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THE FIRST 10^{-35} SECONDS

FROM THE IMAGINARY TO THE REAL

A FIRST COURSE IN THE EXPLORATION OF THE UNKNOWN

SECOND EDITION IN ELECTRONIC FORM

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PREFACE IN THE SECOND EDITION IN ELECTRONIC FORM

The first Edition of this work was published as a book in English under the title “THE FIRST 10^{-35} SECONDS” (ISBN: 960-630-425-6) in Athens on 2005.
The circulation of this book however was restricted mainly in the little community of the Greek physicists. Thanks to the very smart development of the viXra.org. I considered that it would be good to present it to the wide International Physics Community in electronic form since the ideas and findings from my work bring new information in the sectors of Elementary Particle Physics and in Cosmology. Some of these new results are based on other works of mine that have already been published mainly in the international journal Physics Essays and also in my new book published in Greek under the title “The Machinary of Newtonian Gravitation and the fallacies of General Relativity” (ISBN: 978-960-8160-49-1). I hope that for many physicists will be useful to be informed that to many as yet unsolved problems of physics, this presentation will give answers that may be discussed. I thank in advance and I congratulate the viXra. organization for their contribution to transfer to the physics community new ideas that perhaps, to my opinion, will bring a little restlessness to some of the top leading minds of the contemporary physics. Perhaps this is one of the reasons that new ideas are prevented to be exposed by some of the top journals on physics. But the ancient Greeks had a proverb: Nothing can be hidden under the Sun.

P R E F A C E

*This book started as a collection of five papers, some of them presented through the website of the UNION OF GREEK PHYSICISTS as a first course in Cosmology. Finally it ended with one more paper. I considered that this work would be incomplete without this paper, which concerns the origin and nature of what we call **Electric Charge**. I hope that the reader will agree with me on this choice.*

In the first paper under the title Cosmology 1 (C1), my attention was concentrated on an investigation of the period of time before the $1.1631835\ 10^{-43}$ sec, which is a marginal time, according to a general acceptance (in fact this time is usually referred as 10^{-43} sec). Before this time, everything is obscure, the known laws of Nature break down as it is also usually said and as far as I know, nobody has managed to present a theoretical model for this primitive stage of the Universe, even in a speculative manner. In C1 and in a previous paper of mine(1), I tried to describe a model that offers an explanation, in its own manner, to the possible situation of the Universe during the above period. The explanation was based on the introduction of a new concept that dictates all next processes. I gave the name Mini White Holes (MWH) to this concept, because Big White Holes (to my opinion) cannot be created in our Universe to avoid violation of the law of energy conservation. The probable mass or radiation escaping from a Black Hole (BH) according to the Hawking effect, by no way constitutes a white hole. This became absolutely clear in my previous

paper(1). The derivation of the metric of white holes, which contrary to what was accepted till then, is not simply the time reverse of the metric of BHs, led to very interesting applications to the problem of the Deuteron potential in ref. (1) and in the case of multi-nucleon nuclei (in ref. 2). So the, as yet, unexplained *hard core* or *impenetrable sphere* of the nucleons, when they come to centrobaric distances from each other equal to or less than ~0.5 fm, found a completely satisfactory explanation thanks to the new central nuclear potential I introduced in the case of the two nucleons system (Deuteron). Also the MWHs theory, explained undeniably and totally, the behavior of quarks inside the nucleons (asymptotic freedom and infrared slavery). The new nuclear potential I mentioned above was enough to give answers to most of the problems of nuclear forces (especially it gave an absolutely satisfactory and logical explanation for the repulsive nuclear forces at short distances as I said before) and became a powerful tool even in the case of BH (c.f. C2).

Once I had such a basic physical entity to start with, I pursued my investigation for a better understanding of what happens inside a MWH or, what is the same, in the Sub Planckian Space (SPS) as I called the space in the interior of the MWH. So besides the general acceptance that all known laws of Nature break down in the SPS, I managed to show in C1 that in this space, which is an abstract one, develops in a strictly mathematical formalism the Probability for the appearance of an amount of mass in the quantum level of our space. So the SPS is not at all lawless. The modified Klein-Gordon equation was the basis for the development of this probability. As the reader will soon realize by reading C1, apart from the quantum mechanical way where the probability density is interpreted as the square of the wave function of a QM system, and apart from its mathematical formulation in macrocosmos, in C1 I show that there exists a third kind of probability which develops from the value of zero to the value of one as I said above (in a strict manner). Since the SPS is abstract, in the sense that what happens there, does not extend in the three space dimensions and in the dimension of our real time, I thought that I could make a comparison of this Probability with the IDEA, as it was introduced by Plato. I think that if Plato had lived in our times, he should have inevitably concluded to the result: IDEA ≡ Probability in the SPS.

As most of researchers in physics, in their struggle to get an explanation for the happenings in the physical world, introduce always new concepts, which as they believe, will help them for a better understanding of their subject, (atoms, elementary particles, quarks, gauge theories, Super-theories, curved spacetime, black matter etc.), I thought that the MWH concept could be exploited in the development of a cosmological theory, which would cover the very primitive stages in the age of the Universe. This led me to the development of the fourth paper of this work. The 2nd and 3d papers, although started as independent investigations, were finally proved very helpful instruments for the development of my cosmological model. Apart from their importance in a better understanding of the happenings in the interior of a BH (C2) and also in elementary particle physics (C3), where it was shown that the "desert" between 10^{-35} and 10^{-17} m is not at all a desert, but it is populated by an abundance of particles of any kind (hadronic mesons, heavy baryons, heavy leptons, and probably other more exotic particles), some results of C3 were used in C4.

Although the obtained numerical results of the equations I used in these papers and particularly in C4, seem to agree with similar results obtained by much more mathematically advanced theories (which also introduced new concepts for their support), by no means I consider my cosmological model all the way correct or complete. A lot of things remain to be done before this model come to a generally acceptable one. I know most of its weaknesses, some of which have been introduced by intuition rather than pure mathematical formality, so that any comments or objections that will be raised may open a wide field for discussion. So any careful and restrained criticism is welcome. It must not be forgotten, however, that the subject of this work is mostly original and alternative solutions on the relevant problems can hardly be found. But I insist on my belief that if some other people start thinking in terms of MWHs instead of superstrings, branes, false vacuums, dark energy etc., many interesting results may be obtained from the present work.

To close this preface, I must say that it is in my intention to present in a next course the events after the 10^{-35} sec that brought us (human beings and perhaps other living entities) to the situation to observe and to think in our little universe. Another investigation, which also concentrates some interest, concerns the probable existence of more than one Big Universes, the number of which may extend to infinity. But such sort of investigations are almost totally speculative and in any case the existence of other big Universes, either as isolated systems or “parallel” H. Everett type worlds, will hardly have any influence in the happenings of our little universe for some billions of years.

I must also inform the reader that some minor corrections of careless errors or additions on the original papers have been made in this book for a better presentation and interpretation of my writing. So I apologise to the readers of the original papers from the web for the escaped necessary corrections, but I must assure them that the obtained results will not change. For obvious reasons, I omitted in this book, the short abstracts written in Greek in the original web site presentation.

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COSMOLOGY 1 (C1)

INSIDE A MINI WHITE HOLE

Abstract

This paper is the first in a series of five papers, where I will try to present my own cosmological model. A number of definitions based on philosophical, scientific and even theological arguments have been given for the word "Cosmology". The second (and a little the first) case will be our subject and in what follows I shall try to give my own definitions. Beyond that, the success of a model depends on its predictions (or even retrodictions) in accordance with the results of observation and also with the results of other cosmological models, which, more or less, have received a general acceptance. I shall try to follow this procedure in developing this model. It has to be emphasized, however, that this work does not intend to play the role of a textbook on cosmology. It is especially concentrated to as yet, unsolved problems in Cosmology in general and not to details concerning the formation of the constituents of the Universe (Stars, Galaxies etc.). In this first part I shall try to give some information about the events that took place between the zero and the 10^{-43} sec before the "creation" of the Universe (i.e. before the appearance of mater, space and time as we perceive these entities now). The third section of the following work was briefly presented in the 1st Hellenic – Turkish International Physics Conference at the island of Cos (Sept.2001). Here is given the detailed presentation.

Key words: Sub-Planckian Space (SPS), Probability, imaginary time, imaginary mass, mini white holes, potentiality.

INTRODUCTION

Cosmology is the History of the Universe, whichever this Universe may be. It is also the guess about the future fate of the universe. These two tasks must be inferred from the present knowledge we have gained by the means of observation (and experimentation some times), by our intuition and our ability to construct mathematical models that conform to observation.

History-present knowledge-future fate, presuppose the existence of time. So a cosmological theory should start somehow like this: "In the beginning…." Or more plainly: "Once upon a time…".

A complete theory of Cosmology must also include a guess about what existed before the Universe started its life (in the case of course where the Universe is not eternal). Is this question meaningful or is it devoid of meaning as the usually mentioned example: "What exists northern to North Pole?". I shall try to give a meaning to this question in the case of Cosmology. Before, however, proceeding to my presentation, it is necessary to invent a new grammar that will describe in a stricter way what we want to say for periods before the beginning. Although I am not expert in linguistics I believe that in every language of the present world or in languages that may have been forgotten in the depths of time, there should be words or expressions to distinguish the three basic verb tenses: past, present, and future. If however we want to describe situations of any kind of existence before the beginning of time, at least as we perceive this time, the use of the above tenses has no meaning. So if I insist on saying something that describes this timeless period verbally, I must use a grammar parallel to the one we used in our everyday experience to distinguish the pre and after the beginning of time period. For this reason I decided to use the ordinary grammar in the case of verbs but to add at the end of the usual verbs the letter (i) for reasons that will be explained in the ensuing development. As an example instead of "was" I shall write "was(i)" or instead of "became" I shall write "became(i)"and so on. All cosmological models start at 10^{-43} sec. after the time "zero". Between 0 and 10^{-43} sec. we know nothing about this period of time. According to a general acceptance, in this (perhaps smallest) time interval all known laws of nature break down. In fact the above time 10^{-43} sec. may be characterized as the zero real time whereas before this time were taking place various processes but in an imaginary time (it), which are not accessible by our senses or by any kind of instrument. The best theories in circulation nowadays, (General Relativity, Quantum Gravity or Supergravity, Superstrings, inflationary theory, theory of chaos etc.) do not give a definite answer to this problem. Did time, as we measure it with our clocks, exist during this period? After the 10^{-43} sec. exists a plethora of theories, which try to build models that explain the genesis, the evolution up to our present time and the future evolution of the Universe. Of course what exactly Universe is, we do not really know and for this reason we build models. Verbally the Universe is an absolute totality, which exists in space and time or with space and time. These theories may be placed in three basic categories:

a. The Universe has no beginning and no end. It exists forever and will exist forever as it looks to us now, thanks to a continuous matter creation, which fills the gaps that occur between the big concentrations of heavenly bodies (galaxies, clusters of galaxies, superclusters) when these concentrations undergo the observed recession from each other. This recession is something that has been verified undeniably by observation and is attributed to a "stretching" of space (this word is the most inappropriate according to my opinion, which will be presented further on). Of course some people believe that the observed red shifts do not have cosmological origin and are not due to the relativistic Doppler effect but to other reasons (aging of photons)[(1)], bremsstrahlung associated with axial momentum transfer from the photons to electrons[(2)] et al. but these opinions are a minority. The theory of an eternal existence of the universe is known under the name Steady State Universe (SSU) and after its first presentation by its inventors Bondi, and Gold (1948) and Hoyle (1948), has undergone repeated modifications by its founders or other people[(3,4)]. This model accepts the so-called "Perfect Cosmological Principle" (PCP), which states that the Universe in a large scale is uniform in both space and time and new matter is continuously created. The basic argument against this theory is that it cannot cover satisfactorily the observationally verified background microwave radiation of 2.73^0 K. It also predicts a deceleration parameter $q = -1$ in contrast to observation where this value is supposed to be positive. The abundances of Hydrogen and Helium in the Universe are also not explicable without a "hot Big Bang" theory.

b. The second basic theory is that of the Big Bang, which states that, the Universe has a beginning in time (besides of the fact that time as well as space and matter appeared simultaneously from nowhere). The future evolution of this Universe depends on the average density of matter in it. This theory has a variety of versions concerning the initial stages of it (Quantum Cosmology, Inflationary Universe) and its future evolution too, which has also three basic versions (Expansion forever to infinite space and time, either as an open Universe or a marginal expansion (flat space Universe), or a recontraction after a certain time followed by a Big Crunch.

c. A repetitive or oscillating Universe, which undergoes eternal cycles of Big Bangs and Big Crunches. In this case it is not clear whether we talk about one and the same Universe or about an infinite number of different each time universes with perhaps different physical laws and physical constants. One of the problems to which this model cannot give a definite answer is that of the entropy of the Universe. It is supposed that when the Universe is in a super-dense state its entropy is zero whereas when it is in a maximum rarefied state its entropy is maximum.

Apart from these three basic categories of theories, there are also other theories which accept an infinite number of Universes like or unlike to the one we live in, parallel to our Universe (if the word "parallel" has the meaning of no connection with our Universe) or connected with our Universe via space-time singularities, wormholes or other exotic structures.

All efforts for an understanding of the Universe, are based on steadily increasing in difficulty and complexity mathematical models, which up to now have not given a definite answer to the problems I described briefly above (genesis, evolution, future of the Universe) and most of these models arrive at situations where their equations cannot be solved without the introduction of some simplifications, or develop solutions, which lead to infinities i.e. not acceptable results, or even lead to an innumerable number of solutions.

The ancient Greek philosophers (Heraclitus, Anaxagoras, Anaximenes, Anaximandrus, Thales, Democritus, Plato, Aristoteles et al) tried to understand the "Cosmos" as they called the Universe, without the help of even the simplest mathematics of nowadays. Besides this lack of knowledge they found some answers, which even now may be valid. The "war is everything's father" or "the everlasting flux" or "You cannot step twice into the same river" of Heraclitus or the "Ideas" of Plato or "the atomic theory" of Democritus and Anaximandrus etc. are some examples of the predictive capacity of the above philosophers. Of course the complete ignorance of the modern mathematics and the methods of experimentation and observation in physics and astronomy prevented the above philosophers to gain an acquisition of certain solid knowledge of Nature as we now have. On the other hand, however, the continuous development of more and more sophisticated methods in mathematics, in an effort to understand Nature, put forward the question as to whether Nature is in fact so much complicated as the new mathematics demand it to be. I have expressed my reservations(5) about the way a purely geometrical mathematical theory of space-time was applied to the problem of gravitation producing the famous General Theory of Relativity (GTR). Apart from the fact that I have developed a model for the gravitational interactions that leads to a straightforward theoretical derivation from first principles of Newton's law of gravitational attraction without the handicap of the instantaneous action at a distance(6), there are people who believe in the usefulness of the much simpler Newtonian theory in solving gravitational problems even in the case of strong gravitational fields with the same results as those of GTR(7). Milton K. Munitz too(8) writes: "*…Such "Newtonian" models, while admittedly not as adequate as those developed in terms of the more refined theoretical concepts now available, are nevertheless instructive and useful in suggesting analogues for the latter…*". The modified Newton's Law of gravitational attraction presented in the newly published book of mine (for the time being in Greek*)(6) is enough to cover all the four tests of the GTR, and this has been undeniably shown in this book and also have been uncovered many fallacies of General Relativity in solving the problems of the famous four tests and beyond.

* I hope that not too late, this book will be translated in English so that it will be accessible by the totality of the Physics community.

With the above general remarks I proceed to the first subject of this work, which is:

BEFORE THE REAL TIME ZERO (or 1.1631835 10^{-43} sec.)**

The usual question "where did the Universe come from?" receives various answers like: from nowhere, from the zero, from an existing chaos, from nothing, from the vacuum (or false vacuum), from a quantum fluctuation of the vacuum and so on. All these and similar answers the only thing they express is an absolute ignorance about the origin of the Universe. The theologians of course have the definite answer that God created the Universe and this is enough. I do not claim that I have an answer coming from a reliable informing source. My answer, however, comes from a simple sequence of thoughts. Everybody knows that for something to happen, to occur, to take place, a certain probability different from zero is necessary. Otherwise this something will never be accomplished. This probability needs to exist "somewhere". Since the probability in Quantum Mechanics is expressed as the square of a non-measurable quantity i.e. of the amplitude of the wave function, it has to be embedded in an abstract space. Examples of abstract spaces are common in physics (phase space, momentum space, velocity space, Hilbert space etc.). So it is reasonable to define a new abstract space, the space of probability (SP). Such a definition reminds us the IDEA of Plato. According to this philosopher, everything that exists in the universe originates from its existence in the space of ideas. Plato considered the IDEA not as a state of the mind but as a "distinguished reality", which in the present mathematical language could not be anything else than an "abstract space". All material things are projections of ideal prototypes. So returning to the case of probability we cannot exclude from this general rule the Universe as a whole. This Universe to come into existence requires to posses a probability different from zero. So to the question, what existed before the creation of the Universe (i.e. before the time of 1.1631835 10^{-43} sec., which is determined by the expression $t_q = \frac{\hbar}{2m_x c^2}$ where m_x = 5.0437884 10^{-9} kg as it was determined in my previous work[9]) the answer is that: **Before the creation of the universe existed(i) *__somewhere__* a probability different from zero for the creation of the Universe.**

In what follows I shall examine where this "somewhere" may be embedded and this investigation has the following title:

A QUANTUM MECHANICAL MODEL OF THE SUB-PLANCKIAN SPACE AND ITS PHILOSOPHICAL AND COSMOLOGICAL IMPLICATIONS

In a previous paper[9] I presented the metric for Mini White Holes (MWH) and their connection with quarks and nuclear forces. The description of how matter emerges from a MWH left unanswered the question of what kind of matter this could be and for this reason I called the corresponding amount of the emerged mass "proto-mass". In the same paper I made the assumption that the appearance of this mass was(i) the result of the development of a probability in time(i) in this sub-quantum or Sub-Planckian Space (SPS), since the dimensions of this space are near to the Planck length (about four times as this length). In this paper I shall examine how this

** Here is necessary to give a clearer definition of the above time. In fact this is the time needed for a mass to emerge from the central singularity of a White Hole, into the real 3+1 space we live in. In what follows I shall give the details about this procedure.

probability develops in the space restricted by the dimensions of the white hole. Some remarks will follow about the cosmological and philosophical implications of this process.

