

Sheldrake's Morphic Fields and TGD View about Quantum Biology

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1 Introduction

I received two books of Rupert Sheldrake as a gift from Marc McWilliams, who has for years helped me by reporting about problems at my homepage and sending links to interesting articles. The titles of the books of Sheldrake are "*A new Science of Life: the Hypothesis of Formative Causation* [2] and "*The Presence of the Past: Morphic Resonance and Habits of Nature*" [3]. The titles reveal the two basic notions underlying the vision of Sheldrake.

What makes the study of the books so rewarding is that Sheldrake starts from problems of the existing paradigm, analyzes them thoroughly, and proposes solutions in the framework provided by his vision. There is no need to accept Sheldrake's views, just the reading of his arguments teaches a lot about the fundamental ideas and dogmas underlying recent day biology and forces the reader to realize how little we really know - not only about biology but even about so called established areas of physics such as condensed matter physics. These books are precious gems for anyone trying to build overall view.

2 Habits of Nature

The idea that Nature would have habits just as we do is probably one of those aspects which generate most irritation in physicalists believing that Nature is governed by deterministic laws with classical determinism replaced with quantum statistical determinism. Sheldrake is one of those very few scientists able to see the reality rather than only the model of reality. Morphic resonance would make possible to establish the habits of Nature and the past would determine to high extent the present but on organic manner and in totally different sense as in the world of physicalist.

2.1 Some problems of biology

It is instructive to consider as an example the first chapter of the book about formative causation discussing the basic problems of biology. Sheldrake's proposal is that something more than organic chemistry is needed to understand living systems. He assigns to this something the notions of formative causation, morphic fields, and morphic resonance. In the following brief summary I refer also to some TGD inspired proposals for the needed new notions as remarks.

1. First Sheldrake discusses first the standard mechanistic view which does not accept any "vital factors" or goal directedness but just the blind chemistry based on random change and choice but implicitly brings in these factors as genetic programs. In neuroscience one introduces computer paradigm without realizing that computers by definition are systems whose goal is to solve a problem mechanically. The goal is of course not posed by the computer but by its builder. One important aspect of the vision is the idea about chemically operated switches (they could be non-coding DNA sequences) switching genes on and off. Morphogenesis could be seen as differentiation in which genes are switched on and off to produce a particular body part. A fairy tale in which the hero receives a key to open the next door to receive a new key to open... is very attractive metaphor for morphogenesis as a chemical process. This idea is very powerful but might not be all that is needed. The question popping up automatically is "Who turns the switches on and off?".

Note that assigning the information about organism to its genome is very near to the idea about organism as hologram. More generally, the idea about germ cell as a hologram representing some essential aspects about the organism is very attractive. There would no need to assign this information to genes or DNA alone. This would be more refined form of the naive idea that there is some kind of miniature representation of the fully developed organism realized in germ cells level.

2. Sheldrake discusses four problems of morphogenesis.
 - (a) The first problem of morphogenesis is its stability - one speaks about regulation. In some experiments second cell of two-celled embryo is destroyed but the embryo still develops to a full organism albeit with abnormally small size. One can also fuse several embryos and they develop to single abnormally large organism. This suggests goal directedness. In the fairy tale the hero must overcome all kinds of misfortunes while trying to find the door to which the newest key fits.

Development as a self-organization process depending only weakly on initial conditions might help to understand goal directedness as something only apparent. The basic aspect of self-organization indeed is the weak dependence on initial values: the reason is that dissipation in presence of external energy feed leads to a highly unique outcome. In absence of energy feed all motion ceases! Note however that the notion of self-organization should be also defined precisely. Should we adopt a purely classical view about self-organization based on non-equilibrium thermodynamics or about its quantum counterpart?

- (b) Second problem is how completely new structures (eyes, heart, brain, body parts,...) emerge during morphogenesis. It is very difficult to understand this in terms of genetic code alone. Genes seem to be too rigid structures. In the vision of Sheldrake's (and TGD vision) genes are only the hardware. Also software is needed. The fairy tale about hero with the keys comes in mind. Maybe the keys would be represented by the genes serving as switches activating or de-activating genes? This could mean a highly flexible chemical program since each reaction could proceed only when the preceding reactions have proceeded.

