of 56: this is consistent with the genetic code and implies that stopping sign is coded by 8 DNAs. There is no need to tell the number of DNA triplets coded to stopping sign because it can be deduced from the known number 64 for DNA triplets.

The message reads as follows

Beware the bearers of FALSE gifts&their BROKEN PROMISES.Much PAIN but still time.EELI!UVE.There is GOOD out there.We OPpose DECEPTION. Conduit CLOSING

The numbers for the appearance of various capital letters are given by the following table.

A	B	C	D	E	F	G	I	K	L
2	2	3	2	8	1	2	5	1	3
M	N	O	P	R	S	T	U	V	W
2	4	7	4(3)	2	4	2	1	1	1

Table 2: Numbers of capital letters appearing in the Crabwood message. The number of P:s is 4 for OPpose option and 3 for Oppose option. The number of blancos is correspondingly 10 or 11.

Note that the less important amino-acids at the end of the table correspond to largest ASCII numbers. The largest maxima E, I and O could correspond to the 3 amino-acids coded by 6 DNAs in our genome: these amino-acids are leusine, serine and arginine.

Let us denote by n the number of DNAs coding a given amino-acid: now it corresponds to the number of appearances of a given capital letter in the message. The number $N(n)$ of amino-acids corresponding to the same value of n gives overall view about genetic code and about the importance of the amino-acid in question. These numbers are represented in the following table:

n	1	2	3	4	5	6	7	9
N(alien)	5	7	3	3(2)	1	0	1	1
N(us)	2	9	2	5	0	3	0	0

Table 3: A comparison of number $N(n)$ telling the number of proteins coded by n DNAs for capital letter code and our genetic code.

The lowest row represents the numbers of n -plets for our genetic code. What looks strange is that as many as 8 DNAs are coding the same amino-acid and that stopping sign is also coded by 7 codons for OPpose option and by 8 codons for Oppose option! In fact, the model for our genetic code discussed in [30, 21] predicts that the number should not be larger than six.

It would seem that the alien genetic code is not so entropic than ours in the sense that the number of DNAs per amino-acid varies much more. The measure for the redundancy is given by the entropy per amino-acid given by $s = S/N = \sum_n N(n) \log(n) / (N \log(2))$, $N = 20$: here bit is used as a unit. The entropy achieves maximum, when the degeneracies of all amino-acids are same. The entropy per amino-acid is $s = 1.42$ bits for our genetic code and $s = 1.20$ bits for the alien genetic code in case of Oppose option. When stopping sign is regarded as amino-acid, one has $s = 1.49$ and $s = 1.28$ for our *resp.* alien genetic code.

The degeneracies of codes associated with small letters and small letters plus special signs

The numbers of the small letters, of blancos besides those associated with the capital letter code, of backslashes (\) (ASCII number is larger than 64) in the message are represented by first four rows of the table 4 below. The last rows represent the numbers of special signs with ASCII number smaller than 64.

a	b	c	d	e	f	g	h	i	l	m
2	2	1	1	13	2	1	5	6	2	1
n	o	p	r	s	t	u	w	stop	\	
1	4	1(2)	6	5	9	4	1	11	1	
!	&	.								
1	1	5								

Table 4: The numbers n of small letters and special signs appearing in Crabwood message. The number of p :s is 1 for OPpose option and 2 for Oppose option.

In the case of small letters the identification of the code is not unique. There are three different interpretations depending on whether one

1. includes only small letters giving 18 amino-acids with h playing the role of stopping sign (this is possible for Oppose option only),
2. whether also the \backslash appearing in the capital letter column is included giving $19+1=20$ amino-acids, or
3. whether one includes also special symbols, which gives 23 different aminoacids.

1. Are only small letters included?

There are 19 different small letters in the message. For Oppose option the total number of small letters is $68 = 4 \times 17 > 64$ so that a variant of the ordinary genetic code cannot be in question. For cognitive codes based on the regular plane polygons constructible using compass and ruler, the number of code words is power of 2 times a product of some Fermat primes. The code word number $N = 4 \times 17$ obviously corresponds to this kind of code. M_{17} is also Mersenne prime and in [17]) it was speculated that M_{17} Mersenne codes are realized at DNA level. In the case of OPpose option the number of letters is 67 and this kind of interpretation is not possible.

There are two possible interpretations for this code making sense only for the Oppose option.

1. The first identification for the small letter code is as a modification of the genetic code obtained by doubling of one DNA doublet which turns out to be AA. Chilton messages tells that also silicon is fundamental for the alien life at DNA level. This suggests that the modification $(AA)_S$ of AA involving silicon increases the number doublets to 17 and the number of triplets to 68. This modification obviously increases the information content of the genome.
2. The appearance of the number 4 suggests that the four DNA bases send 17 different signals such that a given signal affects only single amino-acid. The code could tell how many signals affect a given amino-acid. One can deduce the number of the stopping sign signals and can also identify the two amino-acids which are not affected by the signals if one assumes that capital and small forms of a given letter code for the same amino-acid. Interestingly, all the code words involved have ASCII number larger than 64 and smaller than 127, which fits nicely with the assumption that DNA triplets are involved and $M_7 = 127$ genetic code is involved. Note that the 'stopping sign' of this new code might be simply one particular signal rather than actual stopping sign.

If one assumes that small letters label amino-acids and capital and small letters code for the same amino-acid, one can conclude that the letter h must code for the counterpart of the stopping sign, and the letters K and V whose small counterparts are not present in the small letter code correspond to amino-acids not involved with the code in question. Thus only 18 amino-acids would be coded and the expressive power of the genome would be reduced. The number $N(n)$ of amino-acids coded by n DNAs is represented in the following table:

n	1	2	4	5	6	9	13
N	6	5	2	2	2	1	1

Table 5: The numbers $N(n)$ of amino-acids coded by n DNAs for pure small letter code for Oppose option.

Stopping sign corresponds to degeneracy $n = 5$. The above defined entropy of the code is $s = 1.22$ bits per amino-acid ($s = 1.43$ for our code) using the formula above and assuming that stopping sign does not contribute. If stopping sign contributes, one has $s = 1.39$ ($s = 1.49$ for our code).

2. Are also blancos and \backslash included into small letter code?

If one includes also the 10 (11 for Oppose) blancos left when 7 (8 for Oppose) is reserved for the capital letter code, one has 20 different small letters and their total number is 79. This number is not divisible by 4 as doublet-singlet product form for any code involving DNA triplets would suggest. Also

one amino-acid is lacking. There is however the symbol \backslash , which appears in the columns containing capital letters unlike other special symbols with ASCII number smaller than 64. If one includes it the number of different symbols becomes 21 and their total number is $20 \times 4 = 80$. In this case blanco has a natural interpretation as a stopping sign and the letters h and \backslash could represent amino-acids different from those coded by our DNA. As a matter fact, it is known that there are more than 20 amino-acids and the 2 additional ones are coded by the DNA of some terrestrial life-forms. One can however wonder what it means that the \backslash does not belong to the small letter columns but to the second capital letter column. Perhaps this amino-acid, or whatever it is, has a very special role.

The interpretation would be following. The code is obtained by adding 16 new codons to the old ones. If the code results from a product of doublet and singlet codes, this is achieved if the number of doublets increases by four. This could result from the doubling of the base T by silicon modification in case that it appears as (say) the first base of the codon. This would mean that one has also four codons of form T_SXY .

If one assumes that small letters label amino-acids and capital and small letters code for the same amino-acid, one can conclude that the letter h and \backslash code for amino-acids by replacing the amino-acids represented by the letters K and V . 20 amino-acids would be coded by the modified DNA. By looking what amino-acids have been replaced with these new ones one could perhaps deduce what amino-acids the letters K and V denote.

The number $N(n)$ of amino-acids coded by n DNAs is represented in the following table:

n	1	2	4	5	6	9	10 (11)	13
N	8(7)	5	2	2	2	1	1 (1)	1

Table 6: The numbers $N(n)$ of amino-acids (with stopping sign included) coded by n generalized DNAs for small letter + \backslash code with 80 generalized DNAs and 20 amino-acids. Numbers in brackets refer to Oppose option.

Stopping sign corresponds to degeneracy $n = 10$ ($n = 11$). The above defined entropy of the code is $s = 1.28$ bits per amino-acid ($s = 1.42$ for our code) for Oppose option assuming that stopping sign does not contribute. The small value of entropy is due to the large numbers of code words coding for stopping sign and one amino-acid. With stopping sign included the entropy is $s = 1.39$ bits per amino-acid ($s = 1.49$ for our code). One can criticize this code for the fact that the large number of DNAs coding stopping sign reduces the information content of the code.

One might think that same amino-acids correspond to a large number of DNA code words in both capital letter and small letter codes. The table below allows to compare capital and small letter codes. The first and third rows denoted by x correspond to small letter code and second and fourth rows denoted by X to the capital letter code.

	a	b	c	d	e	f	g	h	i	k	l
x	2	2	1	1	13	2	1	5	6	0	2
X	2	2	3	2	8	1	2	0	5	1	3
	m	n	o	p	r	s	t	u	v	w	\backslash
x	1	1	4	1(2)	6	5	9	4	0	1	1
X	2	4	7	4(3)	2	4	2	1	1	1	0

Table 7: Comparison of numbers of DNAs coding for same amino-acid in small letter code and capital letter code assuming that small letters and capital letters denote the same amino-acid.

There indeed seems to be this kind of correlation up to amino-acid coded by p: amino-acids e and i and o correspond to maxima of $N(n)$. They could correspond to leucine, arginine and serine which are maximally coded also in our genome. It turns out that the assumption that small and capital letters correspond to each other is not needed in the construction of the small letter code. The assumption of this correspondence would obviously pose serious limitations on the content of the surface message.

3. Do both small letters and special symbols define counterparts of amino-acids for the small letter code?

Since the aliens seem to be more intelligent than us, the idea about higher genetic expressive power seems natural. Also the appearance of two different strands in the Chilbolton message suggests two different genetic codes and there is no reason to assume that these codes would have a same number of amino-acid like molecules.

The observation that the total number of small letters plus special signs is $24 = 8 \times 3$ and divisible by 3 suggests that the genetic code involves both small letters and special signs and that the code is obtained by a modification of ordinary genetic code by adding 3 new 'amino-acids' and yielding the additional expressive power. In fact, the possibly existing decomposition 3×7 for amino-acids (perhaps as composites of simpler molecules or in more general sense) might have expanded to $3 \times (7+1)$, where one new building block of amino-acid involving silicon has appeared and that the 3 special symbols $!, \&, .$ with ASCII number smaller than 32 denote these molecules. Alternatively, and actually more convincingly, 2×10 decomposition for real amino-acids could have expanded to $2 \times (10+2)$ for generalized amino-acids with stopping sign included now. From the degeneracies for special symbols, the entropy is $s = 1.22$ bits per 'amino-acid' for this kind of code. If one includes also stopping sign one has $s = 1.30$.

Comparison of the information contents of various codes

In [17] an information measure to the genetic code was associated. This information gain was defined as a difference of two entropies. The first entropy corresponds to situation when there is no correspondence between amino-acids and DNA. This entropy is given by

$$S_{max} = \log(N_{dna}!N_a!) .$$

Here $N_{dna} = 64$ and $N_{aa} = 20$ refer to the numbers of DNA triplets and amino-acids. The second entropy is entropy due to the permutation symmetry of codons coding the same amino-acid and defined as

$$S = \log\left(\prod_n n!^{N(n)}\right) ,$$

where n runs over amino-acids but does not include stopping sign. The information gain associated with the establishment of the genetic code is defined as

$$I = S_{max} - S .$$

The following table gives the entropies and information gains for various codes.

Code	(N_{dna}, N_{aa})	entropy	I
ours:	(64,20)	45.5	202.1
capital:	(64,20)	40.5	207.0
small:	$(4 \times 17, 20)$	63.1	201.2
small:	$(16+64, 20)$	67.9	248.1
small:	$(16+24, 23)$	75.9	240.5

Table 8: The table gives entropies and information gains for various codes. For the notation see the text above. Oppose option is used for calculation.

Is there a DNA doublet code present?

It is not obvious whether the codon of the possible exotic genetic code corresponds to 3 bases. If the exotic RNA corresponds to passive RNA as the message suggests, the counterparts of the amino-acids need not be molecules but could be some electromagnetic signals, perhaps topological light rays characterized by polarization direction. The work of Gariaev [55] and TGD based interpretation for it suggest that four pairs of radio waves with orthogonal polarizations provide the counterparts of the amino-acids. If plasmoid like life-forms are in question, micro-waves are indeed crucial for the metabolic cycle, and one expects that there is genetic control of micro-waves involved. Of course, doublet code could also be realized chemically: nothing precludes the simultaneous presence of both chemical and micro-wave codes.

If a base pair indeed represents single codon, one has M_5 code, and 16 codons must be represented. In case of the ordinary genetic code the number $M_7 - 1 = 126 = 6 \times 21$ is related to DNA-amino-acid coding with $N = 21$ representing the number of different amino-acids which stopping sign counted as 'amino-acid'. In present case $M_5 - 1 = 30 = 6 \times 5$ would suggest that 5 appears as a factor in the number $N + 1$ of 'amino-acids' with stopping sign counted effectively as 'amino-acid'. There are three possibilities.

1. The fact that doublets code for 10 different 'pre-amino-acids' in case of the product code suggests that the number of 'pre-amino-acids' plus stopping sign is $N + 1 = 10$. This option is consistent with the idea that triplet code has emerged as a fusion of doublet and singlet codes with 10 and 2 'pre-amino-acids' respectively. The degeneracies of various 'pre-amino-acids' are in this case dictated by the product model for the capital letter code.
2. The effective number for the counterparts of amino-acids is $N + 1 = 15$, this would give code for which 16 base doublets map to 14 counterparts of amino-acids and stopping sign. Two base doublets would map to the stopping sign or some amino-acid and the rest faithfully to amino-acids. The code would be maximally non-degenerate and such a low redundancy does not seem to be plausible.
3. There are $5 - 1 = 4$ different 'pre-amino-acids' plus stopping sign. The ratio of number of DNA doublets to the number of 'pre-amino-acids' would be $16/5 = 3 + 1/5$ and is rather near to the corresponding ratio $64/21 = 3 + 1/21$ for the ordinary genetic code. The interpretation in terms of pairs of orthogonal polarizations for micro-waves might make sense. This code might be realized even at the level of ordinary DNA with pairs of bases forming basic units instead of triplets and it might be possible to test whether the translation of DNA to these 'pre-amino-acids' occurs.

Several codes might be associated with special signs and blancos

There are four special signs !, &, \, period, and blanco and the numbers of special signs in the message are given by the following table.

!	.	&	\	blanco
1	5	1	1	19

Table 9: The degeneracies of special signs for Crabwood message.

The interpretation of the last code word as \ raises some worries since the ASCII number of \ is larger than 64 whereas the ASCII numbers of other special symbols are smaller than 48. The total number of the special signs in the message is 8, period appears five times. The number of blancos is 19, this makes 27 signs altogether.

In ASCII code blanco is not counted as a symbol, or more precisely, any non-vanishing number of blancos has the same meaning. If the situation is same now, it is possible to add arbitrary number of blancos to adjust the number of the code words such that it tells the prime k characterizing the life-form in question. This prime could characterize one of the Gaussian Mersennes $k = 151, 157, 163, 167$ characterizing various kind of biologies just as ordinary Mersennes and Gaussian Mersennes characterize various physics below atomic length scale.

There are several candidates for the code involved with the special signs. To discuss them first some background information about Mersenne codes is needed.

1. Mersenne codes

In TGD [17] an important class of cognitive codes correspond to Mersenne primes $M_n = 2^n - 1$ and the number of the code words is M_n power of M_n instead of 2^n . This can be understood as follows. In an external Z^0 magnetic field neutrinos suffer spontaneous magnetization and spins become all parallel. This generates a conscious experience. For the configuration in which spins are parallel to Z^0 magnetic field no phase transition occurs and no experience results. Hence this bit sequence is not consciously representable. The mechanism is actually much more general: any spontaneous

magnetization or spontaneous electret formation process gives rise to similar representation. This reduces the number of code words to $2^n - 1$.

There is a beautiful connection with finite geometries. The finite geometry associated with M_n has M_n points whereas projective geometry with the point at infinity added has 2^n points. The point at infinity corresponds to the code word not consciously representable as spontaneous magnetization phase transition.

There is a hierarchy $M_3 = 7, M_5 = 31, M_7 = 127$ of codes based on Mersenne primes. The number of code words for M_n is $2^n - 1$ and corresponds to the number of statements about n basic statements with the statement which is not representable as a phase transition thrown away. The number of statements consistent with a given atomic statement is 2^{n-1} and is 4, 16, 64 for the three cases $n = 3, 5, 7$ respectively and corresponds to the number of singlets, doublets, and triplets of DNA bases.

1. $M_3 = 7$ which appears in the 9-bit code is more primitive than genetic code: the number of DNAs for this code would be 4. The number of the counterpart of amino-acids for this code would be factor of $M_3 - 1 = 6 = 2 \times 3$ and is 3 most naturally. Single base might could be the counterpart of the DNA triplet.
2. The number of statements consistent with a given atomic statement for $M_5 = 31$ code is 16 and genetic codons correspond to two pairs of DNA bases. The number of counterparts of amino-acids plus stopping sign is factor of $M_5 - 1 = 30 = 6 \times 5$ and is 5 most naturally.
3. $M_7 = 127$ gives rise to 64 statements consistent with atomic statement of 128-element Boolean algebra coded to DNA triplets of the ordinary genetic code. The number of amino-acids plus stopping sign is factor of $M_7 - 1 = 126 = 21 \times 6$ and is 21.

2. Z_5 code

The special signs correspond naturally to the four micro-wave counterparts for amino-acids in case of M_5 code. The 16 RNA base doublets would replace RNA triplets as code words in case of the exotic RNA. Of course, this might make also in case of the ordinary RNA. The senders assume that the receiver knows or discovers the number of codons so that there is no need to code the number of codons mapped to the stopping sign. For this option blancos cannot have any meaning.

To get some ideas about what kind of codes are possible notice that in TGD based model of DNA-amino-acid correspondence is induced by an identification of the set X 64 statements of 128-element Boolean algebra consistent with given atomic statement (single bit in bit sequence fixed). $M_7 - 1 = 126 = 6 \times 21$ -element group Z_{126} is identified as a subset of the 128-element Boolean algebra. This identification induces automatically a map to the coset space $Z_{126}/Z_6 = Z_{21}$ representing amino-acids and stopping sign, and the prediction is that the number of DNAs coding given amino-acid cannot be larger than 6. There are 7 different identifications of the set X so that the identification of DNAs is not unique.

In the case of the special sign code one as $M_5 - 1 = 30 = 2 \times 3 \times 5$ -element group and code could be determined by similar map. There is quite a number of possible codes the possible factorizations of the number 30: Z_2 -dcode, Z_3 -code, Z_5 code, Z_6 code, Z_{10} , and Z_{15} code. Only Z_5 Z_3 codes are possible now.

Z_5 -code would predict that the number of DNAs coded to same element is not larger than 6. Since the total number of special symbols other than blanco is 8, and the number of DNA dublets is 16, 8 elements are mapped to the 'stopping sign'. The Z_5 code decomposes the 16 DNA dublets to two classes representing 8 statements consistent with a given statement and the Boolean complement of this set. Second class is mapped to 'stopping sign' and the rest 8 are mapped to 8 special symbols appearing in the message. For instance, if one of the bits in the four-bit code of DNA base vanishes, this would act as a stopping sign. One can say, that lie stops the action. The entropy of the code is $s = \log(5)/4\log(2) = .6$ bits per polarized micro-wave pair.

Z_5 code has 16 code words and would be naturally associated with the exotic RNA. The code would assign to each DNA base doublet a pair of polarized micro-waves, 4 states altogether. If one takes seriously the suggestion of the Chilbolton message that passive RNA strand consists of doublets and 2 RNA triplets define a unit for which twist is full 2π , one could consider the possibility that this code is associated with the exotic RNA. On the other hand, the approximate decomposition of the

triplet code to a product of doublet and singlet codes suggests that this code could be also associated with the doublets formed by the first to RNA bases of the triplets and realized also in life as we know it.

3. Z_3 code as dual of Z_5 code

For the proposed Z_5 code the second half of DNA doublets are totally passive, and one could argue that this cannot make sense: there must be some code involved also with these DNA doublets. Z_3 code is obviously what comes first in mind. TGD version for this code would predict that the number of elements mapped to a given element is not larger than 10 and is therefore possible. Now only !, & and period are counterparts of amino-acids and if stopping sign like action is at all involved it could correspond to period. Z_3 code requires that \ does not represent a counterpart of amino-acid for Z_3 code. That \ has ASCII number larger than 64 unlike the other three special symbols could be regarded as a signal for this.

The total number of elements mapped to Z_3 by Z_3 code would be 7 rather than 16. This is consistent with the idea that the DNA doublets which are passive with respect to Z_5 code are active with respect to Z_3 code, and that the DNA doublet which corresponds to a bit sequence 0000 is passive with respect to both codes. This conforms with the general ideas about how codes are realized consciously. In the realization based on phase transition the bit sequences consisting of say zeros only is not consciously representable and now it would correspond to the DNA doublet corresponding to 0000 sequence. In the proposed correspondence between DNAs and bit sequences this would correspond to GG.

A possible realization of these codes is in terms of pairs of micro-wave polarizations. Gariaev has found empirical support for the presence of this kind of code of this kind (radiation of laser beam with polarized coherent light generates polarized radio waves [55]) and I have proposed how this kind of codes might be possibly realized [17]. The physical action of the micro-waves would be induction of bridges between magnetic flux tubes and $k = 151$ space-time sheets making leakage of super-conducting ions possible and generating thus kind of dynamical piece of wire in many-sheeted current circuitry responsible for homeostasis. In [24] various aspects of the micro-wave mechanism are discussed.

For Z_5 code all polarization pairs would be active. For the Z_3 code micro-wave pair would induce conscious effect only if at least one polarization is in a selected direction. Logical operation OR for the two bits represented by micro-wave polarizations would be in question

4. Z_3^3 code for DNA triplets

The interpretation of the 19 blancos as representing stopping sign would imply that the number of code words is $19 + 8 = 27 = 3^3$, which brings in mind the number of bits of the code word of the message. This interpretation does not require the assumption that we already have discovered the micro-wave code. In this case one could consider of assigning $M_2 = 3$ code to each DNA of DNA triplet. The 3 statements would correspond to all DNAs except the one represented by 00, G is good candidate for this DNA.

The 2 statements consistent with a given statement of each four-element Boolean algebra associated with $M_2 = 3$ would define $2 \times 2 \times 2 = 8$ statements mapped to the four signals and the remaining 19 statements would be mapped to stopping sign. Translation process would stop to a lie! The code could be associated with the checking whether each base of triplet belongs to the set of two allowed ones, say A or G.

For the proposed identification $A = 10$, $T = 01$, $C = 11$, $G = 00$, the appearance of G(uanine) in the triplet would mean that triplet is mapped to the counterpart of stopping sign (does not generate micro-wave pair at all perhaps) This code would be naturally associated with the ordinary DNA. I have proposed family of codes based on Mersenne primes and associated with DNA in [17]. This interpretation would bring in M_2^3 code, M_3^3 code with 7^3 code words inspired by the 9-bit code words would have 64 DNA triplets in the role of amino-acids.

7.3 What can one conclude about aliens?

In the sequel "aliens" refers to the life forms whose genetic code Crabwood message is assumed to represent. The basic question concerns the identity of aliens.

7.3.1 Intra- or futuro-terrestrials?

The fact that the Chilbolton message has appeared so soon after the sending of Arecibo message could mean two things.

Intra-planetary...

If the constructors of crop circles have received Arecibo message telling about us the, the civilization in question can be at most at a distance of few light decades. Even more, Chilbolton message tells that the aliens live at Earth, Mars and Jupiter and perhaps even in Sun. The Sun is smaller than in Arecibo message, which might mean that the aliens live below the corona, perhaps at the magnetic flux tubes of the convective zone carrying magnetic fields of order .2 Tesla for which electronic cyclotron radiation is at micro-wave range. One should not forget the spectroscopic evidence for water at solar spots [37] and for solid calcium-ferrite surface at photosphere [34] having interpretation in terms of dark N -matter. Notice also the fact both calcium and iron ions are fundamental for the terrestrial life.