PART I

As it is generally accepted, in the space below the Planck length, all known laws of physics break down and this mysterious space is characterized as intrinsically dimensionless, a-temporal and non-local[10]. Since in my previous work[9] I found that it is possible to derive the metric of the white holes in the above space, using a modification of the metric of black holes, the next step I promised to examine was the investigation of how the probability for the emergence of an amount of mass from this space is developed in it. For this investigation the following conditions ought to be taken into account:

1) The "time" of this space is imaginary. Atmanspacher[10] et [11], consider this "virtual" time complex (the word "virtual" has the meaning that although it exists, we have no means to detect or trace its existence). I consider it purely imaginary and with this acceptance I derived the metric of the mini white holes, which led to very successful outcomes in the domain of nuclear forces. So in what follows I shall denote by *t* the ordinary time of our 3d-space which is real and by $t_i \equiv it$ the time of the sub-Planckian space which is obviously imaginary. This choice must not be confused with that of the fourth coordinate in the Minkowskian 4-space where it is used the symbolism ict for this fourth coordinate, since in the SPS do not exist spatial dimensions. Now the reason I add at the end of the verbs I use for the period before the creation the letter (i) is obvious, to distinguish the time t from the time t_i . At this point it is worth to refer to Arthur Koestler[12]. He writes: "…*According to the mathematician Andrian Dobbs, a second temporal dimension (exists) in which the subjective probabilities of future events are included as participants commanding factors, that direct and predetermine what is going to happen with certain special methods… The advantage of this theory (of Dobbs) is that it does not stumbles to the paradox that the forecast of a future event may probably act on the same event destroying so the forecast*" [*]

The above were referred to show that somebody else has thought that the existence of two "parallel" times is not an improbable situation.

2. The appropriate equation for our investigation will be the Schrödinger's relativistic equation in one dimension only, whose the 3-dimensional expression has the form[13] :

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\Psi = \kappa^2\Psi \tag{1}$$

(which is also known as Klein-Gordon equation).

where $\kappa = \dfrac{m_x c}{\hbar}$. (2)

The parameter κ is the inverse of the restricted Compton wavelength of the particle with rest mass m_x whose wave function is Ψ.

Equation (1) may be written now by use of the one-dimensional D'Alambertian operator as follows:

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[*] The above quotation is a translation in English by me from a Greek translation of the original English text. So I apologize if I have not rendered well the original text.

$$\frac{\partial^2\Psi}{\partial r^2} - \frac{1}{c^2}\frac{\partial^2\Psi}{\partial t_i^2} - \kappa^2\Psi = 0 \qquad (3)$$

First of all, since the aim of this paper refers to the concept of probability in a quantum (more precisely sub-quantum) space we are obliged to turn to equations which are suitable in such spaces. And the concept of probability is closely connected with the wave function concept. The use, on the other hand, of the one-dimensional form of eq.(1) is imposed from the fact that in the SPS (according to our model) there are only two variables: The value of the Probability and the imaginary time. So there is meaningless to use the 3+1 dimensional form of (1).

From my previous work[(9)] I had imposed to the process of matter emergence from a white hole, the requirement that it would not violate the law of energy conservation. I used, therefore, the Uncertainty Principle in its time-energy form, from which can be inferred that an amount of energy ΔE or the corresponding amount of mass $m_x = \hbar / 2c^2\Delta t$ may violate the above basic law of energy conservation, for a time interval $\Delta t = \frac{\hbar}{2\Delta E} = \frac{\hbar}{2m_x c^2}$ and this violation would be unobservable for $t < \Delta t$. In the case of $t \geq \Delta t$, the law of energy conservation may be violated in two and only two special cases. A) In the case of the initial creation of the Universe where we had a violation in bulk of this law. B) In the case of very dense environments, like the ones that exist near the central singularity of a Black Hole. These cases will be examined in detail in two next papers.

By using the distance crossed by the emerging mass from its starting point in the central singularity of the white hole, which distance is equal to the quantum radius $r_q = \frac{\hbar}{2m_x c}$, it was clear that the **average** velocity of the crossing would be equal to $r_q / \Delta t = c$. So the case was relativistic. For this reason we had to use the Schrödinger's relativistic wave equation to describe the quantum mechanical procedure of this effect. The coordinate velocity of the expanding mass inside the white hole territory was given by equation (11) in my previous paper as:

$$dr/dt = c(r_s/r)^{1/2}(1+r_s/r) \qquad (4)$$

where r_s is the Schwarzschild radius of the emerging mass equal to $2Gm_x/c^2$ from which it could be shown that the mass from the point-like central singularity of the white hole started with a step-like (or Dirac's Delta function) velocity, which at r=0 is infinite and at the same time (or in an infinitesimally short time) acquires a finite (but superluminal) value which is gradually reduced to lower velocities. At about a distance from the center of the white hole equal to L_{Planck} (more precisely 0.9954 L_{Planck}) the velocity of the emerging mass becomes equal to c (this is obtained by equating the r.h.s. of (4) with c) and after that it continues to reduce[2] to $v < c$. The velocity at the moment of the mass appearance in the quantum level has a value of 0.562958 c. Since the average velocity, by definition is c, the most appropriate equation for the quantum mechanical description of this effect cannot be other than a relativistic invariant equation. Besides, as it can be shown, the use of the ordinary time dependent Schrödinger's wave equation under the conditions that will be

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[2] From the theories for superluminal particles known as tachyons the lower velocity limit of these objects (if they exist) is the velocity of light. So a tachyon cannot propagate with $v < c$. Eq. (4) however permits the surpassing of this limit at $r > 1.60860455\ 10^{-35}$m by the emanating "protomass" m_x and this is due to the peculiarity of this "space" and also to the (as yet) unknown nature of the protomass.

imposed further on, on the quantities that appear in the relativistic equation, result in a probability function P(t) which is imaginary, that is, meaningless.

In our case I do not have spatial coordinates and the time is imaginary. About the emerging matter whose the rest mass is equal to m_x, we must make discrimination with regard to its nature. So since the velocity at which this mass expands from the center of the white hole, being distributed uniformly on the surface of a sphere with negligible thickness, is greater than c from r=0 to a distance r_1 from the center, this rest mass must be imaginary to produce a real moving mass, according to Special Relativity. This has already been accepted by others in the case of superluminal velocities(14) . In what follows I shall replace in this first part of the expansion of this mass $m_x \equiv m_0$ by im_x where m_x is the real rest mass which finally emerges from the white hole. In what follows we shall make use of the time required for the mass m_x to cross the distance 0 to r_1. Let this time being denoted by t_1.

By use of expression (4) the time t_1 is given by:

$$t_1 = \frac{1}{c}\int_0^{r_1} \frac{dr}{\left(\frac{r_s}{r}\right)^{1/2}\left(1+\frac{r_s}{r}\right)} \qquad (5)$$

Since the above integral cannot be calculated analytically, I use numerical integration. I have already found in my previous work(9) that $r_s = 7.489003\ 10^{-36}$ m. In the numerical integration the lower limit is not acceptable by the PC since it is equal to 0 in the denominator. For this reason I used two test values for this limit namely 10^{-60} and 10^{-80} which differ significantly from the upper limit r_1, which was also found in my previous work equal to $1.60860455\ 10^{-35}$m. The answer was the same: t_1=2.7767105 10^{-44} sec.

In the second part of its motion, the mass m_x expands with a velocity less than c in the interval between r_1 and r_q where $r_q = \frac{\hbar}{2m_x c}$ as it was defined in my previous work, i.e. $r_q = 3.4871365\ 10^{-35}$ m is the emerging mass from awhite hole, quantum radius. This lower velocity comes from the expression (4). So it has to be a real mass and for that in this interval it needs not be imaginary so that $m_0 = m_x$.

The mass m_x was also determined in my previous paper(9) and it was found equal to 5.0437884 10^{-9} kg.

Proceeding in my attempt to modify eq. (3) so that it could be adjusted in this abstract space, I had to replace the spatial variable r by an abstract concept too and the most appropriate one was (for our purpose) the concept of Probability. The reason I chosen this concept, is simple. For anything to happen (in microcosmos or in megacosmos) a probability different from zero must **pre-exist of the corresponding event, somewhere**[3]. In the case of the appearance of an amount of mass in the quantum level of reality via the white hole process, the existence of a probability for the realization of this event has to be therefore different from zero. The concept of probability is an abstract concept, and for this reason it has to be embedded in an abstract space in the same way the already mentioned other abstract spaces are used in physics. I called this space, *the space of probability,* and I identified it with the SPS,

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[3] This "somewhere" is not necessarily embedded in our ordinary 3d space. I shall specify this "space" in what follows. The elevation of the concept of the PROBABILITY as a chief factor in the theory of chaos has been introduced by Ilya Prigogine from a different point of view and with a different approach(15).

about which so little is known. The only that is certain for this space is that it is a completely different kind of space, from the one we live in, characterized, for the time being, from our ignorance about its nature. A first approach to this space is my theory on the white holes metric and with the present paper I shall try to throw a little more light about its nature. For this reason I shall make the necessary substitutions in eq. (3) to adjust them in this space. I have already mentioned the modification in the time coordinate and in the mass that appears in the expression of κ. Since the space is dimensionless, I introduce the concept of probability P as the new variable. This variable, however, is dimensionless. To replace the spatial variable r by the new variable I use the expression bP instead of r where b is a constant with dimensions of length to be determined. This constant is not subject to any kind of transformations as e.g. to the Lorenz transformations since, as it will be shown below, it depends on the three basic constants of physics *c,G* and *h.* Another substitution is still necessary. In quantum mechanics *the probability of experimentally finding a body described by the wave function Ψ at a point of the 3-space in time t is proportional to the value of Ψ^2 there at t*[(16)]. This means that in our case too I may put $P = a^2|\Psi|^2$ with (a) being another (dimensionless) constant to be determined. In the above expression I use the modulus of Ψ since Ψ is complex in general so that $|\Psi|^2 = |\Psi\Psi^*|$. The probability however must be real and non-negative. At this point it is necessary to clarify the meaning of the concept of probability as it is used here. According to Richtmyer-Kennard-Laurichen[(17)] "…the *probability* of finding it (the particle) in the neighborhood of a given point is **proportional** to the value of $|\Psi|^2$ at the point. More exactly, the *probability density* at any point is represented by $|\Psi|^2$ …"

In our case we need only "THE PROBABILITY" for something to happen and this something is the emanation from the SubPlanckian Space of an amount of mass (I call it "protomas") to the quantum level of the ordinary space. For this reason I put the probability **proportional** to the probability density $|\Psi|^2$ since I have no spatial dimensions, which impose the existence of a density, and also the probability itself is considered as the variable in this space. (as will be shown the probability is finally independent of a).

Performing the above substitutions in eq. (3) in the case of the first interval, as it was defined above, namely:

$t_i = it$, $\kappa = \dfrac{im_x c}{\hbar} = i\mu$, $r = bP$, and $P = a^2|\Psi|^2$ we finally obtain a differential equation for the wave function $\Psi \equiv \Psi(t)$ which has the following form (It comes from APPENDIX I):

$$\Psi_1^3 \frac{\partial^2 \Psi_1}{\partial t^2} + \lambda^2 \Psi_1^4 - \frac{c^2}{4a^4 b^2} = 0 \qquad (6)$$

where $\lambda = \mu \cdot c = m_x c^2/\hbar = 4.2985477\ 10^{42}\ \text{sec}^{-1}$ and $\mu = m_x c/\hbar$ meters^{-1}.

In the second interval (of time) from t_1 to t_q eq. (3) is written as:

$$\Psi_2^3 \frac{\partial^2 \Psi_2}{\partial t^2} - \lambda^2 \Psi_2^4 - \frac{c^2}{4a^4 b^2} = 0 \qquad (7)$$

To solve eq.(6) we solve first the homogeneous equation:

$$\Psi_1^3 \frac{\partial^2 \Psi_1}{\partial t^2} + \lambda^2 \Psi_1^4 = 0 \qquad (8)$$

to find the complementary function Ψ_{1c}

which for $\Psi_1 = 0$ is obviously verified. For $\Psi_1 \neq 0$ it has the solution:

$$\Psi_{1c} = C_1 \cos(\lambda t) + C_2 \sin(\lambda t) \qquad (9)$$

I need now to find a particular solution of eq. (6). Before doing so I can determine the value of b as follows: We notice that at $r = r_q = \frac{\hbar}{2m_x c}$ it is P = 1 since the mass m_x enters in the real space, so it is observable (and measurable). So $bP = r_q = \frac{\hbar}{2m_x c} \rightarrow b = \frac{\hbar}{2m_x c}$. This means that: $\frac{c^2}{4a^4b^2} = \frac{\lambda^2}{a^4}$

So Equation (6) may be written as:

$$\Psi_1^3 \frac{\partial^2 \Psi_1}{\partial t^2} + \lambda^2 \Psi_1^4 - \frac{\lambda^2}{a^4} = 0 \qquad (10)$$

It is easy to verify that a particular solution of (8) is $\Psi_{1p} = 1/a$ (the (–1/a) may also be a particular solution. Since, however, we are looking for only one such solution, the choice of 1/a is sufficient for our purpose).

The general solution is therefore given by:

$$|\Psi_1| = |\Psi_{1c} + \Psi_{1p}| = |C_1\cos(\lambda t) + C_2 \sin(\lambda t) + \frac{1}{a}| \qquad (11)$$

and $P(t) = a^2|\Psi|^2 = a^2 |\Psi_{1c} + \Psi_{1p}|^2 = a^2| C_1\cos(\lambda t) + C_2 \sin(\lambda t) + \frac{1}{a} |^2$ (12)

For t = 0 i.e. before the appearance of the mass m_x from the central singularity of the white hole the probability $P = a^2|\Psi|^2$ is zero so that from (12) it is:

$$P(0) = a^2 |C_1 + \frac{1}{a}|^2 = 0 \qquad (13)$$

$$\text{or } C_1 = -\frac{1}{a} \qquad (14)$$

By similar steps I proceed to the solution of eq. (7)

The complementary function is found easily and it is equal to:

$$\Psi_{2c} = C_3 e^{-\lambda t} + C_4 e^{\lambda t} \qquad (15)$$

The second term of (15) is ruled out since the positive exponent makes Ψ infinite at large t.

So $\Psi_{2c} = C_3 e^{-\lambda t}$ (16)

To find a particular solution of (7) I set: $\Psi_2 = gt^n$ where g and n are constants to be determined. Upon replacing this expression of Ψ_2 in (7) and after some rearrangements I find that:

$$\Psi_2 = C_3 e^{-\lambda t} \pm \frac{\sqrt{\lambda t}}{a(n(n-1) - \lambda^2 t^2)^{1/4}} \qquad (17)$$

where the second term of (17) is the particular solution of (7).

The corresponding expression for the probability function in this last case is again: $P = a^2|\Psi_2|^2$. (18)

Now the conditions of continuity of Ψ_1 and Ψ_2 at $t = t_1$ (where t_1 has already been calculated from (2)) require:

$$\Psi_1|_{t=t1} = \Psi_2|_{t=t1} \text{ and } \frac{\partial \Psi_1}{\partial t} = \frac{\partial \Psi_2}{\partial t} \text{ at } t = t_1 \qquad (19)$$

One more boundary condition at $t = t_q$ is: $P = a^2 \Psi_2^2 = 1 \Leftrightarrow \Psi_2 = (\pm 1/a)$, which if combined with (17) yields:

$$C_3 = \frac{1}{a}\left(1 \pm \frac{1}{\sqrt{2}(n(n-1)-1/4)^{1/4}}\right)e^{1/2} \equiv \frac{C_3'}{a} \tag{20}$$

In deriving (20) I also made use of the replacement:

For $t = t_q = \dfrac{\hbar}{2m_x c^2}$, it is $\lambda t_q = \dfrac{m_x c^2}{\hbar} \times \dfrac{\hbar}{2m_x c^2} = \dfrac{1}{2}$ (21)

Now since I know the values of λ and t_1 I put $f = \lambda t_1 =$ 0.119358226 and from the first condition of (19) we have:

$$C_1 \cos f + C_2 \sin f + \frac{1}{a} = C_3 e^{-f} \pm \frac{\sqrt{f}}{a(n(n-1)-f^2)^{1/4}} \tag{22}$$

and solving for C_2 we have:

$$C_2 = (C_3 e^{-f} \pm \frac{\sqrt{f}}{a(n(n-1)-f^2)^{1/4}} - \frac{1}{a} + \frac{\cos f}{a})/\sin f \equiv$$

$$\frac{1}{a}((C_3' e^{-f} \pm (\frac{\sqrt{f}}{(n(n-1)-f^2)^{1/4}} - 1 + \cos f)/\sin f) \equiv \frac{C_2'}{a} \tag{23}$$

Since I have expressed C_1, C_2, C_3 in terms of a and n, I use the second condition of eq. (19) which is:

$$\frac{\lambda}{a}(\sin f + C_2' \cos f) = \frac{\lambda}{a}\left(-C_3' e^{-f} \pm \frac{n(n-1)}{2\sqrt{f}(n(n-1)-f^2)^{5/4}}\right) \tag{24}$$

and I obtain the equation:

$$\left(\sin f + C_2' \cos f + C_3' e^{-f} \mp \frac{n(n-1)}{2\sqrt{f}(n(n-1)-f^2)^{5/4}}\right) = 0 \tag{25}$$

where $C_2' = aC_2$ and $C_3' = aC_3$

The λ/a factor, which is contained in all terms of the above equation, cancels out and since λ≠0 I am left with an equation with unknown the n only. This equation may be solved numerically.

I observe that due to the ambiguity of the sign of a, the ± sign appears in the expression of C_2 and C_3 as well as in the front of the fourth term of eq. (25). So all combinations of the (+) and (-) sign led to 16 equations of type (25) to be solved. I proceeded to the numerical solutions of these 16 equations and I found that only six of them have (real) solution. For the other 10 there was no solution found. I shall not present all of the six solutions since the four of them were discarded because the combinations of the signs of (1/a) were not all with the same sign in the same equation (25). In fact, as it can be easily deduced, there are only two equations of type (25) in which the signs of 1/a in the expressions of C_2 , C_3 and in front of the fourth term of (25) are the same. The first combination in the C_2 , C_3 expressions and in the (25) equation is correspondingly (+ , -, -) and the second combination is (-, +, +). So the remaining two equations have all the 1/a signs the same in each equation (+ in the first and – in the second) and gave two different solutions namely:

1st solution: n=1.307491174 , $C_2' = 1.99014126$, $C_3' = -0.21826598$ with a>0 (26)

2nd solution: n=1.310570260, $C_2' = -2.209640509$, $C_3' = 0.203277239$ with a <0 (27)

To find which one of the above solutions could be finally accepted I used the following condition:

Since $P_1 = a^2|\Psi_1|^2 = (-\cos(\lambda t) + C_2' \sin(\lambda t) + 1)^2$ (28)

I shall be able to find the maximum and minimum value of P_1 by setting $dP_1/dt = 0$.