But is morphogenesis only a realization of an existing plan or a genuinely creative process? What happens when something genuine new emerges in the genuine evolutionary process leading to full grown organism? Could non-equilibrium thermodynamics help to conceptualize the situation? In non-equilibrium thermodynamics one has several flow equilibria and the emergence of something genuinely might be seen as emergence of a new flow equilibrium. But is non-equilibrium thermodynamics enough? Is quantum coherence in biological length scales necessary in order to understand the creative aspects of morphogenesis.

- (c) Regeneration is the third problem. Full grown organism is able to regenerate large damaged parts of the organism. Also small pieces of organism can develop to a full organism. The brain of salamander can be split into pieces and these pieces can be shuffled randomly: yet the development leads to a salamander with a healthy brain. Could one regard organisms as hologram like structures with pieces of organisms representing in a good approximation the entire organism?

The recent discoveries showing that the amount of DNA does not correlate much with the evolutionary level force to conclude that DNA alone cannot code for the entire organism. So called homeobox genes thought originally to code the phenotype of the organism are essentially same for all organisms so that something else is definitely involved. Could genetic code combined with self-organization and hologram paradigms be enough? The answer depends much about what we mean with self-organization and with hologram. Or should one interpret DNA as hardware and assume software as something unknown to the recent day physics?

- (d) Reproduction is the fourth problem. It is also clear that a kind of fractal pattern is involved in the sense that the reproduction is scaled up variant of DNA replication and induced by the replication. The idea that everything reduces to DNA replication is attractive but do we really understand DNA replication at the level of first principles? Could it be that replication in some sense reduces to some fundamental process of Nature not yet identified in what we are used to call fundamental physics? Shelldrake suggests that morphic resonance favors the formation of almost copies and therefore replication. Morphic resonance is analogous to the tuning of radio but why this tuning should take place spontaneously? What principle could imply it?

Remark: In TGD framework the notion of generalized Feynman diagram leads to the idea that replication is indeed a key aspect of quantum physics. The 1-D lines of ordinary Feynman diagrams are replaced by 3-D light-like surfaces identifiable as orbits of partonic 2-surfaces. These 2-surfaces can have arbitrarily large sizes and one could assign them even to cell membrane. By strong form of holography these 2-surfaces are very much like holograms representing 4-D physics almost faithfully (the precise characterization of "almost" would require a more technical language telling not much for a non-mathematician). In the vertices of generalized Feynman diagrams the ends of the light-like 3-surfaces are glued together along partonic 2-surfaces. The simplest $1 \rightarrow 2$ vertex representing particle decay or emission has interpretation as a replication of partonic 2-surface. The quantum states associated with the resulting partonic 2-surfaces are not identical but geometrically replication is in question.

Could one identify this process as the fundamental replication process? If so, then replication in living matter would be only special case of a universal process present already in particle physics and distinguished from it only by the enormous complexity involved. This would be of course only the fundamental mechanism of replication. One must also explain why replication occurs.

The idea about self-tuning is highly attractive as a partial explanation for why replication takes place. What tuning makes possible is information transfer and in TGD framework there is temptation to explain tuning in terms of Negentropy Maximization Principle (NMP) [7].

3. The understanding of morphogenesis is difficult but should be child's play as compared to the understanding of behavior. Inherited behavioral patterns - instincts- define the first hard problem. Information is transferred between generations and saying that genes -that is organic chemistry- code this information does not help much. Second problem is the goal directedness of the animal behavior: animals can modify their behavior when something prevents the achievement of the goal. Behavior can be also intelligent: animals can learn new behavioral patterns. This is not in accordance with the idea that behavior is hardwired in the genome.

Remark: Physicist might see behavioral patterns as 4-dimensional patterns resulting in self-organization: characteristic time evolutions. But does this kind of notion make sense? Does it assume additional time? Usually it is thought that self-organization corresponds to an evolution of a 3-D pattern rather than 4-D one. Perhaps TGD based view about time is needed.