The question is where in the Earth's magnetosphere (with dark flux sheets included) the biological bodies of aliens could be hiding (magnetic bodies of aliens could differ from those of ours in any essential manner). The Freudian answer is that since they are not visible they must lurk in the cellar, that is underground. One can indeed build a vision about alien life based on this idea and consistent with the hints provided by the crop formations.

... or futuro-terrestrials?

If the crop circles are generated by communications involving negative energy photons (phase conjugate light) as the model for the realization of intentional actions indeed implies, then the signals responsible for the formation of crop circles arrive from the geometric future. In this case the civilization could be arbitrary far away from Earth and the temporal distance would determine the dark matter level to which it corresponds (in particular, the span of its long term memories). Chilbolton message however leaves only the possibility that the civilization is some other civilization or ourselves of the geometric future after the colonization of Mars and Jupiter.

This civilization must have invented the technology making it possible to apply time mirror mechanism to induce magnetic self-organization patterns leading to the generation of plasmoids serving as mediums for telepathic communications and able to perform simple tasks like construction of crop circles. The smaller size of Sun could indeed mean smaller size of Sun: standard model predicts that the radius increases very slowly so that this interpretation seems to be wrong in standard physics context.

Notice that the idea about intra-planetary life need not be in conflict with the idea that Crabwood and Chilbolton messages come from a distant geometric future. Indeed, intra-terrestrial life, possibly as some variant more primitive than terrestrial life, is supported by the TGD inspired model for pre-biotic evolution [19].

The basic options for the interpretation of Chilbolton and Crabwood messages

One can imagine several options depending on what interpretation of Chilbolton and Crabwood messages one adopts.

1. The minimal assumption is that only plasmoid like life forms survive at the high temperatures of the Earth and planetary interiors. In this case the three codes could be assigned with the life forms assignable to Sun, Mars, and Jupiter. These three codes could also correspond to those of futuro-solars, -martians, and -jovians).
2. Inherently dark bio-molecules and N -molecules could make possible also life at hot temperatures of Earth's interior. This option will be discussed in the sequel. Even in the case that IT life forms with genetic code are possible, the simplest assumption is that their genetic codes are same as those of ordinary terrestrials so that three codes would result as suggested by the Crabwood message.

7.3.2 Two guesses for the temporal distance of futuro-terrestrials

In the following two guesses for the temporal distance of futuro-terrestrials are discussed.

First guess

There are highly controversial claims that Sun is shrinking with the rate of .1 per cent per century [35]: $d\log(R)/dt = 10^{-3}/\tau$, $\tau = 100$ years. The analysis of [36] however led to a conclusion that only oscillations with a period of 76 years are in question. If the shrinking occurred for the entire Sun rather than only surface layers, the claimed rate for shrinking would mean that gravitational energy would be liberated with a rate $P = GM_{Sun}^2/R \times d\log(R)/dt$, which would give $P \sim 10^{29}$ Watts, which is much higher than the power $P \sim 4 \times 10^{26}$ Watts radiated by Sun by known mechanisms. The presence of the classical Z^0 force could make possible considerable deviations from the standard stellar evolution and might be also needed to explain the oscillations of the solar radius. The increase of the gravitational binding energy could be compensated by the increase of the repulsive Z^0 Coulombic energy so that the catastrophic conclusion could be avoided. One could say that gravitational and Z^0 force serve opposite tendencies compensating each other in the "solar homeostasis".

If the shrinking were real and would continue with the rate claimed in [35], one would have $R/R_{now} = \exp(-10^{-3}t/\tau)$. If the radius in Chilbolton message is by a factor $k < 1$ smaller than in Arecibo message, the proposed interpretation implies that the message must have been sent from at temporal distance $t \simeq \log(1/k) \times 10^3\tau \sim 10^5$ years in the geometric future. A more realistic estimate would probably increase the value of t by some powers of 10. If this extremely light hearted argument were taken seriously, a breakthrough in time mirror technology is not to be expected during my lifetime!

In the model for a fractal hierarchy of EEGs predicting correctly the band structure and narrow resonance bands of ordinary EEG the characteristic time scale of life forms at k :th level of hierarchy corresponds to the Josephson period of the Josephson junction defined by the scaled up version of cell membrane and scales as r . $k = 7$ level of dark matter hierarchy corresponds to a time scale of ~ 50 years. The ability to communicate with geometric past in a time scale of 10^5 years, which corresponds to the next $k = 8$ level of the dark matter hierarchy, means that this is also the characteristic time scale for the long term memories of futuro-terrestrials.

Second guess

One can imagine also a second manner to guess the temporal distance of futuro-terrestrials. Rather curiously, Crabwood formation appeared year and one day later than Chilbolton formation. A possible interpretation is as a message telling that the it takes one day more for Earth to rotate around Sun in the geometric future so that year is by one day longer.

The mass loss of Sun causes the gradual weakening of the gravitational force of Sun causing the increase of the radii of planetary orbits and thus also of orbital periods. The rate for the increase of the orbital period is $d\log(T)/dt \equiv 1/\tau = -1/4 \times d\log(M_{Sun})/dt$. The rate of the solar mass loss is believed to be mostly due to the energy liberated in fusion, and one has in a good approximation $d\log(M)/dt = 10^{-13}/year$. This gives $T(t)/T(now) = \exp(t/\tau)$. The lengthening of year by one day requires a time $t \simeq \tau/365 \sim 10^{11}$ years, which is about one percent of the rough estimate for the lifetime of Sun, and of the same order of magnitude as the estimates for the time parameter called the recent age of the Universe. In fact, Sun is estimated to become a red giant within 7.5 billion years making life as we understand it impossible at Earth.

This would mean that futuro-terrestrials would correspond to $k = 10$ level of dark matter hierarchy which almost cosmological time span of long term memories.

This estimate is based on the neglect of perturbations caused by planets to each other's orbits. The multiple gravitational resonances between planets resulting, when the ratios of rotation or precession periods are integer valued, are a route to chaos (in the sense of complexity rather than randomness) in the planetary system. Since also Z^0 force is $1/r^2$ force, this hold true also when classical Z^0 force is taken into account. These resonances can affect dramatically orbital parameters. Numerical simulations lead to the conclusion that the Lyapunov time of planetary system is 5-10 million years [33]. If this holds true also in TGD Universe, then the parameter t for the future civilization for which year is one day longer than for us, could be as small as million years and of same order of magnitude as the first estimate giving $k = 8$ for the level of dark matter hierarchy characterizing futuro-terrestrials.

7.3.3 Conditions on high- T life

In the following some conditions on life at high temperatures are discussed on basis of the general vision about magnetic bodies as controllers of biological bodies discussed in the first part of the chapter [23].

Inherently dark atoms might allow the survival of chemical life at high temperatures

The model for crop formations was developed few years before the emergence of dark matter hierarchy and involved the notion of intra-terrestrial life.

Certainly the high- T life in form of plasmoids could exist but if one interprets Chilbolton and Crabwood messages as information about IT life or high- T life in Sun, Mars, and Jupiter, also chemical life should be possible and should resemble ours to a high degree.

1. First option

The only way out in the framework of the ordinary quantum mechanics is that the space-time sheets are virtually thermally isolated so that even in the interior of Earth space-time sheets with room temperature are possible. Also space-time sheets for which ELF frequencies correspond to energies above thermal threshold must be present to explain the correlation of EEG with consciousness. A further hypothesis was that the typical size of the space-time sheet corresponds to the de Broglie thermal wavelength $\lambda_{dB}(\hbar, T) = \sqrt{3\hbar}/\sqrt{2mT}$ for the typical particles involved. This would allow room temperature space-time sheets also in harsh environments like the interior of Earth. If thermal isolation fails then situation changes and space-time sheets with size larger than $\lambda_{dB}(\hbar, T)$ are not possible.

2. Second option

The discovery of dark matter hierarchy allows to give up the hypothesis about thermal isolation. If inherently dark atoms as r -fold M^4 -coverings of ordinary atoms and having essentially same energy spectrum are possible at k^{th} level of dark matter hierarchy ($\hbar(k) = r\hbar_0$), then also N -atoms and N -molecules become possible as discussed in the first part of this chapter [23]. Note that the formula for $\lambda_{dB}(\hbar, T)$ generalizes and predicts a dark hierarchy of thermal de-Broglie wavelengths.

There is also an additional constraint on the temperature. Quantum criticality plays a key role in TGD inspired quantum biology and since the energies of photons resulting in the transitions of N -particles are scaled up by N , one might argue that also the critical temperature at which intelligent life is possible (about 36-37 °C for ordinary life and understandable in terms of high T_c superconductivity [28, 27]) is simply scaled up by N in the first approximation. Certainly N -water would be required as well as N -DNA and N -aminoacids plus other biologically relevant N -molecules satisfying $N > T/T_{room}$. These molecules could perhaps give rise to a dark variant of ordinary life surviving at temperatures encountered in the Earth's interior.

Also ordinary life could involve N -DNA and N -aminoacids but in the interior of Earth the range of thermally stable values of N would be narrower unless the value of r is higher. The model for the replication of DNA and lock and key mechanism of bio-catalysis suggests that dark N -hydrogen atoms are most probably associated with hydrogen bonds.

How the integers characterizing N -bio-molecules in the Earth's interior should depend on the temperature?

Ordinary life is possible only in a very narrow temperature range around 37 K and as explained quantum criticality explains this [28, 27]. Dark matter inspired option for high- T life is based on replacement of Earthly bio-molecules with their N -variants with larger N so that one would have N -H₂O, N -DNA, N -proteins, etc. with $N/N_{room} > T/T_{room}$.

The critical temperature T_c around which life is possible would be scaled up to $T_c \rightarrow NT_c$ and the minimal value of N as a function of temperature would be given by $N_0 = [T/T_{room}]_+$, where $[x]_+$ is the smallest integer larger than x . In particular, this formula would determine the dependence of N_0 as a function of depth as one goes to interior of Earth. The space-time sheets of N -atoms would be $r \geq N$ -fold coverings of ordinary space-time sheets.

T increases by an order of magnitude from $T_0 = 300$ K to $T = 1300$ K at crust-mantle boundary to $T = 4000$ K at the mantle-core boundary, and to $T = 4600$ K at core-inner core boundary. This means

that also N does so that one would have $N/N_{room} = 40/3 \sim 13$ at the mantle-core boundary and $N/N_{room} \sim 15$ at core-inner core boundary. In principle, even temperatures up to $T = r/N_{room}) \times 300$ K would be possible.

There is evidence for solid structures in the mantle-core boundary [40] where most solids are thermally unstable. Due to the high pressure the interpretations in terms of standard physics are of course possible but one can also ask whether this evidence could be seen as evidence for dark matter structures consisting of N -molecules with $N > T/T_c$, where T_c is the melting temperature of ordinary molecule.

Conditions from the thermal stability of the analog of EEG

The analogs of EEG and its scaled up variants are in a fundamental role in the control of biological body by magnetic body and this should hold true also for ITs. According to the model of EEG resulting as a special case of the model for the fractal hierarchy of EEGs and its generalizations [20], the analog of EEG involves two components.

1. Cyclotron component

The first component corresponds to the harmonics of cyclotron frequencies of biologically important ions: many of them belong to the alpha band in the case of ordinary ions.

Since 10 Hz corresponds to a secondary p-adic time scale assignable to electron defining an inherent time scale of elementary particle in zero energy ontology, one can ask whether this frequency means breakdown of the fractality hypothesis and raises the frequency scale of ordinary EEG in special role. One can also wonder whether 10 Hz frequency could define a universal biorhythm.

Dark ions reside at magnetic flux sheets traversing DNA and cyclotron radiation affects directly DNA. Cyclotron frequencies are associated with motor control affecting directly DNA and inducing gene expression among other things. The models leads naturally to the introduction of the notions of super genome and hyper genome [20].

2. Josephson junction component

Josephson junctions assumed to be associated with cell membrane define second contribution to EEG as frequencies associated with coherent state of photons emitted by Josephson current. This component is present only if Josephson junctions, naturally assignable with a membrane like structure separating the plasmoid from environment, are present.

The frequencies are expressible as $f_{n,\pm} = nf_c \pm f_J$ and in the case of ordinary EEG alpha band and its harmonics split into counterparts of beta and theta band. Alpha band has scaled variant also in more general case and corresponds to ions which define alpha band for ordinary ions.

1. The essential condition is that cyclotron energy scale is above the thermal energy $E_{th} = 2.88T$ ($k_B = 1$ in the units used) . This fixes the minimal value of the integer k_d characterizing the level of dark matter hierarchy involved. For ordinary EEG frequency of order 1 Hz the minimal value of k_d is roughly $k_d = 44$. DNA cyclotron frequencies assuming that the charge of DNA is solely due to the phosphate groups PO_4^{2-} are around 1 Hz and just above the thermal threshold.
2. Second condition is that Josephson energy determined by the membrane voltage defines Josephson energy which is above thermal energy. This gives $Q_{em}eV \geq 2.88T$ for far from vacuum extremals. For almost vacuum extremals the classical Z^0 field proportional to the classical em field contributes to the coupling and one must replace the charge Q_{em} of charge carrier with effect em charge Q_{eff} [20]: this increases the scale of Josephson energies roughly by a factor 10. For far from vacuum extremals Josephson energies are near thermal energies whereas for almost vacuum extremals they are in visible and UV region, and one can identify biophotons and EEG photons as decay products of dark Josephson photons.
3. Superconductivity prevails only below some critical temperature whereas vacuum extremal property is expected to be possible only above some critical temperature. This suggests that cell membrane functions properly only in a narrow temperature range. The range 36-37 C is suggested by the fact that the effects of ELF em fields on vertebrate brain are observed only in this range.

Josephson frequency f_J is inversely proportional to \hbar and would scale in the case of EEG would scale as

$$f_J = \frac{T}{T_{room}} \times f_{J,room} ,$$

where $f_{J,room} \simeq 5$ Hz holds true. Alpha band and its harmonics and also the widths of theta and beta bands would scale like B . The positions of theta and beta bands would scale like temperature, and one would have the formula

$$f_{n,\pm} = \frac{B}{B_E} n f_c \pm \frac{T}{T_{room}} f_J$$

for the frequencies in the generalized beta and theta bands, when $k_d = 44$ holds true also in the high- T environment.

It is illustrative to consider some examples.

1. *Mantle-core boundary*

The temperature is $T = 4000$ K $\sim 13T_{room}$ at the mantle-core boundary. This temperature allows simple ordinary molecules like carbon monoxide and water (due to the high pressure). Thermal energy is still eV and below Josephson energy and super-conductivity is possible only if cyclotron energies are high enough. For 5 Hz cyclotron frequency $r = 47$ gives energy of order eV. One could thus consider the possibility that both the super-conductivity and criticality could be possible in scaled up temperature range.

2. *Sunspots*

The average temperature of the solar photosphere is about 5800 K whereas the minimum temperature is $T_{min} = 4000$ K and same as the temperature at mantle-core boundary. Inside sunspots the temperature varies in the range 3000-4800 K and sunspots, which are analogous to tornadoes, would be good candidates for the seats of solar life forms. Spectral analysis demonstrates the presence of water inside sunspots [37]. There is also evidence for a solid calcium ferrite surface at photosphere [34].

The value of the sunspot magnetic field is between 1600-2500 Gauss and thus cyclotron frequency is about 3200 – 5000 times higher than at the surface of Earth. Also in this case $k_d = 44$ level would correspond to thermally stable "EEG" photons with frequencies in the range of ordinary EEG.

De-Broglie temperature and the p-adic length scale of the space-time sheet

A rough estimate for the typical size of the space-time sheet for a system consisting of N -particles of mass $m = Am_p$, A mass number, at temperature T is obtained as the thermal de Broglie wave length $\lambda = \sqrt{3\hbar_0/\sqrt{2Am_p T}}$. Note that the estimate does not depend on N or $\hbar(k)$ for inherently dark atoms and is same as for ordinary atoms. This follows from the r -covering property alone of N -particles.

1. The hypothesis about the thermal de-Broglie wave length as a typical size of a stable space-time sheet would suggest that the ordinary hot matter (liquid quartz or iron) resides at the $k = 131$ space-time sheets.
2. For water with $A = A_w = 18$ at room temperature $T = 330$ K one has $\lambda \simeq .7$ Angstroms so that $k = 137$ is a reasonable identification for the p-adic prime characterizing the atomic space-time sheet in this case (note however that $L(137) = .78$ Angstroms is slightly above λ).

The p-adic length scale associated with λ changes at certain critical temperatures T coming as powers of 2 using a suitable unit and characteristic for a given atom. The critical values of temperature could define physically detectable boundary layers. The p-adic length scale $L(\lambda)$ is predicted to decrease by a factor of order $x = \sqrt{A_w/A} \times \sqrt{T_0/T}$. This factor should be near to the ratio $L(131)/L(137) = 1/8$ at the layer where $k = 131 \rightarrow k = 137$ transition occurs. For $A(Si) = 32$ resp. $A(Fe) = 56$ $k = 137 \rightarrow 131$ transition should occur at $T = 1524$ K below crust resp. $T = 871$ K inside crust.

The presence of $k = 131$ space-time sheets at the mantle-core boundary (and inside sunspots) would add to the metabolic repertoire strong metabolic energy quanta corresponding to the dropping of protons and electrons to larger space-time sheets from $k = 131$ space-time sheets. The quanta would be about 32 eV for protons and 64 keV for electrons. The hot environment would be an ideal provider of metabolic energy for high- T life-forms.

7.3.4 What IT life could look like?

Taking into account the almost identical properties of N -atoms and ordinary atoms, it might be better to transform the question "What IT life could look like?" can be replaced by "How IT life differs from the life in biosphere?".

Some arguments supporting IT life

The following arguments favor IT hypothesis.

1. Boundary layers are ideal places for self-organization since they contain gradients which give rise to energy currents feeding self-organization. Liquid state is certainly crucial for life since this makes it possible quantum control the atomic space-time sheets very effectively. Ordinary life relies actually on the liquid crystal property of water which suggests that the same is case quite generally. Thus those parts of the planetary core which correspond to boundary regions between solid and liquid phases, should be ideal places for IT life forms to flourish, and it is actually difficult to imagine any other state of matter making possible life able to control the surrounding world effectively. This picture is consistent with and would realize concretely the general vision about magnetosphere as a living system. In Earth's interior the mantle-core and core-inner core boundaries are especially interesting in this respect since these boundaries represent solid liquid boundaries. Recall also that N -DNA and N -aminoacids would be possible for $N > T/T_{room}$ by the previous argument.
2. According to the Chilbolton message, also silicon is an element involved with the alien DNA. Magnetized iron and SiO_2 (glass, quartz) balls of radius about 10-30 micro-meters are found from crop circles, and these elements must have been solidified from molten state in situ. The additional message of molten state for quartz and iron, besides providing information about plasmoids themselves, could be that it is planetary interiors, where the biological bodies of the life-forms responsible for the crop circles reside. Molten glass would be associated with the mantle-core boundary and molten iron with the core-inner core boundary. The small size of Sun could thus also mean that these life-forms receive much less solar radiation than us.
3. A further possibly important aspect is the transparency of the liquid state implying that visible light propagates over long distances without absorption. This might be absolutely essential for the possibility of visible photons to propagate through sufficiently long distances. For dark photons situation changes, and the transparency of liquid glass might be due the fact that some fraction of photons propagate as dark photons through it. Hence quartz is transparent in liquid state, and thus an optimal candidate for a medium whose behavior is quantum controlled from larger space-time sheets.

Structure of the Earth's interior and IT life

Combining the above described general ideas with the knowledge about Earth interior, one ends up with a more detailed picture.

1. Earth's interior decomposes into a relatively thin crust of thickness 30-60 km; a plastic mantle consisting mainly of Si, O, Mg, Fe, and Al mostly in form of silicates $FeO-SiO_2$ and $MgO-SiO_2$; a liquid core containing mainly Fe and S; and the inner core consisting mainly of solid Fe. There are thus two solid-liquid boundary regions. The upper boundary region could contain at least glass in liquid crystal form and the lower boundary region Fe in liquid crystal form. Remarkably, it is just glass and Fe solidified in situ, which are found from crop circles, and Crabwood message indeed contains two different genetic codes. Also silicon-based crystal structures not encountered in Nature are found from crop formations: the interpretation as artifacts suggests itself. The

richer chemical structure of the mantle is consistent with the hypothesis that the glassy life is based on 80 DNA-23 amino-acid code whereas iron-men correspond to 64 DNA- 20 amino-acid code.

2. Theoretically, the thickness for the mantle-core layer is expected to be of order few meters. The reflection of tectonic waves from mantle-core boundary has given evidence for a rich structure at this boundary and suggests that this expectation is not quite correct [40]. Structures of thickness about 150 meters and with of several kilometers and between liquid and solid state have been identified at the top of the liquid core. One explanation is that lighter elements in the core-inner core boundary saturate and condense to solid form and being lighter than iron, raise up and form kind of puddles at the highest points of core.

A more radical explanation is that these structures are artifacts built by ITs possibly consisting of thermally stable N -atoms and -molecules. In the mantle-core layer the velocity of tectonic waves gets ultra-low. The velocity of sound in solid phase is quite generally higher than in liquid phase: this reflects directly the fact that the approximately harmonic forces between atoms are stronger. If liquid crystal phase is present the velocity in transversal liquid directions should be low. What is fascinating that sooner or later the analysis of reflected tectonic waves could give detailed information about mantle-core boundary.

3. Quite recently it has been announced that Earth contains a previously unidentified core region with size of 300 km [39]. Assuming that the magnetic field behaves like a dipole field down to the distances of order 300 km, the electronic cyclotron frequency at this distance is 5 GHz which corresponds to the wave length of about 6 cm, the size scale of BOLs. If the magnetization density below this distance is constant (so that the core would be like ordinary magnet), the magnetic field would be constant below this length scale.

Also some other experimental findings support this picture. It has been found that the times for of the compressional waves to travel through Earth in magnetic north-south direction and equatorial direction differ by 2-3 seconds [41]. This suggests a gigantic crystal structure with symmetry axis parallel to magnetic field. If the join along boundaries condensate associated with atomic space-time sheets is hollow with a hole of radius 300 km, and if only $k = 151$ space-time sheet consisting of cold and magnetized iron is at this space-time sheet one can understand the crystal structure and how Earth's magnetic field results by magnetization. The estimated velocity of propagation for compressional waves in the crystal is about 3 km/s which is rather near to the 5 km/s for steel at room temperature. The appearance of a relatively small hole at the atomic space-time sheet is not so surprising since typically the field equations of TGD imply hole like singularities at given space-time sheet, and the hole could be analogous to black hole like singularity carrying inertial and gravitational masses at its boundary.

The simplest hypothesis is that the magnetic field associated with the plasmoids is the Earth's magnetic field or its dark variant in the core region of Earth. This would mean that some kind of life forms could reside also at the boundary layer associated with the new core. If the $k = 151$ space-time sheet is not ferromagnet above the radius $r = 300$ km, the boundary region could be in spin glass type magnetic phase and the bio-control from magnetic flux tubes would operate on the local direction of magnetization of the magnetized regions in the boundary region. Crabwood message could contain also a third genetic code consisting say 5+1+1+1 special symbols alone and coding 16 DNA doublets to 8 amino-acid. This simpler life-form might reside at the most inner boundary and be associated with the plasmoid like life forms.

What could the EEG and sensory representations of ITs look like?

If the sensory representations of IT life-forms are realized at the personal magnetic canvas and at magnetosphere in the same manner as ours, the cyclotron transitions at the distance of about

$$r_1(A) = (A/A_1)^{1/3} \times r_0 ,$$

giving

$$y(A, A_1) = (A/A_1)^{1/3} \times x .$$

Here $r_0 = xR$ is the radius associated with the life-form, and $r_1 = yR$ is the distance at which the sensory representation is realized. R denotes the radius of Earth and A the mass of the ion at r_0 associated with IT cyclotron transition and A_1 the mass of the ion at r_1 defining the cyclotron transitions associated with the sensory representation.

If the most important frequencies of alien EEG correspond to cyclotron frequencies, if aliens live at the mantle-core and core-inner core boundaries, and if the magnetic field inside Earth behaves as dipole field in a reasonable approximation, one can deduce the EEG frequency range of aliens by scaling the human frequency range by the ratio

$$x^{-3} = \left(\frac{R}{r}\right)^3 = \left[\frac{f_S(r)}{f_S(R)}\right]^3 ,$$

where r is the distance of the boundary region from the center of the Earth. The constraint that representation is realized in inner magnetosphere gives the bound $y \leq 6$ and the constraint that it is realized in ionosphere gives $y \simeq 1$.