So I have: $dP_1/dt = 2\lambda\,(-\cos(\lambda t) + C_2'\sin(\lambda t) + 1)\,(\sin(\lambda t) + C_2'\cos(\lambda t)) = 0$ (29)

It is obvious that for t=0 $P_1 = 0$ and $dP_1/dt = 0$ so this is a minimum (since P in general can not be negative). But also $dP_1/dt=0$ if:

$-\cos(\lambda t) + C_2'\sin(\lambda t) + 1 = 0$ which occurs if:

$$t = -\frac{1}{\lambda}\sin^{-1}\frac{2C_2'}{1+C_2^2} \qquad (30)$$

Now if C_2' is negative it will be t > 0. But this is unacceptable because this would mean that $P_1 = 0$ not only at t = 0 but also at another t > 0. By definition I have r = bP so that I would have that r = 0 not only at t = 0 but also at a later time which is senseless. By the same token, the second parenthesis of (29) makes $dP_1/dt=0$ if $\tan(\lambda t) = -C_2'$ or equivalently if:

$t = (-\tan^{-1}(C_2'))/\lambda$. So again if C_2' is negative I shall have another point t > 0 at which dP/dt = 0 and this will be another extreme point of the P_1 function. At $(\sin(\lambda t) + C_2'\cos(\lambda t)) = 0$ it is: $\sin(\lambda t) = -C_2'\cos(\lambda t)$ and by replacing in (28) we find that:

$P_1 = (1-(1+C_2')\cos(\lambda t))^2$. (31)

Now if $C_2' = -2.209640509$ then since $0 < \lambda t < 0.5$ this means that P_1 will be greater than 1 for any value of λt, which is again unacceptable. So this solution must be discarded and the remaining 1st solution is the only acceptable one, for which it is 1/a > 0. This final solution does not present the pathology of the 2nd solution

So the expressions for Ψ_1 and Ψ_2 are:

$\Psi_1 = (-\cos\lambda t + aC_2\sin\lambda t + 1)/a$ (32)

$$\Psi_2 = \left(aC_3e^{-\lambda t} + \frac{\sqrt{\lambda t}}{(n(n-1)-\lambda^2t^2)^{1/4}}\right)/a \qquad (33)$$

For the determination of the last unknown, a, we use the normalization condition which in our case is written:

$$\frac{1}{a^2}\left(\int_0^{t1}\Psi_1^2dt + \int_{t1}^{tq}\Psi_2^2dt\right) \equiv \frac{1}{a^2}(S_1 + S_2) = 1 \qquad (34)$$

By numerical integration and taking again as lower limit of the first integral 10^{-80} with $t_1 = 2.7767105\ 10^{-44}$ and $t_q \equiv 1/2\lambda = 1.1631835\ 10^{-43}$ I solve for (a) and I find:

$$a = \sqrt{S_1 + S_2} = 5.357742810^{-23} > 0 \qquad (35)$$

The corresponding expressions for the probability functions are, of course:

$P_1 = a^2|\Psi_1|^2$ and $P_2 = a^2|\Psi_2|^2$ and they are independent of (a) since aC_2 and aC_3 that appear in the l.h.s. parentheses of (31) and (32) are independent of (a) as can easily be verified from (20) and (23). As it can also be easily verified it is: at t=0 $P_1 = 0$, at $t = t_1$ $P_1 = P_2$ and at $t = t_q$ $P_2 = 1$. I give below the graph of the variation of P with λt (and hence with time) in the Sub-Planckian Space:

Looking at the graph below I found it tempting to see whether the two parts of the graph fit satisfactorily to a power curve of the form : $y = a\,x^b$. By using an appropriate computer program I calculated the a and b as follows:

a = 3.66466183, b = 1.96221698 and with a coefficient of determination equal to: $R^2 = 0.99932698$ i.e almost unity. Is this coincidence of the two curves accidental or some unknown rule requires the development of Probability in the SPS to obey to a power-type regression? I cannot say.

Λt	Probability
0,00	0,000000000
0,02	0,001600013
0,04	0,006461638
0,06	0,014674004
0,08	0,026321760
0,10	0,041484905
0,119358226	0,059580347
0,14	0,081822705
0,16	0,105410785
0,18	0,130902288
0,20	0,158271394
0,25	0,235246652
0,30	0,326202665
0,35	0,435351562
0,40	0,570602062
0,45	0,747382781
0,50	1,000000000

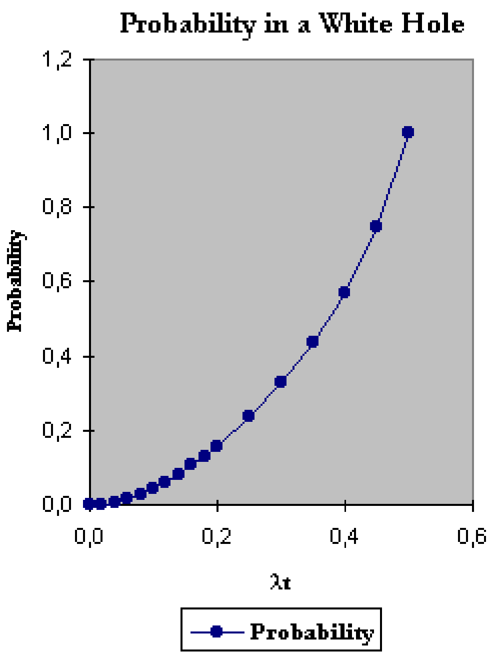

Figure 1

PART II

Before saying anything else, I must emphasize the aim of the present paper:
It is nothing more than an attempt for a model that possibly may be a description of the SPS nature and its relation with the happenings in the ordinary 3+1 space. As a matter of fact, besides my efforts, I was unable to find a similar approach in the existing literature, so my references are very poor on this subject.
The first thing I can infer from the above brief investigation is the following:
In my previous paper[(9)] I examined the emergence of mass from a mini white hole, by using an appropriate adjustment of the metric of spherically symmetric non-rotating and uncharged black holes, to the case of a white hole. In Part I of the present paper I examined the same effect from the point of view of wave mechanics. By characterizing the Sub-Planckian Space as an abstract space where the concept of Probability develops in time I proved that the probability for the emergence of mass from this space can attain the value 1 permitting the emergence of a mass m_x in the real quantum level in a time t_q from the very beginning. A first question that is naturally raised is the following: Since one and the same effect is examined in two different ways i.e. by use of General Relativity first and by use of Quantum Mechanics next, which method reflects the true *reality* of this effect? In other words, is this Sub-Planckian Space a non dimensionless one in which an amount of mass *moves* from a point (central singularity), crosses a distance $r_q = \dfrac{\hbar}{2m_x c}$ without any possibility to be observed during this motion and finally appears, somehow out of the blue, in our ordinary space? Or this space is an abstract space as we described it in the preceded discussion, in which the concept of probability develops in time, permitting again the appearance of the same as above amount of mass?

The question is not so easily answered but I shall try to explain that the second way (the quantum mechanical one) corresponds most likely to the *true reality*, although without the data from the solution of the white hole problem by use of the equations of General Relativity (but in a different way than that used in the case of the Schwarzschild black holes metric) I would be unable (in practice) to solve it by the Quantum Mechanical method alone.

The reasons for the above preference may be summarized as follows:

When inside the SPS, the imaginary “mass” im_x , as long as it is imaginary, has no electric charge, no spin and is not subject to gravity because in the opposite case it would be unable to emerge not only from the radius r_q but even from its Schwarzschild radius $r_s = 2Gm_x/c^2$. When this mass attains a real value, i.e. when its expansion velocity becomes less than c, it is still inside the white hole, so that it remains unobservable. I believe that it is at this time that it develops the **latent** characteristics of electric charge and spin. But even the now real mass m_x inside the white hole, is not yet subject to gravitation, which would oppose its appearance in the quantum level of existence. The above statement is not only a supposition we made in our previous work, but also it reflects the general opinion referred in the foregoing development, that in the above region all known laws of physics (gravitation included) break down. This means that not only gravitation, but neither electroweak forces are present nor strong nuclear attractive forces exist. So the mass m_x, when inside this space, is an alien to what we characterize as mass in our ordinary space.

The fact that in this space exists a determinism that permits the development of an abstract concept (of the Probability) with a strict mathematical method, in (imaginary) time, is an indication that the SPS is not governed by a complete chaos due to the non validity of the physical laws that exist in our ordinary space.

Although the amount of emerging matter is certainly the heaviest elementary particle mass, there is no restriction that this amount of mass may appear a, perhaps, infinite number of times, permitting the creation of one or an infinite number of Universes. The double role played by the probability function, i.e. as the square of the wave function and at the same time as the variable which along with the time characterizes the identity of the SPS as an abstract space, permits some speculations of how the Universe might had come in existence. On this basis I developed a new cosmological model whose Part 1 is this presentation and the other parts will be presented next. This model can describe satisfactorily the creation, the evolution and the future of our Universe. The only I shall say here is that the initial mass that emerged from the SPS was a close packed collection of proto-masses as they were described above. The reason they were in such a super-dense state is that space, as we know it around us was not yet created. There was not empty space to incorporate the emerging masses. These eventually underwent, after their emergence, a series of permutations that allowed the acquisition of electric charge and spin and the generation of quarks, X gauge super-heavy bosons and finally all the other particles we know them today, along with the 3d-space. The total amount of this initial mass **for the creation of only one universe** is not infinite but it is subject to certain restrictions, which will be described in the promised next papers. So matter preceded (by a very tiny fraction of time) the creation of space in my model.

I shall make now a guess about the nature of the emerging proto-mass. First of all I must emphasize that the only characteristic it posses is the amount of matter it contains. This amount was determined in my previous paper(9). It has neither electric or magnetic charge nor spin or any other characteristic that is attached to the masses of the known elementary particles (strangeness, charm, beauty etc.). Since we can not ascribe to this mass, characteristics that are attributed to macroscopic matter, such as solid, liquid, gas, plasma matter, characteristics that are due to the existence and motion of the elementary particles that constitute the ordinary matter, we must look for other entities that may be the essence of this proto-mass. The space it emerges from is completely different from the space we live in. This space, as we saw in the preceding discussion, is characterized by imaginary magnitudes. The word *imaginary* was simply used by the mathematicians to distinguish the new system of numbers that permits the solution of the equation $x^2 + 1 = 0$, from the system of the real numbers. It is probably the most successful choice that could be attached to something that resides only in our imagination (in the sense that we have find ways to manipulate mathematically these numbers but we cannot touch a table whose mass is imaginary or has dimensions ix,iy,iz). The proto-mass when inside the white hole is an imaginary quantity as long as it expands with superluminal velocity. It becomes *real* after its velocity of expansion has dropped below the velocity of light c. But though real, its observation is still unattainable since it has not yet reached the quantum radius r_q as I have described in part I. It becomes measurable after its emergence from the white hole. Since we know that the elementary particles (quarks, leptons, mesons, baryons etc.) have the two basic properties i.e. electric charge and spin, we have to infer that these properties were hidden in the proto-mass in a latent state and they presented themselves after certain transformations that took place after the emergence of the proto-mass. So the basic characteristic feature of this proto-mass is a kind of **potentiality.** In a book of mine[18] I have given the following definition of this term. *By **potentiality** we mean the **latent tendency** of something to **become** something different plus the ability of this something to satisfy this tendency.* P. Davies and John Gribbin[19] that Heisenberg has argued that "….atoms or elementary particles themselves are not as real; they form a world of **potentialities** (the emphasis is mine) or possibilities rather than one of things or facts…". And P. Davies[20] too writes: "… Thus creation ex *nihilo* is here given the concrete interpretation of "actualization" of possibilities….". The presented theory of mine is a mathematical development of the above statement. **The possibilities or the Probability in the Sub- Planckian Space create matter.** But if the **ess**ence of the proto-mass is the potentiality and since the potentiality is an abstract (i.e. a mental) concept, is it 100% absurd to say that the basic stuff of the ultimate matter is a kind of entity that resembles the Platonic IDEA as we already mentioned above? Think of it. Since **no body** can give a definite answer about the stuff that constitutes the ultimate stones of matter (quarks, electrons etc.), it is not quite absurd to think that the emerged proto-mass from a white hole is in itself an abstract entity, an entity of another world, the world of abstract concepts. And not try to say that a quark is a condensed energy because this answer simply leads to another one, i.e. what is energy, where is it coming from and so on. The transformation of an abstract concept to a "material" particle occurs in the borders of the mini white holes with the outside world. The above references are not mere speculations. As a matter of fact we are not allowed to speculate about completely unknown things. They are desperate final efforts to understand somehow the ultimate essence of what a quark or a neutrino may be (beyond of being simple labels to distinguish them from other particles) or at least how can we make an even hazy picture of the stuff of these entities. If someone has a better answer I would be very grateful if he/she let me know what they know.

We may give now a brief example of what is meant by the words "*latent tendency*" that characterizes the term Potentiality.

As it is known, there exists a mathematical relation, which defines the well-known *Relation of the Geometrical Mean* (RGM). This relation among any three numbers x,y,z is $z^2 = x \cdot y$ where z is the geometrical mean of x and y. It governs many quantities in both the micro- and mega-cosmos. I shall very briefly and without mathematical expressions present few examples that manifest the validity of the above very simple relation in their domain of application. But most of them are already known. So:

a. The Planck length is the geometrical mean of the quantum and the Schwarzschild radius of the same mass m.
b. If r_e is the classical radius of the electron and r_B is the first Bohr radius in the hydrogen atom application of RGM to the above lengths provides a length r_c which is the quantum diameter of the electron or equivalently, the reduced Compton wavelength of it.
c. The proton Compton wavelength $h/m_p c$ is the geometrical mean of its Schwarzschild radius and the average diameter of the biggest gravitationally held aggregations in the Universe, namely the clusters of galaxies.
d. The *golden ratio, which* by the ancient Greeks was considered to posses aesthetic or even mystical meaning, is a special application of the RGM.
e. The average diameter of the Sun is the geometrical mean of the average diameter of the only inhabited by intelligent beings, planet, i.e. of the Earth and of the average Earth-Sun distance.
f. Even J.Gribbin1 and M Rees[(20)] seem to have some appreciation to the RGM since they refer: "…The size of human being is the geometric mean of the size of a planet and the size of an atom; the size of a planet is the geometrical mean of the size of an atom and the size of the Universe…".

There are many more applications of the RGM in elementary particle magnitudes[(18)] and in other realms[(21)], but the reason I referred to the above applications of such a simple mathematical relation, was to emphasize its importance (and perhaps its mysterious role in the physical world) which may finally be proved as an as yet hidden universal law. In any case it permits one more application connected with our main subject.

As it is known, the definition of the imaginary unit i is: $i^2 = -1$. Suppose now that we rewrite the above definition in the trivial form: $i^2 = (-1) \times (+1)$. This relation may be red as follows: *The product of the positive and the negative unit of real numbers is related with the imaginary unit through the RGM.* Or equivalently: The imaginary unit is the geometrical mean of the negative and positive real units. From the above definition we may infer that the concept of positive and negative is hidden in a *latent state* in the imaginary unit. And since the imaginary unit characterizes the Sub-Planckian Space, it may be reasonable to expect that when something emerges from this space in the real space, may contain in itself the tendency for the creation of the dual concepts Positive-Negative, which in themselves are manifestations of the more basic ones, namely Thesis-Antithesis. This tendency is revealed (perhaps) as a positive and negative electric charge and in a peculiar way, is the reason for the development of spin of the elementary particles, as we shall show in Cosmology 4. One may put the question: Why the latent tendency of positive-negative, manifests itself as a positive and negative charge and not as a matter-antimatter simultaneous creation? Our answer, contrary to what is generally accepted, is that *from a white hole only matter emerges.* The antimatter appears wherever is enough energy supplied for the creation of particle-antiparticle pairs and this occurred after the transmutations of the proto-mass, which happened after the appearance of the maximum amount of

matter permitted by certain conditions. A similar opinion is expressed by Prigogine[15] who writes that: "… Our Universe is constructed basically by matter while the antimatter is only the transient result of high energy processes at least as we know up to now…".
About all these speculations I shall give answers in detail in the promised next papers, since the subject is immense and requires extended presentation. Any way, the only we have to say is that there is no problem of excess of matter over antimatter and the observed abundance of photons over baryons is due to other reasons. If the readers of this paper consider the above strange opinions of me as unfounded, it is better to wait for the promised next papers to come for their final decision. I remind to everybody who reads these lines that most of the proposed cosmological models introduce new concepts, which are on the same level of arbitrariness and peculiarity as the concept of the nature of the SPS as an abstract space. Remember e.g. the false vacuum of the inflationary theories, the perfect cosmological principle of the Steady State Theory, the infinities of the Big-Bang theory at t=0, the wormholes and so on.
6. To end this brief discussion, I return to the initial question about which interpretation of the happenings inside a white hole is closer to reality. The general relativistic one or the quantum mechanical? As I noticed, both led to the same result, which is the appearance of matter from a white hole in the real world we live in. From what we have said up to this point, it is more reasonable to accept that the description of white holes processes according to General Relativity is a rather phenomenological description, which yields correct answers but it does not correspond to what really happens. The phenomenology of General Relativity in the case of white holes is due, to my opinion, to the model of curved space-time it uses to describe gravitation. Such a space-time does not exist in the SPS. So the metric of the mini white holes uses a model where the space coordinate r appears necessarily as it happens in the case of black holes. But we must not forget that the Schwarzschild solution is an external solution whereas the solution in the interior of black holes, although suggests the mutual replacement of the time and space coordinates, it does not give a final answer about the happenings in the interior of the event horizon, especially about the fate of the collapsing matter when it reaches the central singularity. This answer will be given in the next paper of this theory. In the solution of the white hole metric we used one of the conditions imposed for the quantum mechanical treatment of the problem, namely the imaginary time condition. The reality in the interior of the white hole, however strange it may seem at first glance, is that described by quantum mechanics, which may better be called sub-quantum mechanics. I think that the present work is an attempt for a determination of "the place" where the concept of Probability can be developed**.** Now if some one wonder whether any kind of probabilities for macroscopic events to occur develops in the SPS, the answer is that it is too early to even speculate about that. So cards and roulette gamblers should be patient for a long yet time. In the next three papers I shall present my complete cosmological model.
S.Weinberg[22] has given a fair description of the First Three Minutes. In the present paper I tried to describe what happened in the first 1.1631835 10^{-43} seconds before the beginning of the real time.

APPENDIX I.

I give below the (trivial) analytical calculation of the derivative $\frac{\partial^2 \Psi}{\partial r^2}$ when r= bP and $P = a^2\Psi^2$:

$$\frac{\partial^2\Psi}{\partial r^2}=\frac{\partial^2\Psi}{b^2\partial P^2}=\frac{1}{b^2}\frac{\partial}{\partial P}\left(\frac{\partial\Psi}{\partial P}\right)=\frac{1}{a^2b^2}\frac{\partial}{\partial P}\left(\frac{\partial\Psi}{\partial\Psi^2}\right)=\frac{1}{a^2b^2}\frac{\partial}{\partial P}\left(\frac{1}{\frac{\partial\Psi^2}{\partial\Psi}}\right)=\frac{1}{2a^2b^2}\frac{\partial}{\partial P}\left(\frac{1}{\Psi}\right)=$$

$$=\frac{1}{2a^2b^2}\frac{\partial}{\partial\Psi}\left(\frac{1}{\Psi}\right)\frac{\partial\Psi}{\partial P}=-\frac{1}{2a^2b^2\Psi^2}\frac{\partial\Psi}{\partial P}=-\frac{1}{2a^2b^2\Psi^2}\left(\frac{1}{\frac{\partial P}{\partial\Psi}}\right)=-\frac{1}{2a^2b^2\Psi^2}\frac{1}{2a^2\Psi}=$$

$$=-\frac{1}{4a^4b^2\Psi^3}$$

Acknowledgements

My thanks to the mathematician Jimmy Angelis for his useful suggestions regarding the presentations of the mathematical topics of this work.