The experienced/subjective time is assigned to conscious experience identified as a sequence of quantum jumps defining the basic building brick of conscious existence. Subjective time is not identified with the geometric time although they relate closely to each other- at least in standard wake-up consciousness [1].

Each quantum jump replaces 4-dimensional pattern with a new one and the self-organization patterns in this 4-D sense could correspond to behavioral patterns whereas approximately static 4-D patterns reducing to 3-D patterns would represent morphologies. There are quantum jumps within quantum jumps so that the outcome is a fractal pattern having also interpretation as a self hierarchy. This gives one possible meaning for the "presence of the past" in the title of the second book of Shel Drake. Living matter would be essentially 4-dimensional and the goal directed behavior based on memory would reflect this 4-dimensionality: goal in general case 4-D pattern. In zero energy ontology the arrow of geometric time need not be always the same and signals propagating to geometric past are key element of TGD based view about memory, intentional action, and metabolism [1]. This would represent a new element distinguishing TGD view from Shel Drake's view.

4. The notion of evolution is also problematic. Can microevolution within species explain the evolution of species itself? Or do sudden discontinuous jumps take place? Could evolution involve a genuinely creative aspect? Is there any hope that a choice among random mutations could explain the emergence of a new highly organized morphological or behavioral pattern? Note that exactly the same problem was encountered at the level of morphogenesis and development of individual. Only the time scale is different.

Also adaptive convergence looks mysterious: same structure emerges at different sides of Earth simultaneously. For instance, the emergence of large primates leading to humans took place at widely separated places. This forces to ask whether morphic fields are involved and make entire species an organism so that the evolution is non-local process. This also relates to the idea about bio-system as a hologram. In Shel Drake's vision the simultaneous emergence of new species would reflect the holistic evolution of the entire biosphere.

Remark: In TGD framework the emergence of a completely new structure could involve a phase transition introducing a new level to the hierarchy of Planck constants assignable to a given species. Since the value of Planck constant serves as a measure for evolutionary level, something genuinely new would emerge in the process. The maximal value of Planck constant could allow to characterize the evolutionary level of cell or neuron, organ, organism, population, and even species. The understanding of dark matter would become a prerequisite for the understanding of the living matter.

5. Shel Drake discusses also the origin of minds and parapsychology in this chapter. Morphic fields could obviously relate to mind and make also possible remote mental interactions.

Remark: In TGD framework the theory of living matter involves quantum theory of consciousness as an essential part and the notion of magnetic body carrying dark matter - in particular dark photons- is a good candidate for the counterpart for the morphic fields.

2.2 The notion of morphic field

The notions of morphic field, morphic resonance and formative causation are very interesting and there is considerable support for Shel Drake's vision. The initial motivation for the notion of morphic field was that the same skill discovered by populations located in different parts of the world. Theory leads to idea about learning and memory at the level of species and also to an idea about gene expression at level of species in which remote activation of genome takes place using morphic signals from past. Genome would be the hardware and morphic fields the software.

Shel Drake uses TV as an analogy.

1. Morphic fields would be analogous to radio waves carrying information (say in terms of amplitude or frequency modulation) and could code genetic information and genetic programs. Genes act as antennas and the details of gene expression depend on the value of the tunable antenna frequency. When the antenna frequency changes, the received signal changes and gene expression changes too. Adaptation could correspond to a change of antenna frequency in turn modifying gene

expression as a response to a modified morphic signal. Also epigenetic inheritance could relate to the activation of genes acting as switches for genes. Mutations would correspond to changes in the genome analogous to the changes in the hardware of TV.