1. Biosphere

In this case the basic equation is obtained by putting $x = 1$ in the general equation so that one has

$$y = \left(\frac{A}{A_1}\right)^{1/3} .$$

For protonic representations with $A_1 = 1$ possible in entire inner magnetosphere the constraint $y \leq 6$ allows all possible values of A .

2. Mantle-core boundary

For mantle-core boundary the ratio is roughly $x^{-3} = 7.1$ so that the EEG frequency range 1.5 – 90 Hz scales up to 107 – 639 Hz. Sensory representations can in this case be realized as ionic transitions in atmosphere. The basic equation is

$$y = \left(\frac{A}{A_1}\right)^{1/3} x ,$$

where A is the mass number of the ion in mantle-core boundary and A_1 is the mass number of representative ion. For protonic representation one has

$$y = 1.92A^{1/3} .$$

The condition $y \leq 6$ guarantees that representation is realized in the inner magnetosphere and gives $A \leq 27$. This corresponds in ordinary EEG to frequencies $f \geq 11$ Hz. For $A_1 > 1$ also scaled up variants of alpha and theta frequencies are representable: note however that the densities of these ions are probably much smaller than in ionosphere.

One can consider also ionospheric ion representations satisfying $y \simeq 1$ for mantle-core boundary. Now the mass numbers of the ions involved are related by

$$\frac{A}{A_1} \simeq x^{-3} \simeq 7.1 .$$

The biologically most interesting ions have $A > 7$ and are representable. One manner to realize this sensory representation is using cells or brains of various organisms and one might consider the possibility that we actually are life-forms which have developed as magnetospheric sensory representations of the life-forms at the mantle-core boundary.

3. Core-inner core boundary

For core-inner core boundary the ratio is roughly $x^{-3} = 263$ for $f_S(r) = 50$ Hz and $x^{-3} = 135$ for $f_S(r) = 40$ Hz. In this case only electronic sensory representations are possible and one has

$$y = \left(\frac{Am_p}{m_e}\right)^{1/3} x ,$$

1. For $x^{-3} = 263$ this gives

$$y \simeq 1.98 \times A^{1/3} .$$

The range $[1, 6]$ for y corresponds to the inner magnetosphere and the upper bound $A \leq 27$ and to scaled up variants of cyclotron frequencies above 11 Hz in ordinary EEG. Only beta and gamma bands would be represented.

2. For $x^{-3} = 135$

$$y \simeq 2.48 \times A^{1/3}$$

The upper bound for A is $A \leq 14$ and to the scaled up variants of cyclotron frequencies above ~ 20 Hz in ordinary EEG.

4. Inner core-most inner core boundary

The boundary of the most inner core of radius 300 km could also be carrier of life-forms, perhaps plasmoid like life-forms. The simplest hypothesis is that the magnetic field associated with the plasmoids is the Earth's magnetic field in the core region of Earth, which would be constant and of order .2 Tesla below this distance if dipole approximation makes sense.

If important EEG frequencies correspond to cyclotron frequencies, part of the EEG would be scaled up by a factor $2^{169-157} = 2^{12} \simeq 4000$ so that EEG frequency range .25 – 90 Hz would be mapped to 1 – 360 kHz. Ionic cyclotron frequencies would be in the MHz range with proton cyclotron frequency equal to 1.2 MHz. The cavity resonance frequency analogous to the lowest Schumann frequency for a structure with radius 300 km is 159 Hz.

If the sensory representations of IT life-forms possibly existing at at $r_0 = 300$ kilometers are realized as electronic cyclotron transitions one has

$$y \simeq .59 \times A^{1/3} .$$

Ions with $A \geq 6$ would be represented above Earth's surface. All ionic representations would be realized in Earth's interior.

What are the metabolic energy quanta of ITs?

ITs would share with us the basic quanta of metabolic energy which are .5 eV *resp.* 1 keV corresponding to the dropping of proton *resp.* electron from $k=137$ space-time sheet to the magnetic flux tube of the Earth's magnetic field.

If $k = 131$ corresponds to the hot space-time sheets at which liquid iron and quartz reside, the dropping of proton from the hot $k = 131$ space-time sheet would correspond to a much higher energy of about 32 eV able to ionize hydrogen atom. For electron the corresponding energy would be 64 keV. 32 eV energy quantum might play a role in the intelligent control of the hot iron or quartz from larger space-time sheets. Even some kind of liquid iron or quartz metabolism could be imagined.

Also heavier atomic nuclei can drop to larger space-time sheets from $k = 131$ space-time sheet. The zero point kinetic energy for a particle of mass number A at $k = 131$ space-time sheet is obtained from proton's zero point kinetic energy $E_p(137) \simeq .5$ eV by scaling $E_A(131) = 2^6 * E_p(137) \simeq 32/A$ eV. For mass numbers $A = 12, 14, 16, 32$ associated with N, C, O and Si which, according to Chilbolton message, appear in the DNA of aliens, this gives energies 2.7, 2.3, 2.0, 1.0 eV. These energies cover the wave length range for visible light. Obviously the dropping of ions from $k = 131$ space-time sheet to larger space-time sheets could explain the visible light generated by plasmoids and the generation of light at these frequencies might provide a possibility to get a contact with plasmoids. These energies would be in exactly the same role as the proton's zero point kinetic energy in the ordinary metabolism, which suggests that IT and also plasmoid metabolism involves also the energies besides those associated with our metabolism. Entire fractal hierarchy of energy currencies would be thus involved. If the sizes of $k = 131$ space-time sheets can vary so that the spectrum becomes effectively continuous, one can even consider the possibility that bio-photons are generated by the dropping of

atoms from $k = 131$ space-time sheets. The question is whether the propagation of a plasmoid like excitation at a temperature of order 3700 K along DNA double strand could generate bio-photons.

Dark micro-waves amplified by quartz crystals might be crucial for the metabolism of plasmoid life-forms and replace visible light serving as the "food" of the terrestrial life forms. Tectonic activity might be as important for these life-forms as solar radiation is for us. The crust and mantle could serve as amplifiers of em waves in a wide wave length range and make possible communications between IT and us.

7.3.5 Where did those 223 genes pop up?

The reports of the Public Consortium about human genome in Nature, Feb 15, 2001 [53] and of Celera Genomics in Science of Feb 16th, 2001, [54] contained two big surprises.

Are we really so near to fruit flies?

The first astonishing discovery was that the amount of human genome differs relatively little from those of lower organisms: we have only about 30,000 genes, little more than twice the number 13,601 of genes for fruit fly. This paradoxical finding forces to think that our genome is not solely responsible for what we are and that the intronic portion of DNA (only about 1 per cent codes of human DNA codes or amino-acid sequences), is not "junk DNA", but contains important biological information and expresses it non-chemically.

In TGD Universe introns would express memes as the classical field patterns associated with MEs ("topological light rays") responsible for the basic expressions of language understood in an extremely general sense. This language includes body language and even cellular signalling, and could quite well make possible (not necessarily conscious) interspecies communications based on memes expressed by communicating species and forming a common vocabulary. All eukaryotes (cells with nuclei), even bacteria, would possess part of the vocabulary of this universal language. The memetic code word is predicted to consist of a sequence of 21 DNA triplets and carries 126 bits of information instead of 6 bits of genetic code. Of course, also genes are expressed in terms of MEs and define a lower level language.

In this framework the actual role of DNA can be understood using the computer analogy. Memes represent the program modules written using the programming language defined by the memetic code, and realized in terms of the field patterns associated with MEs. Genes represent the necessary hardware needed to realize these programs. System builds only the hardware needed, that is cell expresses only part of the genome. DNA engineering requires besides the addition of the new programs (memes, introns) also the insertion of the necessary hardware (new genes). Memes and corresponding genes should have very intimate relationship. In this conceptual framework the standard view is wrong since it identifies the build-up of a new hardware as the sole activity at the DNA level. This would be like identifying the addition of a net card to a computer as the fundamental activity related with computers.

The head-scratching discovery

The "head-scratching discovery" by the public consortium, as Science termed it, came when the genome was compared with the genomes of our predecessors. It was found that human genome contains 223 genes not possessed by invertebrates. Contrary to what one might expect, these 223 genes could make an enormous difference. The reason is that this number is more than two thirds of the number of the 300 genes differentiating between humans and chimpanzees so that these genes could be the main determinant of the dramatic difference between humans and chimpanzees in standard genetics.

Of course, in TGD framework the most important differences would probably relate to the intronic portion of the DNA responsible for language. Dramatic differences between our intronic DNA that of our invertebrate and perhaps even vertebrate predecessors, in sharp conflict with the idea of continuous evolution, should be discovered.

Are the enigmatic genes a horizontal gene transfer from bacteria?

Biologists can explain the presence of the enigmatic genes only by a "rather recent horizontal transfer from bacteria". Here "rather recent" refers to the evolutionary time scale.

This explanation can be challenged on various grounds.

1. The simplest working hypothesis is that the transfer from bacteria is a probabilistic process. The problem is however why the horizontal transfer did not occur to the genomes of other vertebrates and invertebrates and gradually through the whole evolution. One could argue that something characteristic to the vertebrate genome should have made this process possible. In TGD framework one could imagine that the intronic portion of the vertebrate genome could have contained something which made the transfer possible: a common part of memone with the bacteria involved and making possible language based communications ("language" understood in a generalized sense) at DNA level perhaps?
2. The enigmatic genes are involved with important physiological functions. In particular, they are responsible for important neurological enzymes which stem from mitochondria having its own genome. According to my non-professional interpretation this statement means that also mitochondrial genome contains these enigmatic genes. Thus both mitochondrial and nuclear genomes would have been altered by this horizontal transfer from bacteria. Simultaneous double horizontal transfer does not however look a probable event.
3. Only 113 of the 223 enigmatic genes are widespread in bacteria: it would be easier to believe in the horizontal transfer if all of them were widespread. These 113 widely occurring genes are not encountered in invertebrates at all. As a matter fact, this finding suggests that the transfer occurred from the vertebrate genome to the bacterial one and only partially, rather than vice versa. The analysis of proteins expressed by the enigmatic genes demonstrated that out of 35 identified, only 10 had counterparts in other vertebrates. 25 of them were unique to humans. This suggests that a considerable part of the horizontal transfer has occurred relatively recently and together with associated introns might even distinguish us from chimpanzees.

Horizontal transfer as DNA engineering?

The objections against the horizontal transfer from bacteria force to consider seriously the possibility that the horizontal transfer represents an intentional DNA engineering, both memetic and genetic. The most important transfer should have been to the intronic part of the DNA. The addition of memes would be like adding a new program to a computer. The addition of genes would be like adding a new hardware (say net card or data cable) required by the program to run. The comparison of the intronic portions of DNA of humans and lower vertebrates might thus lead to further "head-scratching" discoveries. The data are consistent with the assumption that genetic/memetic engineering activities have occurred in several steps during the evolution of the vertebrates although a considerable portion of the enigmatic genes and associated introns, perhaps even two thirds, have been "injected as a single dose".

The evolution of the hominides in Africa had a stagnation period of about 1.5 million years as demonstrated by the study of the ancient stone tools. Then, for about 50 thousand years ago, a sudden jump to creativity occurred. The first ornaments appeared meaning that hominides had become artists and started to express their position in the social hierarchy by clothing and ornaments. This signals about development of highly refined social structures. A general belief is that also language began to develop rapidly and made possible a cumulation of knowledge. It seems that modern human was born and started to migrate from Africa to North. Could it be that memetic engineering induced this crucial step in evolution? Could it be that Neanderthals had to leave because they were not subject to this memetic engineering? Also the emergence of the first civilizations for about 10 thousand years ago might have involved memetic engineering. The ancient Sumerian myths about Gods who came from Heaven and made us their images might be memetic fossils reflecting what occurred.

Who performed the (memetic and) genetic engineering?

One can imagine two identifications for the ancient genetic/memetic engineers.

1. The guess that the engineers were extra-terrestrials (ETs) is supported by ancient myths. The Sumerian and Akkadian texts found inscribed on clay tablets, in which the role of the Elohim in Genesis is performed by the Anunnaki, tell about "Those Who From Heaven to Earth Came". According to Zecharia Sitchin these myths can be seen as narratives about genetic engineering by life-forms, which were technologically much more advanced. These myths would relate to the last step in the sequence of engineering activities.
2. The second guess, intra-terrestrials (ITs), is natural if one accepts the TGD based identification of the life-forms responsible for the art of crop formations as ITs. The term intra-planetary (IPs) is actually more appropriate: the Chilbolton crop formation, which obeyed the same format as the Arecibo message sent to the outer space and telling about our species, suggests that the life-forms responsible for the crop formations live in our own solar system and inhabit besides Earth also Mars and Jupiter. Taking the ancient mythologies seriously, IPs from Mars or Jupiter would be the most plausible candidates for the ancient memetic/genetic engineers.
3. The third guess, is that genetic engineering is due to a highly advanced civilization of a remote geometric future populating Earth, Mars, and Jupiter, and applying highly advanced technology based on time mirror mechanism and possibly utilizing simpler intra-terrestrial life forms, perhaps plasmoids, as their couriers. Abduction experiences might relate to genetic manipulations using plasmoids to do the hard job. In this case encounters with aliens would be based on sharing of mental images.
4. The fourth guess is that genetic engineering is self engineering. The work of Yu. Chen Kangeng gives evidence that the transfer of the genetic information by electromagnetic means is possible [65]. According to [56], where the method is summarized, the successful transfer of the genetic information from a donor bio-system to an acceptor system was achieved via high-frequency electromagnetic fields feed repeatedly through the optically-active donor bio-system and then delivered over a long period of time to the receiving bio-system in its early developmental stages. The hybrids created through the irradiation of eggs and seeds with such "genetically loaded" fields are claimed to show very specific mixed characteristics that were transferred to the next generation without need for further irradiation.

It would seem that the donor genome or parts of it are imprinted to the electromagnetic field pattern in the process and that this field pattern is able to modify the target genome.

Nothing precludes the possibility that genes/supergenes/hyper genes at some level of dark matter hierarchy can also code for genetic self engineering since these activities are after all very similar to other genetically coded bio-chemical activities. The computer analogy would be programs writing programs. The engineering genes would be activated by W MEs inducing plasma oscillation patterns. The claimed effects could be understood if the interaction with genetically imprinted electromagnetic field pattern activates genes inducing genetic self engineering yielding the genetic modifications consistent with the pattern represented by the em radiation.

Magnetic body would receive information about the desired outcome as electromagnetic field patterns emitted by other organisms, most naturally members of the same species. If these modifications are successful, the magnetic body is exposed to this information for long enough time to react and activate W MEs inducing the genetic program inducing the genetic program leading to the suggested genetic modification.

Hyper-genes integrating groups of organisms to larger wholes would be naturally involved with the mechanism. This mechanism would guarantee a rapid propagation of successful genetic modifications to the entire population and would be much more effective than the slowly occurring selection of random mutations. The possibly existing genes responsible for the genetic self engineering could be also introns and express themselves by activating nuclear RNA and process like reverse transcription.

A further quite recent mystery discussed in [30] is that corals seem to possess genes responsible for higher level psychological functions in mammals [58]: it is very difficult to understand this as an outcome of selective pressures combined with random mutations. The proposed mechanism might explain these genes as a result of genetic engineering.

During the early developmental stages the genome might be plastic enough to allow genetic self engineering. The genetic modification during this period also the most rational option since this gives the best guarantee that the modifications are transferred to the offspring.

Is genetic/memetic engineering an ongoing process?

Irrespective of whether IPs are the active genetic engineers or only realized the intentions of the civilization of geometric future, the memetic/genetic engineering by ITs or even IPs from other planets might be an ongoing process. This is consistent with the idea that also other vertebrates than humans might have been a target of genetic/memetic engineering. The following arguments, which restate what has been already said elsewhere in this chapter, support this view.

1. The seeds from crop circle formations have been reported to have better germination and growth properties, and it has been proposed that this is due to genetic and/or memetic engineering.
2. There exists a rare form of RNA for which the role of RNA triplet as the code word is taken by RNA doublet. We have in our immune system so called interferon-RNAase L system against this RNA. Does this mean that we have been in contact with this form of RNA, or even life-forms for which this form of RNA carries genetic information? On the other hand, the model of the genetic code inspired by the Chilbolton and Crabwood crop formations and by the symmetries of the genetic code, leads to the conclusion that RNA triplets responsible for our genetic code have resulted in a fusion of RNA doublets and RNA singlets. If this is the case, the ability of immune system to produce RNAase L would be natural.
3. Some persons who have reported abduction experience remain ill with a chronic fatigue and their immune system has been reported to contain high levels of RNAase L, as if they had been in contact with an exotic life form.

A possible TGD inspired identification for the primitive life form with RNA consisting of sequences of exotic RNA doublets would be as a plasmoid, plasma ball, serving as an intelligent quantum medium making possible telepathic communication with IPs by the sharing of mental images. Telepathy might be the only reasonable means of communications since a direct physical contact between highly life forms and us would probably be a catastrophic event. The reason is that the immune system of both ours and of higher life forms would be powerless against invaders obeying different genetic code. The stories about intelligently behaving light balls are indeed the basic stuff of UFO reports. Balls of light have been reported to appear also around crop formations and there is even a report about ball of light caught in an act of constructing a crop formation.

7.3.6 Do Ts and ITs live in symbiosis?

IT hypothesis conforms with the age old beliefs about shamanic state as a travel to the interior of Earth. Shamanic state would involve quantum entanglement with IT life forms and sharing of their mental images. One can even imagine that magnetic bodies control several biological bodies, say ordinary biological body and IT body giving rise to a kind of superego-ego-id trinity. In the sequel some aspects of this hypothesis are discussed.

How Ts and ITs could communicate?

Ts and ITs could interact via several mechanisms.

1. Communication via sensory representations would mean that for instance our magnetic bodies receive generalized EEG emanating from the biological bodies of ITs and in this manner experiences what it is to be IT. Reception would mean generation of cyclotron transitions. A model for the sensory representations of ITs have been already discussed. Since the cyclotron frequency scales and Josephson frequencies of ITs would differ from ours, positions and widths of EEG bands would be different and if the signal is received it is received by different portions of our magnetic body. For instance, for mantle-core ITs positions and widths of alpha band and its harmonics would be scaled up by $B/B_E \sim 7$ and positions of beta and theta band relative to alpha band would be scaled up by $T/T_{room} \sim 13$.
2. Telepathic communications involving sharing of mental images of ITs by us could be considered. This would mean that our magnetic body entangles with the "brain" of IT or vice versa by W MEs. This mechanism would allow also to realize remote motor control of IT (our) biological

body by generating dark plasma wave patterns by exotic ionization. If ITs correspond to N -atoms with different value of N there are restrictions on this communication mode.

One can imagine several mechanisms of telepathic communications between Ts and ITs.

1. The first mechanism is based on pairs of dark ELF MEs and micro-wave MEs such that microwave MEs propagate like particles inside ELF MEs acting as wave guides and define patterned pulses of duration not much longer than $T = 1/f$. For these representations the amplification of micro-wave MEs by piezo-electric quartz crystals in crust and mantle could be involved. Piezo-electricity is basic characteristic of also ordinary life. Microwave hearing for which a concrete model is discussed in [18], provides a concrete example about this kind of communication: in this case microwave carrier frequency is modulated by audible frequencies. The discrete version of the modulation would be the presence of microwave ME of varying duration or its absence.
2. The second communication mechanism would use pairs of radio wave MEs and MEs at the frequency range of visible light.
3. IT sensory representations generated by ionic cyclotron transition at mantle-core boundary can be realized using lighter ions at the surface of Earth: these ions could belong to our body or brain. Light ions in core-inner core boundary correspond to the frequencies of electronic cyclotron transitions at MHz range at the surface of Earth and provide a mechanism of communications based on active generation of mental images at our end of the communication line.

Microwaves modulated by MHz frequencies are involved with Priore's machine [52] and the findings of Sue Benford about intentional generation of dots and tracks on photographic emulsions [60]: the models are discussed in [18]. Egyptian pyramids have a size scale which corresponds to MHz frequency scale: one can wonder whether these pyramids could have served as amplifiers making possible communications between humans and ITs or between humans and future civilization?

1. *ELF-micro-wave communications*

ELF-micro-wave communications could involve ELF MEs containing micro-wave MEs and coupling to Schumann resonances. Micro-wave MEs would in turn be amplified by quartz crystals.

Quartz crystals are piezo-electrics and ideal for transforming em waves to lattice oscillations and vice versa, and thus also for amplifying em waves. The frequency range of lattice oscillations has the cutoff frequency $f_c = v/a$, v the velocity of sound in crystal and a the lattice constant. For $v = x$ km/s this gives $f_c = 10^4 \times x$ GHz, which corresponds to infrared photon wave length $10/x$ micro-meters, so that micro-waves belong to the amplified range. The sizes of connected quartz crystals are bound from below and for the size of order 5 micro-meters, the frequency is about $.2 \times x$ GHz, so that the length scale range between $.3 \times x - 5 \times x$ micro-meters covers the frequency range $.2 - 3$ GHz involved with the micro-wave hearing. At room temperature the values of the longitudinal and transversal velocities of sound in quartz correspond to $x_L \simeq 2.7$ and $x_T \simeq 2.0$ for the density for which SiO_2 molecule corresponds to lattice cell with side .1 nm.

Micro-waves are the key controllers of the homeostasis, and quartz crystals could serve as amplifying mediums making possible remote self-organization induced by friendly ITs in the bodies of Ts and based on micro-wave MEs amplified by quartz crystals and propagating along ELF MEs. Shamanic healing could involve this kind of remote self-organization. Thus the old belief that quartz crystals have positive effects on health could have justification.

The correlation between tectonic activity and Schumann resonances on one hand and various altered states of consciousness on the other hand, in particular UFO and ET experiences, could be seen as an evidence for communications with ITs. That micro-waves generated by protein/DNA conformational transitions and rotational transitions of water molecules and their clusters seem to be so important for biological life, might relate to several facts: that quartz crystals in the size scale range defined by cell size amplify them, that they might serve as the "food" of the IT life forms and induce self-organization of T life forms, and that they are involved with the communications between IT and T life forms.

2. *Radio waves and visible light*

Interestingly, kHz frequency, which is the fundamental frequency of terrestrial life (frequency of neuronal synchrony, the time scale of nerve pulse, frequency involved with Kirlian imaging), correspond

to a length scale $r = 3 \times 10^5$ meters. Interestingly, this is nothing but the radius of recently found new core region of Earth, at which Earth's magnetic field corresponds to .2 Tesla important for the plasmoid like life forms. This might be a pure accident but might have some deeper meaning too.

For quartz crystals kHz frequency would require a structure of size x meters using the parametrization $v = x$ km/s for the velocity of sound in quartz. $x = 3.2$ would mean a reasonable size. The thickness of the mantle-core boundary layer is measured in meters so that this layer might contain the needed large quartz crystals. Note that the velocity of sound is inversely proportional to the square root of density so that x is smaller near the mantle-core boundary and thus also the size of the required structures. For 2 cm sized quartz crystal the frequency would be near electron cyclotron frequency in $B_{end} = 2B_E/5$ (this is the magnetic field explaining the effects of ELF em radiation in vertebrate brains and might be identified as a dark companion of the Earth's magnetic field).

According to the general model of remote mental interactions ("remote" is actually a very relativistic notion), these radio wave MEs should contain visible light MEs propagating like mass-less particles inside them and induce self-organization at the receiving end. The question is whether Ts routinely communicate with ITs using kHz radio wave MEs, and whether the neuronal synchrony is a signature of this communication. One can also ask whether terrestrial life could in this manner serve as a source of visible light for IT life in absence of a direct solar radiation. If so, there could be a symbiosis between these life forms and we would be only be at the verge of becoming conscious about this symbiosis.

3. Observations about resonance frequencies

One can imagine several resonances possibly relevant for T-IT communications and interactions.