SUMMARY

The present work is the first from a series of five works, where I shall try to present my cosmological model (in fact not all of it. There are more to be said but they are not included. So definitions that are based on philosophical or scientific or even to religious arguments have been given for the word COSMOLOGY. The second and (a little the first) case will be our subject and in what follows I will try to give my definitions. Beyond that, the success of a model depends on its predictions (or the verifications) according to the results of other cosmological models, which have accepted a more general acceptance. I will try to follow this process in the development of my model. It has to be emphasized, however, that the present work does not intend to play the role of a text book on cosmology. It is concentrated especially to, for the time being, unsolved problems of Cosmology, in general, and not to details that concern to the formation of the constituents of universe (stars, galaxies etc.). For the present first part I tried to give some information for the events that took place between the time 0 and 10^{-43} seconds before the "creation" of the universe. (i.e.. before the appearance of matter, time and space as we understand these concepts now). This first work was presented in the first International Greek-Turkish conference at the Greek Island Kos at Sept. 2001. Here is given the detailed development of the subject.

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COSMOLOGY 2 (C2)

THE FATE OF THE MASS FALLING TOWARDS THE CENTRAL SINGULARITY OF A SCHWARZSCHILD BLACK HOLE

Abstract

This is the second part of a series of papers for the presentation of a new Cosmological model.

According to the interior solution of the equations of General Relativity (GR) for a Schwarzschild (non rotating-electrically neutral-spherically symmetric) Black Hole (BH), the collapsing mass of a star will inevitably reach the central singularity where it will either disappear or will end up in a mathematical point with infinite density within a zero volume. This situation is unavoidable because no mechanism is known that will resist to the final implosion of the mass that has crossed the event horizon (provided that it is within the limits that permit the formation of a black hole). This fact is generally accepted by the physics community and the only that the people who are dealing with this problem do, is to develop scenarios about what happens to this mass or where it goes. So "wormholes" have been proposed or the so called Einstein—Rosen Bridge, through which this mass is transferred to another point of the Universe and appears as a white hole or it is even transferred to another Universe. These hypothetical mechanisms will be proved at least unnecessary by the present work. As will be shown, a final resistance does exist and most probably prevents the approaching to the central singularity so that the known laws of physics remain intact, contrary to what happens if the central singularity is reached according to GR. The development will be done by use of Newtonian gravitation for reasons that will be explained in the ensuing development. The theory we shall present will permit a more accurate determination of the least mass necessary for the formation of a BH. The present work will also permit some cosmological deductions, which are compatible with the outcomes of the inflationary theory, but they will be presented in a next paper.

Key Words: Newtonian gravitational potential, Repulsive nuclear potential, event horizon, internal barrier.

INTRODUCTION

As it is known, the literature on Black Holes (BHs) in either a strict mathematical formalism or in popular and semi-popular expositions is vast, although from their own nature the BHs do not permit but indirect observations only. The general opinion is that the problem of BH can be examined in the framework of the theory of GR only, because of the existence of the very strong gravitational field that accompanies the formation of a BH. The huge pressures that develop during the collapse of a star, although they resist to the squeezing of the material, they generate very high energies, which according to GR contribute to the increase of the gravitational attraction. Besides, however, of the application of the very powerful equations of GR, the final result is that the fate of the collapsing matter in the interior of the event horizon is its disappearance in the central singularity. A similar result can be obtained from the application of the simple Newtonian potential -GM/r which becomes infinite at r=0, if there is no an as yet unknown resisting factor. So a BH is finally nothing more than a mathematical point of infinite density plus a non-material event horizon plus, perhaps *an exterior self-sustaining gravitational field in its own right that has no further use for the body which originally built it*[1] as R. Penrose argues in an attempt to explain the reason of the non disappearance of the exterior gravitational field when the collapsed mass is totally enclosed inside the event horizon. Since the problem of quantum gravity is still waiting for a solution, in what follows I shall show that the central singularity is never reached, thanks to a very strong factor that can be considered as the third (or perhaps the fourth) defense mechanism that prevents the extinction of matter that implodes in a BH. For the sake of history I quote few words by Jayant Narlikar (ref.(2) p.163) about the way this problem is confronted by the existing theories.

"…*Can nothing whatsoever prevent the gravitational collapse of a massive object? In Newtonian theory we could conceive of some 'new' agency with strong enough pressures to halt the collapse. In Einstein's theory the situation is different. If we invent any such agency, its pressure must be accompanied by energy. This energy itself attracts and therefore helps the collapse. In the late 1960s work by theoreticians Roger Penrose and Stephen Hawking, has shown that, in general, unless we introduce new agencies with negative energy, collapse into a singularity is inevitable for most physical systems which have already contracted beyond a certain limit…".*

2. PRELIMINARY NOTATIONS

I will very briefly present what is known for the final steps of the evolution of stars. Almost everything depends on the amount of mass of the star. So:

1) The first case refers to the formation of a White Dwarf, when the star has exhausted its nuclear fuels. If a stable White Dwarf is formed, its mass necessarily cannot exceed the so- called Chandrasekhar's limit, which is equal to about 1.4 Sun masses. The collapse in this case is stopped thanks to the development of a gas of degenerate electrons for which the Fermi-Dirac statistics is applicable and the Pauli Exclusion Principle develops a kind of repulsion between the electrons. The radii of White Dwarfs are of the order of about 6500 Km.

2) The second case refers to the formation of a Neutron Star. In this case too, the neutrons become degenerate and develop a resistance to a further collapse. The corresponding limit of mass for the formation of a stable Neutron Star is not well known but in many text books it is generally accepted that the mass has to be somehow between 1.6 and 2 Solar masses and definitely less than 3 Solar masses. The radii of Neutron stars are of the order of 10 Km. In ref. (3) are given various estimations for the maximum mass for stable neutron stars made by different researchers, as e.g. 1.78-1.98 M_o, or 2.15 M_o, or 1.41 M_o or 1.3-1.8 M_o or 3.2 M_o and finally it is suggested by the author of the article that a useful consensus on the limiting mass is somewhat less than $2M_o$. (By M_o I have denoted the Sun mass). So since I shall determine a lower limit of mass for the formation of a BH this will be an upper limit for the formation of a stable neutron star.

3) If the mass of the collapsing star is greater than the existing lower limit for the formation of a BH, the star becomes a BH since the gravitational attraction is so strong that no mechanism can resist to the formation of the BH.

4) There has been mentioned a third possibility that may present a resistance to the final implosion of the mass to the central singularity of a BH if the mass of the star is a little greater than 2 Sun masses. This possibility comes from the idea that the quarks that constitute the neutrons present degeneracy since they are fermions too. So in the

super dense material of a neutron star that is a state of transition from a neutron star to a BH, it is possible the quarks that constitute a neutron to behave as free particles and develop a degenerate gas that can resist to the collapse. It is not clear however, what is the mass of the star whose degeneracy will be finally defeated by the gravitational attraction. We do not think that this situation really happens due to the infrared slavery and the asymptotic freedom of the quarks, which (the latter) occurs at the Planck-scale energy and dimensions (according to a work of this mine[(4)]).

Up to this point I have nothing to add since these steps have been verified by some indirect astronomical observations apart from their theoretical prediction (except the last case 4 above). My contribution to the time evolution of the so formed BH refers to the fate of the mass that is trapped inside the event horizon. As I said above, the GR theory concludes that the disappearance of the mass in the central singularity is inevitable and nothing can prevent this unimaginable event that puts in question the basic law of mass-energy conservation. If the theories of quantum gravity (supergravity, superstrings etc.) need the existence of messengers (called gravitons) for the transmission of the gravitational interactions, four basic questions need to be answered: a) If gravitons are emitted and exchanged by all gravitating objects, then if there is no “object” (i.e. if the object has disappeared in/or through the central singularity) how can exist a field outside the event horizon? Are the gravitons “trapped” in this field as a kind of standing waves and “remember” that once upon a time they were conveying the information from one object to another? b) If the gravitons are transmitted with the speed of light and they are gravitating too with each other and with any mass in the universe (as the quantum theories of gravitation accept), how can they escape from the interior of a BH to transfer to the external world the information “here is an amount of mass-energy which exerts gravitational interactions to the rest objects in the Universe”, whereas photons that also move at the speed of light, cannot escape from the interior of a BH? c) If the gravitons interact gravitationally with each other then according to quantum field theories, they also need some messengers to mediate for their gravitational interactions, and if these messengers are gravitating too….. the series of messengers has no end. These doubts put in question the nature and existence of gravitons as they are proposed by the corresponding quantum theories of gravitation, as well as the GR theory which allows the existence of space-time singularities. And d) If it happens that the star possessed a substantial static electric field thanks to the existence of only positively or only negatively charged particles, then when these particles would arrive at the central singularity too along with the neutral particles, the repulsion between them would become infinite. Would this repulsion be not enough to resist to the gravitational attraction given that the electric forces are much stronger than the gravitational ones at the same distance? Beyond the above questions, another one also may be raised. According to Hawking’s theory about the evaporation of the BH, one expects that the whole mass of the BH sooner or later will be evaporated. But the very quick collapse of the in-falling mass towards the central singularity (with a velocity near to that of light) leaves (basically) two alternatives. It is either transferred to another place of the universe through a “wormhole” so that the BH is empty of mass and possesses only a theoretical event horizon and an empty of mass central point in other words it is a balloon without its shell i.e. nothing, or its mass possessing infinite density, if it stays in the mathematical point of the central singularity, will evaporate continuously for ever since an infinite density cannot be reduced to a finite one. How can we get water out of an empty bottle, which is also without walls to encompass the water? The above questions may be nothing but mere absurdities. The supporters of GR, however, must teach us how to get rid of such absurdities. I also think that the people who insist on the idea of evaporation (which most probably is correct) have to decide between two other alternatives: Either the mass of the BH never reaches the central singularity, so that it can feed its evaporation, or if the mass has escaped through the central singularity then this fact does not permit the interaction of the BH with the rest of the universe, as quantum mechanics requires. The BHs do not evaporate since they are empty of mass, so they finally do not exist.

The first time I thought on this problem, was when I developed my theory of the Mini White Holes[(4)] (MWH) and their connection with quarks and nuclear forces. This theory proved to be very successful in the case of the deuteron ground state and also in the next part of this theory[(5)] , in the case of the application of the two nucleons potential to multi-nucleon nuclei. The obtained results were in excellent agreement, in both cases, with observation and/or experiment. The MWH theory solved the problem of the origin of the repulsive nuclear forces when nucleons come closer than about 0.5 fm. The introduced nuclear potential consists of two terms: An attractive (negative) term and a repulsive (positive) term. The last one is a Yukawa-type potential, which for the first time is used as the cause of the repulsive nuclear forces. Up to that time, the nuclear theory, being unable to discover an analytical expression for a central potential that causes the repulsion between the nucleons when they come close to each other, attributed this repulsion to the so called "hard core" or "impenetrable sphere" of the nucleons with an infinite potential for $r \equiv$ centrobaric nucleons distance$<\cong$ 0.5 fm. If this last case (i.e. with $V \rightarrow \infty$) were correct, (although the nature of the hard core or impenetrable sphere has never been analytically explained) it was only one step for anyone who is studying the BH problem to (at least) think that since the nucleons are squeezed by the gravitational attraction to always shorter distances with each other, there would come one moment where gravitation would be unable to overcome the infinite nuclear repulsive force between them, so that the collapse would come to a stop before reaching the central singularity. This idea, as far as I know, has not been expressed by anyone till now in the context of GR. Perhaps this is due to two facts: a) Nobody thought that the repulsion of the nucleons could be connected with the problem of BH, although everything indicated that the squeezing of matter inside the event horizon presents an ideal condition for bringing the nucleons close enough for the repulsion to develop between them. b) The most advanced nuclear theory is based upon the concept of quarks and gluons which however does not cover, as far as I know, the problem of the repulsive nuclear forces in an analytical way. So since I have an analytical expression for the central nuclear potential (which has the major contribution to the development of both attractive and repulsive forces between the nucleons and it is a scalar potential), I thought that it would be a good exercise to investigate, as a start, the case of a comparison of my nuclear potential with the Newtonian gravitational potential. The investigation of the case where the gravitational potentials coming from GR are used instead of the scalar Newtonian potential is an open subject and may be examined by anyone who will consider my investigation insufficient, but even in this case the nuclear potential cannot be ignored. This nuclear potential does not impose high pressures to resist against the collapse. Its repulsive term comes from a new metric I introduced for the MWH[(4)] (which, according to my theory, are the ancestors of the quarks) and in fact it represents a **fifth force field** along with the already known four fields of nature, since it is the only one that has a repulsive short range behavior of non electromagnetic nature among most kinds of elementary particles and with more certainty, among all baryons. For the hadronic mesons and for the leptons the situation is still not clear.

The bosons which mediate this repulsive force and are zero spin mesons[(4)] certainly do not exert repulsive forces among each other since they are virtual particles and also the Pauli exclusion principle does not hold for them). Another reason for using the Newtonian potential is that I have serious reasons to doubt whether the Newtonian theory of gravitation is derivable from the equations of GR in the case of week gravitational fields and if this opinion of mine is correct, the present theory has a chance to be applicable to even strong gravitational fields besides the little departures of its results from those of GR in the case of the four (and controversial) tests of GR. This opinion of mine has already been presented analytically in another work of mine[(6)]. I believe that even though the application of the well known Newtonian potential does not guarantee absolute accuracy, in view of a modified correction of it I have presented in another work of mine[16], it gives a better picture of the happenings in the interior of the BH than the one coming from the equations of GR (interior Schwarzschild solution where these equations break down with the infinities they produce). It is worth to mention how the authors of ref. (7) p.p. 839,840, describe this situation: "*….The region r = 0 is a physical singularity of infinite tidal gravitation forces and infinite Riemann curvature. Any particle that falls into that singularity must be destroyed by those forces. Any attempt to extrapolate its fate through the singularity using Einstein's field equations must fail; the equations lose their predictive power in the face of infinite curvature. Consequently to postulate that the particle reemerges from the earlier singularity is to make up an <u>ad hoc</u> mathematical rule, one unrelated to physics…".* The above quotation is nothing but a clear confession (and acceptance) that GR is unable to give persuasive solution to the problem of the fate of mass that implodes in the interior of the event horizon. So in the calculation of the evaporation of a BH the equations of GR must be forgotten. From the above mentioned work of mine[(6)] it is inferred that the non applicability of the Newtonian gravitation in the case of strong gravitational fields, i.e. the characterization of the Newtonian gravitational field as a "weak" one, was an arbitrary decision made by the people who were unable to get a general solution of the equations of GR which are non linear, so difficult (or impossible) to be solved. So they made simplifying assumptions as in the case of the Schwarzschild exterior solution, which accepts a *time-independent* and *spherically symmetric* line element. By getting an expression for the geodesic equations, the authors of the book of ref (8) identified the resulting expression with the expression of the Newtonian gravitational potential by an a priori and non-provable assumption that this last one holds only in the case of weak gravitational fields. Before the development of GR nobody had doubt that the Newtonian theory was applicable to any gravitational field either weak or strong and no distinction was made between them since there is no sharp discrimination between the "weak" and the "strong". At this point it is crucial to remind that the MWHs I introduced[(4)] , derive their repulsive character from a modification of the Schwarzschild line element appropriate to the case of white holes. A quantum mechanical explanation of the formation of a white hole has been presented in a conference[(9)] and in more extended form in the first paper of this book (C1). The applicability in the BH problem of the Newtonian potential is proved satisfactory by the author of ref. 7 of C1.

METHOD OF CALCULATION

Following fig.1, I consider a collapsing star with its center at O, that is in the transition from the state of a neutron star to the state of a BH.

I shall examine the inward motion of a test neutron on the geometrical surface of the neutron star. The potential energy of this neutron in the Newtonian gravitational field is equal to $E_g = -GMm_n/R$ where M is the total mass of the star [2], m_n is the

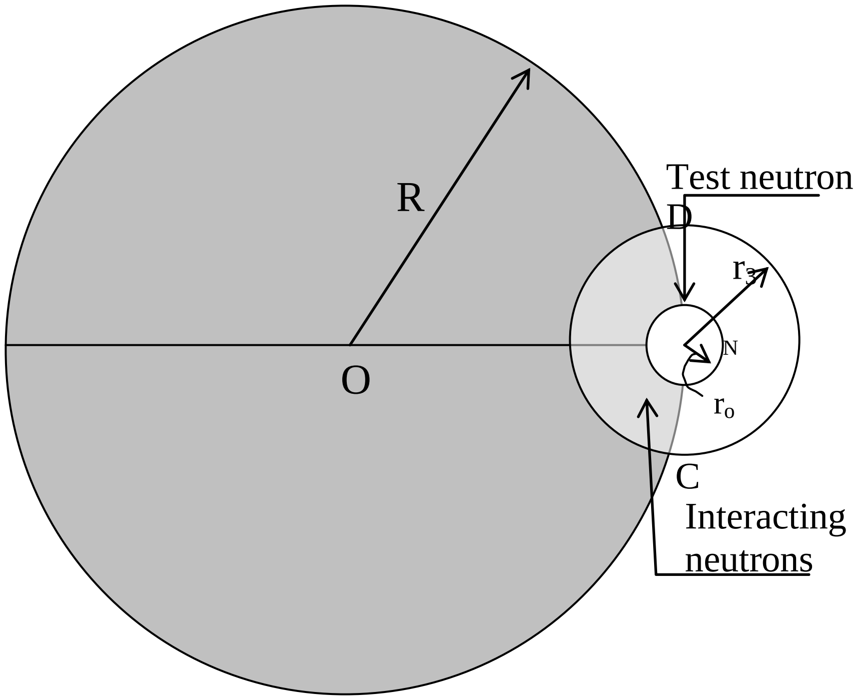

Figure 1
General view of the interaction of a neutron at the surface of a collapsing star towards the BH center with the surrounding neutrons, via the central nuclear potential. The figure is completely out of scale. The indicated radii are defined in the main text

neutron rest mass and R is the radius of the star. The minus sign comes from the convention of the force law indicating that the force is attractive. At this point it is necessary to say that M is not the mass of the star before the formation of a neutron star but it is the mass that remains after the explosion of the star as a supernova where it may lose perhaps the 90% or more of its initial mass which spreads in the surrounding interstellar space (c.f. ref. 10, p.88). Apart from this interaction, the neutron interacts with a number of neutrons in its neighborhood through the two-body potential I have derived in my previous work[4].