2. The tuning to some frequency would be the basic process in brain and is known as entrainment. In fact, even mechanical systems such as clocks are known to entrain to a common rhythm. The physical mechanism for this is not well-understood. Perhaps the entrainment is a fundamental physical process having explanation in terms of NMP (Negentropy Maximization Principle [7]). If so, the idea about tuning would be a generalization of what we already know to take place.
3. The idea about morphic signals from past affecting the gene expression in the genomes of the same species would explain many strange findings discussed by Sheldrake. Morphic signals could silence or activate genes. If there are genes inducing modifications of DNA, then morphic signals could even modify the genome. Species would be kind of hologram: each member would be a representation for the species and genetic expression would be collectively determined.
4. What kind of morphic field patterns are possible? A natural proposal is that DNA sequences can be coded to the spatiotemporal patterns of morphic fields. TGD based realization of morphic fields is one possible realization of his condition. In this case frequency which for a fixed photon energy is coded by the value of Planck constant matters as also the connection defined by magnetic flux tube between molecules involved.

Modern radio-communications code the data to bit sequences represented as temporal patterns of the radio wave. Could the temporal patterns of morphic fields be important and could one imagine some codes? Among other words this would make possible selective communications using passwords. For resonance common antenna frequency would be enough and the experience from computer communications suggests the possibility of a coding based on the representation of bits as pulses but many other codes can be imagined.

Remark: If certain carrier frequencies carry information, NMP would explain why self-tuning occurs.

Sheldrake proposes speculative but fascinating applications of morphic resonance in somewhat unexpected contexts.

1. The fact is that even the formation of simplest crystals is poorly understood for the simple reason that the calculations needed are extremely complex. Simplified models represent larger numbers of crystal structures and it is difficult to understand why only very few crystal forms are realized in Nature. The standard professional folklore among chemists is that once some new chemical compound has been crystallized for the first time its crystallization becomes gradually easier and easier. The obvious looking explanation for this is not however obvious. Could morphic fields select one of the many possible crystal forms? Could crystallization to a specific crystal form be a habit of Nature?
2. Protein folding is second mysterious phenomenon. The mysterious aspect of the process are its deterministic character and its rapidity. The number of possible foldings is astrophysical and one can expect a huge number of local minima of free energy and therefore a huge number of thermodynamically stable foldings. Sheldrake suggests that the interaction with the morphic fields of the environment is part of the process and makes the folding a learned habit.

2.3 Inheritance and morphic fields

Sheldrake discusses inheritance and suggests that besides genetic inheritance and epigenetic inheritance also morphic fields could give rise to a new kind of inheritance. The basic question is whether the acquired characteristics resulting from adaptation could be inherited in some manner. This is usually known as Lamarckian inheritance of acquired characteristics. One can also ask whether adaptations perhaps allowing interpretation as mutations of morphic fields- software- could be transformed to mutations - modifications of the hardware.

1. Epigenetics [1] is the study of the mechanisms inducing changes in gene expression without change in DNA itself. Differentiation of cells is the most obvious example of this kind of process. The suppression of gene expression without altering the DNA sequence of altered genes by DNA methylation or histone deacetylation is one mechanism of epigenesis. Epigenetic changes are preserved in cell division.

Also epigenetic inheritance is possible. This requires that the modification of genes -say methylation of DNA - takes place also at the level of eggs and sperm. For instance, it has been discovered that the effects of famine and diseases can echo to the next generations. The mechanism making this possible is not well-understood and one can ask whether morphic resonance is involved and affects also the eggs and sperm. If so, one could speak about inheritance of acquired characteristics.

2. The notions of dominating and recessive gene are familiar for everyone from school days but very few of us has asked what makes the gene dominant or recessive. Or whether both genes (alleles) could affect the phenotype (say color of the flower) to some degree. Usually the chromosomes appear as non-identical pairs and the members contain corresponding genes (alleles) coming from the parents. These genes are not identical so that they can code different trait for the same phenotype. The question is what chooses which allele is expressed. The usual answer is that the "normal" gene is expressed. But what makes the gene "normal"?

The proposal of Sheldrake is that morphic signals from past force the expression of the normal gene. The normal gene is the one expressed also in the past and for these reason the signal from past supporting the expression of this gene dominates. Gene expression is to some degree like a habit due to majority democratic decision of a 4-D society. It is also possible that both alleles determine the trait. Sheldrake's interpretation would be that in this case both morphic signals can be realized and the outcome is a mixture of traits. Different cells have in this case different habits.