1. The space-time sheet associated with the 20-70 km thick layer defined by the Earth's crust allows cavity resonances just as the 100 km thick layer between the Earth's surface and the lower edge of ionosphere does.
 - i) For the first type of resonances the wave is essentially constant in the radial direction and effectively 2-dimensional: these radial resonances are different from Schumann resonances. For ionosphere the lowest resonance frequency of this kind would be $\simeq 10$ Hz. For the crust space-time sheet the lowest frequency would vary in the range 16.7 – 33.4 Hz.
 - ii) There are also radial resonances analogous to waves in box in the radial direction. For these resonances the varying thickness $d = 20 - 70$ km of the crust would correspond to range of frequencies $f = c/d = 4 - 15$ kHz for radial resonances. The strange 5 kHz sound reported near the crop formations corresponds to the thickness 60 km for the thickness of the crust, and one can wonder whether it also serves as a hint. What is interesting is that the time taken for this kind of radial wave to travel the distance 90+90+60 km from Earth's surface to the ionosphere and back down to the lower boundary of crust corresponds to a time interval which is quite near to the duration $T = 1/1260$ of the bit of the memetic codon.
2. A further interesting finding is that for $d = 2900$ km corresponding to the thickness of the mantle, the frequency of the radial waves is $f_{max} = c/d \simeq 103$ Hz. Hence EEG frequencies correspond to distances larger than the vertical distance to the mantle-core boundary. Of course, the waves need not be purely vertical and this means that waves propagating to the mantle span the range $f_{max} \times [1/\sqrt{1 + 2R/d}, 1]$. The lower bound corresponds to 44.4 Hz slightly above the thalamocortical resonance band.
3. Interestingly, the so called taos hum [51] (which I also personally experience now and then) discussed in detail in [24] has its fundamental frequency around 80 Hz. Taos hum begins at the sunset and ends at the sunrise, and correlates strongly with the micro-wave static which on basis of its complexity is believed to have a biological origin although to my best but unprofessional knowledge no detailed identification of the source of the static has been suggested. Could it be that the micro-wave static arrives along vertical MEs connecting Earth's surface with the mantle-core boundary? Micro-wave radiation would be naturally modulated by the 80 Hz resonance frequency and its harmonics and would generate taos hum by the same mechanism as in the case of micro-wave hearing [57].

Could taos hum be generated by IT life-forms and is it meant to compensate for the loss of the micro-wave radiation coming during daytime from Sun? This would conform with the idea of fractal

metabolism involving in an essential manner also micro-wave photons at special frequencies inducing ion flows between space-time sheets, say micro-wave photons at wave length of about 25 cm (6 cm) kicking protons from the magnetic flux tubes of the $B_{end} = .2$ Gauss to $k = 151$ ($k = 149$) space-time sheets.

Paramagnetic rocks, bio-photons, and ITs

Dr. Phil Callahan has made fundamental contributions to the understanding of insect olfaction as infrared vision, and his findings have been of great help in developing quantum model for sensory receptors and sensory organs. The work of Callahan relating to paramagnetic rocks might have non-trivial connection with IT hypothesis.

1. Callahan's findings about paramagnetism

Dr. Phil Callahan has found that the presence of paramagnetic rocks (say granite and basalt: quartz crystals basically) in a combination with a compost and micro-bes facilitate dramatically the growth of plants [48]. Why paramagnetic rocks are important is that their magnetic field is not fixed as in case of ferromagnets but varies with the external magnetic field and amplifies it. For instance, Schumann contribution to the magnetic field could be amplified. The flux tubes of the amplified magnetic field could also originate from the interior of Earth. Paramagnetically optimal rocks contain magma from volcanic eruptions and thus originating from the region where IT life forms are predicted to exist. Could it be that this material quantum entangles the plants via volcanic material with the ITs and makes communications possible?

Paramagnetism seems to be important for humans too. Callahan has carried out extensive measurements of the level of paramagnetism (presumably defined by the value of magnetic field in the soil) all around the world, and found that the soil in sacred places tends to be more paramagnetic than elsewhere. On basis of his measurements Callahan also reports that the intensity of the oscillating Schumann resonance part of the Earth's magnetic field correlates with the paramagnetic level of the soil. This looks natural since paramagnets amplify the oscillations of the Earth's magnetic field and possibly also those of its dark variant.

Furthermore, on basis of his measurements carried out around Earth Callahan concludes that the Schumann contribution to the Earth's magnetic field is abnormally weak in places where a lot of violence occurs. This kind of correlation is not surprising if magnetosphere, in particular its dark counterpart $B_{end} = 2B_E/5$ is a living system interacting strongly with biosphere. In TGD framework Schumann resonances mediate horizontal communications between personal magnetic bodies, whose magnetic tubes might reside inside magnetic flux tubes of the Earth's magnetic field or its dark companion B_{end} . Thus abnormally low intensity of Schumann contribution would weaken the horizontal communications and in turn lead to a weakening of the collective consciousness. Sacred places would in turn be places where horizontal communications are strongest due to the strong Schumann resonance contribution.

2. Bio-photons and paramagnetism: could IT see with phase conjugate laser light?

Callahan has also found that paramagnetic rocks generate bio-photons received by the roots of plants which he believes to act as wave guides. Bio-photons could serve communication purpose. Perhaps ITs communicate using memetic code realized as modulations of the bio-photon beam. This would be consistent with the earlier suggestion that visible MEs propagating along MEs corresponding to frequencies of order kHz are key element of IT-biosphere communication. Quartz crystals with size slightly below micro-meter (cell size) would be ideal for generating the bio-photons. The depth of the cavity below ionosphere is about $d = 80 - 100$ km whereas the thickness of the space-time sheet associated with the Earth's crust is $d = 30 - 60$ km. The time taken by a photon to traverse 100 km distance forth and back is .67 ms very near to the duration of the bit of the memetic codon. Memetic codewords represented as sequences of bits represented by the presence of absence of this kind of back-forth reflected ray might be transformed by quartz crystals to signals propagating to the interior of Earth.

Also negative energy bio-photons analogous to phase conjugate laser beams could be involved. Feinberg has demonstrated that phase conjugate laser beams allow to see the target through say chicken [32]. The reason is that negative energy photons have energies with magnitude larger than thermal energy, and cannot not be "absorbed" (in this case absorber drops to lower energy state)

except resonantly, say when they induce droppings of ions of living matter to larger space-time sheets. This makes this communication mode extremely selective.

Negative energy bio-photons would quite literally allow the ITs to see through the rock. Either ITs could provide energy for biosphere (as suggested by Callahan's findings) or biosphere could feed ITs. The high temperature of the Earth's interior would suggest that it we who receive the energy, and ITs who receive the sensory information about the world above Earth's biosphere!

DNA, hallucinogens, shamans, Freud, and myths of Christianity

Peter Gariaev [55] has found that the irradiation of DNA by laser light generates radio waves below kHz, and Fritz Popp [59] has discovered that DNA emits bio-photons with wave lengths in the visible wave length range. Both findings fit with the hypothesis that these telepathic communications occur at DNA level.

In his book "Cosmic Serpent" Jeremy Narby [63] takes seriously the stories of the shamans about travels under Earth during trance, and the myth that spirits have taught to the people of forests their surprisingly profound wisdom about medicinal plants and skills like weaving and spinning. Narby proposes that snake and double snake encountered universally in the shamanic mythology is a symbol for DNA. He even suggests that DNA and also visible light and radio waves are somehow involved with the telepathic communications during the shamanic trance but does not make guesses about the other participant of these communications.

Besides its extreme complexity and "reality", the objectivity of the experience supports the view that these experiences are much more than reactions to neuro-physiological disorders caused by drugs. Random input from the brains stem defining a starting point pattern completed by cortex to a sensible experience, was also the earlier view about the origin of dreams but has been given up now. Narby tells about collective experiences in which several participants had same experience, one participant continuing to tell about what he saw, when other participant ceased. The creatures encountered in shamanic experiences, in particular snakes, are same in all cultures. Snakes are seen by shamans even in areas, where snakes are not encountered.

If the communications are based on entanglement at DNA level, one has hopes of understanding the role of various hallucinogens in generating this kind of experiences. Perhaps some neurotransmitters and information molecules, while binding to the neuronal receptors, become molecular mediums entangling us with ITs. Hallucinogens could have more or less permanent entanglement with the IT life forms. Hallucinogens reduce inhibition in brain and this suggests that the role of the inhibition is to de-entangle and thus give rise to modern subjective consciousness in which the sharing of mental images is minimized and the organism behaves highly individually.

Shamans tell that the spirits have very human weaknesses: for instance, they like tobacco more than anything else. Nicotin affects like a neurotransmitter, and also our brains like tobacco. If the ITs share the experiences produced by tobacco smoking, it is easy to understand how sprits can become remote tobacco addicts.

"The mother of a tobacco is a snake" is the title of a chapter in the book of Narby. Collective consciousness associated with the DNA in biosphere and below it could be the mother of tobacco and also the cosmic serpent believed to be the creator of all life-forms. The genetic codes of aliens, to be deduced later from the Crabwood message, encourage to think that ITs are at a higher evolutionary level than us. The myths according to which these spirits created also the life as we see it support the same conclusion. Perhaps IT life forms have actively guided the evolution of life-forms at the surface of Earth, and are doing it right now, and are in this sense creators of life-forms in biosphere. An active genetic manipulation of crops might be occurring in the crop formation areas. Remarkably, some women who have had abduction experiences claim that a cross breeding with aliens is involved with the fetus somehow taken away after some time.

On basis of his lifelong experimentation with certain hallucinogens Terence McKenna [67], one of the initiators of quantum consciousness movement at eighties, states that there are myriads of exotic life-forms just here, there is no need to travel to the outer space. In a description of tryptamine induced experiences McKenna says "First of all (and why, I don't know) you have the impression that you are underground - far underground - you can't say why, but there's just this feeling of immense weight above you but you're in a large space, a vaulted dome...".

Freud has given a modern formulation for ancient myths in terms of the trinity of super-ego, ego, and id. Magnetic body and higher magnetospheric levels of consciousness would represent the

super-ego, physical body the ego, and id would correspond to the IT life-forms, all in a continual telepathic communication with each other. Also the shamanic tradition includes the spirits in the sky to their word order. In Finnish language 'Manala', the place where the dead continue to live and where also shamans visit, means 'under ground'. Perhaps the tradition of burying the dead relates to the intuitive idea that dead in some sense continue to live under ground. The Christian myths of holy trinity, of heaven-earthly life-hell trinity, and of ultimate salvation could also reflect the trinity of consciousness and anticipate the inevitable breakthrough of consciousness in which these three levels of self hierarchy become fully conscious of each other.

Model for the sensory representations and magnetospheric id-ego-super ego trinity

The model for the sensory representations requires a comprehensive view about the structure of the personal magnetic body and its relationship to the Earth's magnetosphere. One can make only tentative guesses in this respect but quite general arguments lead to a picture supporting the magnetospheric id-ego-super ego trinity.

1. The personal magnetic body interacts with the external world, in particular, with the Earth's magnetic field and its dark variant and with the solar wind carried by the solar magnetic field. Hence the idea about personal magnetic body as a structure analogous to the Earth's magnetosphere is worth of testing. Personal magnetosphere could decompose into a part moving with the physical body and analogous to the inner magnetosphere, and a stationary, highly stretched, part analogous to the outer magnetosphere at the night side of Earth. Earth's magnetosphere-solar magnetic field interaction would be replaced by personal magnetosphere-Earth's magnetosphere interaction.

There are reasons to believe that one must distinguish between dark magnetic magnetic fields and ordinary ones and that dark magnetic fields are those which are most relevant ones for living systems. $B_{end} = 2B_E/5$ would be the basic example of a dark magnetic field playing a key role in living matter. What dark space-time sheets with Planck constant not equal to the normal could really be is discussed in detail in [16].

2. Solar wind would enclose the personal magnetic body inside the Earth's magnetosphere, whereas the interaction with the flux tubes of the Earth's magnetic field could force the flux tubes of the personal magnetic body to be more or less parallel to them. Incoherent summation of the personal and terrestrial magnetic fields, fractality, plus the fact that the field strengths associated with the flux tubes of the personal magnetic body should decrease much slower with the distance from Earth's surface than those of the Earth's magnetic field, are consistent the possibility that the flux tubes of the personal magnetic body reside inside the magnetic flux tubes of the Earth's magnetic field in far-away regions.
3. The highly self-organizing plasma sheet at the equatorial plane at the night side of the Earth's outer magnetosphere is an especially interesting structure as far as personal and magnetospheric sensory representations are considered. For the fractal option the plasma sheet of the Earth's magnetosphere would contain plasma sheets inside plasma sheets, in particular the plasma sheets associated with the personal magnetic bodies. Personal and magnetospheric sensory representations would correspond to different levels of the same fractal structure.
4. Also the intra-terrestrial part of the Earth's magnetosphere is important for the magnetospheric sensory representations and, if the fractality hypothesis holds true, also for the personal ones. The strange co-incidences of important cavity resonance frequencies of intra-terrestrial structures with EEG resonance frequencies, and the fractal correspondence between the architectures of brain and magnetosphere (discussed in [24]) support the view that personal magnetic body extends also to the interior of Earth. The flux tubes of the Earth's magnetic field (with field strength increasing faster than for the flux tubes of the personal magnetic body) would be however contained *inside* those of the personal magnetic body in this region. The intra-terrestrial consciousness would therefore represent sub-...selves of ours, something analogous to Id whereas magnetospheric sensory representations would correspond to the super ego. This interpretation conforms with the proposal that intra-terrestrial life forms are possible in the many-sheeted space-time, and that crop circle formations could be interpreted as attempts of ITs to communicate about their existence.

5. Probably it makes sense to speak about Z^0 magnetosphere (both solar and terrestrial). Z^0 magnetic flux tube structures are crucial for the model of long term memories [25], and the sizes of the flux tube structures associated with the personal Z^0 magnetic body should be measured in light years. This suggests that also much weaker personal magnetic and Z^0 magnetic fields with the lengths of the closed flux tubes measured in light years are relevant.

Connection with the general view about life cycle of self

By the fractality of consciousness the anatomy of quantum jump represents the general structure of the life cycle of any self. First totally entangled multi-verse is generated, then state function reduction and preparation by self measurements occur and the end result is a maximally un-entangled state. This is what analysis following the birth of an intuitive idea is. By the fractality of consciousness same process occurs also in longer time scales since the sequences of quantum jumps effectively integrate to single quantum jump and the sequences of these effective quantum jumps have similar structure.

What is tragic is that the evolution of self at any level is also a decay process leading to alienation and loneliness at the level of conscious experience of sub-selves. What is consoling is that selves can lose consciousness and wake-up into new childhood. One can say that a healing sleep after a hard day is possible at all levels of self hierarchy.

Also ancient myths inspire to think that this vision applies to the evolution of modern subjective consciousness from more collective consciousness. Jaynes has proposed a vision about how bicameral consciousness [69], in which the voices of Gods talking to people were talking to everyone, gradually transformed to the modern subjective consciousness. TGD based articulation of Jaynes's views based on the notion of semi-trance is discussed in the last chapters of this book written much before these lines were written.

The basic theme of this evolution is the gradual de-entanglement. The ancient world has survived in fairy tales. In this world remote mental interactions like telepathy, remote healing, and witchcraft were every-day life. Incredible-to-us physical feats like building of pyramids might have been made possible by the liberation of energy and coherent momentum in the formation of collective bound state entanglement. The rhythmic work songs helping to generate body synchrony are a remnant from this period, but are not sung in modern IT companies. Also the strange intra-terrestrial creatures and spirits of magnetosphere; fairies, trolls, eagle-headed humans, dreadful snakes,..., populated this world. Shamans tell completely seriously to the anthropologists about these creatures without any doubt about their reality. The human sacrifices for Gods, which look extremely cruel to us, were not experienced as such since these people were not individuals with ambitious plans for a lifelong career.

This development has a parallel at the level of personal life. Fairy tales are told to children, who themselves are living the period of oneness. Then these children grow, become more and more rational and analytic. They lose their ability to make choices and there is not much to choose anymore, and become often also lonely and separated. Gradual physical decay adds its own flavor to this process.

The entire evolution can be seen as wake-ups or re-births, bursts of potentialities from which only few are selected during gradual de-entanglement accompanying self-organization, with dissipation serving as the Darwinian selector. Huxley's view about brain as a filter makes sense: our brains minimize the sharing of mental images, which does not aid controlled behavior and survival, and thus make us modern individuals.

Inhibition by various neurotransmitters is a good candidate for a measure for the degree of de-entanglement. Inhibition acts as the filter, which de-entangles the brain from other brains and the body from the bodies of other life forms. During hallucinatory experiences, generated by say drugs, inhibition "fails". The degree of inhibition indeed increases, as one climbs along evolutionary tree and in human brain most of the neural activity is inhibition, a rather strange finding difficult to understand in the framework of the ordinary neuroscience.

In accordance with ontogeny recapitulates phylogeny principle, this evolution is seen as an increasing dominance of inhibition during the development of individual leading from spontaneous children to well-behaved and highly controlled adults. Only in some periods of life inhibition fails: during puberty, in physical death and in great turning points of life. Indeed, puberty and physical death are sometimes accompanied by poltergeist phenomena. Physical death also by telepathic phenomena. I experienced telepathic contacts and remote sensory experiences during my great experience. The anthropologist reporting his experience induced by ayahuasca in the book of Narby [63] tells that the strange creatures that he met told him that usually they are seen only by people who are dying.

This speculative picture could be tested. One could find whether some drugs could enhance telepathic and psycho-kinetic abilities. The "blessed are the meek since they quantum entangle" prediction could be also tested. Indeed, one of the most dramatic experiments supporting psychokinesis was done using chicken which imprinted to a robot [66]. The robot, whose behavior was programmed earlier by random number generator, tended to stay near the chicken, as if chicken had induced a quantum jumps changing the geometric past in macro-temporal time scales. Also the mysterious ability of birds and fishes to migrate back to their birth places might actually involve quantum entanglement.

Also magnetospheric selves have their own life cycle. As a matter fact, we should be living highly interesting times now. There is a compelling evidence suggesting that pole reversal has already started and occurs during next millenia [68]. This would perhaps mean a period of sleep for the magnetospheric self followed by a wake-up to a new magnetospheric day. If the proposed general vision is correct, this could have enormous consequences for the character of the magnetospheric collective consciousness. We might be approaching the end of the period of individualization and the decay of the collective consciousness and have hopes about a new collective period.

The myth of salvation might be interpreted as this kind of wake-up of magnetospheric selves after un-conscious period. Note that also magnetospheric selves have geometries memories from the earlier wake-up periods so that dramatic loss of information about past would not be involved. The Omega Point of Teilhardt de Chardin is different articulation of the salvation myth. The rebirth of the magnetospheric selves would presumably mean a conscious sharing of mental images between the various layers of self-hierarchy including ITs, ourselves and magnetospheric selves. At least we have some hopes that the modern "global" market economy is not the final outcome of the human evolution.

7.3.7 Some questions

Unpleasant questions help to clarify thoughts and to see the weak points of the thought constructs.

Why crop circles?

The basic goal of aliens is to get us to realize that they are there and that they are receiving information about us. The task is to wake up us from our anthropocentrism and only "miracles" could wake-up us.

Aliens could send radio waves but no one would take seriously a radio amateur telling about messages from aliens. As a matter fact, they might be trying also this: so called electronic voice phenomena (EVP) involve often radio waves ([64], see also [22]). In some cases the senders of the messages are believed to be physically deceased persons. Very few professional scientists take EVP seriously. UFOs could be also as an attempt to tell to us about the presence of other life-forms but academic community, which is the natural target group, has filtered UFOs from its public consciousness. By their subjective character UFO observations and encounters with aliens can be also claimed to be just hallucinations or hoax. UFOs are also problematic because apart from very few exceptions [67] they are interpreted as being of extraterrestrial origin. Crop circles might be a more successful attempt since they are static formation and anyone can see them.

The only reasonable strategy for higher life forms to communicate about their existence is to maximize "miracles" and the basic means to communicate is by inducing supra current leakage from their space-time sheets, or space-time sheets that they can control, to our space-time sheets.

1. Using the format of Arecibo message for a crop circle is an ingenious choice. It immediately tells what the message is about; that it cannot be a "natural" phenomenon; and that the senders cannot be at a distance larger than a couple of light decades. All this together with the content of message leaves only the interpretation that they are really here.
2. The small glass and magnetic iron particles and magnetic iron around crop stems are an equally ingenious manner to tell both that the formations are neither "natural" phenomena nor hoax; that mantle-core and core-inner core boundary layers are the places, where the aliens might live; and that alien life forms control liquid glass and iron at atomic space-time sheets. Also the observed artifact like silica crystals suggest the presence of a conscious IT intelligence. Various silicates such as MgO/FeO-SiO₂ dominate in the mantle of the Earth. As will be found in the next chapter devoted to the pre-biotic evolution, crop circles could be also interpreted as giving

information about the evolution of life at Earth. Earth consists mostly of ancient meteorites known as chondrites, and carbonaceous chondrites are known to contain organic molecules. Thus IT life might have developed from these molecules in the womb of Mother Gaia and messages might try to tell also about this. Continuing the fractal metaphor, the bio-molecules in meteorites from outer space would take the role of the sperm as in panspermia theory.

3. The micro-wave induced explosions in growth nodes are a further manner to tell the serious researcher that hoax cannot be in question and that micro-waves are crucial aspect for the communications.
4. Of course, there are also other means to communicate. For instance, seismic waves from Earth's interior might be one manner to communicate and it would be interesting to search for "unnatural" sounds having no identifiable source at the surface of Earth.

Why not earlier?

There are many reasons for why not earlier.

1. We are now ripe to learn that we are not alone and there is much more advanced civilization just below our feet. This kind of news might have destroyed us just like the encounter with more advanced culture has been fatal for many of the so called primitive cultures. We are now at the verge of having the first TOEs and theories of consciousness, and our self esteem is not destroyed even if we now that those below us have 80 DNAs of something to say and 23 amino-acids to say it (well, this *is* somewhat humiliating!).

One cannot underestimate the importance of web. Web makes it possible to communicate the facts about crop circles demonstrating that they are not hoax. Two decades ago the academic community would have simply silenced these phenomena away.

Everyone knows what fractals are nowadays and also that crop circles do not represent "natural" fractals but those constructed by a mathematician with high aesthetic sense. Thus the fractals are an ideal manner to communicate about the presence of a higher level intelligence.

The explosion of the knowledge about genetic code motivates the attempts to communicate information about the genetic code. Since the images about crop formations are well documented in the web and accessible to anyone, there are good hopes that someone sooner or later notices that the number of the capital letters in the Crabwood message is 20, the number of amino-acids, and gradually realizes that every detail of message is beautiful hint about what the aliens are and where they live. We are also approaching the time when a good theory about alien genetic codes allows us to conclude something about these life-forms and perhaps even produce small alien bacteria in our labs. If code allows to develop new understanding about our own genetic code and how it was evolved, there are even better hopes to get us convinced that the crop formations communicating the code are not hoax.

2. Second reason might be that the situation is getting so catastrophic that they must tell that they are there and willing to help us.
 - i) The magnetic field of Earth has started to flip and this catastrophic event could dramatically affect magnetospheric consciousness.
 - ii) There are good reasons to argue that we are an exhausted civilization and decaying, self at a very high age. A period of healing sleep followed by a wake-up to a new magnetospheric day in maximally entangled state of collective one-ness is highly well-come. Magnetic flip is perhaps needed for this and it might be induced intentionally. Earth's magnetic field is indeed highly un-predictable self-organizing structure.

Note that solar magnetic field has memory [38] and 11+11 year cycle: the interpretation as a sleep-awake cycle of a conscious entity deserves a serious consideration. If the duration of the magnetospheric sleep-wake cycle scales like the inverse of the magnetic field strength, and if the fields strength at the surface of Sun *resp.* Earth is taken to be $\sim .2$ Tesla *resp.* $.5$ Gauss, this gives 4.4×10^4 year duration for the magnetospheric sleep-wake cycle. 10^4 years seems to be the average duration between magnetic flips. This rough estimate is too high by a factor of 4.

The Earth's magnetic field has reduced during the last thousand years by a factor of two so that by using the peak values for the magnetic fields of Earth and Sun a better estimate should result. Unlike solar magnetic field, Earth's magnetic field flips in an irregular manner (also the sleep-wake periods of infants are irregular, perhaps magnetic Earth lives its magnetic infancy!).

iii) The magnetospheres of also other planets and helio-magnetosphere have been also changing rapidly during last decades. In [68] Russian scientist A. M. Dmitriev proposes that a dramatic transformation catalyzed by the collision of the solar system with large plasma clouds in outer space is taking place and affects the whole heliosphere. In TGD based cosmology of consciousness these plasma clouds could correspond to an external plasmoid like intelligence. What is happening would be the heliospheric counterpart for what occurs when I am in a dark wood and suddenly realize that I am not alone: there is something there and it might be dangerous. My every cell is suddenly in a state of full alertness and ready to react, and my brain intensely develops ideas about what might be there and how to react for various options. Perhaps the very fact that human kind is intensely developing consciousness theories, and even what I am writing just now, is part of this intense alertness.