The two-body nuclear potential energy of the test neutron and a neighboring neutron (in fact with a proton in the case of the two nucleon's system i.e. of the Deuteron in its ground state) is:

$$\mathbf{E_n(r) = V_x \exp(-\lambda r)/r - V_G \exp(-a\, r^b)} \qquad \mathbf{(1)}$$

where V_x ,V_G, a, b, λ have been derived in my previous paper[4] and are equal to:

$V_x = 1.2961619\ 10^{-26}$ Kg m^3 sec^{-2}, $a = 1.365816135837\ 10^{246}\ m^{-b}$,
b=16.731680392255,
$\lambda = 2.501789888\ 10^{15}\ m^{-1}$, $V_G = 7.707742\ 10^{-12}$ Joules = 48.112 MeV

The values of the physical constants I use are as follows:

$\pi = 3.14159265359$, $c = 2.99792458\ 10^8$ m/sec (velocity of light in vacuum),
$G = 6.672521799\ 10^{-11}$ Nt m^2 Kg^{-2} (Gravitational constant),

$m_n = 1.674942\ 10^{-27}$ Kg (neutron rest mass), $M_o = 1.9889\ 10^{30}$ kg (Sun mass)

The application of the above potential in the case of two neutrons interaction does not produce any significant error since the neutron and the proton rest masses are almost equal and there are no electrical forces present, which are also absent in the deuteron case.

I shall write bellow all the necessary relations for the determination of the distance at which the collapse inside the BH comes to a stop i.e. when $E_g(R) + E_n(r) = 0$ and I shall explain what each one of these relations represents.

Let us denote by n_0 the number of Sun masses (M_o) that constitute the mass of the collapsing star after the abstraction of the mass that has been left in the star at the supernova explosion. Then the mass M of the neutron star will be equal to:

$$M = n_0 \times M_o \qquad (2)$$

If a_o is the number of neutrons in the star it will be (to a good approximation):

$$a_o = M / m_n \qquad (3)$$

According to what is known about ordinary nuclei, the nucleons are in a close packed system and as such I have chosen the face centered cubic system as in crystals which presents the greatest packing fraction for hard spheres equal to $\pi\sqrt{2}/6 = 0.74048049$. The close packing will certainly be applicable for the neutrons in a neutron star thanks to the squeezing effect of gravitation. Although there is a general opinion that may exist a gradient for the density inside the neutron star, an assumption, which may be accepted, is that when the collapse of a neutron star comes to an end and the star is in equilibrium, its density is uniform throughout the mass of the star. This assumption comes closer to the true situation as the star continues the collapse towards a BH formation and this case is of interest now. A similar assumption of constant density is accepted in the case of the interior Schwarzschild solution (c.f.ref. 8, p.468) although the physical situation may not present such constancy of the mass density. So, although the density inside a collapsing star may not be uniform, the uniformity is implicitly accepted as an average throughout the ensuing development. A non- uniform density would make the solution far more difficult, unless the density gradient of the density from the center to the periphery could be known from observation. It is obvious that in the case of a BH such information is strictly prohibited.

Six neutrons

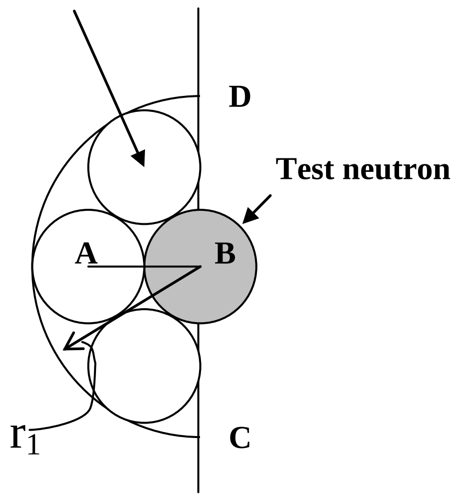

Figure 2

Interaction of the test Neutron with the six others in the hemisphere. The strait line CD is a good approximation of the arc CD of the circle (O,R) in Fig. 1. The distance AB ≡ r_2 is the range of nuclear forces in this special case.

I will first examine the marginal case when all the mass of the star has been just enclosed in the event horizon of a BH, which case will permit the determination of the least mass necessary for the formation of a BH. This mass is at the same time the maximum mass for the existence of stable neutron stars.

If R is the geometrical radius of the star (I suppose perfect spherical symmetry), then due to the above assumption, this radius will be given by the relation:

$$R = 2GM/c^2 \qquad (4)$$

If I denote by $2r_0$ the average centrobaric distance of two neighboring neutrons in the star then taken into account the close packing condition I will have:

$$r_0 = R\,(\pi\, 2^{1/2}/a_o/6)^{1/3} \qquad (5)$$

I denote next by r_1 the radius of a sphere with center at N, which contains all the neutrons the test neutron interacts with plus the test neutron. The number of neutrons in contact with the test neutron in the chosen tightly packed assembly is 12 (from a comparison of the atoms in a crystal with the same packing system). Since the range of the nuclear forces is the distance of the mass centers of two neutrons in contact, the radius r_1 will be equal to $3r_0$, where all the neutrons in the sphere (N,r_1) (if it was full of neutrons) are 12+1 = 13. Wherever I refer to the radius r_1 it is in fact the radius r_3 of fig. 1 but in the case of only six neutrons in the left hemisphere of fig. 2.

The neutrons that finally interact with the test neutron will be 6 i.e. those which are in the left hemisphere in fig. 2. This is a very good assumption for two reasons: A) The test neutron will interact with all the neutrons that are contained in the volume of the two spherical segments, which are defined by the section of the two spheres (O,R) and (N,r_1). But because R will have a length of several meters or even kilometers and r_1 will have a length of the order of 10^{-15} m. (i.e. about 18 orders of magnitude smaller), the spherical surface that separates the empty and the full of neutrons space may be replaced with excellent accuracy by a plane perpendicular to the line joining the centers O and N and at distance R from O. Hence this plane cuts the sphere (N,r_1) in two hemispheres. So the number of neutrons the test one interacts with is 12/2=6. B) Since the interaction distance between two neutrons is taken equal to the distance between their mass centers, we define as the range of the interaction this distance, which is equal to:

$$\text{Range} \equiv r_2 = (r_1 - r_0) = 2r_0 \text{ as in fig.2 (in the case under examination)} \qquad (6)$$

The same principle was applied for the determination of the range of the nuclear force in the case of the deuteron nucleus[4] where this range was taken equal to the centrobaric distance between the neutron and the proton.

In the present case the test neutron is in a position, which permits the maximum number of interactions i.e. the 6 other neutrons altogether, which are at the same distance from the test neutron at N. As it is believed[3] the neutron stars are giants hypernuclei and this means that their average density will be equal to or more than the density of nucleons inside ordinary nuclei where the gravitation does not play any significant role. In the case of BH, however the situation is different. The distance r_2 is a good candidate that defines the maximum range of nuclear forces in the case of neutron stars and BH. This range in the case under examination (i.e. when $R=r_s$) is determined as the distance between the mass centers of two nucleons as in the case of the deuteron. In the case of heavy nuclei (28<A<208) I used the range of nuclear forces as it was determined for the deuteron and I found that the inter-nucleon distance was a little shorter (2.09 fm instead 2.15 fm in the deuteron). For this reason the range when $R = r_s$ will be kept constant in the case of the BH interior, no matter how many neutrons will exist each time inside the pre-described hemisphere. As it is expected, the inter-neutron distance will be decreasing, as the number of neutrons will increase in the left hemisphere. The radius of this hemisphere when R is less than the Schwrzschild radius r_s will be determined further on. The number of neutrons in the hemisphere, however, may change by a decrease of their radius, due to the squeezing force exerted on them from the gravitational field of the star. The accepted uniform density of matter in the ideal Schwarzschild BH advocates to the accepted constancy of the range r_2.

Now it can be easily proved that the distance between the point of application of the resultant force of the 6 neutrons and the center of the test one will be equal to:

$r = 3\, r_2 / 8$ (7)

where r is the distance between the center of mass of the test neutron and the geometrical center of mass of the hemisphere with radius r_2 where the interacting nucleons are embedded. The use of r_2 in (7) is due to the fact that in the case of only 6 neutrons they are all embedded in only one pile and at the same distance from the test neutron. In the case of more than the six neutrons, as is the case of heavier stars, we shall use the distance $r_2 + r_0$ where r_2 will be constant but r_0 will be variable. So the nuclear potential energy of the test neutron in the field of the 6 others will be given by the expression:

$E_n(r) = 6[V_x \exp(-\lambda r)/r - V_G \exp(-a\, r^b)]$ (8)

The gravitational potential energy of the test neutron in the field of the whole star will be equal to:

$E_g(R) = -GMm_n / R$ (9)

We need now to solve the equation:

$E_n(r) + E_g(R) = 0$ (10)

in which the unknown is the n_0 .

I first solve this equation in the case of the limit that distinguishes a neutron star from a BH. I suppose that as a star collapses to form a BH it passes a very short phase of a neutron star as long as the total mass of the star has not completely been enclosed within the event horizon of the BH. The radius R as it is given in (4) is the geometrical radius that encompasses the total mass of the star every moment. If our basic assumption that the nuclear potential can counterbalance the attractive gravitational potential is correct, we may calculate for what n_0 the radius R becomes equal to the Schwarzschild radius $r_s = 2GM/c^2$ and simultaneously $E_n + E_g = 0$. (Before the total collapse into the event horizon, R is greater than r_s . After the collapse R is less than r_s).

The solution is achieved by an appropriate computer program in which unknown is the n_0 and both the above conditions are fulfilled.

The necessary relations are (2) up to (10):

I obtained the following results:

$r_0 = 0.401637\ 10^{-15}$ m. = 0.401637 fm, $R \equiv r_s = 5.931354\ 10^3$ m.

$n_0 = 2.008456 \pm 0.0000001$ (least number of Solar masses for the formation of a BH)

$r_1 = 1.204909598\ 10^{-15}$ m. (radius of a sphere that contains the 13/2 = 6 1/2 neutrons in the left hemisphere of it altogether as in fig. 2).

$r_2 = r_1 - r_0 = 8.032731\ 10^{-16}$ m. (range of nuclear forces when $R \le r_s$)

$r = 3.012274\ 10^{-16}$ m. (The variable in eq. (8))

Some comments on the above results will reveal interesting information. A) The least number n_0 of Sun masses needed for the formation of a BH is 2.0085. This figure is within the limits that have been proposed by others i.e. between 1.41 and 3.2 Sun masses and according to ref.(3) the author of this article gives a more stringent estimation that restricts the maximum mass of stable neutron stars in the narrow

range of 1.79-1.98 Sun masses and he accepts as a useful consensus of the limiting mass as being somewhat less than 2 M_o. On the other hand John Talor[11] writes that "….*BHs are expected to form naturally from an aggregation of matter which is heavier than about twice the sun mass…"*. My determination, therefore, of n_0 made by use of the least of assumptions and of a simple theory which does not leave many doubts about its consistency, has to be taken as the best and most detailed estimation of the least mass that a star must posses (after the supernova explosion) to collapse in a BH. B) From now on the value of r_2 as I said above, represents the **maximum** and **constant** distance at which nuclear interactions between the test neutron and its neighbouring ones take place inside the BH, for the determination of the ensuing quantities i.e. of R, r_0 , n_0 etc. no matter how many neutrons are contained in the hemisphere of radius r_4 which will be defined below.
With reference to fig. 3 I shall write now the necessary relations for the determination of R, r_0 , n_0 etc. in the case where the mass of the star continues its contraction towards the central singularity of a BH (which, however, is never reached).

$$M = n_0 \times M_o \quad (11)$$

$$a_o = M / m_n \quad (12)$$

$$R = (6a_o / \pi / \sqrt{2})^{1/3} r_0 \quad (13)$$

$$r_2 = 8.032731\ 10^{-16}\ \text{m.} \quad (14)$$

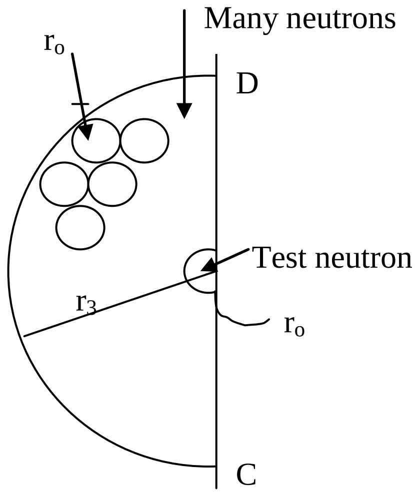

Figure 3
Interaction of the test neutron with the neutrons contained in the hemisphere. For the CD line applies the same approximation as in fig 2. The radius r_3, which in the present case plays the role of r_1 of fig. 2 is defined in the main text.

$$r_3 = r_2 + r_0 \quad (15)$$

$$r = 3\ r_3 / 8 \quad (16)$$

$$n_1 = \pi\sqrt{2} r_3^3 / 6 / r_0^3 \quad (17)$$

$$n_2 = (n_1 - 1)/2 \quad (18)$$

$$E_n(r) = [V_x \exp(-\lambda r)/r - V_G \exp(-a\ r^b)] n_2 \quad (19)$$

$$E_g(R) = -GMm_n / R \quad (20)$$

$$E_n(r) + E_g(R) = 0 \quad (21)$$

$$r_s = 2GM/c^2 \quad (22)$$

In (16) I used r_3 instead of r_2 since this choice gives a better determination of the geometrical center of the left hemisphere. For many nucleons in the hemisphere the difference is immaterial. This is shown clearly in TABLE 1 below.
Equation (21) is solved for the determination of the unique unknown r_0 for every chosen n_0, with another appropriate computer program, so that n_0, R (and the other quantities in the above relations), are determined. Then the comparison of R, with the corresponding $r_s = 2GM / c^2$ may be found in TABLE I below along with all the obtained interesting results from the solution of (21).

TABLE I

n_0	R_0 (m)	R (m)	r_s (m)	$E_n = -E_g$ (MeV)
2.008456	$4.01637\ 10^{-16}$	$5.931354\ 10^{3}$	$5.931354\ 10^{3}$	$4.697868\ 10^{2}$
3	$2.261499\ 10^{-16}$	$3.817628\ 10^{3}$	$8.859573\ 10^{3}$	$1.090235\ 10^{3}$
4	$2.088957\ 10^{-16}$	$3.881341\ 10^{3}$	$1.181276\ 10^{4}$	$1.429781\ 10^{3}$
5	$1.960606\ 10^{-16}$	$3.924161\ 10^{3}$	$1.479596\ 10^{4}$	1.76772910^{3}
6	$1.859590\ 10^{-16}$	$3.955191\ 10^{3}$	$1.771915\ 10^{4}$	$2.104632\ 10^{3}$
7	$1.777022\ 10^{-16}$	$3.978859\ 10^{3}$	$2.067234\ 10^{4}$	$2.440798\ 10^{3}$
8	$1.707660\ 10^{-16}$	$3.997586\ 10^{3}$	$2.362553\ 10^{4}$	2.77641610^{3}
9	$1.648172\ 10^{-16}$	$4.012822\ 10^{3}$	$2.657872\ 10^{4}$	$3.111609\ 10^{3}$
10	$1.596316\ 10^{-16}$	$4.025490\ 10^{3}$	$2.953191\ 10^{4}$	$3.446463\ 10^{3}$
20	$1.287178\ 10^{-16}$	$4.089514\ 10^{3}$	$5.906382\ 10^{4}$	6.78501310^{3}
30	$1.131322\ 10^{-16}$	$4.114589\ 10^{3}$	$8.859573\ 10^{4}$	$1.0115496\ 10^{4}$
40	$1.031285\ 10^{-16}$	$4.128243\ 10^{3}$	$1.181276\ 10^{5}$	$1.344272\ 10^{4}$
50	$9.593690\ 10^{-17}$	$4.136905\ 10^{3}$	$1.476596\ 10^{5}$	$1.676821\ 10^{4}$
60	$9.041123\ 10^{-17}$	$4.142915\ 10^{3}$	$1.771915\ 10^{5}$	$2.009267\ 10^{4}$
70	$8.597463\ 10^{-17}$	$4.147329\ 10^{3}$	$2.067234\ 10^{5}$	$2.341644\ 10^{4}$
80	$8.229913\ 10^{-17}$	$4.150736\ 10^{3}$	$2.362553\ 10^{5}$	$2.362553\ 10^{4}$
90	$7.918191\ 10^{-17}$	$4.153428\ 10^{3}$	$2.657872\ 10^{5}$	$3.006272\ 10^{4}$
100	$7.648954\ 10^{-17}$	$4.155615\ 10^{3}$	$2.953191\ 10^{5}$	$3.338544\ 10^{4}$
200	$6.085875\ 10^{-17}$	$4.165811\ 10^{3}$	$5.906382\ 10^{5}$	$6.660745\ 10^{4}$
300	$5.320926\ 10^{-17}$	$4.169278\ 10^{3}$	$8.859573\ 10^{5}$	$9.982809\ 10^{4}$
400	$4.836341\ 10^{-17}$	$4.170967\ 10^{3}$	$1.181276\ 10^{6}$	$1.330502\ 10^{5}$
500	$4.490704\ 10^{-17}$	$4.171935\ 10^{3}$	$1.476596\ 10^{6}$	$1.662742\ 10^{5}$
600	$4.226530\ 10^{-17}$	$4.172543\ 10^{3}$	$1.771915\ 10^{6}$	$1.995000\ 10^{5}$
700	$4.011523\ 10^{-17}$	$4.172948\ 10^{3}$	$2.067234\ 10^{6}$	$2.327274\ 10^{5}$
800	$3.840687\ 10^{-17}$	$4.173228\ 10^{3}$	$2.362553\ 10^{6}$	$2.659563\ 10^{5}$
900	$3.692995\ 10^{-17}$	$4.173426\ 10^{3}$	$2.657872\ 10^{6}$	$2.991866\ 10^{5}$
1000	$3.565670\ 10^{-17}$	$4.173569\ 10^{3}$	$2.953191\ 10^{6}$	$2.324182\ 10^{5}$
2000	$2.830292\ 10^{-17}$	$4.173891\ 10^{3}$	$5.906382\ 10^{6}$	$6.647850\ 10^{5}$
3000	$2.472399\ 10^{-17}$	$4.173741\ 10^{3}$	$8.859573\ 10^{6}$	$9.972135\ 10^{5}$
4000	$2.246217\ 10^{-17}$	$4.173543\ 10^{3}$	$1.181276\ 10^{7}$	$1.329681\ 10^{6}$
5000	$2.085109\ 10^{-17}$	$4.173354\ 10^{3}$	$1.476596\ 10^{7}$	$1.662176\ 10^{6}$
6000	$1.962082\ 10^{-17}$	$4.173184\ 10^{3}$	$1.771915\ 10^{7}$	$1.994693\ 10^{6}$
7000	$1.863741\ 10^{-17}$	$4.173030\ 10^{3}$	$2.067234\ 10^{7}$	$2.327228\ 10^{6}$
8000	$1.782546\ 10^{-17}$	$4.172893\ 10^{3}$	$2.362553\ 10^{7}$	$2.659776\ 10^{6}$
9000	$1.713866\ 10^{-17}$	$4.172769\ 10^{3}$	$2.657872\ 10^{7}$	$2.992338\ 10^{6}$
10000	$1.654675\ 10^{-17}$	$4.172656\ 10^{3}$	$2.953191\ 10^{7}$	$3.324909\ 10^{6}$
20000	$1.313079\ 10^{-17}$	$4.171902\ 10^{3}$	$5.906382\ 10^{7}$	$6.651020\ 10^{6}$