3. Sheldrake discusses also what is known as genetic assimilation discovered by Waddington in his study of fruit flies. Fruit flies are subjected to external stimuli and as a result develop abnormal phenotypes. What happens that when external stimuli are absent the abnormal phenotype still appears. One can consider several explanations.

- (a) Waddington explains this in terms of canalized pathways of development which he calls chreodes. Abnormal chreodes would be so stable that the the absence of stimulus originally inducing them would not affect the situation.

Remark: In TGD framework chreods could correspond to 4-D self-organization patterns depending only weakly on the initial conditions.

- (b) Epigenetic inheritance could explain the phenonenon.
- (c) Also morphic resonance could explain the finding. The morphic signals from previous generations are present and the net signal would favor the continuation of abnormal gene expression. Indeed, Mae-Wan Ho demonstrated that a strain of flies not subjected to the treatment at all also exhibited the abnormal phenotype in absence of the stimuli. Gradually however the normal phenotype wins. Morphic resonance explains this finding whereas epigenetic inheritance fails to do it.

4. Adaptation to an external stimulus (such as X-rays, come chemical, unusual temperature) can produce similar effects on phenotype as a genuine homeotic mutation (say the replacement of antenna of fruit fly with wing). Why mutations can produce effects similar to those produced by adaptation? Is it possible that adaptive changes are transformed to mutations by some mechanism?

- (a) Epigenesis is a possible explanation for the change of the phenotype. Epigenetic inheritance does not however explain why mutations and adaptations look so similar.
- (b) Morphic resonance would modify only the software but not hardware and could thus explain adaptation. The modification of the antenna frequencies of genes could have profound effects on gene expression in the case that the antenna frequencies of the switch genes are modified. Morphic signal could be even turned off or on.

Neither explanation for adaptation is able to explain why mutation and adaptation produce similar modifications of the phenotype nor provide a mechanism transforming long term adaptation transform to a mutation. In the case of adaptation the same effect would be produced by using suitable genetic program. Does the finding of the correct genetic modification - addition of a new gene in the simplest case- require trial and error process? How the system knows what mutation produces the same effect as the more complex genetic pathway induced by adaptation? How the activation of this pathway could favor the selection of mutated genes producing the same effect? The Darwinian answer to the question would be of course "survival of the fittest" but is this process too slow?

Remark: Later a TGD inspired mechanism for the transformation of adaptation to mutation will be discussed.

3 TGD inspired quantum biology

TGD inspired quantum biology leads to a picture which has quite a lot in common with Sheldrake's vision. The hypothesis are following.

1. There is a hierarchy of conscious entities and therefore also what can be called hierarchy of collective levels of consciousness. One can speak about species as a living and conscious organism. This suggests among other things coherent collective gene expression and one ends up with the notions of super genome assignable to organs and hyper genomes assignable to organisms, populations and even species. Entire biosphere can be seen as conscious living organism.
2. TGD is an attempt to unify real number based physics and p-adic physics for various p-adic number fields interpreted as physical correlates of cognition. One can assign to each p-adic prime a number theoretic entropy making sense when probabilities are rational or even algebraic numbers. The number theoretic entropy can have negative sign and in this case represents genuine information. In the case of negentropic entanglement the interpretation is that entanglement represents information. This information is not about the state of individual subsystem but about the state of the entire entangled system. A kind of abstraction representing a rule with paired states in the superposition representing the instances of the rule.

The proposal is that living systems reside in well-defined sense in the intersection of real and p-adic worlds: in the intersection of matter and cognition. Combined with negentropy maximization principle (NMP) stating the information contents of conscious experience is maximal [7] this leads to a more general view about quantum jump and state function reduction: state function reduction need not anymore be a random process. NMP could explain why morphic resonance identified as tuning to particular frequencies takes place spontaneously.