3. Third kind of reasons might relate to the physical prerequisites for sending these messages. There are stringent conditions to be satisfied. Magnetic flux tubes carrying strong local magnetic field of about .2 Tesla are needed: magnetized meteoric iron at magnetic flux tubes might be one means to make flux tubes of Earth's magnetic field to carry this field. Two thirds of the circles involve the meteoric iron. Meteoric iron is not always available. The overall size of the structure depends strongly on the magnitude of the electric field in the region between earth and ionosphere. If it is normal the size scale of circles would be too large and the phenomenon would remain un-detected. The local negative charge possible in limestone regions could be the crucial factor reducing the electric potential and in reducing the size scale of the formations. Also the state of ionosphere depending on factors like the presence sunspots might be important.

Interestingly, during the last decade two sub-belts have emerged inside the inner radiation belt [68]. The first belt is electronic and at $r \sim 2R$, R the radius of Earth. The second newcomer contains mainly O^+ ions. Van Allen belts are carriers of magnetospheric sensory representations in TGD. Both the state of van Allen belts and the appearance of crop circles correlate with the solar activity.

How to communicate with ITs?

These considerations motivate the question how to communicate with the ITs.

1. If the higher life forms behind Chilbolton message are indeed ITs, they have received and understood the Arecibo message so that we could continue communicating using this micro-wave wave length using the same frequency modulation based binary code. If ITs are only simple quantum couriers for the civilization of the geometric future, then direct communications with ITs are not so simple. In this case we could however try to establish conscious-to-us communication directly with the civilization of the future: very probably unconscious-to-us communications would be probably occurring all the time. It might be a good idea to try to develop communications based on topological light rays using light at p-adic frequencies utilizing binary cognitive codes [30]. We could also try to demonstrate the existence of the future civilization by using population inverted lasers at p-adic frequencies to receive negative energy signals from future.
2. $k = 151$ sheets space-time sheets could couple with DNAs and also with micro-tubules which seem to be basically responsible for our long term memories. The zero point kinetic energy liberated when ion drops from this space-time sheet corresponds to micro-wave energy and scaling law of homeopathy implies that the velocity parameter involved with the process is about 6 m/s: the phase velocity of alpha waves. If DNA provides a direct connection to their world we could try to communicate via DNA: this communication might be occurring unconsciously all the time and alpha waves are the correlate for these communications. Gariaev has found that DNA responds to a visible coherent light by emitting radio waves, and one might imagine of using DNA to transform messages represented using visible light to radio waves and understood by the aliens.

3. Schumann resonances, being cavity resonances, might provide especially effective manner to communicate. In standard physics these waves would not propagate to the interior but in TGD framework this would be possible at non-atomic space-time sheets. Hypnagogic states during which the lowest Schumann resonance dominates in EEG could correspond to these communications.
4. Situation might be even simpler than this: the Crabwood message suggests that the higher life forms talk English and ASCII code fluently, and are at a higher level in the understanding of biology. Perhaps the aliens are receiving information about us all the time and the problem is how to get us to receive the information sent by them! Perhaps the hardest challenge for the aliens is to get us convinced that they really are there.

Shouldn't volcanoes contain signatures of IT life?

If IT life is really there, volcanoes should be ideal places if one wants to find evidence for it since volcanic eruptions could have brought into daylight both organic material at the colder space-time sheets and liquid glass, perhaps even characterized by complex self-organization patterns. Why traces of life haven't then been found from the surroundings of old volcanoes?

This question does not kill the IT hypothesis. The oldest structures identified as bacterial and cyano-bacterial fossils are accompanied by very complex structures consisting of quartz. The fact that these structures are associated with volcanoes has led to suspect that they do not represent genuine life forms, and a heated debate is going on about this [49]. The puzzle might be resolved if life has developed also underground, and even before the ordinary life so that the photosynthesizing life as we know it might have developed from primitive IT life forms. The complex quartz structures could be seen as results of an intelligent quantum control. The study of the material associated with the volcanic eruptions provides direct means to test the IT hypothesis.

IT life forms could perform remote metabolism by sending negative energy photons inducing the dropping of ions between atomic space-time sheets and magnetic flux tubes so that zero point kinetic energy becomes usable energy. Negative energy photons of visible light might even make possible primitive remote photosynthesis and ADP-ATP cycle. What I have called miracle wave lengths correspond to p-adic length scales between cell membrane thickness and cell size defined by four Gaussian Mersennes $(1 + i)^{-1}$ with p-adic length scales $L(k) = 2^{(k-151)/2} \times 10$ nm, $k = 151, 157, 163, 167$. The photon energies are (126, 15.68, 1.96, .49) eV and correspond to the wave lengths (10, 80, 640, 2560) nm. Remarkably, the last two photon energies correspond to the energies of photon absorbed in photosynthesis and the energy liberated when single ATP molecule is used respectively.

Are ITs really at higher evolutionary level than us?

The metaphor about Earth's interior as the womb of Mother Gaia suggests that the life at the surface of Earth's is in the same relation as adult to a child. Therefore it seems strange that the genome of ITs would be more complex than that of ours. Also the Freudian IT=Id identification suggest that IT life is more primitive than T life. One can also wonder how a highly advanced intra-terrestrial civilization would see the trouble to and even could hide from us.

This forces to consider the possibility that the senders of the Arecibo message are in the geometric future. This would explain the smaller size of the Sun, that also Mars and Jupiter are populated, and the more complex genome, in particular the presence of silicon in the DNA. This does not mean that one should give up the IT hypothesis. ITs could be simple plasmoid like life forms used by the civilization of the geometric future to carry out simple tasks like building crop circles and even activities related to genetic engineering. This requires that the civilization of geometric future has a highly developed time mirror technology.

What is the message of the sacred geometry of crop circles?

Astronomer Gerald Hawkins has found that the areas for the circles associated with the crop formations are in diatonic ratios, that is simple rational numbers characterizing the ratios of frequencies for the basic musical scales. According to the theorem deduce by Hawkins, the ratios are simple rational numbers for the areas for circles which are tangential to the sides of any triangle having its vertices at the circumference of a circle [44]. Surprisingly, no reference to this theorem appears in the works

of Euclid or in any book that he has consulted. Crop circle geometries express also simple algebraic numbers such as square roots of small numbers, in particular Golden Mean $\Phi = (\sqrt{5} - 1)/2$ but also the transcendental number π represented by the the circumference of circle.

The use of sacred geometry could try to express some deep message. The most general message would be that rational numbers and more generally, sacred numbers, play a fundamental role in the world order not understood yet by us. The number theoretic formulation of quantum TGD unifying real and p-adic quantum physics to single coherent whole leads to a discovery of number theoretic information measures definable using p-adic norms for rational valued probabilities [31]. If entanglement probabilities are rational numbers, and more generally finitely extended rational numbers, one can assign to them a negative entanglement entropy, and thus positive information measure, whereas ordinary continuum entanglement entropy is positive in all number fields. This kind of entanglement represents bound state entanglement stable under state function reduction and preparation and is the physical correlate for the experience of understanding. One can say that rational numbers and finitely extended rational numbers represent islands of order in the real and p-adic continua.

The number theoretic formulation of TGD inspires some interesting conjectures. In particular, the ratios of π , e , $\log(p)$, p any prime, and $\log(\Phi)$, where Φ is Golden Mean, should be rational numbers. π indeed appears in the sacred geometry besides simple algebraic numbers. Thus the message might be that finite-dimensional extensions of p-adic numbers involving algebraic numbers and some selected transcendentals are fundamental for cognitive consciousness as indeed predicted by TGD.

A less general interpretation, which deserves to be noticed, relates to the p-adic length scale hypothesis, which states that p-adic length scales come as square roots of primes. This implies that ratios for areas of p-adically fractally scaled variants of a given structure are ratios of primes.

7.4 Number theoretical models for genetic codes

The naive thinking would suggest that the DNA-amino-acid correspondence is unique and same in the alien biology as in our biology. This is not the case. The notion N -particle leads to a model how N -hydrogen atoms define names for molecules and how molecules with conjugate names form especially stable bound states and how the same mechanism explains lock and key mechanism of bio-catalysis. The lock and key mechanism depends only weakly on chemistry and it is quite possible that several genetic codes are realized.

Hence the tRNA molecules mediating DNA-amino-acid correspondence could be different for various life-forms. The stability of various possible tRNA type molecules determining the code would be determined by the electromagnetic environment. Therefore one must take genetic code as a result of selection. The findings about the alien codes, if taken seriously, suggest also guesses about the origin of the genetic code.

The basic new result inspired by the attempt to identify the alien genetic code is the finding that both our and alien genetic codes factorize in a good approximation to a product codes associated with DNA doublets and singlets. This raises the question whether the factorization occurs also at the level of amino-acids. Could DNAs triplets have resulted as a symbiosis of singlets and doublets whereas amino-acids might have been developed via a symbiosis of 2 (3) molecules coded by 4 DNA singlets and 10 (7) molecules coded by 16 DNA doublets?

7.4.1 Three kinds of number theoretical models for the genetic code

TGD has led to three different number theoretic approaches concerning the understanding of the genetic code.

1. In [30] the model of the genetic code based on the notion of Combinatorial Hierarchy is discussed. This approaches predicts at least one additional code that I have christened memetic code.
2. In [29] a universal number theoretical code giving genetic code as a special case and based on the maximization of a number theoretic information measure was developed.
3. The model based on the assumption that genetic code has evolved from a product code is the one to be discussed in this chapter (see also the discussion in [19]).

Genetic codes as deformations of product codes

In this section number theoretical models based on the approximate factorization of the genetic code into product code formed by doublet and singlet codes are discussed. Product code as such predicts degeneracies approximately but fails at the level of detailed predictions for DNA-amino-acid correspondences. A volume preserving flow in discrete DNA space is needed to produce realistic DNA-amino-acid correspondences. This flow has the general tendency to cluster amino-acids to connected vertical stripes inside the 4-columns appearing as elements of the 4×4 code table, whose elements are labelled by the first two bases of DNA triplet. One can invent an information maximization principle providing a quantitative formulation for this tendency.

Genetic codes based on the maximization of number theoretic information measure

In the chapter [29] an alternative number theoretic model for the ordinary genetic code and its variants is discussed. This model is based on very general number theoretic notions, in particular, number theoretical generalization of Shannon entropy, and must be regarded as the most convincing one of the three number theoretic models constructed hitherto. This model allows to identify ordinary genetic code and its variants as codes maximizing a unique number theoretic information measure. The model is also consistent with the idea that genetic code has evolved from a product of singlet and doublet codes.

The model predicts the number for "aminoacids" once the number n of "DNAs" is known as $N(n) + 2$, where $N(n)$ is the number of primes not larger than n . For 80 DNA triplets the prediction would be $24 = 3 \times 8$ rather than 23 aminoacids. Hence the two models for the genetic code would not be consistent.

Before making any hasty conclusions one should recall that the interpretation of the Crabwood circle as ASCII text involves considerable uncertainties. A modification of single special symbol or small letter to a symbol not appearing in the proposed interpretation of the Crabwood message would give 24 "amino-acids". For instance, the ASCII symbols for dot *resp.* comma are 00110100 *resp.* 01110100 and differ only by a single bit so that misinterpretation cannot be excluded.

This model of genetic code emerged much later than the model for alien genetic codes and is not discussed in this chapter.

7.4.2 Does amino-acid structure reflect the product structure of the code?

The exact A-G symmetry and the almost exact T-C symmetry of our genetic code supports approximate 2×10 structure such that 16 DNA doublets and 4 DNA singlets code for 10 *resp.* 2 "pre-amino-acids" which combine to form the real amino-acids. The 3×7 decomposition of the number 21 of amino-acids plus stopping sign suggests 3×7 decomposition of the genetic code. This decomposition is however not favored by the symmetries of the genetic code.

The coding of amino-acids involves tRNA binding with amino-acids and this means that the structure of amino-acids need not reflect the product structure of the genetic code and it might be that only the structure of tRNA reflects the product structure. Indeed, the identification of pre-amino-acids as DNA singlets or doublets dictated by RNA-DNA translation mechanism is strongly favored by the physical model for the evolution of the genetic code. With this identification triplet pre-amino-acids (DNA triplets) are simply composites of doublet and singlet pre-amino-acids (DNA doublets and singlets).

Despite this interpretation, the study of the amino-acid geometric structure is in order. It does not reveal any obvious structural 3×7 -ness or 2×10 -ness. One can however wonder whether this kind of structures might be present at more abstract level and present only in the interactions of tRNA and amino-acids.

1. 2×10 product structure at amino-acid level

2×10 decomposition for real amino-acids might approximately correspond to hydrophobic-hydrophilic dichotomy which plays a key role in the amino-acid chemistry. This correspondence cannot be very precise since the number of the hydrophobic (-philic) amino-acids is 8 (12) rather than 10 (10). Of course, this is what one expects since the product symmetry is broken.

2. 3×7 product structure at amino-acid level

Aminoacids can be classified into three groups. The first class contains 8 hydrophobic non-polar amino-acids: ala, val, leu, ile, pro, met, phe, trp, Second class consists of 7 hydrophilic polar amino-acids gly, ser, thr, cys, asp, glu, tyr. The third class consists of polar hydrophilic acidic amino-acids asp, glu and hydrophilic basic amino-acids lys, arg, his: 5 altogether.

Could these three classes correspond to the 3×7 -ness?

1. First of all, the non-varying group contains almost(!) as a rule both the acidic carboxy group $COOH$ which tends to ionize to COO^- and basic aminegroup NH_3 which tends to ionize to NH_3^+ . When carboxy or amine group is associated with the side group, the $2+3=5$ acidic or basic polar amino-acids result. Thus the three-ness in standard sense corresponds to the difference for the total numbers of acidic and basic groups of the side chains: amino-acid side chain is either neutral and non-polar, neutral and polar, or charged. This leads to $8+7+5$ decomposition and a slight breaking of three-ness.
2. One could however consider a modified definition in which one counts the numbers N_+ of basic and N_- of acidic groups of the *entire* amino-acid and uses the difference $N_+ - N_-$ to tell the net charge of the amino-acid. If this criterion is used, the first group contains one alien, proline. Proline differs from all other amino-acids in that the neutral group $H_3N^+ - COO^- - C - H$ group is replaced by a charged $HN - COO^- - C - H$ group. But this means nothing but replacing the basic group NH_3^+ with a non-basic NH. This implies also a net charge for proline. If net charge is taken as the characterizing property of the third group of amino-acids, proline belongs to it. Therefore first and second would group contain 7 amino-acids and the third group would contain 3 positively charged and 3 negatively charged amino-acids.
3. If one thinks that stopping sign formally corresponds to one additional amino-acid in the third group, one indeed has $7+7+7$ decomposition. For some rare life-forms to be discussed later stopping sign codon ATC can code for both stopping sign and non-standard amino-acid pyrrolysine depending on context [61]. Pyrrolysine, being a derivative of lysine, is basic so that in this case one would have $7+7+7$ decomposition even without counting stopping sign formally as an amino-acid.

The 7-ness index labelling the amino-acids with the three groups should be some abstract property and it is impossible to make any conclusions on basis of the chemical formulae alone.

3. *Is the product structure at the level of amino-acids really needed?*

It has become clear that the product structure for amino-acids is not necessary.

1. The number theoretic model of the genetic code discussed in [29] neither predicts nor requires the product structure for amino-acids but is consistent with the approximate product structure for codons.
2. In [19] a model for the evolution of the genetic code from a product code mapping RNAs to a subset of RNAs is studied. In this model the product structure at the level of coded RNAs is natural but there is no reason for it at the level of amino-acids which, according to the model, originally only catalyzed $RNA \rightarrow RNA$ mapping but later replaced the coded RNAs in a kind of palace revolution.

7.4.3 Number theoretical model for the terrestrial genetic code

The study of the terrestrial genetic code allows to deduce the process leading to the breaking of the product symmetry and T-C symmetry. This process turns out to work as such also in case of alien codes.

Approximate reduction to a product code

The dependence of the amino-acid coded by DNA on the third codon of DNA triplet is weak and Crabwood message suggests that both doublet and triplet codes are realized. This inspires the guess that triplet code might have evolved as a fusion of doublet code and singlet codes.

This should be reflected in its structure. There are two options.

1. The decomposition $20 = 2 \times 10$ for real amino-acids suggest that singlet code maps four bases to 2 'pre-amino-acids' such that A and G resp. T and C are mapped to same pre-amino-acid, and 16 doublets to 10 'pre-amino-acids'. The exact A-G symmetry and almost exact T-C symmetry of our genetic code support this interpretation.
2. The decomposition $21 = 3 \times 7$ for amino-acids plus stopping sign suggests that singlet code maps four bases to 3 'pre-amino-acids' and 16 doublets to 7 'pre-amino-acids'. In the first approximation the triplet code would decompose to a product of doublet code and singlet code in the sense that 4 singlets are mapped to Z_3 and 16 doublets are mapped to Z_7 so that 21 different product states result. The decomposition of the statements consistent with some atomic statements suggests itself strongly. In the first approximation the triplet code would decompose to a product of doublet code and singlet code in the sense that 4 singlets are mapped to Z_3 and 16 doublets are mapped to Z_7 so that 21 different product states result. The problem of this option is that it predicts complete breaking of T-C symmetry and the breaking of the product symmetry should produce T-C symmetry. This looks too complicated.

Product code hypothesis is very strong since the degeneracies of the product code are products of the degeneracies for the composite codes so that the number n_{AB} of DNA triplets coding a given amino-acid having the product form 'AB', to be referred as the degeneracy of the amino-acid, is given by the product

$$n_{AB} = n_A \times n_B$$

of the degeneracies of the 'pre-amino-acids' A and B. Here A and B can refer to $(A, B) = (3, 7)$ or $(A, B) = (2, 10)$ respectively.

The number $N_{AB}(n)$ of amino-acids with given degeneracy n is given by the formula

$$N_{12}(n) = \sum_{n_1 \times n_2 = n} N_1(n_1)N_2(n_2) ,$$

where $N_1(n_1)$ resp. $N_2(n_2)$ is the number of pre-amino-acids with the degeneracy n_1 resp. n_2 .

For 2×10 case singlet sector allows only single candidate for the code since the genetic code has exact A-G symmetry and almost exact T-C symmetry with respect to the last base. Thus A and G code for the first pre-amino-acid and T and C the second one. A breaking of the T-C symmetry is needed to obtain realistic code.

In 3×7 case singlet code would have following interpretation. Z_3 is identified as negations of 4 selected statements with 00 excluded. Statement and its negation are projected to this Z_3 representing negations with 00 excluded so that 11 must be projected to some other statement. The degeneracies of the code are unique: 2, 1,1 since any change of the code changing this degeneracy spectrum implies that one degeneracy vanishes.

Same applies to Z_7 and 16 DNA doublets. Now 1111 is mapped to some statement in the set of negations. In this case the simplest coding is obtained by mapping 7 statements to their conjugates and the two remaining statements to different conjugate statements in the set of 7 statements. The resulting degeneracy structure is 2222233 and entropy is maximal for this code.

Our genetic code as result of symmetry breaking for 2×10 product code

As found, there are two cases to be considered: 3×7 T-C asymmetric and 2×10 T-C symmetric product code. The approximate T-C symmetry favors strongly 2×10 option and 3×7 will be considered only briefly in a separate subsection. On basis of degeneracies alone it is not possible to distinguish between these codes and 3×7 code was in fact the first guess for the product code.

In case of 2×10 code the decomposition of 16 DNA doublets giving almost the degeneracies of our genetic code is (3322 111 111).

$$(2 \oplus 2) \times (3 \oplus 3 \oplus 2 \oplus 2 \oplus 6 \times 1)$$

This gives

n	1	2	3	4	6
N(prod)	0	12	0	4	4
N(real)	2	9	2	5	3

Table 10: The numbers $N(n)$ of amino-acids coded by n DNAs for unperturbed 2×10 product code and for the real genetic code for 2×10 option.

It is important to notice that the multiplets appear as doubled pairs corresponding to A-G and T-C symmetries. One generalized amino-acid (which cannot correspond to stopping sign) is lacking and must result by a symmetry breaking in which one amino-acid in the code table is transformed to a new one not existing there. Alternatively three amino-acids are transformed to stopping signs.

It is easy to find the deformation yielding correct degeneracies by removing DNAs from the DNA-boxes defined by various values of degeneracies to other boxes and adding them to other boxes. The rule is simple: taking m DNAs from a box containing n DNAs creates a box with $n - m$ DNAs and annihilates one n -box:

$$N(n) \rightarrow N(n) - 1, \quad \text{and} \quad N(n - m) \rightarrow N(n - m) + 1.$$

If one adds k of these DNAs to r -box one has

$$N(r) \rightarrow N(r) - 1, \quad N(r + k) \rightarrow N(r + k) + 1.$$

The operation which is not allowed is taking the entire content of a DNA box defined by amino-acid and adding it to other boxes since this would mean that the amino-acid in question would not be coded by any DNA. Thus the number of boxes can only grow in this process.

Realistic degeneracies are obtained by a rather simple operation.

1. Take from one 6-plet two amino-acid and move the first of them to 2-plet to get $N(6) = 3$, $N(4) = 5$, $N(3) = 1 < 2$, $N(2) = 11 > 9$ and move the second one to hitherto non-existing singlet to get $N(1) = 1$.
2. Move one DNA from some doublet to second doublet to get triplet and singlet to get $N(1) = 2$, $N(2) = 9$ and $N(3) = 2$. This operation gives correct degeneracies only and it turns out that correct symmetry structure requires additional operations.

Failures of the product structure and the symmetry breaking as volume preserving flow in DNA space

A slightly broken product structure allows to understand the degeneracies of our genetic code relatively easily. It however leads also to wrong predictions at the level of DNA-amino-acid correspondence.

1. Exact product structure predicts that all 4-columns XYU , $U = A, G, T, C$ appearing as elements of the code table labeled by first and second bases of DNA triplet should have similar amino-acid structure. For 3×7 code the 4-column should have $AABC$ structure. This is not case. Almost all 4-columns have $AABB$ structure and there are also many $AAAA$ type 4-columns. For 2×10 code the prediction is that all 4-columns should have $AABB$ structure and this prediction breaks down only for $AAAA$ type 4-columns.
2. For 3×7 code a given amino-acid should be coded by DNA pairs of form (XYA, XYG) , or DNA of form XYC or XYT . For 2×10 code a given amino-acid should be coded either by DNA pairs of form (XYA, XYG) or of form (XYC, XYT) . This is not the case. A given amino-acid tends to appear as connected vertical stripes inside the elements of the 4×4 table (4-columns). For instance, all 4-columns of form $AAAA$ (A=leu, val, ser, pro, thr, ala, arg, gly) and 3-column ile break the prediction of the product code.
3. For 3×7 each 2n-plet formed by degenerate (XYA, XYG) -pairs is accompanied by n -plets of type XYT and XYC . In case of 2×10 2n-plet formed by (XYA, XYG) -pairs is accompanied always by an n -plet formed by (XYT, XYC) pairs. By studying the degeneracies of the codes one can get idea about how good these predictions are.

It seems that the breaking of the product symmetry tends to form connected vertical clusters of amino-acids inside a given element of the 4×4 code table but that one cannot regard stripes longer than 4 elements as connected structures. The 2×10 structure is favored by approximate T-C symmetry, and one can imagine that relatively simple flow in DNA space could yield the desired condensation of the amino-acids to form connected vertical stripes. The most general flow is just a permutation of DNAs and obviously preserves the degeneracies of various amino-acids. There are $64!$ different permutations but A-G and T-C symmetries reduce their number to $32!$.

The idea about discrete volume preserving flow in DNA space can be made more precise. A-G and T-C gauge symmetries suggest the presence of a discrete symplectic structure. Perhaps one could regard 16×4 DNAs as 16 points of 4-dimensional discrete symplectic space so that the canonical symmetries of this space (volume preserving flows) acting now as permutations would be responsible for the exact A-G gauge invariance and approximate T-C gauge invariance. This brings in mind the canonical symmetries of CP_2 acting as $U(1)$ gauge transformations and acting as almost gauge symmetries of the Kähler action.

A natural guess is that the DNAs coding same amino-acid tend to be located at the same column of the 4×4 code table before the breaking of the product symmetry. If this is the case then only vertical flows need to be considered and A-G and T-C symmetries imply that their number is $8!^4$ corresponding to the four columns of the table.