30000	$1.146962\ 10^{-17}$	$4.171472\ 10^{3}$	$8.859573\ 10^{7}$	$9.977558\ 10^{6}$
40000	$1.042011\ 10^{-17}$	$4.171180\ 10^{3}$	$1.181276\ 10^{8}$	$1.330434\ 10^{7}$
50000	$9.672668\ 10^{-18}$	$4.170961\ 10^{3}$	$1.476596\ 10^{8}$	$1.663130\ 10^{7}$
60000	$9.101953\ 10^{-18}$	$4.170789\ 10^{3}$	$1.771915\ 10^{8}$	$1.995839\ 10^{7}$
70000	$8.645783\ 10^{-18}$	$4.170648\ 10^{3}$	$2.067234\ 10^{8}$	$2.328557\ 10^{7}$
80000	$8.269158\ 10^{-18}$	$4.170529\ 10^{3}$	$2.362553\ 10^{8}$	$2.661284\ 10^{7}$
90000	$7.950598\ 10^{-18}$	$4.170427\ 10^{3}$	$2.657872\ 10^{8}$	$2.994018\ 10^{7}$
100000	$7.676054\ 10^{-18}$	$4.170337\ 10^{3}$	$2.953191\ 10^{8}$	$3.326758\ 10^{7}$
10^{6}	$3.561653\ 10^{-18}$	$4.168868\ 10^{3}$	$2.953191\ 10^{9}$	$3.327930\ 10^{8}$
10^{7}	1.65287010^{-18}	$4.168103\ 10^{3}$	$2.953191\ 10^{10}$	$3.328541\ 10^{9}$
10^{8}	7.67125510^{-19}	$4.167730\ 10^{3}$	$2.953191\ 10^{11}$	$3.328839\ 10^{10}$
10^{9}	$3.560530\ 10^{-19}$	$4.167553\ 10^{3}$	$2.953191\ 10^{12}$	$3.328980\ 10^{11}$
10^{10}	$1.652619\ \ 10^{-19}$	$4.167470\ 10^{3}$	$2.953191\ 10^{13}$	$3.329046\ 10^{12}$
10^{11}	$7.670706\ 10^{-20}$	$4.167431\ 10^{3}$	$2.953191\ 10^{14}$	$3.329077\ 10^{13}$
10^{12}	$3.560411\ 10^{-22}$	$4.167413\ 10^{3}$	$2.953191\ 10^{15}$	$3.329092\ 10^{14}$
10^{13}	$1.652593\ 10^{-20}$	$4.167405\ 10^{3}$	$2.953191\ 10^{16}$	$3.329098\ 10^{15}$
10^{14}	$7.670650\ 10^{-21}$	$4.167402\ 10^{3}$	$2.953191\ 10^{17}$	$3.329101\ 10^{16}$
10^{15}	$3.560399\ 10^{-21}$	$4.167400\ 10^{3}$	$2.953191\ 10^{18}$	$3.329103\ 10^{17}$
10^{16}	$1.652590\ 10^{-21}$	$4.167399\ 10^{3}$	$2.953191\ 10^{19}$	$3.329103\ 10^{18}$
10^{17}	$7.670644\ 10^{-22}$	$4.167399\ 10^{3}$	$2.953191\ 10^{20}$	$3.329104\ 10^{19}$
10^{18}	$3.560398\ 10^{-22}$	$4.167398\ 10^{3}$	$2.953191\ 10^{21}$	$3.329104\ 10^{20}$
10^{19}	$1.652590\ 10^{-22}$	$4.167398\ 10^{3}$	$2.953191\ 10^{22}$	$3.329104\ 10^{21}$
10^{20}	$7.670644\ 10^{-23}$	$4.167398\ 10^{3}$	$2.953191\ 10^{23}$	$3.329104\ 10^{22}$
10^{21}	$3.560397\ 10^{-23}$	$4.167398\ 10^{3}$	$2.953191\ 10^{24}$	$3.329104\ 10^{23}$
10^{22}	$1.652590\ 10^{-23}$	$4.169398\ 10^{3}$	$2.953191\ 10^{25}$	$3.329104\ 10^{24}$
$4.474913\ 10^{22}$	$1.002852\ 10^{-23}$	$4.167398\ 10^{3}$	$1.321527\ 10^{26}$	1.48974510^{25}
$4.819137\ 10^{22}$	$9.783826\ 10^{-24}$	“	$1.4231833\ 10^{26}$	$1.604309\ 10^{25}$
$5.220732\ 10^{22}$	$9.526236\ 10^{-24}$	“	$1.5417819\ 10^{26}$	$1.738036\ 10^{25}$
$5.695344\ 10^{22}$	$9.253908\ 10^{-24}$	“	$1.681944\ 10^{26}$	$1.896039\ 10^{25}$
$6.264879\ 10^{22}$	$8.964531\ 10^{-24}$	“	$1.850138\ 10^{26}$	$2.085643\ 10^{25}$
………..	……………..	…………….	………………	………………
$3.935625\ 10^{50}$	$4.8584\ 10^{-33}$	$4.167398\ 10^{3}$	$1.162265\ 10^{54}$	$1.31021\ 10^{53}$

Some remarks on the above results are necessary for a further elucidation of the subject:

1) There is an *internal barrier* that prevents the collapse of the in-falling matter to the central singularity of the BH. This barrier has a radius which starts with a value of $5.931354\ 10^{3}$ m that corresponds to the least mass necessary for the formation of a black hole and seems to tend to a limit of the order of about 4167.39817 ± 0.00001 m. whichever the collapsing mass may be (not infinite of course). This radius R is always smaller than the Schwarzschild radius. So the mass of the BH is squeezed in the sphere (O, R) and this is achieved by a continuous reduction of the radius of the neutrons r_0 (or equivalently by reduction of the distance between the mass centers of the neutrons).

2) As I said previously, the mass M entering in my calculations is the one left after the supernova explosion, which preceded the collapse, so the star initially should have a mass greater than M.

3) The reason I stopped our calculations of Table I at the last 5 +1 n_0 that correspond to 6 different solar masses is the following:

Many people[12,13] have suggested that the universe we live in is a huge BH. Isaak Asimov[14] too writes that according to Kip Thorne the whole Universe may be a BH. I understand that they are talking about the *observable Universe*, i.e. the one which has a *cosmic radius* R_c given by the Hubble's Law c = H R_c in the extreme case where the distant galaxies recede from **us** with the velocity of light. If the above assertion is correct then the observable Universe has a definite spherical shape as the Schwarzschild BHs do, since there is not observed rotational motion of the whole universe. It has to be reminded that if the whole Universe is infinite in size, the same will apply for **any other observer** sited in a different from us position. But this problem will be the subject of another paper. From various observations the most probable values of the Hubble's constant lie between 50 and 70 km Mpc^{-1} sec^{-1} , so from Hubble's Law the corresponding R_c will be equal to:

For H 50 km Mpc^{-1} sec^{-1} = 1.6203786 $10^{-18}sec^{-1}$ it is R_c = 1.8501383 10^{26}m.
For H 55 km Mpc^{-1} sec^{-1} = 1.7824165 $10^{-18}sec^{-1}$ it is R_c = 1.6819439 10^{26}m.
For H 60 km Mpc^{-1} sec^{-1} = 1.9444543 $10^{-18}sec^{-1}$ it is R_c = 1.5417819 10^{26}m.
For H 65 km Mpc^{-1} sec^{-1} = 2.1064922 $10^{-18}sec^{-1}$ it is R_c = 1.4231833 10^{26}m.
For H 70 km Mpc^{-1} sec^{-1} = 2.968550 $10^{-18}sec^{-1}$ it is R_c = 1.3215273 10^{26}m.

If the observable Universe is a BH the most probable Cosmic Horizon will be the event horizon of this huge BH so that $r_s = R_c$ and the total **present** mass of the observable Universe will be given for the 5 cases respectively by:

For H = 50 km Mpc^{-1} sec^{-1} M_u = 1.2460217 10^{53} kg. = 6.264879 10^{22} M_o
For H = 55 km Mpc^{-1} sec^{-1} M_u = 1.1327469 10^{53} kg. = 5.695344 10^{22} M_o
For H = 60 km Mpc^{-1} sec^{-1} M_u = 1.0383514 10^{53} kg. = 5.220732 10^{22} M_o
For H = 65 km Mpc^{-1} sec^{-1} M_u = 9.5847821 10^{52} kg. = 4.819137 10^{22} M_o
For H = 70 km Mpc^{-1} sec^{-1} M_u = 8.9001548 10^{52} kg. = 4.474913 10^{22} Mo

The last five rows of Table 1 concern calculations which yield Schwarzschild radii for the above five cases of cosmic radii. If the expansion of the universe could come to a stop and reversed to a contraction, then the radii of the neutrons inside the universal BH would become equal to about 9 10^{-24} m. But this does not happen for the time being and perhaps for any time to come, although I keep some reservations for this last opinion, which will be discussed in another paper. The last row of the above Table I refers to a mass of about 4 10^{50} M_o or more precisely 7.8275645 10^{80} kg. This last row along with the other five rows, contain very interesting information that will be used in the 5^{th} part of the presentation of my cosmological model. As an interlude, in the third part I shall present a work concerning some new elementary particles and more specifically I shall present the masses of certain not yet discovered zero spin mesons which very probably correspond to the hunted Higgs particles. Since it is generally accepted that the theory on elementary particles is closely connected with the first stages of the appearance of the Universe, the promised work will also reveal useful information of these first stages.

In my mentioned paper[4] I related the concept of quarks with the concept of the Mini White Holes with dimensions of the order of Planck Length. One question that may be raised is the following: How the neutrons (and more generally the nucleons in nuclei) can approach each other to so short distances as the ones I calculated in the present work? To this question I shall give the following answer, supposing that the reader has red my paper on quarks and MWH:

The emerging from a MWH, mass, however big it may be (in fact equal to 5.0437884 10^{-9} kg.), is an elementary particle which is subject to the Uncertainty Principle. So even in its lowest energy state, it will have an uncertainty of position and momentum, which usually is translated to a quantum mechanical harmonic oscillation (since the existing theory does not accept rotational motions of the quarks inside the nucleons). This motion leads to a centrobaric departure of the quarks from each other. Due to this departure on one hand and due to the fact that the emerging from the MWH mass is distributed uniformly on the outer surface of a sphere of negligible thickness and with radius $\hbar/2mc$, which is a justified condition in my previous paper(4), on the other, the increase of this quantum radius will result to a decrease of the mass m. So it can be shown easily that when the mass centers of the nucleons are about 2.16 fm apart (c.f. my previous work(4)) which distance is usually considered as the range of nuclear forces in the deuteron, then the quantum radius of the u and d quarks is equal to ¼ of the above distance. The corresponding mass of each quark in this case is equal to:

$$m_q \cong 4\hbar/2.1587926\cdot10^{-15}c = 5.6446246\cdot10^{-28}kg = 365.6\,\text{MeV/c}^2 \qquad (23)$$

(m_q is the u or d *effective* quark mass inside nucleons). In the existing literature this effective mass of the u and d quarks is given equal to 363 MeV/c^2 (c.f. ref 15 e.g.). The coincidence of the last two estimations is obvious. So in a nucleon three MWHs may exist with the huge masses I gave above, but the measurement of these masses can only be achieved if we may supply our suitable equipment with enough energy to penetrate into the nucleons at distances of the order of 10^{-35} m or to squeeze the nucleons to come close to each other at the above distance. The result of this brief exposition is that although practically we cannot employ the necessary huge amount of energy for a straightforward measurement of the mass that emerges from a MWH, its measurability is achieved with an indirect method (i.e. when it appears as a quark mass inside a nucleon). The above paradigm applies in the case of the neutrons squeezed in the collapsing star mass inside a BH and the necessary energy is supplied by the gravitation of the BH. For the quarks that constitute the neutrons it is still enough space to perform their oscillations inside the neutrons. So when the neutrons approach each other in less and less distances one would expect their mass to increase accordingly. This really happens, but this increase of mass does not contribute to an increase of the mass M entering in the Newtonian potential energy expression, because it is exchanged between the neutrons as a virtual zero spin meson which transmits the repulsive forces between the neutrons when they are below the distance of the approximately 0.5 fm. In the mentioned work of mine(4) I have shown that the closer the nucleons, in general, come with each other the heavier is the exchanged meson, starting from the $K^{\pm}$ meson up to the bottom B^0 mesons and beyond. In the mentioned above work of mine, to be presented in Cosmology 3, I have calculated masses of zero spin mesons up to about 10^{12} GeV/c^2, something that required the existence of two (and only two) new quark flavors, but this story will be said in the new paper.

CONCLUSION

The aim of the presented work was twofold: First I had to remind to the people who are involved in the examination of the happenings in the interior of a BH, that there exists a powerful factor that may prevent the extinction of matter in the central singularity, which factor had never been taken into account up to now, in the existing literature. Second I wanted to show that the conclusion of another work of mine(6) that GR is wrongly connected with gravitation may be valid for one more reason, i.e. because this theory cannot avoid the infinities at the central singularities of the BHs. In contrast the Newtonian law of gravitation may be used, satisfactorily for the solution of the problem and as we saw it yields at least an acceptable result for the minimum mass required for the formation of a BH. So I leave the reader to decide which theory is closer to the case of the Black Holes mystery: The one that yields space-time singularities i.e. infinite solutions coming from very "elegant equations" or the one which though approximate, yields finite solutions compatible mainly with logic and at the same time saves the validity of the known laws of physics even in the extreme case of the interior of a BH. Beyond that, it saves too the Hawking's theory of evaporation of the BH, which otherwise could not work if the imploding mass of a star was rapidly annihilated in the central singularity. In any case we hope that the problem will be revisited when we shall have a satisfactory analytical expression for the velocity v(r) at which the gravitational interactions propagate, so that expression E1 in the ensuing endnotes will be workable in the case under consideration, i.e. the calculations will be repeated with E1 in place of the known expression of the gravitational force from Newton's Law.

The research on the BHs problem, however, will not stop even when the modified Newton's law of E1 is used, since the majority of the existing BHs will certainly possess rotational motion and perhaps, electric and magnetic fields. So the present work let be considered as a start for a new consideration of this problem.

Endnotes

[1] I present here without any comment or explanation, the expression of the gravitational force of attraction between two elementary particles, as we derived it in the mentioned work of ours(16):

$$F = -\frac{GM_1M_2}{r^2}\frac{a^2}{3}\frac{v}{c}\left(\frac{2vt}{r} - \frac{dv}{dr}t - 1\right) \qquad \text{(E.1)}$$

where a= $\sqrt{3}$ and v= v(r) is the velocity at which gravitational interactions propagate. If v = c a simple substitution in the above relation yields the known expression of Newton's law without the handicap of the instantaneous action at a distance. If we could find an analytical expression of v(r) or if we could measure it experimentally, we could obtain the results of the four tests of GR by using eq. (E.1). The already presented analysis for the fate of the mass in the interior of the BH must also be repeated for more accurate results, but from the analysis in my book on Newton's Law, showed in the case of the black holes Newton' law is the proper one for the calculations. Some preliminary search by the author brings v a little greater than c and it becomes equal to c at r = ∞. The whole work (ref. 16) is contained in a book (unfortunately written in Greek and published in Athens in 2010 with ISBN: 978-960-8160-49-1). A revised English translation is my future concern.

[2] It has been mentioned(8) that the mass M which appears in the Schwarzschild metric represents all mass-energy contained in the source, even *the negative gravitational binding energy*. This is not the case for the Newtonian solution. In this last case apart from the rest mass of the star, only any kind of energy (thermal, electromagnetic etc.) which contributes to the total mass by the equivalent amount given by Special Relativity $m=E/c^2$, may be acceptable.

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COSMOLOGY 3

INTERCONNECTION OF THE REST MASSES OF ZERO-SPIN MESONS WITH EACH OTHER- PREDICTIONS FOR NEW MESON REST MASSES

Abstract

The probable relation of the rest masses of the known zero-spin mesons with each other is investigated. Based on a theory presented in a previous paper[(1)], the above masses are translated into certain lengths (not the Compton wavelengths), which emerge from the solution of the spherically symmetric Schrödinger's equation of the two-nucleon system (deuteron). These lengths express the spatial separation of the nucleons' mass centers, at which the carriers of the nuclear repulsive force are exchanged between them. From the investigation it became possible: a) to find certain regularities that exist among the above lengths and, in consequence, among the masses of the corresponding mesons. b) To find also some relations, which permit predictions about not yet discovered rest masses of new zero-spin mesons, which are composed not only from the known quarks but also from new quark flavors. If the existing or future technology on particle colliders concentrate the search on the predicted masses and if these masses are finally found, our speculations will open new routes in the investigation of the so called "desert region" that exists between nucleons dimensions ($\sim 10^{-17}$ m) and Planck length dimensions ($\sim 10^{-35}$m). This region is covered completely if 2 new quarks only are introduced. The whole work must be considered as a first attempt for the solution of the mass problem of some elementary particles with the help of a simple, unorthodox but fruitful method, the outcomes of which have to wait for experimental verification. It can also be considered as an aid (or a guide) for the experimenters who try to get information from the violent collisions of elementary particle beams, about new particle masses. Instead of looking for accidental events, they may concentrate their attention to the masses predicted in this work of ours, and they will know a priori if the available energy may be enough in giving rise to the production of new particles (and specifically of new mesons). This paper is characterized as Cosmology 3 because some of the outcomes of it will be used in the next Cosmology 4. As it is generally accepted, the search for an understanding of the first moments of the Universe is tightly connected with the physics of highly energetic elementary particles.

Key words: Zero-spin mesons, Mini White Holes (MWH),"hard core" of nucleons, two nucleons central potential, new quark flavors, new baryons, new leptons.

1. INTRODUCTION

One of the major problems that wait for a solution from the Physics of the future, is an answer to the question:

Why the rest masses of the (about 140 or more) known elementary particles are those we have measured experimentally and not some different ones?

From my (very little) knowledge on the theory of superstrings[(e.g.2,3)], apart from the unification of all known forces of Nature, this theory is expected to be capable to produce in a theoretical way, the rest masses of all elementary particles. If such a target is achieved, it will be a triumph of this theory. But, to our knowledge, such a success is still very remote.

In this paper the investigation is restricted to the masses of zero-spin mesons. So what follows, let be considered as a start for a theoretical determination of some elementary particle masses only. Or, to put it in another way, this investigation attempts to put a little order (perhaps logic) in a field (that of elementary particle masses) where, for the time being, there is no order at all whatsoever. To the reader is left to judge whether the little order is better than the complete absence of order. Vector mesons (with spin≠0) are not investigated because the repulsive component of the two nucleon potential I have introduced in my previous paper(1), is a Yukawa-type potential, which results from a solution of the time independent Klein-Gordon equation. This equation accepts solutions that are scalar wave functions so that the corresponding mesons must have zero spin. At this point it is worth to remind what we noticed in my previous paper(1). I explained there that in the repulsive nuclear potential energy term $V_x e^{-\lambda r}/r$ of the total nuclear potential, the factor V_x depends on the constants $\hbar$ and c and not on the gravitational constant G, although I started with a G dependence of this factor. So although this repulsive potential opposes the gravitational attraction, it expresses in fact a quite different force field and the $\sqrt{V_x}$ may be called the "mesonic" charge of the repulsive nuclear field since its use in the nuclear potential may provide the masses of various mesons. On the other hand, a future investigation of the vector mesons' case is in my intention, which mesons seem to play also a role in the development of nuclear forces. The question to be answered is: can we find some rules or principles or even a law that determines the generation of the, otherwise, arbitrary masses of the 25 zero-spin mesons that are given in tables of elementary particles? (e.g. in the Blue Booklet of CERN).