3. Non-locality is essential. TGD provides a new view about fields and the relationship between experienced and physicist's time. One outcome is possibility of macroscopic quantum entanglement and also time-like entanglement in macro-temporal scales of order of memory span and time scale of planned action. One can say that any physical system is four-dimensional and for the understanding of living system this four-dimensionality is essential.
4. The identification of dark matter (the dominant portion of matter) as ordinary matter but with (effective) Planck constant equal to integer multiple of and hence larger than ordinary Planck constant, is essential. For large values of Planck constant macroscopic quantum phases are possible even in the scales of order Earth size and would be a crucial element of living matter making among other things quantum entanglement in the scale of species possible. One can indeed imagine the possibility of collective gene expression. Also phase transitions changing the value of Planck constant would play a key role in bio-chemistry. Dark matter indeed plays a key role in the TGD inspired model for living systems.
5. So called topological quantization of classical fields is essential. In particular, magnetic fields correspond to flux quanta which have concrete geometric representations as flux tubes and sheets identifiable as non-trivial topology of space-time in macro scales.

- (a) The notion of magnetic body is in a key role. One can say that magnetic body uses biological body as a motor instrument and sensory receptor. A fractal hierarchy of EEG like radiation patterns makes possible control by magnetic body and communication to it from biological body. Topological field quanta- in particular magnetic body carrying dark matter- plus ordinary inanimate matter make together living matter.
 - (b) Also classical electric fields are predicted to be important: living matter is indeed full of electrets. One can consider two kinds of electric fields. In the first case one can have strong electromagnetic (electro-weak) fields although space-time sheet is almost vacuum extremal. In the second case one has far from vacuum extremal and electromagnetic field and color gauge field are proportional to each other. Both situations are expected to be important in biology [4, 2].
 - (c) So called topological light rays ("massless extremals") attached to magnetic flux tubes are in central role [8]. Topologically condensed dark photons propagate along them and they can be regarded as analogs of laser beams making possible precisely target communications without dispersion and with maximal signal velocity.
6. Morphic fields might allow identification as dark photon signals propagating with light velocity: this implies effective simultaneity. Also genuine simultaneity is possible by quantum entanglement in macroscopic scales. I have proposed a model for remote DNA replication and remote gene expression and even remote modification of genome becomes possible if there are genes specialized to this [6].
- DNA and also other biomolecules act as quantum antennas receiving and sending "dark" photons. Two molecules communicate and are able to interact when they have same antenna frequency. This is key part of also bio-catalysis and quantum antenna resonance makes it possible for biomolecules to find each other in the dense soup of biomolecules.
7. Genetic code generalizes and has several realizations. One can say that DNA sequences provide names for polar molecules and one can imagine a mechanism which assigns to this kind of molecule a DNA sequence which codes for a protein attaching to this polar molecule. This might be the basic mechanism allowing the immune system to modify itself rapidly as a response to external stimuli such as invader molecules.

3.1 The TGD counterparts of morphic fields

Sheldrake does not speak about quantum effects but is well aware that new physics is needed to understand morphic fields. It is indeed clear that one cannot understand morphic fields in standard physics framework. Even standard quantum theory might not be enough since it allows quantum coherence only in atomic and molecular length scales and already now it is known that quantum coherence prevails in longer length scales in living matter.

1. Quite generally, the ordinary classical gauge fields allowing geometrization in TGD framework and their quanta would define good candidates for the counterparts of morphic fields. This would include both electro-weak and color gauge fields and for large values of Planck constants both weak and color gauge fields could have interaction range relevant for living matter. Biomolecules would act as quantum antennas and morphic resonance would correspond to antenna resonance.
2. Magnetic flux tubes carrying dark photons would replace morphic fields. The braiding of magnetic flux tubes would make possible coding of topological quantum computer programs and flux tubes could connect various molecules with same resonance frequencies making them quantum antennas. The changes of Planck constant for the flux tubes would change their lengths and the contraction of the flux tube could bring distant molecules near to each other so that they would participate in common reaction. This would be the basic mechanism of DNA replication, DNA-mRNA transcription, mRNA-aminoacid transcription and other similar processes. One can also imagine remote replication of DNA and remote version of gene expression. Here TGD based view about dark matter predicting that the states of dark nucleons are in 1-1 correspondence with DNA, RNA, tRNA, and amino-acids is of crucial importance since it makes possible for water to realize genetic code so that biological realization would emerge from this more fundamental realization.