The table 11c) summarizes our genetic code. It is convenient to denote the rows consisting of A-G resp. T-C doublets by X_1 and X_2 . For instance, A_1 corresponds to the highest row phe-phe, ser-ser, tr-tyr, cys-cys and G_2 to the row leu-leu, pro-pro, gln-gln, arg-arg.

1. The simplest hypothesis is 2×10 option is realized and that the flow permutes entire rows of the code table consisting of A-G and T-C doublets. From the table below it is clear that there is a G-C symmetry with respect to the first nucleotide broken only in the third row. This kind of primordial self-conjugacy symmetry would not be totally surprising since first and third nucleotides are in a somewhat similar position.
2. There are 3 6-plets leu, ser, and arg, and it is easy to see that one cannot transform them to the required form in which all 6-plets are on A-G or T-C row alone using this kind of transformation. For instance, one could require that leu doublets correspond to T-C doublets before the symmetry breaking. This is achieved by permuting the G_1 row with the C_2 row. Since A_2 contains also ser-doublet, also ser must correspond to T-C type 6-plet, and since arg is contained by G_2 row, also arg must correspond to T-C type 6-plet. Thus there would be 4 T-C type 6-plets but the product code gives only 2 of them.
3. The only manner to proceed is to allow mixing of suitable 6-plet of A-G type and 4-plet of T-C type in the sense that A-G doublet from 6 is moved to T-C doublet inside 4-plet and T-C doublet in 4-plet is moved to A-G doublet inside 6-plet. The exchange of AG_2 (ser doublet) and TG_1 (trh-doublet) represents this kind of permutation.

The tables below summarize the three stages of the construction.

1. *Table 11a): Code table before the flow inducing the breaking of the product symmetry.*

	A	G	T	C	
A	phe	ser	tyr	cys	A
	phe	ser	tyr	cys	G
	leu	thr	stop	thr	T
	leu	thr	stop	thr	C
G	val	ala	glu	gly	T
	val	ala	glu	gly	C
	leu	pro	gln	arg	T
	leu	pro	gln	arg	C
T	ile	ser	asn	ser	A
	ile	ser	asn	ser	G
	met	thr	lys	arg	T
	met	thr	lys	arg	C
C	val	ala	asp	gly	A
	val	ala	asp	gly	G
	leu	pro	his	arg	A
	leu	pro	his	arg	G

2. Table 11b): The code table after the action of the flow inducing the breaking of product symmetry.

	A	G	T	C	
A	phe	ser	tyr	cys	A
	phe	ser	tyr	cys	G
	leu	ser	stop	thr	T
	leu	ser	stop	thr	C
G	leu	pro	his	arg	A
	leu	pro	his	arg	G
	leu	pro	gln	arg	T
	leu	pro	gln	arg	C
T	ile	thr	asn	ser	A
	ile	thr	asn	ser	G
	met	thr	lys	arg	T
	met	thr	lys	arg	C
C	val	ala	asp	gly	A
	val	ala	asp	gly	G
	val	ala	glu	gly	T
	val	ala	glu	gly	C

3. Table 11c): The code table after the T-C symmetry breaking

	A	G	T	C	
A	phe	ser	tyr	cys	A
	phe	ser	tyr	cys	G
	leu	ser	stop	stop	T
	leu	ser	stop	trp	C
G	leu	pro	his	arg	A
	leu	pro	his	arg	G
	leu	pro	gln	arg	T
	leu	pro	gln	arg	C
T	ile	thr	asn	ser	A
	ile	thr	asn	ser	G
	ile	thr	lys	arg	T
	met	thr	lys	arg	C
C	val	ala	asp	gly	A
	val	ala	asp	gly	G
	val	ala	glu	gly	T
	val	ala	glu	gly	C

At the last stage the T-C symmetry breaking giving rise to bla-trp and ile-met doublets occurs.

1. thr 6-plet is transformed to 4-plet by replacing thr-thr in AC_2 by bla-trp. trp is the missing amino-acid.
2. TA_2 met-doublet is transformed to ile-met so that the realistic genetic code results.

One might argue that symmetry breaking permutations $G_1 - C_2$ and $AG_2 - TG_1$ should permute amino-acids with a similar chemical character. A similar constraint applies to T-C symmetry breaking. By studying the chemical structure of the amino-acids, one finds that this is satisfied to a high degree.

1. The permutations val-leu and ala-pro exchange aminocids with non-polar (hydrophobic) side-groups. The permutations glu-his and gly-arg exchange polar (hydrophilic) amino-acid with a polar amino-acid which is also basic. Ser and thr are both non-polar amino-acids.
2. ile and met are both non-polar so that ile \rightarrow met replacement satisfies the condition.
3. The objection is that the side group for trp is non-polar but polar for thr. Interestingly, the code table decomposes to two connected regions corresponding to non-polar/polar side groups at the left/right such that the non-polar trp located inside the polar region is the only black sheep whereas thr naturally belongs to the polar region. As will be found trp is also otherwise singular case.

A working hypothesis worth of studying is that the symmetry breaking mechanism is universal and applies also to the capital letter code and even to the small letter + special symbol code in an appropriately generalized form. This hypothesis is highly predictive, and the fact that one can produce these codes using the product ansatz, the same "volume preserving flow", and T-C symmetry breaking, encourages to think that the picture has some truth in it.

The information maximization principle determining the "volume preserving flow"

The interaction between the DNA singlets and doublets is the physical explanation for the breaking of the product symmetry. This interaction involves two parts: the flow and T-C symmetry breaking. The flow is analogous to the formation of connected vertical stripes of amino-acids in DNA space: kind of condensation process in which different phases represented by amino-acids tend to condense to form regions consisting of at most 4-units of type XYU , $U = A, G, T, C$. Obviously this means continuity and thus also symmetry analogous to that emerging when (amino-acid) gases condense to a liquid state: the breaking of the product symmetry is the price paid for this additional symmetry. It turns out to be possible to formulate a variational principle consistent with the proposed flow in the direction of the columns of the code table and defining the dynamics of the condensation.

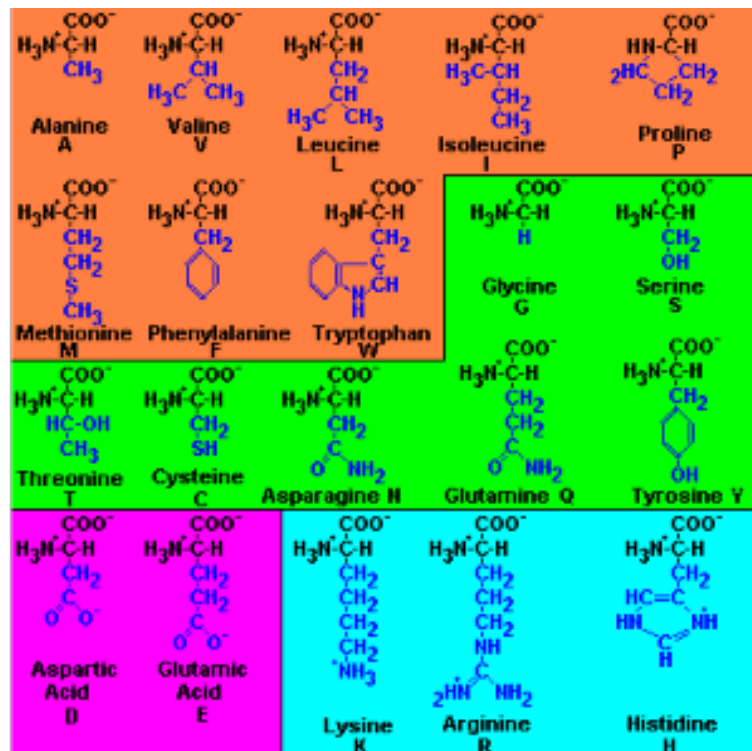


Figure 7.4: The chemical structure of amino-acids. The first group (ala, ..) corresponds to non-polar amino-acid side groups, the remaining amino-acids to polar side groups. The two lowest groups correspond to acidic (asp, glu) and basic side groups.

What this means that one can assign an information measure to the code table such that the volume preserving flow in question maximizes this information measure.

1. Information measure is assumed to be local in the sense that it decomposes into a sum of information measures associated with the elements C_{AB} , $A, B \in \{A, G, T, C\}$, of the 4×4 code table (elements are 4-element columns). In the physical analogy this means that the condensed droplets of various amino-acids can have at most the size of single 4-element column.
2. Consider the element C_{AB} . Let the multiplet associated with the amino-acid a_k contain $n(k, AB)$ amino-acids and let $i(k, AB)$ tell the number of the disjoint parts to which the amino-acidss a_k in the 4-plet AB split. The number of these disjoint multiplets can be 0, 1, 2.

Let the i :th region contain $n(k, AB, i)$ amino-acids a_k . The meaning of the equations

$$\begin{aligned} \sum_{i=1}^{i(k, AB)} n(a_k, AB, i) &= n_k(AB) \quad , \\ \sum_{AB} n_k(AB) &= n_k \quad , \\ \sum_k n_k &= 64 \end{aligned}$$

is obvious.

Assign to the i :th connected region containing $n(k, i, AB)$ identical amino-acids a_k probability

$$p(k, i, AB) = \frac{n(k, i, AB)}{64} \quad ,$$

to the element AB the total probability

$$p(k, AB) = \sum_{i=1}^{i(k, AB)} p(k, i, AB) \quad ,$$

and to the entire table the probability

$$p_k = \sum_{AB} p(k, AB) = \frac{n(k, AB)}{64} \quad .$$

The sum of the probabilities associated with various amino-acids satisfies

$$\sum_k p_k = 1 \quad .$$

The information measure associated with amino-acid a_k element AB is defined as

$$I(k, AB) = \sum_{i=1}^{i(k, AB)} p(k, i, AB) \times \log[p(k, i, AB)] \quad ,$$

Note that this number is non-positive always. The total information associated with the amino-acid a_k in code table is defined as

$$I(k) = \sum_{AB} I(k, AB) \quad .$$

The total information of the code table is defined as the sum of the information measures associated with various amino-acids:

$$I = \sum_k I(k) \quad .$$

This information measure is maximized (which means the minimization of the absolute value of the measure since one can speak of the minimization of entropy) by the vertical flow satisfying the previous constraints, and thus satisfying the constraints that the numbers a_k of various amino-acids are fixed

and $A \leftrightarrow G$ and $T \leftrightarrow C$ symmetries are respected. There is a direct analogy with thermodynamical equilibrium with fixed particle numbers and symmetry. The equilibrium is characterized by the chemical potentials associated with the amino-acids. There is no temperature type parameter now.

The variational principle indeed favors the formation of vertically connected regions consisting of $n = 2, 3$ or 4 amino-acids. By construction the variational principle does not tell anything about larger regions. In particular, it is more favorable for 4 amino-acids in a given column (say ser in the second column of the table) to be contained by single element than by 2 elements since the information measure would be $-1/16 \log(1/16)$ for two disjoint doublets and $-1/16 \log(1/8)$ for singlet 4-plet in same element and thus smaller in absolute value. In the similar manner the AAAB decomposition of singlet element instead of say AABA is favored.

The deviations from the standard code as tests for the basic symmetries of the model

The deviations of the terrestrial genetic code from the standard code [61] provide a testing ground for the postulated symmetries of the genetic code and might also help to deduce the alien codes.

The deviations from universality of the start codon (coding for met) and stop codons are very rare. With two exceptions all known deviations from the standard code are located in the first and fourth columns of the code table. For the first exceptional case the codon is ATC in the third column and codes for both stopping sign and pyrrolysine, which is an exotic amino-acid. It is somewhat a matter of taste whether one should say that the universality of the third column is broken or not since, depending on context, ATC codes stopping sign or pyrrolysine. Second exceptional case corresponds to the use of two stop codons to code amino-acids and this necessarily breaks the universality of the third column in T-C 2-subcolumns. The construction of the small letter code indeed forces to assume this kind of breaking of universality. No violations of the predicted A-G symmetry and the universality of the second column of the code table are known.

The deviations from the standard code [61] provide valuable hints when one tries to deduce information about the alien codes.

1. Consider first the mitochondrial genes.
 - i) Mitochondrial codon ACT from animals and micro-organisms (but not from plants) codes trp instead of stopping sign.
 - ii) Most animal mitochondria use TAT to code met instead of ile.
 - iii) Yeast mitochondria use GAX codons to code for thr instead of leu. This suggests that also in the case of the capital letter code the amino-acid coded 8 times is thr. In case of the small letter + special sign code the 13-fold degerate amino-acid could be thr.
2. The violations of the universality are very rare for nuclear genes. A few unicellular eukaryotes have been found that use one or two of three stop codons to code amino-acids instead. The use of two stop codons to code amino-acids necessarily violates the universality of the third column but need not break the universality for the imbedding of amino-acid space to DNA space.
3. There are also two non-standard amino-acids: selenocysteine and pyrrolysine.
 - i) Selenocysteine is encoded by ACT (fourth column) coding stopping sign normally. Interestingly, ACT codes also stopping sign and the translation machinery is somehow able to discriminate when selenocysteine is coded instead of stop. This codon usage has been found in certain Archaea, eubacteria, and animals. This deviation means that the number of amino-acids is 21 or 20 depending on context. This conforms with the view that number 21 indeed has a deep number theoretical meaning and that one can regard stopping sign formally as amino-acid.
 - ii) In one gene found in a member of the Archaea, exotic amino-acid pyrrolysine is coded by ATC, which corresponds to the lower stopping sign in the code table. This case represents the only deviation from universality of the third column of the code table but even in this case also stopping sign is coded. How the translation machinery knows whether to code pyrrolysine or to stop translation is not yet known. TGD would suggest that electromagnetic signaling mechanisms ('topological light rays') might be involved.

The small variants of the letters K and V are lacking from small letter+special sign code. This might signal that the corresponding amino-acids are replaced by selenocystein and pyrrolysine represented by h and \backslash in the small letter code.

7.4.4 Capital letter code as a product code with broken T-C symmetry

What about capital letter code: does it also have approximate product structure? Product structure predicts that many degeneracies, in particular the largest degeneracies should be divisible by two. In case of 2×10 code all degeneracies are predicted to be divisible by two. This is not the case now as the table above shows. One can however try to find a product code which is as near as possible to the real one.

The degeneracies 111111234 for the doublet 2×10 representation differs from our genetic code in that 111112233 is modified to 111111234. These degeneracies would be the degeneracies most naturally associated with the 16 DNA doublet code with 10 'pre-amino-acids' possibly associated with plasmoid like life forms serving as messengers of the aliens.

The simplest option would be that this correspond to taking one doublet from second 2 and adding it to second 3 so that one additional singlet results. Unfortunately, the fact that stopping sign has degeneracy 7(8) excludes this option.

The 111111234 decomposition predicts the following numbers for DNAs with various degeneracies. Also the corresponding numbers for capital letter code are included.

n	1	2	3	4	5	6	7	8
N(product)	0	14	0	2	0	2	0	2
N(capital)	5	7	2(3)	3(2)	1	0	2(1)	1(2)

Table 12. The numbers $N(n)$ of amino-acids coded by n DNAs as predicted by the 2×10 product model for the capital letter code in comparison with the degeneracies deduced from the Crabwood message: 2×10 option.

The following process gives the degeneracies of the OPpose code.

1. Take one DNA from second 8-plet and add it to 6-plet to get two 7-plets so that one has $N(7) = 2$ and $N(6) = 1 > 0$.
2. Change one DNA in 6-plet to the DNA which does not exist in the table to get $N(6) = 0$, $N(5) = 1$, $N(1) = 1$. The non-existing DNA is generated in essentially the same manner also in case of our code.
3. One can transform 7 2-plets into 2 3-plets, 4-plet and 4 singlets as follows. Take from two doublets one DNA and move them to third doublet to get $N(1) = 3 < 5$, $N(2) = 11 > 7$, and $N(4) = 3$. There are four superfluous doublets remaining and forming pairs. For each pair take DNA from one doublet and move it to second one to get $N(1) = 5$, $N(2) = 7$ and $N(3) = 2$.

Assuming that the decomposition of DNA doublets is obtained from that for our code in the proposed manner and that the same flow induces T-C symmetric part of the breaking of the product symmetry, one can fix the DNA-amino-acid correspondence highly uniquely for the capital letter code. The unbroken code contains two octets. Since for yeast mitochondria both GA and TA columns code for thr, the guess is that the second octet corresponds to thr. The second octet must be ser from the product symmetry. The requirement that the code table resembles as much as possible the code table of our genetic code leads to the following working hypothesis for the code table before symmetry breaking.

1. Table 13a): Capital letter code table before the flow

	A	G	T	C	
A	phe	ser	tyr	cys	A
	phe	ser	tyr	cys	G
	leu	thr	stop	stop	T
	leu	thr	stop	stop	C
G	val	ala	glu	gly	T
	val	ala	glu	gly	C
	thr	stop	gln	arg	T
	thr	stop	gln	arg	C
T	ile	ser	asn	ser	A
	ile	ser	asn	ser	G
	met	thr	lys	arg	T
	met	thr	lys	arg	C
C	val	ser	asp	gly	A
	val	ser	asp	gly	G
	thr	pro	his	arg	A
	thr	pro	his	arg	G

2. Table 13b): Capital letter code table after the flow

	A	G	T	C	
A	phe	ser	tyr	cys	A
	phe	ser	tyr	cys	G
	leu	ser	stop	stop	T
	leu	ser	stop	stop	C
G	thr	pro	his	arg	A
	thr	pro	his	arg	G
	thr	stop	gln	arg	T
	thr	stop	gln	arg	C
T	ile	thr	asn	ser	A
	ile	thr	asn	ser	G
	met	thr	lys	arg	T
	met	thr	lys	arg	C
C	val	ser	asp	gly	A
	val	ser	asp	gly	G
	val	ala	glu	gly	T
	val	ala	glu	gly	C

3. Table 13c): Capital letter code table after the T-C symmetry breaking

	A	G	T	C	
A	phe	ser	tyr	cys	A
	phe	ser	tyr	cys	G
	phe	ser	stop	stop	T
	leu	ser	stop	trp	C
G	thr	pro	his	arg	A
	thr	pro	his	arg	G
	thr	stop	gln	arg	T
	thr	stop	gln	arg	C
T	ile	thr	asn	ser	A
	ile	thr	asn	ser	G
	ile	thr	lys	arg	T
	met	stop	lys	stop	C
C	val	ser	asp	gly	A
	val	ser	asp	gly	G
	val	asp	asp	gly	T
	val	ala	glu	gly	C

T-C symmetry breaking can be understood as follows.

1. Take one DNA from second 8-plet (ser or thr and add it to 6-plet representing stopping sign to get two 7-plets so that one has $N(7) = 2$ and $N(6) = 1 > 0$. Thr is chosen in the sequel for definiteness and corresponds to TGC.
2. Change one DNA in thr 6-plet to the DNA which does not exist in the table to get $N(6) = 0$, $N(5) = 1$, $N(1) = 1$. The non-existing DNA is generated in essentially the same manner also in case of our code. stop at ACT is transformed to trp as so that trp is in the same position as in our genetic code.
3. What one must do is to transform 7 2-plets into 2 3-plets, 4-plet and 4 singlets. This is achieved in the following manner.
 - i) Take from two T-C doublets one DNA and move them to a third doublet to get $N(1) = 3 < 5$, $N(2) = 11 > 7$, and $N(4) = 3$. For instance, this is achieved by transforming glu and ala to asp. The value of information measure decreases by $\log(64/27)$ in this process. There are also many other manners to do this.
 - ii) There are four superfluous doublets remaining and forming pairs. For each pair take DNA from one doublet and move it to second one to get $N(1) = 5$, $N(2) = 7$ and $N(3) = 2$. More concretely $(AA)_2$ leu doublet is transformed to phe-leu, and $(TA)_2$ met-doublet is transformed to ile-met so that correct degeneracies result and the information measure increases in these processes by $2 \times \log(27/16)$ which is larger than $\log(64/27)$ so that the net increase of the information measure is positive in the entire process.

The process is not obviously completely unique but the proposed choice is favored because the small letter+special sign code can be obtained as a small deformation of this code.

7.4.5 T-C symmetric models for small letter plus special symbol code

One can apply T-C symmetric product model with symmetry breaking also to the code candidates involving small letters. There are three candidates for these codes.

1. The 4×17 code with 18 amino-acids involving only small letters with h interpreted as stopping sign: this code makes sense for Oppose option only and since the expressive power is not maximal, it will not be discussed in the sequel.
2. $4 \times (16+4)$ code with 23 generalized amino-acids (\backslash , h , and special symbols $!$, $\&$, $.$ are interpreted as belonging to the extended family of amino-acids).

- The $4 \times (16 + 4)$ code with 20 amino-acids (\backslash and h are interpreted now as amino-acids). This code results from the code with 23 generalized amino-acids by assuming that the DNAs coding for $!$, $\&$ and period code for the stopping sign.

The candidates 2) and 3) appear as Oppose and OPpose options.

The nature of silicon modification

The product model for the genetic codes suggests an interpretation of the small letter codes. The Chilbolton message tells that also silicon is fundamental for the alien life at DNA level so that one can consider the possibility that one of the DNA and RNA doublets is modified by an addition of something containing silicon to give an additional doublet.

For $(4 + 16) \times 4$ code four additional doublets must be present. If some base of DNA suffers a modification, it suffers the modification also if it appears in RNA triplet at the same position, and this in turn implies that also the conjugate of the DNA base suffers modification so that 32 additional triplets are generated. Thus the modified base of DNA cannot appear in RNA and vice versa. DNA bases (A,G,T,C) correspond to RNA bases (U,C,A,G). Since the T of DNA corresponds to the U of RNA, there is only one possibility. The modified base is T for DNA and U for RNA, and the T_S of DNA must correspond to U_S of RNA rather than A_S . The simplest possibility is that the doublets of form XT have doubled by the silicon modification of the second T to XT_S . Also $T_S X$ type modification is in principle possible but the construction of the code favors the XT_S option (in this case code the table gets a fifth column whereas for $T_S X$ gives rise to a fifth row).

2×12 product model for the small letter plus special symbol code with 80 generalized DNAs and 23 amino-acids

The optimal candidate for the code involving 64+16 generalized DNAs involves 20+3 generalized amino-acids. There are two options corresponding to the decompositions $24 = 3 \times 8$ and $24 = 2 \times 12$. The assumption that small letter plus special sign code follows from the capital letter code as extension favors 2×12 option. 2×12 option for the small letter + special sign code allows highly unique model since one can assume that the code results as a simple extension of the capital letter code and is obtained by the same symmetry breaking procedure as the capital letter code and terrestrial genetic codes. The discussion below is restricted to OPpose option.

The first step is to deduce the composition in the set of 4 + 16 DNA doublets defining the product code. The only working option has the decomposition 11111112235, which corresponds to the decomposition

$$20 \times (2 \oplus 2) = (5 \oplus 3 \oplus 2 \oplus 2 \oplus 8 \times 1) \times (2 \oplus 2) .$$

This gives the following table for the degeneracies.

n	1	2	3	4	5	6	8	9	10	12	13
N	0	16	0	4	0	2	0	0	2	0	0
N	10(9)	4(5)	0	3	2(3)	3(2)	0	1	0	0	1

Table 14: The numbers $N(n)$ of amino-acids coded by n DNAs for code containing small letters and special symbols for 2×12 option. Both OPpose and Oppose options are included.

The breaking of the product symmetry looks large but it turns out that the code can be obtained as a relatively small deformation and extension of the capital letter code.

The first things to observe about the code are following.

- Comparing the decomposition 11111112235 with the corresponding decomposition 111111234 for the capital letter code, one can guess that the small letter code is obtained from the capital letter code by the following process in the set of 4 exotic RNA-doublets. Decompose the four exotic RNAs to $(2 \oplus 1 \oplus 1) \times (2 \oplus 2)$ such that $2 \times (2 \oplus 2)$ codes for exotic and ordinary amino-acid quartet. Since trp is lacking from capital letter code before symmetry breaking, one can assume that trp is the ordinary amino-acid. Since the exotic amino-acid "period" appears five times, the

second 4-plet must code for "period". The two doublets must code for exotic doublets & and ! which reduce to singlets after symmetry breaking. Two exotic doublets fuse with the two octets of the capital letter code to code for two decouplets and must therefore code for the ordinary amino-acids ser and thr. Thus the code table without symmetry breaking looks very much like capital letter code table.