Some known zero-spin mesons (16 of them) with masses ≥ to the mass of the $K^{\pm}$ meson, were presented in Table II of the mentioned paper(1). In the present paper, I have completed the above Table II with more mesons and also with a few minor corrections in the 5th or 6th decimal place of the values of the nucleons' separation indicated by r_1 in the computer program attached to my previous paper, after some more accurate solutions of Schrödinger's equation. So I shall work from now on, with the values of TABLE I below.

TABLE I

This Table contains: a) the masses of the known zero-spin mesons in MeV/c², b) the corresponding lengths (in fm) which are the distances between the mass centers of the proton and neutron in the deuteron nucleus as they were defined in my previous paper(1) , c) the characterization of mesons and their quark content, d) The M_{24} and M_{25} a_i's were calculated by a computer program not presented here for space economy.

Serial Number for Mesons	Meson and its electric charge	Experimental meson masses MeV/c²	Length a_i from solution of Schroedinger equation fm	Characterization of mesons from their quark content	Quark Content of Mesons
1	2	3	4	5	6
M_1	K(±)	493.677	0.491592	Strange	$u\bar{s}, s\bar{u}$
M_2	K(0)	497.672	0.4899573	Strange	$d\bar{s}, s\bar{d}$
M_3	η(0)	547.30	0.470435	Non strange	$u\bar{u}, d\bar{d}, s\bar{s}$
M_4	η'(0)	957.78	0.354065	Non strange	$u\bar{u}, d\bar{d}, s\bar{s}$
M_5	f_0(0)	980.00	0.34948	Non strange	$u\bar{u}, d\bar{d}, s\bar{s}$
M_6	a_0(0)	984.8	0.348509	Non strange	$u\bar{u}, d\bar{d}$
M_7	η1297(0)	1297	0.29601	Non strange	$u\bar{u}, d\bar{d}, s\bar{s}$
M_8	π1300(0)	1300	0.29559	Non Strange	$u\bar{u}, d\bar{d}$
M_9	$f_0$1370(0)	1370	0.28617	Non Strange	$u\bar{u}, d\bar{d}, s\bar{s}$

M_{10}	η1440(0)	1440	0.2774	Non Strange	$u\bar{u}, d\bar{d}, s\bar{s}$
M_{11}	$a_0$1450(0)	1474	0.27338	Non Strange	$u\bar{u}, d\bar{d}$
M_{12}	$f_0$1500(0)	1500	0.27039	Non Strange	$u\bar{u}, d\bar{d}, s\bar{s}$
M_{13}	$f_0$1710(0)	1715	0.2481625	Non Strange	$u\bar{u}, d\bar{d}, s\bar{s}$
M_{14}	π1800(0)	1801	0.240467	Non Strange	$u\bar{u}, d\bar{d}$
M_{15}	D^0 (0)	1864.50	0.23499	Charmed	$c\bar{u}, u\bar{c}$
M_{16}	$D^{\pm}(\pm)$	1869.30	0.234595	Charmed	$c\bar{d}, d\bar{c}$
M_{17}	$D_s^{\pm}(\pm)$	1968.6	0.226717	Charmed, strange	$c\bar{s}, s\bar{c}$
M_{18}	η_c(0)	2979.8	0.1709	Charmonium	$c\bar{c}$
M_{19}	χ_{c0}(1P) (0)	3415	0.15243	Charmonium	$c\bar{c}$
M_{20}	B(±)	5279	0.113207	Bottom	$u\bar{b}, b\bar{u}$
M_{21}	B(0)	5279.40	0.1132005	Bottom	$d\bar{b}, b\bar{d}$
M_{22}	B_s(0)	5369.6	0.111791	Bottom strange	$s\bar{b}, b\bar{s}$
M_{23}	B_c(±)	6400	0.098086	Bottom charmed	$c\bar{b}, b\bar{c}$
M_{24}	χ_{b0}(1P)(0)	9859.9	0.0690225	Bottomonium	$b\bar{b}$
M_{25}	χ_{b0}(2P)(0)	10232.1	0.0669474	Bottomonium	$b\bar{b}$

The above Table I is a guide that with almost certainty directs the investigation to the conclusion that since there exist mesons which are combinations by two of any quark flavor with all the lighter (and itself) known anti-quarks and vice versa, (e.g. since there are combinations of the bottom anti-quark with the u,d,s,c,b quarks, it has to be expected that there must be mesons resulting from combinations of the top anti-quark with the u,d….b,t quarks too (and vice versa).

Before the development of the applied method of investigation, I consider necessary to elucidate a point that had been left uncommented in my previous paper. I refer to the possibility of applying the simple Yukawa-type potential in the case of pseudoscalar mesons (i.e. mesons with odd parity wave function). In Table I above I have included both scalar (e.g. the f_0, a_0 etc.) mesons and pseudoscalar ones (e.g. the charged and neutral kaons, the η, η′, D^0 etc.) whose masses were connected with the nucleons' separation distance through the solution of the corresponding Schrödinger's equation. As in this equation the repulsive part of the potential corresponds to the simple Yukawa potential, one could think that this potential does not hold in the case of pseudoscalar mesons since in this case the source of the mesonic field η(r) is not zero and $\eta(-\mathbf{r}) = -\eta(\mathbf{r})$. According to Elton(4), however, the intrinsic parity of the wave function of an elementary particle becomes important when particles are created or destroyed singly, since as long as particles are conserved or created and destroyed in pairs, their combined parity is conserved. In my previous paper(1) I have presented two scenarios of how the kaons K^0 and $K^{\pm}$ may participate in the case of the two nucleons interaction and simultaneously conserve strangeness. From the above scenarios it is easily inferred that although the kaons in some steps of the interaction are emitted as single particles, they are virtual particles so that they have not enough time (they approximately have 10^{-23} sec) for their weak decay (which requires about 10^{-8} sec.). So they are conserved during the interaction and consequently their parity is conserved which means that it is permitted to use in the deuteron potential, the simple Yukawa type in the part of its repulsive component. For the same reason there are no doubts that what holds in the case of kaons will not be valid in the case of other strange or charmed etc. mesons. And for the same reason if the time of interaction is much less than the time of decay of the pseudoscalar mesons so that they are conserved, they may be solutions of the equations where the simple Yukawa potential is present. With the above connotations I proceed to the development of the method of investigation.

METHOD OF INVESTIGATION

The investigation of the possible relations that may exist between the characteristic lengths a_i , each one of which corresponds to the rest mass of a zero-spin meson, through the solution of Schrödinger's equation as described in the introduction, has followed a trial and error method. This means that I shall work in an empirical manner, with an intensive and careful concentration on my effort to find characteristic relations among the above lengths a_i and with a bit of intuition and of luck of course. Thus most of the developed calculations will be based on simple algebra. Some other calculations will be based on certain computer programs I have developed, mainly curve fitting programs, which have been proved particularly fruitful in the ensuing investigation. In a sense, I follow a method which has some remote resemblance to the one followed by Mendeleev when he found the periodicity that existed among the various chemical elements when they were placed in order of atomic weight. This periodicity was explained later by the atomic theory. So by finding certain characteristic relations between the lengths a_i, I have an indication that the corresponding rest masses of the zero-spin mesons are not so much arbitrary as they look at first glance. Apart from that, the above relations make possible the prediction of new rest masses of not yet experimentally discovered zero-spin mesons, as will be shown immediately below.
I have at my disposal 25 lengths. The search contains three separate calculations, which however, are complementary to each other:

1. The finding of relations among the lengths a_i of the up to now known zero spin mesons which give results very close to the known experimental ones.
2. By extrapolation of the above relations, the determination of new zero-spin meson masses became possible, which have neither been found experimentally nor even predicted by the existing theories (GUTs, superstrings et al.), which however, are based on combinations of the top quark (anti-quark) with the lighter anti-quarks (quarks).
3. By a further extrapolation, the investigation permitted the calculation of new zero-spin meson masses, the quark content of which included at most two new quark flavors beyond the top quark.

Some regularities that can be derived at first glance from the 25 lengths a_i, may be summarized as follows:

a. First of all, it has to be noticed that it is easier to work with lengths rather than with masses when we investigate for existing relations. This will become apparent in what follows since exist more relations to work with in the case of lengths than in the case of masses.

b. These lengths are decreasing as the mass of the corresponding mesons increases.

c. There are three groups of lengths that contain 2 lengths each, which correspond to the pairs of charged and neutral particles, that is, to the charged and neutral kaons, to the $D^{\pm}$ and D^0 charmed non-strange mesons and to the $B^{\pm}$ and B^0 bottom mesons. Since I am concerned with the masses of the above mesons, the positively and negatively charged mesons are confronted as one and the same particle with the same mass but with opposite charges. For this reason is taken as a single particle, which with the neutral particle makes a group of two particles.

d. From a knowledge of relations that connect the a_i's of the above 3 groups and by doing an extrapolation I shall try to determine first the masses of the mesons with a quark content of *ut* and *dt* and their antiparticles of course (since the mass of *u* and $\bar{u}$ quark and that of *d* and $\bar{d}$ and *t* and $\bar{t}$ quark are equal I shall use from now on for brevity the notation *ut* and *dt* to denote these mesons wherever there is no need for the complete notation). These mesons (the *ut* and *dt*) will be denoted from now on M_{26} and M_{27} and the corresponding lengths and masses $a_{26} \equiv a_{ut}$ and $a_{27} \equiv a_{dt}$ and $m_{26} \equiv m_{ut}$ and $m_{27} \equiv m_{dt}$ respectively. It must be noticed that since the pair of K^0, $K^{\pm}$ mesons contains *su* and *sd* quarks respectively and similarly the pair D^0, $D^{\pm}$ contains *cu* and *cd* quarks and the pair of B^0, $B^{\pm}$ contains *bu* and *bd* quarks, it is reasonable to search for a new pair of mesons, the already called M_{26}, M_{27} which is expected to contain *tu* and *td* quarks. Because, as will be shown further on, the quark flavors can be increased by two (and only two) new quarks, we shall include in this first step of calculations the determination of the masses of the new mesons that contain *u* or *d* quarks along with the proposed new quarks. I attach a name to these new quarks from now and I call them *e* from "**extra**" and *h* from "**high**". So in this section I shall determine the masses of the new mesons that contain the *ue, de* and the *uh*, *dh* quark combinations.

e. From a knowledge of relations that connect the $s\bar{s}$, $c\bar{c}$, $b\bar{b}$ mesons (usually called ((?), charmonium, bottomonium) I shall make extrapolations to find the mass of the $t\bar{t}$ meson (toponium). In the parenthesis above, I have put a question mark (?) in the place of the $s\bar{s}$ meson, since this meson is not given in tables and probably does not exist[1]. We shall propose a remedy for this discrepancy so that the search will cover the $s\bar{s}$ case. It is expected that since there exist two charmonia and two bottomonia with different masses there will be two toponia too (and two "strangeonia" if you like). In this same section we shall determine the masses of the two "extraonia" and the two "highonia".

f. The next calculation will be devoted to the investigation for the masses of mesons that lie between the M_{27} meson and the first toponium. The quark content of these mesons is expected to be *st, ct, bt.* Also the masses of the mesons that contain the quark combinations *se, ce, be, te,* as well as the *sh, ch, bh, th, eh* combinations.

When the a_i's that correspond to all mesons will have been determined, the masses of the mesons will be calculated by use of Schrödinger's equation of the two-nucleon system (deuteron). This solution cannot be applied for masses greater than the $B_c(\pm)$ mass because in the numerical solution of Schrödinger's equation of the two nucleon system (deuteron) appear exponents of 10 greater than about 4100 which cannot be handled by the Pascal Turbo 6 program I have used. I have invented however a way to calculate the required masses by using a curve-fitting computer program as I said before.

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[1] It has been mentioned[(5,6)] that the φ meson is probably an $s\bar{s}$ combination. But since this meson has spin 1 it is not investigated in the present work. But we cannot exclude the possibility that when the $s\bar{s}$ combination is mixed with $\bar{u}u$ or $\bar{d}d$ mesons it may present itself with zero spin.

DETERMINATION OF ZERO-SPIN MESON MASSES THAT CONTAIN TOP, EXTRA AND HIGH QUARKS IN COMBINATIONS WITH UP AND DOWN QUARKS

I. Determination of the masses of the M_{ut} and M_{dt} mesons

I first calculated all the lengths a_i from the experimentally known masses of the mesons contained in TABLE I either by use of the solution of Schrödinger's equation of the two-nucleon system (deuteron) or by use of the curve-fitting program of ours. Then I thought that it could be helpful to express the ratios $\frac{a_{15}}{a_{16}}$ and $\frac{a_{20}}{a_{21}}$ in terms of the ratio $\frac{a_1}{a_2}$ and by use of the simple numbers 1,2,3 and of the number π. The relation of the first two fractions with $\frac{a_1}{a_2}$ will reveal a possible connection of the charmed and bottom mesons with the strange mesons. Since we are dealing with lengths and their ratios, the use of π is legitimate in the sense that it expresses also the constant ratio of two lengths i.e. of the perimeter and the diameter of the circle (in a flat space where quantum mechanics has been developed).

After some trial and error we found the following expressions:

$$\frac{a_1}{a_2} = \frac{0.491592}{0.4899573} = 1.003336413 \equiv \left(\frac{a_1}{a_2}\right)^1. \quad (1)$$

$$\frac{a_{15}}{a_{16}} = 1.001683753 \cong \left(\frac{a_1}{a_2}\right)^{\frac{2+3}{\pi^2}} = \left(\frac{a_1}{a_2}\right)^{\frac{5}{\pi^2}} = 1.001688858 \quad (2)$$

and the difference between the actual and the calculated value is : Δ = 0.0005096%

The 1.001683753 will be called from now on "actual value" since it is based on experimentally known data and the 1.001688858 will be called "calculated value", which is based on the model that is used in any one particular case of the present work.

$$\frac{a_{20}}{a_{21}} = 1.00005742 \cong \left(\frac{a_1}{a_2}\right)^{\frac{5}{3\pi^4}} = 1.000056993 \quad (3)$$

and the difference between the actual and the calculated value is : Δ = 0.000042698%.

As it is easily observed, the exponents of the ratio $\frac{a_1}{a_2}$ go as follows:

1, $5/\pi^2$, $5/3\pi^4$.

The 2nd exponent results from multiplication of the 1st by $5/\pi^2$ and the third from multiplication of the second by $1/3\pi^2$. The question is: How a fourth exponent will result from the third? Let us write the exponents of the $\frac{a_1}{a_2}$ ratio in a kind of a Table.

$1 \times 1 = 1$ (4)

$1 \times 5/\pi^2 = 5/\pi^2$ (5)

$5/\pi^2 \times 1/3\pi^2 = 5/3\pi^4$ (6)

$5/3\pi^4 \times 1/6\pi^2 = 5/18\pi^6$ (7)

$5/18\pi^6 \times 1/12\pi^2 = 5/216\pi^8$ (8)

$5/216\pi^8 \times 1/24\pi^2 = 5/5184\pi^{10}$ (9)

The first three lines of the above little Table are derived from existing data (relations (1), (2), (3) above). The question is raised about the 4th exponent. The second multiplier on the l.h.s., has in the denominator the π^2 in the second line and the $3\pi^2$ in the 3d line. So (by use of the numbers 2 and 3) this second multiplier in the 4th line could be equal to: $1/(2\times3)\pi^2 = 1/6\pi^2$ or $1/(3\times3)\pi^2 = 1/9\pi^2$ or $1/3^3\pi^2 = 1/27\pi^2$. The use of the first case is already written in the fourth line of the above little Table. The second case would result to an exponent equal to $5/27\pi^6$ and the third case to an exponent equal to $5/81\pi^6$. The 5 (=2+3) in the numerator seems that remains constant. I shall examine the three above cases to see which one gives acceptable results.

1. The $5/18\pi^6$ gives: $\frac{a_{26}}{a_{27}} = \left(\frac{a_1}{a_2}\right)^{\frac{5}{18\pi^6}} = 1.000009625$ (10)

2. The $5/27\pi^6$ gives: $\frac{a_{26}}{a_{27}} = \left(\frac{a_1}{a_2}\right)^{\frac{5}{27\pi^6}} = 1.0000006416$ (11)

3. The $5/81\pi^6$ gives: $\frac{a_{26}}{a_{27}} = \left(\frac{a_1}{a_2}\right)^{\frac{5}{81\pi^6}} = 1.000000214$ (12)

For the determination of a_{26} and a_{27} we need one more relation. This relation may be obtained from a consideration of the differences $a_i - a_{i+1}$ where i takes the values 1,15,20. So we have:

$P_0 = a_1 - a_2 = 0.0016347$ fm
$P_1 = a_{15} - a_{16} = 0.000395$ fm
$P_2 = a_{20} - a_{21} = 0.0000065$ fm

In the present case I looked for an expression of the ratio $\frac{P_1^2}{P_0 P_2}$ which is a dimensionless number, in terms of the three numbers $2,3,\pi$. After a little trial and error we found that a good choice may be the following:

$$\frac{P_1^2}{P_0 P_2} = 14.68394577 \cong 3\pi + \frac{3}{2}(\sqrt{\pi} + \sqrt{3}) = 14.68153495 \qquad (13)$$

and the difference between the actual and the calculated value is : $\Delta = 0.016418\%$.
We suggest that expression (13) which represents a relation between the three differences of the groups of mesons under consideration will be a constant quantity for all consecutive such differences. So if $P_3 = a_{26} - a_{27}$ we should have:

$$P_3 = \frac{P_2^2}{P_1 \times (3\pi + \frac{3}{2}(\sqrt{\pi} + \sqrt{3}))} = a_{26} - a_{27} = 7.2854797 \cdot 10^{-9} \text{ fm} \qquad (14)$$

I may now calculate the values of a_{26} and a_{27} and the corresponding masses for cases (10) up to (12).
I thus obtain:
From (10) and (14):
$a_{26} = a_{ut} = 0.007569337$ fm and $m_{26} \equiv m_{ut} = 114.760$ GeV/c^2
$a_{27} = a_{dt} = 0.0075693295$ fm and $m_{27} \equiv m_{dt} = 114.760$ GeV/c^2
From (11) and (14):
$a_{26} = 0.011355181$ fm and $m_{26} = 74.747$ GeV/c^2

a_{27} = 0.011355174 fm and m_{27} = 74.747 GeV/c^2
From (12) and (14):
a_{26} = 0.034044305fm and m_{26} = 22.529 GeV/c^2
a_{27} = 0.034044298 fm and m_{27} = 22.529 GeV/c^2
The values of masses m_{26} and m_{27} have some small differences in the 4th decimal digit (and/or beyond that) but they have been rounded in the 3^{d} decimal digit. From the fact that the above second and third values of m_{26} and m_{27} are within the limits of capacity of the already existing particle accelerators (LEP, Fermilab) they should probably had to be spotted. If this has not happened, it is very probable that they do not correspond to the really existing mesons. So the only candidate values for the masses of the *ut* and *dt* mesons are the first ones, which are of the order of 115 GeV/c^2 . This value may be found in the next few years experimentally by the under construction accelerator LHC at CERN or any other powerful particle collider. We cannot say whether the above meson has anything to do with the alleged (and hunted) Higgs particle at the 115 GeV/c^2 or not. If these heavy Higgs bosons have zero spin and are either charged or electrically[(7)] neutral, then the *ut* and *dt* mesons agree with the above requirements. An experimental verification of the above mass will support the idea for existing relations and regularities between the masses of the already existing zero spin mesons and for the new and heavier ones we are going to determine in the ensuing development.