3. The fractal hierarchy of magnetic bodies makes possible collective quantum coherent gene expression and perhaps even collective modifications of genome explaining the convergent evolution. One can imagine that the flux sheets traversing through DNA arrange it to flux sheets organizing the DNAs of organs to single coherent whole. Same would apply in the case of organism and perhaps even in the case of group of organisms and of population. I have introduced the notions of super - and hyper genome to describe this idea [5].

It must be emphasized that the TGD counterpart for morphic fields and morphic resonance would not explain the creative aspects of evolution. Also the TGD based view about quantum jump, zero energy ontology, hierarchy of Planck constants, NMP, and other new notions are needed.

3.2 Self-organization and morphic resonance

Consider next the general TGD inspired view about self-organization by the analog of morphic resonance.

1. In TGD Universe one could see morphologies as 3-D static self-organization patterns and behavioral patterns as 4-D self-organization patterns. The signals defined by morphic fields should select these self-organization patterns. Since self-organization patterns typically depend only weakly on their initial values (now basically 4-D self-organization patterns replaced by new ones in quantum jumps), morphic fields must select initial values properly. In 4-D situation about which static 3-D situation is special case, frequencies and wave lengths would represent simplest information about the asymptotic self-organization pattern. They would correspond to higher level slowly varying fields serving as effectively external parameters determining the self-organization patterns in shorter time and length scales in accordance with the Slaving Principle of Haken.
2. One can also imagine the morphic resonance mechanism in which molecules act as quantum antennas tuning to each other and forming interacting groups of molecules. The ability of biomolecules to find each other in a dense soup of biomolecules could be based on pre-existing flux tube connections between them. Morphic resonance could be seen as spontaneous self tuning. Organisms would be like radio receivers spontaneously tuning to frequencies at which the previous generations send information. After this tuning the self-organization would proceed rapidly. In terms of consciousness theory one might say that self at the higher level of hierarchy would turn its subselves like we tune radio to a particular wavelength.

But why this tuning would take place spontaneously? One can argue that tuning generates negentropy and in TGD framework the basic distinction between living and inanimate is negentropy. Could the NMP - in some sufficiently strong form- explain why this tuning takes place? What the maximization of the information content of conscious experience [7] can mean is however not clear. NMP could also relate to how the arrow of geometric time emerges and in sufficiently general form could even explain why the contents of sensory experience is about rather narrow time interval (with duration of about .1 seconds for human sensory perception) [1].

Tuning to the frequencies or morphic fields realized as antenna frequencies would be the manner to determine in a given scale the initial conditions leading to unique final outcome very rapidly. The hierarchy of Planck constants assignable to flux tubes mediating dark photons signals would allow the dark photons to have same energy -say at visible range- but different wave-length to which flux tube would be proportional to. Kind of Indra's web would serve as space-time correlate for the morphic fields.

Tuning to a particular frequency to maximize conscious information suggests that this particular frequency defines a carrier wave for information transfer. Frequency and amplitude modulations and bit sequences represented as temporal patterns is what comes first in mind as concrete representations of this information. TGD based view about hearing [4, 9] suggests two basic representations of information corresponding to temporal patterns and frequencies (the inspiration comes from the 'left brain talks, right brain sings' metaphor).

3. The explanation of Sheldrake for dominating/recessive genes in terms of morphic resonance implying that normal gene expression is a genetic habit based on majority decision of members of species in the past is very elegant but need not be correct of course!

If the antenna frequency of the corresponding genes (alleles) in the chromosome pair are same and corresponds to the antenna frequency of either parent, the gene corresponding to this frequency is expressed. Suppose that this frequency corresponds to the same dark photon energy so that the frequencies are inversely proportional to Planck constant so that higher Planck constant would correspond to a lower frequency. Could the lower frequency defined the common antenna frequency for chromosomes so that the parent with larger value of Planck constant would dominate? This option would explain the dominance differently and normal would correspond to the larger value of Planck constant. The mutations favoring the increase the value of Planck constant would be favored. NMP - understood in sufficiently strong sense- would favor the increase of Planck constant quite generally. One must of course be however very cautious in order to avoid systematic use of NMP to fill the holes in the theory.