2. The modification $XT \rightarrow XT_S$ implies that code table gets fifth column. Only this option allows to generalize in non-trivial manner the flow and allows to see trp 4-plets as being consistent with product code.
3. Terrestrial codes contain two exotic amino-acids scys and plys. The fact that the small letter + special sign code contains the symbols h and \backslash with ASCII number larger than 64 not appearing in the capital letter code is taken as a suggestion that the corresponding amino-acids are exotic. A natural working hypothesis is cys is replaced with scys and lys with plys. Needless to add, this hypothesis must be taken with a grain of salt.

1. Product code before flow

The code table before the action of the flow and T-C symmetry breaking looks like follows. The code table obviously resembles capital letter code table to a very high degree and satisfies all the constraints resulting from the A-G and T-C symmetries and product structure of the code.

	A	G	T	C	T_S	
A	phe	ser	tyr	scys	.	A
	phe	ser	tyr	scys	.	G
	leu	thr	stop	stop	thr	T
	leu	thr	stop	stop	thr	C
G	val	ala	glu	gly	!	T
	val	ala	glu	gly	!	C
	thr	stop	gln	arg	trp	T
	thr	stop	gln	arg	trp	C
T	ile	ser	asn	ser	.	A
	ile	ser	asn	ser	.	G
	met	thr	plys	arg	&	T
	met	thr	plys	arg	&	C
C	val	ser	asp	scys	ser	A
	val	ser	asp	scys	ser	G
	thr	pro	his	arg	trp	A
	thr	pro	his	arg	trp	G

Table 15a: Small letter special sign product code before flow and T-C symmetry breaking.

2. The action of the flow

	A	G	T	C	T_S	
A	phe	ser	tyr	scys	.	A
	phe	ser	tyr	scys	.	G
	leu	ser	stop	stop	thr	T
	leu	ser	stop	stop	thr	C
G	thr	pro	his	arg	trp	A
	thr	pro	his	arg	trp	G
	thr	stop	gln	arg	trp	T
	thr	stop	gln	arg	trp	C
T	ile	thr	asn	ser	.	A
	ile	thr	asn	ser	.	G
	met	thr	plys	arg	&	T
	met	thr	plys	arg	&	C
C	val	ser	asp	scys	ser	A
	val	ser	asp	scys	ser	G
	val	ala	glu	gly	!	T
	val	ala	glu	gly	!	C

Table 15b: Small-letter special sign genetic code after the flow and before T-C symmetry breaking.

3. T-C symmetry breaking

The basic assumptions are that the G-column of the code is universal for the alien code just as it is universal for the terrestrial codes, and that the code table resembles maximally to our code table and capital letter code table.

1. One must transform the two 10s (thr and ser) to 13 and 9. The clue to the symmetry breaking mechanism comes from the finding that one must be able to generate as many as 10 singlets. Hard trial and error work teaches that one cannot get these singlets unless one allows $10 + 4 \rightarrow 13 + 1$ mechanism for producing one of the singlets. The transformation of val-val-val-val to ser-ser-ser-val is the only candidate for this transformation and gives $N(4) = 3$ (scys, period, trp) and $N(1) = 1$.

The thr is the second 10-plet and the transformation of TTC-thr to stop is the only possibility if the universality of the G column in alien sector is assumed. The transformation of $(AC)_2$ stop-stop column to trp-trp implies maximal resemblance with our genetic code, and one obtains $N(13) = N(9) = 1$ (thr,ser), $N(6) = 2$ (arg,trp), $N(5) = 1 < 5$ (stop) and $N(4) = 2 < 3$ (scys,period).

2. The remaining transformations must produce $N(1) = 10 > 1$, $N(2) = 4$, $N(4) = 3 > 2$, $N(5) = 2 > 1$, $N(6) = 3 > 2$ by acting on the T-C type doublets only and thus generating a breaking of T-C symmetry. The first step is to replace & in the $(TT_S)_2$ by "period" to get $N(5) = 2$, $N(4) = 1$, $N(1) = 2$. What one must create by the splitting all the remaining T-C doublets so that 2 4-plets and 1 6-plet as extension of A-G type doublets results. The choice of the A-G type doublets is not unique but the requirement that the code table resembles maximally the code table of the capital letter code fixes the choice of A-G type doublets extended to 4-plets to be AA_1 (phe), $(TT)_1$ (ile) and the A-G type doublet extend to 6-plet to be CT_1 (asp). The table below summarizes one possible code table satisfying these constraints. For comparison also the table for capital letter code is given.

	A	G	T	C	T_S	
A	phe	ser	tyr	cys→scys	.	A
	phe	ser	tyr	cys→scys	.	G
	phe	ser	stop	stop→trp	thr	T
	leu	ser	stop	trp	thr	C
G	thr	pro	his	arg	trp	A
	thr	pro	his	arg	trp	G
	thr	stop	gln→phe	arg	trp	T
	thr	stop	gln	arg	trp	C
T	ile	thr	asn	ser	.	A
	ile	thr	asn	ser	.	G
	ile	thr	lys→ile	arg	.	T
	met	stop	lys→plys	arg	&	C
C	val→ser	ser	asp	gly→scys	ser	A
	val→ser	ser	asp	gly→scys	ser	G
	val→ser	asp	asp	gly→asp	asp	T
	val	ala	glu	gly	!	C

Table 15c: Small letter special sign genetic code resulting from T-C symmetry breaking. The replacements $X \rightarrow Y$ tell how the code in the sector of ordinary DNAs is obtained from the capital letter code.

Product model for the small letter code with 20 amino-acids and 80 generalized DNAs

The number theoretical model generalizes for the codes defined by 64 ordinary DNAs + 16 DNAs of form $XT_S Y$ and assuming that besides 20 amino-acids there are 3 additional modified amino-acids. A small letter-special symbol code with 80 DNAs and 20 amino-acids is obtained from 23-amino-acid code by assuming that the exotic DNAs coding for special signs !, & and period code for stopping sign and the previous construction for 2×12 code works as such. Oppose option with 64 DNAs (special signs being not interpreted as belonging to the code) and 18 amino-acids is in conflict with the requirement of a maximal expressive power. My personal conviction is that this option can be safely forgotten.

Why the numbers 64 and 80?

The dark matter hierarchy based on the hierarchy of increasing values of Planck constant predicts that the entire universe is a macroscopic quantum system and elementary particles have a hierarchy of zoomed up variants with arbitrarily large Compton length (proportional to \hbar) [16]. Dark matter should be especially important for living matter and life should therefore involve fundamental physics in an essential manner rather than emerge at some very high level of complexity. Hence one can ask whether the numbers 64 and 80 for the codons of the two codes could reflect basic facts about fundamental physics in TGD Universe. The following numerological argument based on detailed counting of particle states encourages to take this idea half-seriously at least.

1. Gravitons and more general stringy states are not counted since they correspond to bound states of fermions and bosons connected by flux tubes. Color is counted neither since it corresponds to CP_2 partial wave and is not spin like degree of freedom in TGD framework. Family replication phenomenon has a topological explanation and is counted neither. This leaves only spinorial degrees of freedom which according to TGD inspired theory of consciousness are responsible for Boolean representations using fermionic Fock states. The natural guess is that these fermionic degrees of freedom might relate to the genetic code or genetic code might represent them.
2. TGD predicts in purely spinorial degrees of freedom 8 lepton states (lepton and anti-lepton both having 4 states due to spin and electro-weak isospin). Also phase conjugates of these states are predicted so that $8+8=16$ states are obtained. The number of spinor states is same in the quark sector. This gives $16+16=32$ states altogether.

3. Bosons are identifiable as tiny wormhole contacts carrying fermion and anti-fermion numbers at the light-like wormhole throats. Essentially lepto-antilepton and quark-antiquark pairs or their superpositions are in question. $(2+1) \times (3+1) = 12$ leptonic and 12 quark like bosons with spin and electro-weak isospin equal to 1 or 0 (only two massless spin states are possible). Together with phase conjugates this makes $24+24=48$ states. 24 of them correspond to ordinary electro-weak gauge bosons and Higgs and the remaining 24 are exotic bosons with charge matrices orthogonal to the charge matrices of electro-weak gauge bosons. For exotic counterparts of W bosons and Higgs the sign of the coupling to quarks is opposite. For photon and Z^0 also the relative magnitudes of the couplings to quarks much change. The total number of bosonic states is 48 and the number of all particle states in this sense is $48+16+16=80$. If quarks are dropped from consideration the number is 64.
4. The numerological question is whether the 64 ordinary genetic codons are in some deeper sense in one-one correspondence with 48 color singlet gauge bosons and 16 lepton states and the 80 codons of the extended code in one-one correspondence with all states constructed in this manner.

7.4.6 Imbedding of the amino-acid space into DNA space and the universal part of the genetic code

The concrete geometric formulation for the symmetries is based on the imbedding of 20+1 generalized amino-acids to the space of 64 DNAs. Obviously, the amino-acids are coded by the DNAs to which they are mapped by this imbedding. There is indeed an imbedding of 20 amino-acids plus stopping sign with 2×10 structure to the set of 64 DNA triplets which have 4×16 structure. 2 is imbedded into 4 which corresponds to the 4 last bases of DNA and 10 into 16 which corresponds to 16 pairs of first two bases of DNA. The lacking amino-acid is embedded as a kind of outsider for 64 DNA codes. In case of 80 DNA-24 generalized amino-acid code this imbedding is replaced with the imbedding of 2 amino-acids to 4 and 12 to $16+2$ structure.

This kind of imbedding would be regarded in the language of mathematician as a discrete bundle structure which is also singular in the sense that the fiber above a given base point does not always have the same number of points. The 10×2 and 16×4 compositions suggest the interpretation as the imbedding of the space formed by 10 points of 2-D space-time to the space formed by 16 points of 4-D space-time. Analogous interpretation applies also in the case of the extended codes.

The interpretation conforms with the general idea that DNA represents a plan and involves intentionality and time dimension somehow. The amino-acids coded by several DNAs correspond to surfaces for several time values correspond to the same spatial point represented by amino-acid. The set of DNAs coding single amino-acid brings in mind the notion of 'association sequence' defined as a disjoint union of space-like 3-surfaces with time-like separations and possible by the classical non-determinism of the Kähler action absolutely crucial for understanding consciousness in TGD framework [26]. The number of DNAs coding the amino-acid would measure the degree of intentionality involved with it: each DNA associated with the amino-acid would symbolize one step in a plan. Some of alien amino-acids would be highly intentional: the degeneracies can be as high as 13 to be compared to the maximal degeneracy of 6 for our code!

Consider now in more detail this structure.

1. Exact A-G gauge symmetry implies that the pairs (XYA, XYG) form fibers and one can choose freely XYA or XYG to represent the amino-acid. In case of T-C symmetry symmetry breaking can select either XYT or XYC uniquely as a representative of the amino-acid.
2. For amino-acid coded by two DNAs only the identification of the amino-acid is unique apart from the possible gauge symmetry. For $n > 2$ -plets the identification involves non-uniqueness.
3. The requirement that the imbedding of amino-acids to DNA space is universal allows to fix identification uniquely in case of $n > 2$ -plets. It turns out that one can assume universal imbedding to make sense for both terrestrial and alien codes (if the replacements $cys \rightarrow scys$ and $lys \rightarrow plys$ possibly occurring for the small letter + special sign code are appropriately interpreted). This assumption fixes the imbedding highly uniquely and the only uncertainties relate to the T-C symmetry breaking. The possibility to choose the universal part of the code table to be the same

for all codes, suggests that the proposed model catches something essential. It is also difficult to imagine that a randomly generated ASCII message could allow interpretation in terms of genetic codes having so high symmetry properties and common construction principles. The table below summarizes the universal part of the genetic code resulting from the imbedding of the amino-acid space to DNA space. Also small letter code is included.

	A	G	T	C	T_S	
A	phe	ser	tyr	cys (scys)	.	A
						G
						T
	leu		stop	trp		C
G		pro	his	arg		A
						G
						T
			gln			C
T	ile	thr	asn			A
						G
						T
	met	thr	lys (plys)		&	C
C			asp			A
						G
						T
	val	ala	glu	gly	!	C

Table 16: A possible imbedding of the amino-acid space to the DNA space. The gauge choice XYA allowed by A-G gauge invariance of the last codon is made. The identification is same for both our code, capital letter code, and small letter plus special sign code. There is some uncertainty related to the T-C symmetry breaking.

7.4.7 Summary

To sum up, both the terrestrial and hypothetical alien genetic codes can be constructed from the A-G and T-C symmetric product codes by assuming a breaking of both product- and T-C symmetries. Product structure and symmetries suggests strongly that genetic codes have evolved as a fusion of much simpler doublet and singlet codes. Hydrophilic-hydrophobic dichotomy is a good candidate for the dichotomy implied by the 2×10 product structure. The assumption that the breaking of the product symmetry induced by the "volume preserving flow" in DNA space tending to cluster amino-acids in the vertical direction of the code table is universal, and the hypothesis that the imbedding of the amino-acid space to the DNA space is universal, together fix the identification of the codes highly uniquely.

The small letter-special symbol code with 80 DNAs and 23 amino-acids is favored because it maximizes both the information content and the expressive power of the code. The degenerate code with 80 DNAs and 20 amino-acids is obtained from the 23-amino-acid code by assuming that the exotic DNAs coding for special signs !, & and period code for stopping sign. To my own opinion the OPpose option for the small letter code with 80 DNAs and 23 amino-acids is the most plausible alternative.

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I will sooner or later invent the means of establishing communications with aliens (the third bottle of champaign). I would also want to thank the ITs responsible for these charming Chilbolton and Crabwood crop formations. If I only knew their names! As an underground intellectual myself, I hope that amplitude modulated micro-waves or whatever from my computer could mediate my deep gratitude and warm greetings to this underground intelligentsia.

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Chapter 1

Appendix

A-1 Basic properties of CP_2

A-1.1 CP_2 as a manifold

CP_2 , the complex projective space of two complex dimensions, is obtained by identifying the points of complex 3-space C^3 under the projective equivalence

$$(z^1, z^2, z^3) \equiv \lambda(z^1, z^2, z^3) . \quad (\text{A-1.1})$$

Here λ is any non-zero complex number. Note that CP_2 can be also regarded as the coset space $SU(3)/U(2)$. The pair z^i/z^j for fixed j and $z^i \neq 0$ defines a complex coordinate chart for CP_2 . As j runs from 1 to 3 one obtains an atlas of three coordinate charts covering CP_2 , the charts being holomorphically related to each other (e.g. CP_2 is a complex manifold). The points $z^3 \neq 0$ form a subset of CP_2 homeomorphic to R^4 and the points with $z^3 = 0$ a set homeomorphic to S^2 . Therefore CP_2 is obtained by "adding the 2-sphere at infinity to R^4 ".

Besides the standard complex coordinates $\xi^i = z^i/z^3$, $i = 1, 2$ the coordinates of Eguchi and Freund [16] will be used and their relation to the complex coordinates is given by

$$\begin{aligned} \xi^1 &= z + it , \\ \xi^2 &= x + iy . \end{aligned} \quad (\text{A-1.2})$$

These are related to the "spherical coordinates" via the equations

$$\begin{aligned} \xi^1 &= r \exp\left(i \frac{(\Psi + \Phi)}{2}\right) \cos\left(\frac{\Theta}{2}\right) , \\ \xi^2 &= r \exp\left(i \frac{(\Psi - \Phi)}{2}\right) \sin\left(\frac{\Theta}{2}\right) . \end{aligned} \quad (\text{A-1.3})$$

The ranges of the variables r, Θ, Φ, Ψ are $[0, \infty], [0, \pi], [0, 4\pi], [0, 2\pi]$ respectively.

Considered as a real four-manifold CP_2 is compact and simply connected, with Euler number Euler number 3, Pontryagin number 3 and second $b = 1$.

A-1.2 Metric and Kähler structure of CP_2

In order to obtain a natural metric for CP_2 , observe that CP_2 can be thought of as a set of the orbits of the isometries $z^i \rightarrow \exp(i\alpha)z^i$ on the sphere S^5 : $\sum z^i \bar{z}^i = R^2$. The metric of CP_2 is obtained by projecting the metric of S^5 orthogonally to the orbits of the isometries. Therefore the distance between the points of CP_2 is that between the representative orbits on S^5 .

The line element has the following form in the complex coordinates

$$ds^2 = g_{a\bar{b}} d\xi^a d\bar{\xi}^b , \quad (\text{A-1.4})$$

where the Hermitian, in fact Kähler metric $g_{a\bar{b}}$ is defined by

$$g_{a\bar{b}} = R^2 \partial_a \partial_{\bar{b}} K , \quad (\text{A-1.5})$$

where the function K , Kähler function, is defined as

$$\begin{aligned} K &= \log(F) , \\ F &= 1 + r^2 . \end{aligned} \quad (\text{A-1.6})$$

The Kähler function for S^2 has the same form. It gives the S^2 metric $dzd\bar{z}/(1+r^2)^2$ related to its standard form in spherical coordinates by the coordinate transformation $(r, \phi) = (\tan(\theta/2), \phi)$.

The representation of the CP_2 metric is deducible from S^5 metric is obtained by putting the angle coordinate of a geodesic sphere constant in it and is given

$$\frac{ds^2}{R^2} = \frac{(dr^2 + r^2 \sigma_3^2)}{F^2} + \frac{r^2(\sigma_1^2 + \sigma_2^2)}{F} , \quad (\text{A-1.7})$$

where the quantities σ_i are defined as

$$\begin{aligned} r^2 \sigma_1 &= \text{Im}(\xi^1 d\xi^2 - \xi^2 d\xi^1) , \\ r^2 \sigma_2 &= -\text{Re}(\xi^1 d\xi^2 - \xi^2 d\xi^1) , \\ r^2 \sigma_3 &= -\text{Im}(\xi^1 d\bar{\xi}^1 + \xi^2 d\bar{\xi}^2) . \end{aligned} \quad (\text{A-1.8})$$

R denotes the radius of the geodesic circle of CP_2 . The vierbein forms, which satisfy the defining relation

$$s_{kl} = R^2 \sum_A e_k^A e_l^A , \quad (\text{A-1.9})$$

are given by

$$\begin{aligned} e^0 &= \frac{dr}{F} , & e^1 &= \frac{r\sigma_1}{\sqrt{F}} , \\ e^2 &= \frac{r\sigma_2}{\sqrt{F}} , & e^3 &= \frac{r\sigma_3}{F} . \end{aligned} \quad (\text{A-1.10})$$

The explicit representations of vierbein vectors are given by

$$\begin{aligned} e^0 &= \frac{dr}{F} , & e^1 &= \frac{r(\sin\Theta \cos\Psi d\Phi + \sin\Psi d\Theta)}{2\sqrt{F}} , \\ e^2 &= \frac{r(\sin\Theta \sin\Psi d\Phi - \cos\Psi d\Theta)}{2\sqrt{F}} , & e^3 &= \frac{r(d\Psi + \cos\Theta d\Phi)}{2F} . \end{aligned} \quad (\text{A-1.11})$$

The explicit representation of the line element is given by the expression

$$ds^2/R^2 = \frac{dr^2}{F^2} + \frac{r^2}{4F^2} (d\Psi + \cos\Theta d\Phi)^2 + \frac{r^2}{4F} (d\Theta^2 + \sin^2\Theta d\Phi^2) . \quad (\text{A-1.12})$$

The vierbein connection satisfying the defining relation

$$de^A = -V_B^A \wedge e^B, \tag{A-1.13}$$

is given by

$$\begin{aligned} V_{01} &= -\frac{e^1}{r}, & V_{23} &= \frac{e^1}{r_2}, \\ V_{02} &= -\frac{e^2}{r}, & V_{31} &= \frac{e^2}{r}, \\ V_{03} &= (r - \frac{1}{r})e^3, & V_{12} &= (2r + \frac{1}{r})e^3. \end{aligned} \tag{A-1.14}$$

The representation of the covariantly constant curvature tensor is given by

$$\begin{aligned} R_{01} &= e^0 \wedge e^1 - e^2 \wedge e^3, & R_{23} &= e^0 \wedge e^1 - e^2 \wedge e^3, \\ R_{02} &= e^0 \wedge e^2 - e^3 \wedge e^1, & R_{31} &= -e^0 \wedge e^2 + e^3 \wedge e^1, \\ R_{03} &= 4e^0 \wedge e^3 + 2e^1 \wedge e^2, & R_{12} &= 2e^0 \wedge e^3 + 4e^1 \wedge e^2. \end{aligned} \tag{A-1.15}$$

Metric defines a real, covariantly constant, and therefore closed 2-form J

$$J = -ig_{a\bar{b}}d\xi^a d\bar{\xi}^b, \tag{A-1.16}$$

the so called Kähler form. Kähler form J defines in CP_2 a symplectic structure because it satisfies the condition

$$J^k_r J^{rl} = -s^{kl}. \tag{A-1.17}$$

The form J is integer valued and by its covariant constancy satisfies free Maxwell equations. Hence it can be regarded as a curvature form of a $U(1)$ gauge potential B carrying a magnetic charge of unit $1/2g$ (g denotes the gauge coupling). Locally one has therefore

$$J = dB, \tag{A-1.18}$$

where B is the so called Kähler potential, which is not defined globally since J describes homological magnetic monopole.

It should be noticed that the magnetic flux of J through a 2-surface in CP_2 is proportional to its homology equivalence class, which is integer valued. The explicit representations of J and B are given by

$$\begin{aligned} B &= 2re^3, \\ J &= 2(e^0 \wedge e^3 + e^1 \wedge e^2) = \frac{r}{F^2} dr \wedge (d\Psi + \cos\Theta d\Phi) + \frac{r^2}{2F} \sin\Theta d\Theta d\Phi. \end{aligned} \tag{A-1.19}$$

The vierbein curvature form and Kähler form are covariantly constant and have in the complex coordinates only components of type (1,1).

Useful coordinates for CP_2 are the so called canonical coordinates in which Kähler potential and Kähler form have very simple expressions

$$\begin{aligned} B &= \sum_{k=1,2} P_k dQ_k, \\ J &= \sum_{k=1,2} dP_k \wedge dQ_k. \end{aligned} \tag{A-1.20}$$

The relationship of the canonical coordinates to the "spherical" coordinates is given by the equations

$$\begin{aligned}
P_1 &= -\frac{1}{1+r^2} , \\
P_2 &= \frac{r^2 \cos \Theta}{2(1+r^2)} , \\
Q_1 &= \Psi , \\
Q_2 &= \Phi .
\end{aligned} \tag{A-1.21}$$

A-1.3 Spinors in CP_2

CP_2 doesn't allow spinor structure in the conventional sense [19]. However, the coupling of the spinors to a half odd multiple of the Kähler potential leads to a respectable spinor structure. Because the delicacies associated with the spinor structure of CP_2 play a fundamental role in TGD, the arguments of Hawking are repeated here.

To see how the space can fail to have an ordinary spinor structure consider the parallel transport of the vierbein in a simply connected space M . The parallel propagation around a closed curve with a base point x leads to a rotated vierbein at x : $e^A = R_B^A e^B$ and one can associate to each closed path an element of $SO(4)$.

Consider now a one-parameter family of closed curves $\gamma(v) : v \in (0, 1)$ with the same base point x and $\gamma(0)$ and $\gamma(1)$ trivial paths. Clearly these paths define a sphere S^2 in M and the element $R_B^A(v)$ defines a closed path in $SO(4)$. When the sphere S^2 is contractible to a point e.g., homologically trivial, the path in $SO(4)$ is also contractible to a point and therefore represents a trivial element of the homotopy group $\Pi_1(SO(4)) = Z_2$.

For a homologically nontrivial 2-surface S^2 the associated path in $SO(4)$ can be homotopically nontrivial and therefore corresponds to a nonclosed path in the covering group $\text{Spin}(4)$ (leading from the matrix 1 to -1 in the matrix representation). Assume this is the case.

Assume now that the space allows spinor structure. Then one can parallel propagate also spinors and by the above construction associate a closed path of $\text{Spin}(4)$ to the surface S^2 . Now, however this path corresponds to a lift of the corresponding $SO(4)$ path and cannot be closed. Thus one ends up with a contradiction.

From the preceding argument it is clear that one could compensate the non-allowed -1 - factor associated with the parallel transport of the spinor around the sphere S^2 by coupling it to a gauge potential in such a way that in the parallel transport the gauge potential introduces a compensating -1 -factor. For a $U(1)$ gauge potential this factor is given by the exponential $\exp(i2\Phi)$, where Φ is the magnetic flux through the surface. This factor has the value -1 provided the $U(1)$ potential carries half odd multiple of Dirac charge $1/2g$. In case of CP_2 the required gauge potential is half odd multiple of the Kähler potential B defined previously. In the case of $M^4 \times CP_2$ one can in addition couple the spinor components with different chiralities independently to an odd multiple of $B/2$.

A-1.4 Geodesic sub-manifolds of CP_2

Geodesic sub-manifolds are defined as sub-manifolds having common geodesic lines with the imbedding space. As a consequence the second fundamental form of the geodesic manifold vanishes, which means that the tangent vectors h_α^k (understood as vectors of H) are covariantly constant quantities with respect to the covariant derivative taking into account that the tangent vectors are vectors both with respect to H and X^4 .

In [17] a general characterization of the geodesic sub-manifolds for an arbitrary symmetric space G/H is given. Geodesic sub-manifolds are in 1-1-correspondence with the so called Lie triple systems of the Lie-algebra g of the group G . The Lie triple system t is defined as a subspace of g characterized by the closedness property with respect to double commutation

$$[X, [Y, Z]] \in t \text{ for } X, Y, Z \in t . \tag{A-1.22}$$

$SU(3)$ allows, besides geodesic lines, two nonequivalent (not isometry related) geodesic spheres. This is understood by observing that $SU(3)$ allows two nonequivalent $SU(2)$ algebras corresponding to

subgroups $SO(3)$ (orthogonal 3×3 matrices) and the usual isospin group $SU(2)$. By taking any subset of two generators from these algebras, one obtains a Lie triple system and by exponentiating this system, one obtains a 2-dimensional geodesic sub-manifold of CP_2 .

Standard representatives for the geodesic spheres of CP_2 are given by the equations

$$S_I^2 : \xi^1 = \bar{\xi}^2 \text{ or equivalently } (\Theta = \pi/2, \Psi = 0) ,$$

$$S_{II}^2 : \xi^1 = \xi^2 \text{ or equivalently } (\Theta = \pi/2, \Phi = 0) .$$

The non-equivalence of these sub-manifolds is clear from the fact that isometries act as holomorphic transformations in CP_2 . The vanishing of the second fundamental form is also easy to verify. The first geodesic manifold is homologically trivial: in fact, the induced Kähler form vanishes identically for S_I^2 . S_{II}^2 is homologically nontrivial and the flux of the Kähler form gives its homology equivalence class.

A-2 CP_2 geometry and standard model symmetries

A-2.1 Identification of the electro-weak couplings

The delicacies of the spinor structure of CP_2 make it a unique candidate for space S . First, the coupling of the spinors to the $U(1)$ gauge potential defined by the Kähler structure provides the missing $U(1)$ factor in the gauge group. Secondly, it is possible to couple different H -chiralities independently to a half odd multiple of the Kähler potential. Thus the hopes of obtaining a correct spectrum for the electromagnetic charge are considerable. In the following it will be demonstrated that the couplings of the induced spinor connection are indeed those of the GWS model [18] and in particular that the right handed neutrinos decouple completely from the electro-weak interactions.

To begin with, recall that the space H allows to define three different chiralities for spinors. Spinors with fixed H -chirality $e = \pm 1$, CP_2 -chirality l, r and M^4 -chirality L, R are defined by the condition

$$\begin{aligned} \Gamma\Psi &= e\Psi , \\ e &= \pm 1 , \end{aligned} \tag{A-2.1}$$

where Γ denotes the matrix $\Gamma_9 = \gamma_5 \times \gamma_5$, $1 \times \gamma_5$ and $\gamma_5 \times 1$ respectively. Clearly, for a fixed H -chirality CP_2 - and M^4 -chiralities are correlated.

The spinors with H -chirality $e = \pm 1$ can be identified as quark and lepton like spinors respectively. The separate conservation of baryon and lepton numbers can be understood as a consequence of generalized chiral invariance if this identification is accepted. For the spinors with a definite H -chirality one can identify the vielbein group of CP_2 as the electro-weak group: $SO(4) = SU(2)_L \times SU(2)_R$.

The covariant derivatives are defined by the spinorial connection

$$A = V + \frac{B}{2}(n_+ 1_+ + n_- 1_-) . \tag{A-2.2}$$

Here V and B denote the projections of the vielbein and Kähler gauge potentials respectively and $1_{+(-)}$ projects to the spinor H -chirality $+(-)$. The integers n_{\pm} are odd from the requirement of a respectable spinor structure.

The explicit representation of the vielbein connection V and of B are given by the equations

$$\begin{aligned} V_{01} &= -\frac{e^1}{r} , & V_{23} &= \frac{e^1}{r} , \\ V_{02} &= -\frac{e^2}{r} , & V_{31} &= \frac{e^2}{r} , \\ V_{03} &= (r - \frac{1}{r})e^3 , & V_{12} &= (2r + \frac{1}{r})e^3 , \end{aligned} \tag{A-2.3}$$

and

$$B = 2re^3 , \tag{A-2.4}$$

respectively. The explicit representation of the vielbein is not needed here.

Let us first show that the charged part of the spinor connection couples purely left handedly. Identifying Σ_3^0 and Σ_2^1 as the diagonal (neutral) Lie-algebra generators of $SO(4)$, one finds that the charged part of the spinor connection is given by

$$A_{ch} = 2V_{23}I_L^1 + 2V_{13}I_L^2 , \quad (\text{A-2.5})$$

where one have defined

$$\begin{aligned} I_L^1 &= \frac{(\Sigma_{01} - \Sigma_{23})}{2} , \\ I_L^2 &= \frac{(\Sigma_{02} - \Sigma_{13})}{2} . \end{aligned} \quad (\text{A-2.6})$$

A_{ch} is clearly left handed so that one can perform the identification

$$W^\pm = \frac{2(e^1 \pm ie^2)}{r} , \quad (\text{A-2.7})$$

where W^\pm denotes the charged intermediate vector boson.

Consider next the identification of the neutral gauge bosons γ and Z^0 as appropriate linear combinations of the two functionally independent quantities

$$\begin{aligned} X &= re^3 , \\ Y &= \frac{e^3}{r} , \end{aligned} \quad (\text{A-2.8})$$

appearing in the neutral part of the spinor connection. We show first that the mere requirement that photon couples vectorially implies the basic coupling structure of the GWS model leaving only the value of Weinberg angle undetermined.

To begin with let us define

$$\begin{aligned} \bar{\gamma} &= aX + bY , \\ \bar{Z}^0 &= cX + dY , \end{aligned} \quad (\text{A-2.9})$$

where the normalization condition

$$ad - bc = 1 ,$$

is satisfied. The physical fields γ and Z^0 are related to $\bar{\gamma}$ and \bar{Z}^0 by simple normalization factors.

Expressing the neutral part of the spinor connection in term of these fields one obtains

$$\begin{aligned} A_{nc} &= [(c+d)2\Sigma_{03} + (2d-c)2\Sigma_{12} + d(n_+1_+ + n_-1_-)]\bar{\gamma} \\ &+ [(a-b)2\Sigma_{03} + (a-2b)2\Sigma_{12} - b(n_+1_+ + n_-1_-)]\bar{Z}^0 . \end{aligned} \quad (\text{A-2.10})$$

Identifying Σ_{12} and $\Sigma_{03} = 1 \times \gamma_5 \Sigma_{12}$ as vectorial and axial Lie-algebra generators, respectively, the requirement that γ couples vectorially leads to the condition

$$c = -d . \quad (\text{A-2.11})$$

Using this result plus previous equations, one obtains for the neutral part of the connection the expression

$$A_{nc} = \gamma Q_{em} + Z^0(I_L^3 - \sin^2\theta_W Q_{em}) . \quad (\text{A-2.12})$$

Here the electromagnetic charge Q_{em} and the weak isospin are defined by

$$\begin{aligned} Q_{em} &= \Sigma^{12} + \frac{(n_+1_+ + n_-1_-)}{6} , \\ I_L^3 &= \frac{(\Sigma^{12} - \Sigma^{03})}{2} . \end{aligned} \quad (\text{A-2.13})$$

The fields γ and Z^0 are defined via the relations

$$\begin{aligned} \gamma &= 6d\bar{\gamma} = \frac{6}{(a+b)}(aX + bY) , \\ Z^0 &= 4(a+b)\bar{Z}^0 = 4(X - Y) . \end{aligned} \quad (\text{A-2.14})$$

The value of the Weinberg angle is given by

$$\sin^2\theta_W = \frac{3b}{2(a+b)} , \quad (\text{A-2.15})$$

and is not fixed completely. Observe that right handed neutrinos decouple completely from the electro-weak interactions.

The determination of the value of Weinberg angle is a dynamical problem. The angle is completely fixed once the YM action is fixed by requiring that action contains no cross term of type γZ^0 . Pure symmetry non-broken electro-weak YM action leads to a definite value for the Weinberg angle. One can however add a symmetry breaking term proportional to Kähler action and this changes the value of the Weinberg angle.

To evaluate the value of the Weinberg angle one can express the neutral part F_{nc} of the induced gauge field as

$$F_{nc} = 2R_{03}\Sigma^{03} + 2R_{12}\Sigma^{12} + J(n_+1_+ + n_-1_-) , \quad (\text{A-2.16})$$

where one has

$$\begin{aligned} R_{03} &= 2(2e^0 \wedge e^3 + e^1 \wedge e^2) , \\ R_{12} &= 2(e^0 \wedge e^3 + 2e^1 \wedge e^2) , \\ J &= 2(e^0 \wedge e^3 + e^1 \wedge e^2) , \end{aligned} \quad (\text{A-2.17})$$

in terms of the fields γ and Z^0 (photon and Z - boson)

$$F_{nc} = \gamma Q_{em} + Z^0(I_L^3 - \sin^2\theta_W Q_{em}) . \quad (\text{A-2.18})$$

Evaluating the expressions above one obtains for γ and Z^0 the expressions

$$\begin{aligned} \gamma &= 3J - \sin^2\theta_W R_{03} , \\ Z^0 &= 2R_{03} . \end{aligned} \quad (\text{A-2.19})$$

For the Kähler field one obtains

$$J = \frac{1}{3}(\gamma + \sin^2\theta_W Z^0) . \quad (\text{A-2.20})$$

Expressing the neutral part of the symmetry broken YM action

$$\begin{aligned} L_{ew} &= L_{sym} + f J^{\alpha\beta} J_{\alpha\beta} , \\ L_{sym} &= \frac{1}{4g^2} Tr(F^{\alpha\beta} F_{\alpha\beta}) , \end{aligned} \quad (A-2.21)$$

where the trace is taken in spinor representation, in terms of γ and Z^0 one obtains for the coefficient X of the γZ^0 cross term (this coefficient must vanish) the expression

$$\begin{aligned} X &= -\frac{K}{2g^2} + \frac{fp}{18} , \\ K &= Tr [Q_{em}(I_L^3 - \sin^2\theta_W Q_{em})] , \end{aligned} \quad (A-2.22)$$

In the general case the value of the coefficient K is given by

$$K = \sum_i \left[-\frac{(18 + 2n_i^2)\sin^2\theta_W}{9} \right] , \quad (A-2.23)$$

where the sum is over the spinor chiralities, which appear as elementary fermions and n_i is the integer describing the coupling of the spinor field to the Kähler potential. The cross term vanishes provided the value of the Weinberg angle is given by

$$\sin^2\theta_W = \frac{9 \sum_i 1}{(fg^2 + 2 \sum_i (18 + n_i^2))} . \quad (A-2.24)$$

In the scenario where both leptons and quarks are elementary fermions the value of the Weinberg angle is given by

$$\sin^2\theta_W = \frac{9}{(\frac{fg^2}{2} + 28)} . \quad (A-2.25)$$

The bare value of the Weinberg angle is $9/28$ in this scenario, which is quite close to the typical value $9/24$ of GUTs [20].

A-2.2 Discrete symmetries

The treatment of discrete symmetries C, P, and T is based on the following requirements:

- Symmetries must be realized as purely geometric transformations.
- Transformation properties of the field variables should be essentially the same as in the conventional quantum field theories [15].

The action of the reflection P on spinors is given by

$$\Psi \rightarrow P\Psi = \gamma^0 \otimes \gamma^0 \Psi . \quad (A-2.26)$$

in the representation of the gamma matrices for which γ^0 is diagonal. It should be noticed that W and Z^0 bosons break parity symmetry as they should since their charge matrices do not commute with the matrix of P .

The guess that a complex conjugation in CP_2 is associated with T transformation of the physicist turns out to be correct. One can verify by a direct calculation that pure Dirac action is invariant under T realized according to

$$\begin{aligned} m^k &\rightarrow T(M^k) , \\ \xi^k &\rightarrow \bar{\xi}^k , \\ \Psi &\rightarrow \gamma^1 \gamma^3 \otimes 1 \Psi . \end{aligned} \quad (A-2.27)$$

The operation bearing closest resemblance to the ordinary charge conjugation corresponds geometrically to complex conjugation in CP_2 :

$$\begin{aligned}\xi^k &\rightarrow \bar{\xi}^k, \\ \Psi &\rightarrow \Psi^\dagger \gamma^2 \gamma^0 \otimes 1.\end{aligned}\tag{A-2.28}$$

As one might have expected symmetries CP and T are exact symmetries of the pure Dirac action.

A-3 Basic facts about induced gauge fields

Since the classical gauge fields are closely related in TGD framework, it is not possible to have space-time sheets carrying only single kind of gauge field. For instance, em fields are accompanied by Z^0 fields for extremals of Kähler action. Weak forces is however absent unless the space-time sheets contains topologically condensed exotic weakly charged particles responding to this force. Same applies to classical color forces. The fact that these long range fields are present forces to assume that there exists a hierarchy of scaled up variants of standard model physics identifiable in terms of dark matter.

Classical em fields are always accompanied by Z^0 field and some components of color gauge field. For extremals having homologically non-trivial sphere as a CP_2 projection em and Z^0 fields are the only non-vanishing electroweak gauge fields. For homologically trivial sphere only W fields are non-vanishing. Color rotations does not affect the situation.

For vacuum extremals all electro-weak gauge fields are in general non-vanishing although the net gauge field has $U(1)$ holonomy by 2-dimensionality of the CP_2 projection. Color gauge field has $U(1)$ holonomy for all space-time surfaces and quantum classical correspondence suggest a weak form of color confinement meaning that physical states correspond to color neutral members of color multiplets.

A-3.1 Induced gauge fields for space-times for which CP_2 projection is a geodesic sphere

If one requires that space-time surface is an extremal of Kähler action and has a 2-dimensional CP_2 projection, only vacuum extremals and space-time surfaces for which CP_2 projection is a geodesic sphere, are allowed. Homologically non-trivial geodesic sphere correspond to vanishing W fields and homologically non-trivial sphere to non-vanishing W fields but vanishing γ and Z^0 . This can be verified by explicit examples.

$r = \infty$ surface gives rise to a homologically non-trivial geodesic sphere for which e_0 and e_3 vanish imply the vanishing of W field. For space-time sheets for which CP_2 projection is $r = \infty$ homologically non-trivial geodesic sphere of CP_2 one has

$$\gamma = \left(\frac{3}{4} - \frac{\sin^2(\theta_W)}{2}\right)Z^0 \simeq \frac{5Z^0}{8}.$$

The induced W fields vanish in this case and they vanish also for all geodesic sphere obtained by $SU(3)$ rotation.

$Im(\xi^1) = Im(\xi^2) = 0$ corresponds to homologically trivial geodesic sphere. A more general representative is obtained by using for the phase angles of standard complex CP_2 coordinates constant values. In this case e^1 and e^3 vanish so that the induced em, Z^0 , and Kähler fields vanish but induced W fields are non-vanishing. This holds also for surfaces obtained by color rotation. Hence one can say that for non-vacuum extremals with 2-D CP_2 projection color rotations and weak symmetries commute.

A-3.2 Space-time surfaces with vanishing em, Z^0 , or Kähler fields

In the following the induced gauge fields are studied for general space-time surface without assuming the extremal property. In fact, extremal property reduces the study to the study of vacuum extremals and surfaces having geodesic sphere as a CP_2 projection and in this sense the following arguments are somewhat obsolete in their generality.

Space-times with vanishing em, Z^0 , or Kähler fields

The following considerations apply to a more general situation in which the homologically trivial geodesic sphere and extremal property are not assumed. It must be emphasized that this case is possible in TGD framework only for a vanishing Kähler field.

Using spherical coordinates (r, Θ, Ψ, Φ) for CP_2 , the expression of Kähler form reads as

$$\begin{aligned} J &= \frac{r}{F^2} dr \wedge (d\Psi + \cos(\Theta)d\Phi) + \frac{r^2}{2F} \sin(\Theta)d\Theta \wedge d\Phi , \\ F &= 1 + r^2 . \end{aligned} \quad (\text{A-3.1})$$

The general expression of electromagnetic field reads as

$$\begin{aligned} F_{em} &= (3 + 2p) \frac{r}{F^2} dr \wedge (d\Psi + \cos(\Theta)d\Phi) + (3 + p) \frac{r^2}{2F} \sin(\Theta)d\Theta \wedge d\Phi , \\ p &= \sin^2(\Theta_W) , \end{aligned} \quad (\text{A-3.2})$$

where Θ_W denotes Weinberg angle.

a) The vanishing of the electromagnetic fields is guaranteed, when the conditions

$$\begin{aligned} \Psi &= k\Phi , \\ (3 + 2p) \frac{1}{r^2 F} (d(r^2)/d\Theta)(k + \cos(\Theta)) + (3 + p) \sin(\Theta) &= 0 , \end{aligned} \quad (\text{A-3.3})$$

hold true. The conditions imply that CP_2 projection of the electromagnetically neutral space-time is 2-dimensional. Solving the differential equation one obtains

$$\begin{aligned} r &= \sqrt{\frac{X}{1-X}} , \\ X &= D \left[\left| \frac{k+u}{C} \right| \right]^\epsilon , \\ u &\equiv \cos(\Theta) , \quad C = k + \cos(\Theta_0) , \quad D = \frac{r_0^2}{1+r_0^2} , \quad \epsilon = \frac{3+p}{3+2p} , \end{aligned} \quad (\text{A-3.4})$$

where C and D are integration constants. $0 \leq X \leq 1$ is required by the reality of r . $r = 0$ would correspond to $X = 0$ giving $u = -k$ achieved only for $|k| \leq 1$ and $r = \infty$ to $X = 1$ giving $|u+k| = [(1+r_0^2)/r_0^2]^{(3+2p)/(3+p)}$ achieved only for

$$\text{sign}(u+k) \times \left[\frac{1+r_0^2}{r_0^2} \right]^{\frac{3+2p}{3+p}} \leq k+1 ,$$

where $\text{sign}(x)$ denotes the sign of x .

The expressions for Kähler form and Z^0 field are given by

$$\begin{aligned} J &= -\frac{p}{3+2p} X du \wedge d\Phi , \\ Z^0 &= -\frac{6}{p} J . \end{aligned} \quad (\text{A-3.5})$$

The components of the electromagnetic field generated by varying vacuum parameters are proportional to the components of the Kähler field: in particular, the magnetic field is parallel to the Kähler magnetic field. The generation of a long range Z^0 vacuum field is a purely TGD based feature not encountered in the standard gauge theories.

b) The vanishing of Z^0 fields is achieved by the replacement of the parameter ϵ with $\epsilon = 1/2$ as becomes clear by considering the condition stating that Z^0 field vanishes identically. Also the relationship $F_{em} = 3J = -\frac{3}{4} \frac{r^2}{F} du \wedge d\Phi$ is useful.

c) The vanishing Kähler field corresponds to $\epsilon = 1, p = 0$ in the formula for em neutral space-times. In this case classical em and Z^0 fields are proportional to each other:

$$\begin{aligned} Z^0 &= 2e^0 \wedge e^3 = \frac{r}{F^2}(k+u) \frac{\partial r}{\partial u} du \wedge d\Phi = (k+u) du \wedge d\Phi \ , \\ r &= \sqrt{\frac{X}{1-X}} \ , \ X = D|k+u| \ , \\ \gamma &= -\frac{p}{2} Z^0 \ . \end{aligned} \tag{A-3.6}$$

For a vanishing value of Weinberg angle ($p = 0$) em field vanishes and only Z^0 field remains as a long range gauge field. Vacuum extremals for which long range Z^0 field vanishes but em field is non-vanishing are not possible.

The effective form of CP_2 metric for surfaces with 2-dimensional CP_2 projection

The effective form of the CP_2 metric for a space-time having vanishing em, Z^0 , or Kähler field is of practical value in the case of vacuum extremals and is given by

$$\begin{aligned} ds_{eff}^2 &= (s_{rr}(\frac{dr}{d\Theta})^2 + s_{\Theta\Theta})d\Theta^2 + (s_{\Phi\Phi} + 2ks_{\Phi\Psi})d\Phi^2 = \frac{R^2}{4}[s_{\Theta\Theta}^{eff}d\Theta^2 + s_{\Phi\Phi}^{eff}d\Phi^2] \ , \\ s_{\Theta\Theta}^{eff} &= X \times \left[\frac{\epsilon^2(1-u^2)}{(k+u)^2} \times \frac{1}{1-X} + 1 - X \right] \ , \\ s_{\Phi\Phi}^{eff} &= X \times [(1-X)(k+u)^2 + 1 - u^2] \ , \end{aligned} \tag{A-3.7}$$

and is useful in the construction of vacuum imbedding of, say Schwartzchild metric.

Topological quantum numbers

Space-times for which either em, Z^0 , or Kähler field vanishes decompose into regions characterized by six vacuum parameters: two of these quantum numbers (ω_1 and ω_2) are frequency type parameters, two (k_1 and k_2) are wave vector like quantum numbers, two of the quantum numbers (n_1 and n_2) are integers. The parameters ω_i and n_i will be referred as electric and magnetic quantum numbers. The existence of these quantum numbers is not a feature of these solutions alone but represents a much more general phenomenon differentiating in a clear cut manner between TGD and Maxwell's electrodynamics.

The simplest manner to avoid surface Kähler charges and discontinuities or infinities in the derivatives of CP_2 coordinates on the common boundary of two neighboring regions with different vacuum quantum numbers is topological field quantization, 3-space decomposes into disjoint topological field quanta, 3-surfaces having outer boundaries with possibly macroscopic size.

Under rather general conditions the coordinates Ψ and Φ can be written in the form

$$\begin{aligned} \Psi &= \omega_2 m^0 + k_2 m^3 + n_2 \phi + \text{Fourier expansion} \ , \\ \Phi &= \omega_1 m^0 + k_1 m^3 + n_1 \phi + \text{Fourier expansion} \ . \end{aligned} \tag{A-3.8}$$

m^0, m^3 and ϕ denote the coordinate variables of the cylindrical M^4 coordinates) so that one has $k = \omega_2/\omega_1 = n_2/n_1 = k_2/k_1$. The regions of the space-time surface with given values of the vacuum parameters ω_i, k_i and n_i and m and C are bounded by the surfaces at which space-time surface becomes ill-defined, say by $r > 0$ or $r < \infty$ surfaces.

The space-time surface decomposes into regions characterized by different values of the vacuum parameters r_0 and Θ_0 . At $r = \infty$ surfaces n_2, ω_2 and m can change since all values of Ψ correspond to the same point of CP_2 : at $r = 0$ surfaces also n_1 and ω_1 can change since all values of Φ correspond to same point of CP_2 , too. If $r = 0$ or $r = \infty$ is not in the allowed range space-time surface develops a boundary.

This implies what might be called topological quantization since in general it is not possible to find a smooth global imbedding for, say a constant magnetic field. Although global imbedding exists

it decomposes into regions with different values of the vacuum parameters and the coordinate u in general possesses discontinuous derivative at $r = 0$ and $r = \infty$ surfaces. A possible manner to avoid edges of space-time is to allow field quantization so that 3-space (and field) decomposes into disjoint quanta, which can be regarded as structurally stable units a 3-space (and of the gauge field). This doesn't exclude partial join along boundaries for neighboring field quanta provided some additional conditions guaranteeing the absence of edges are satisfied.

For instance, the vanishing of the electromagnetic fields implies that the condition

$$\Omega \equiv \frac{\omega_2}{n_2} - \frac{\omega_1}{n_1} = 0 \quad , \quad (\text{A-3.9})$$

is satisfied. In particular, the ratio ω_2/ω_1 is rational number for the electromagnetically neutral regions of space-time surface. The change of the parameter n_1 and n_2 (ω_1 and ω_2) in general generates magnetic field and therefore these integers will be referred to as magnetic (electric) quantum numbers.

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