4. What is the role of magnetic body and of topological quantum computer programs coded by braidings? Certainly this level should be very closely related to morphic fields. The function of introns is not well-understood and the obvious question is whether the flux tubes emerging from introns could be responsible for quantum computer like activities defining the real software [3, 10]. Is the magnetic body itself genetically coded and does temporal self-organization patterns - behavior - correspond to this coding?

It is known that the distribution of codons in intronic portion mimic distribution of letters in natural languages. Could the intronic part of the genome code for the magnetic body, in particular its braiding? What is the effect of external perturbations inducing flow of lipids at lipid layers of cell membrane to the braiding. Zipf law stating that the frequency of the word of natural language is proportional to its rank defined according to the ordering defined by its frequency of occurrence holds also for artificial words identified as sequences of subsequent intronic DNA nucleotides of fixed length. Does this mean that intronic DNA defines some kind of language.

5. A reasonable guess is that adaptation affects the genetic programs identified as topological quantum computer programs but not DNA and only rarely even genome (as in case of methylation). In mutation the hardware- genome- is affected and the question concerns the mechanism for the transformation of adaptation to mutation. Dark nuclei define representation of the genetic code and the following proposal is a suggestion for how this could happen.

3.3 Dark nucleons, genetic code, and its modifications

Dark nucleons represent genetic code in TGD Universe. What could be their role in the gene expression and in the evolution of genome? Cold dark nucleons define a kind of R&D laboratory allowing to test various kinds of DNA sequences.

1. The basic idea is that any polar molecular is covered by an "ice layer" consisting of ordered water. Assume that this layer determines the magnetic body of the molecule. External perturbation such as the feed of energy cuts the hydrogen bonds connecting the molecule to this layer and molecule can temporarily loose its magnetic body. Assume that this process generates sequences of dark nucleons (dark nuclei consisting of dark protons) which correspond to RNA, DNA, tRNA or amino-acid sequences. In this manner polar molecule would get name coded by the dark nuclei. If transcription of this sequence to DNA or RNA exists, it is possible to assign to this sequence DNA sequence serving as a gene coding for a protein which interacts resonantly with the polar molecule via the antenna frequencies defined by the cyclotron frequencies of its magnetic body. This would allow to generate a gene coding for gene attaching to the invader molecule.
2. At least in the case of immune system one might think that system is able to perform genetic engineering as a response to molecules invading to the system and I have proposed a mechanism for this. The transcription of dark genes represented as dark nuclei to DNA or RNA could provide a completely new mechanism of modifying the genome of egg and sperm cells since dark nuclei could penetrate cell membrane without difficulty.
3. Could the mechanism assigning to polar molecule a protein attaching to it allow the transformation of adaptation to mutation? If some protein defines a bottleneck step in adaptation, one

could imagine that the transcription of the dark nucleon assigned with this protein to a piece of RNA reverse transcribed to DNA could transform the adaptation to mutation. More generally, if some proteins appear as basic steps in adaptive production of the change of phenotype then this process applied to them could produce the desired mutation of DNA.

4. Also collective genetic modifications can be imagined if there are genes inducing standard genetic modifications. Hardware would modify itself. Species could modify itself by using remote or collective expression of this kind of genes. Recall that retroviruses consist of RNA and reverse transcriptase catalyzing the reverse transcription of RNA to DNA in turn yielding the copies of retrovirus via transcription to mRNA and RNA. If RNA era continues in cell nucleus one can ask whether genome is continuously modified by the attachments of reversely transcribed DNAs from pieces of RNA. Reverse transcription has a high error rate.

To sum up, TGD approach would allow physical interpretation for morphic fields making possible remote gene expression and perhaps even remote genetic engineering. The past of species would affect the recent species. Both spatial and temporal non-locality would be key elements of life making possible memory and planned action.

Books related to TGD

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