II Determination of the masses of the M_{ue} and M_{de} mesons

I enter now in a completely new region of research, since I shall try to investigate the probable existence of new mesons that contain new quarks whose existence has not been predicted by any of the under circulation theories. As it is understood, the up to now presented theory concerns only zero spin mesons as I intensively explained in the beginning. But if exist new quarks beyond the *t* quark, it is absolutely certain that they will also constitute new baryons, and this will open new routs for research. The procedure for the new investigation will follow the same steps as in the foregoing development by making the necessary and logical extrapolation of the already derived expressions.

For the determination of the masses of the M_{ue} and M_{de} the necessary formulae are almost ready to be used. From the little Table used in the case of the M_{ut} and M_{dt} mesons, I have ready the exponent of the (a_1/a_2) ratio which is in expression (8) of this Table i.e. $5/216\pi^8$
So I may immediately write my first equation as follows:

$$\frac{a_{33}}{a_{34}} = \left(\frac{a_1}{a_2}\right)^{\frac{5}{216\pi^8}} = 1.00000000813 \qquad (15)$$

For the determination of a_{33} and a_{34} I need one more relation. This relation may be obtained from a consideration of the differences $a_i - a_{i+1}$ by use of expression (14), which now is written:

$$P_4 = \frac{P_3^2}{P_2 \times (3\pi + \frac{3}{2}(\sqrt{\pi}+\sqrt{3})} = a_{33} - a_{34} = 5.5620064 \cdot 10^{-13} \text{ fm} \qquad (16)$$

I may now calculate the values of a_{33} and a_{34} and the corresponding masses.
I thus obtain from (15) and (16):
$a_{ue} \equiv a_{33}$ = 0.000068667 fm and m_{33} = 14290 GeV/c^2 (17)
$a_{de} \equiv a_{34}$ = 0.000068667 fm and m_{34} = 14290 GeV/c^2 (18)

The values of masses m_{33} and m_{34} have some small differences in the 1st decimal digit (and/or beyond that) but they have been rounded to the last integer digit.

II Determination of the masses of the M_{uh} and M_{dh} mesons

For the determination of the masses of the M_{uh} and M_{dh} the necessary formulae are also ready to be used. From the little Table used before, I have ready the exponent of the (a_1/a_2) ratio which is in expression (9) of this Table, i.e. $5/5184\pi^{10}$.
So I may immediately write my first equation as follows:

$$\frac{a_{41}}{a_{42}} = \left(\frac{a_1}{a_2}\right)^{\frac{5}{5184\pi^{10}}} = 1.00000000003 \qquad (19)$$

For the determination of a_{41} and a_{42} I need one more relation. This relation may be obtained from a consideration of the differences $a_i - a_{i+1}$ by use of expression (16), which now is written:

$$P_5 = \frac{P_4^2}{P_3 \times (3\pi + \frac{3}{2}(\sqrt{\pi}+\sqrt{3})} = a_{41} - a_{42} = 2.8922335 \cdot 10^{-18} \qquad (20)$$

I may now calculate the values of a_{41} and a_{42} and the corresponding masses.
I thus obtain from (19) and (20):
$a_{uh} \equiv a_{41} = 9.64077833333\ 10^{-8}$ fm and $m_{41} = 1.1403871\ 10^{7}$ GeV/c^2 (21)
$a_{dh} \equiv a_{42} = 9.64077833333\ 10^{-8}$ fm and $m_{42} = 1.1403871\ 10^{7}$ GeV/c^2 (22)
The difference of the values of masses m_{41} and m_{42} is not noticeable.
I have thus completed the first round of my investigation as I promised. The next calculations are devoted to the masses of mesons that contain $t\bar{t}, e\bar{e}$ and $h\bar{h}$ quarks.

DETERMINATION OF ZERO-SPIN MESON MASSES THAT CONTAIN TOP, EXTRA AND HIGH QUARKS IN COMBINATIONS OF $q\bar{q}$ TYPE

I Determination of the masses of the two toponia.

My next job will concern the determination of the masses of the two toponia $t\bar{t}$ by use of the known masses of the two charmonia and the two bottomonia. Here I first observe that while exist two $c\bar{c}$ and two $b\bar{b}$ zero spin mesons, there not exist two zero spin $s\bar{s}$ mesons. On the contrary exist 8 mesons with a quark content $u\bar{u}, d\bar{d}, s\bar{s}$. The non-existence of the pure $s\bar{s}$ zero spin mesons is possibly due to the fact that the *s* quark effective mass is of about the same order of magnitude with the masses of the *u* and *d* quarks as they are confined in mesons. So at the formation of the $s\bar{s}$ mesons the masses of the $u\bar{u}, d\bar{d}$ mesons are no longer negligible so that only combinations of the $(u\bar{u}, d\bar{d}, s\bar{s})$ mesons are possible.

Since there are 8 $(u\bar{u}, d\bar{d}, s\bar{s})$ mesons and since I expect to have only two $s\bar{s}$ mesons in correspondence to the $c\bar{c}$ and $b\bar{b}$ mesons, I thought that it would have some meaning to work as follows:

I find all the combinations of the a_i's of the 8 mesons by 4, which are 70 altogether. Then I combine the summation of each group of the four mesons with its supplementary group, e.g. if one of the sums is $a_2+a_5+a_6+a_8$ its complementary is

$a_1+a_3+a_4+a_7$ and so on. So I obtain 35 sets of pairs, where each member of the pair is the sum of the four a_i's divided by 4 to have a mean value. I give bellow the values of the a_i's of the 8 mesons and the corresponding combinations by four:

$x_1 \equiv a_3 = 0.470435$
$x_2 \equiv a_4 = 0.354065$
$x_3 \equiv a_5 = 0.34948$
$x_4 \equiv a_7 = 0.29601$
$x_5 \equiv a_9 = 0.28617$
$x_6 \equiv a_{10} = 0.2774$
$x_7 \equiv a_{12} = 0.27039$
$x_8 \equiv a_{13} = 0.2481625$

and the 70 combinations are:

$(x_1+x_2+x_3+x_4)/4 = 0.367475$
$(x_1+x_2+x_3+x_5)/4 = 0.36503750$
$(x_1+x_2+x_3+x_6)/4 = 0.362845$
$(x_1+x_2+x_3+x_7)/4 = 0.3610925$
$(x_1+x_2+x_3+x_8)/4 = 0.355535625$
$(x_1+x_2+x_4+x_5)/4 = 0.35167$
$(x_1+x_2+x_4+x_6)/4 = 0.3494775$
$(x_1+x_2+x_4+x_7)/4 = 0.347725$
$(x_1+x_2+x_4+x_8)/4 = 0.342168125$
$(x_1+x_2+x_5+x_6)/4 = 0.3470175$
$(x_1+x_2+x_5+x_7)/4 = 0.345265$
$(x_1+x_2+x_5+x_8)/4 = 0.339708125$
$(x_1+x_2+x_6+x_7)/4 = 0.3430725$
$(x_1+x_2+x_6+x_8)/4 = 0.3300625$
$(x_1+x_3+x_4+x_5)/4 = 0.35052375$
$(x_1+x_3+x_4+x_6)/4 = 0.34833125$
$(x_1+x_3+x_4+x_7)/4 = 0.34657875$
$(x_1+x_3+x_4+x_8)/4 = 0.341021875$
$(x_1+x_3+x_5+x_6)/4 = 0.34587125$
$(x_1+x_3+x_5+x_7)/4 = 0.34411875$
$(x_1+x_3+x_5+x_8)/4 = 0.338561875$
$(x_1+x_3+x_6+x_7)/4 = 0.34192625$
$(x_1+x_3+x_6+x_8)/4 = 0.336369375$
$(x_1+x_3+x_7+x_8)/4 = 0.334616875$
$(x_1+x_4+x_5+x_6)/4 = 0.33250375$
$(x_1+x_4+x_5+x_7)/4 = 0.33075125$
$(x_1+x_4+x_5+x_8)/4 = 0.325194375$
$(x_1+x_4+x_6+x_7)/4 = 0.32855875$
$(x_1+x_4+x_6+x_8)/4 = 0.323001875$
$(x_1+x_4+x_7+x_8)/4 = 0.321249375$
$(x_1+x_5+x_6+x_7)/4 = 0.325109875$
$(x_1+x_5+x_6+x_8)/4 = 0.320541875$
$(x_1+x_5+x_7+x_8)/4 = 0.318789375$
$(x_1+x_6+x_7+x_8)/4 = 0.316596875$
$(x_2+x_3+x_4+x_5)/4 = 0.32143125$
$(x_2+x_3+x_4+x_6)/4 = 0.31923875$
$(x_2+x_3+x_4+x_7)/4 = 0.31748625$
$(x_2+x_3+x_4+x_8)/4 = 0.311929375$
$(x_2+x_3+x_5+x_6)/4 = 0.31677875$
$(x_2+x_3+x_5+x_7)/4 = 0.31502625$
$(x_2+x_3+x_5+x_8)/4 = 0.309469375$
$(x_2+x_3+x_6+x_7)/4 = 0.31283375$
$(x_2+x_3+x_6+x_8)/4 = 0.307276875$
$(x_2+x_3+x_7+x_8)/4 = 0.305524375$
$(x_3+x_4+x_5+x_6)/4 = 0.302265$
$(x_3+x_4+x_5+x_7)/4 = 0.3005125$
$(x_3+x_4+x_5+x_7)/4 = 0.3005125$
$(x_3+x_4+x_5+x_8)/4 = 0.294955625$
$(x_3+x_4+x_6+x_7)/4 = 0.29832$
$(x_3+x_4+x_6+x_8)/4 = 0.292763125$
$(x_3+x_4+x_7+x_8)/4 = 0.291010625$
$(x_4+x_5+x_6+x_7)/4 = 0.2824925$
$(x_4+x_5+x_6+x_8)/4 = 0.276935625$
$(x_2+x_4+x_5+x_6)/4 = 0.30341125$
$(x_2+x_4+x_5+x_7)/4 = 0.30165875$
$(x_2+x_4+x_5+x_8)/4 = 0.296101875$
$(x_2+x_4+x_6+x_7)/4 = 0.29946625$
$(x_2+x_4+x_6+x_8)/4 = 0.293909375$
$(x_2+x_4+x_7+x_8)/4 = 0.292156875$
$(x_2+x_5+x_6+x_7)/4 = 0.29700625$
$(x_2+x_5+x_6+x_8)/4 = 0.291449375$
$(x_2+x_5+x_7+x_8)/4 = 0.289696875$
$(x_2+x_6+x_7+x_8)/4 = 0.287504375$
$(x_3+x_5+x_6+x_7)/4 = 0.29589$
$(x_3+x_5+x_6+x_8)/4 = 0.290303125$
$(x_3+x_5+x_7+x_8)/4 = 0.288550625$
$(x_4+x_6+x_7+x_8)/4 = 0.286358125$
$(x_4+x_6+x_7+x_8)/4 = 0.275183125$
$(x_5+x_6+x_7+x_8)/4 = 0.272990625$
$(x_2+x_5+x_6+x_7)/4 = 0.270530625$

I first find the 35 ratios of each pair and finally I get the average of these ratios.

The detailed exposition of each fraction (ratio) is omitted for space economy. I suggest that this average corresponds to the ratio of expected but not existing in practice, two $s\bar{s}$ mesons. This average ratio was found equal to 1.149481295. So I have the following ratios:

$$l_1 = \frac{s_1}{s_2} = 1.149481295 \qquad (23)$$

$$l_2 = \frac{c_1}{c_2} = 1.100854789 \qquad (24)$$

$$l_3 = \frac{b_1}{b_2} = 1.030995976 \qquad (25)$$

where by s_1 and s_2 I denote the $(s\bar{s})_1$ and $(s\bar{s})_2$ mesons and similarly for the c_1, c_2, b_1, b_2.

After a little trial and error the following relations were found by use of the same simple numbers 1, 2, 3, and the number π.

$$\frac{c_1}{c_2} = 1.100854789 \cong \left(\frac{s_1}{s_2}\right)^{\frac{2}{\pi^{1/3}+\pi^{1/\pi}}} = 1.100689816 \qquad (26)$$

and the difference between the actual and the calculated value is : Δ = 0.014986%

$$\frac{b_1}{b_2} = 1.030995976 \cong \left(\frac{s_1}{s_2}\right)^{\frac{2}{\pi(\pi^{1/3}+\pi^{1/\pi})}} = 1.031008783 \qquad (27)$$

and the difference between the actual and the calculated value is: Δ = 0.0012422%

It was therefore reasonable to do the following extrapolation:

$$\frac{t_1}{t_2} \cong \left(\frac{s_1}{s_2}\right)^{\frac{2}{\pi^2(\pi^{1/3}+\pi^{1/\pi})}} = 1.009767857 \qquad (28)$$

For the determination of t_1 and t_2 *I* need one more relation and for this reason I use again the difference $t_1 - t_2$.

From the up to now data I have:

q_0 = average of $(s_1 - s_2)$ = 0.04321925 (29)

$$q_1 = c_1 - c_2 = 0.015657 \cong \frac{4q_0}{\pi^{\frac{1}{3}}(2(\sqrt{\pi}+2))} = 0.015644679 \qquad (30)$$

and the difference between the actual and the calculated value is: Δ = 0.078692%

$$q_2 = b_1 - b_2 = 0.0020751 \cong \frac{4q_0}{\pi^{\frac{1}{3}}(2(\sqrt{\pi}+2))^2} = 0.002073541 \qquad (31)$$

and the difference between the actual and the calculated value is: Δ = 0.07513%

For the determination of I we have two choices:

$$1.\ q_3 = t_1 - t_2 \cong \frac{4q_0}{\pi^{\frac{1}{3}}(2(\sqrt{\pi}+2))^3} = 0.000274827 \qquad (32)$$

$$2.\ q_3 = t_1 - t_2 \cong \frac{4q_0}{\pi^{\frac{1}{3}}(2(\sqrt{\pi}+2))^4} = 0.000036425 \qquad (33)$$

With the first choice (32) and with use of expression (28) I find the $a_{31} \equiv t_1$ and $a_{32} \equiv t_2$ and the corresponding masses m_{31} and m_{32}, which are equal to:

a_{31} = 0.028410681 m_{31} = 27.601 GeV/c^2 and
a_{32} = 0.028135854 m_{32} = 27.901 GeV/c^2

With the second choice I find:

a_{31} = 0.003765492 $m_{31} \equiv m_{(tt)1}$ = 237.728 GeV/c^2 and 34)
a_{32} = 0.003729068 $m_{32} \equiv m_{(tt)2}$ = 240.135 GeV/c^2 (35)

It is obvious that the first solution has to be excluded since the masses of the $t\bar{t}$ mesons must be greater than the masses of the *ut* and *dt* mesons, which have already been determined. So solutions (34) and (35) are valid. It has to be mentioned that for the topponium exist various estimations among which I will present the following: a) from ref.12 it is expected that the toponium mass should be in the range of 60 – 120 GeV/c^2 and this result remains to be confirmed. b) From ref. 5 it is given a lower limit for the mass of the t quark i.e. t > 23 GeV/c^2. Although it is not said, such estimation sets a lower limit for the toponium of 46 GeV/c^2. c) From ref. 6 the mass of the t quark varies from 168 to 174 GeV/c^2. This estimation brings the mass of the toponium to about 340 GeV/c^2 on the average. Although all the above estimations have not concluded to a final value for the toponium, it is worth to note that my calculation gives a value in between the above three estimations. There is nothing more to be said.

II. Determination of the masses of the two extraonia.

My next job will concern the determination of the masses of the two extraonia $e\bar{e}$ by use of the known masses of the two bottomonia and the two toponia.

By extrapolating expressions (26), (27), and (28) we expect that it will be valid:

$$\frac{e_1}{e_2} \cong \left(\frac{s_1}{s_2}\right)^{\frac{2}{\pi^3(\pi^{1/3}+\pi^{1/\pi})}} = 1.0030989 \tag{36}$$

For the determination of e_1 and e_2 we need one more relation and for this reason I use again the difference $e_1 - e_2$.

From (33) we find by extrapolation again:

$$q_4 = e_1 - e_2 \cong \frac{4q_0}{\pi^{\frac{1}{3}}(2(\sqrt{\pi}+2))^8} = 1.124059 \cdot 10^{-8} \tag{37}$$

So from (36) and (37) $e_2 = \dfrac{1.124059 \cdot 10^{-8}}{0.0030989} = 3.6272721 \cdot 10^{-6}$ fm (38)

and e_1 = 1.0030989 10^{-6} × 3.6272721 = 3.638512654 10^{-6} fm (39)

The use of the exponent 8 in the expression in parentheses in the denominator of the above fraction of (37) is justified because for the toponium I explained why I used the exponent 4 which is 2×2 and in (31) the exponent is 1×2 so 8 = 4 × 2 and neither 4+2=6 nor 4^2 = 16.

and the corresponding masses m_{39} and m_{40} are equal to:

$a_{39} \equiv e_1 \equiv (e\bar{e})_1$ = 3.638512654 10^{-6} m_{39} = 2.83883 10^5 GeV/c^2 and (40)
$a_{40} \equiv e_2 \equiv (e\bar{e})_2$ = 3.6272721 10^{-6} m_{40} = 2.847777 10^5 GeV/c^2 (41)

I have now completed the determination of the masses of the zero-spin mesons, which contain the "extraonium".

III. Determination of the masses of the two highonia.

Since I am still in a scale bellow the Planck scale equal to:
$2(m_x - m_r) = 2(5.0437884\ 10^{-9} - 3.979578\ 10^{-10}) = 9.2916612\ 10^{-9}$ kg = $5.21265\ 10^{18}$ GeV/c^2 (c.f. ref. 1), it is reasonable to pursue my investigation for possible new zero-spin mesons based on new heavier quarks. Since the heaviest member of mesons is the one that contains two similar quarks, say $q\bar{q}$, I shall try first to determine the next to the $e\bar{e}$ meson, say the $h\bar{h}$ meson where *h* stands for the name "high" quark as I have defined before. The upper mass of $5.21265\ 10^{18}$ GeV/c^2 was calculated above by taking some data from my previous paper[(1)].
Extrapolating (36) and (37) I find:

$$\frac{h_1}{h_2} \cong \left(\frac{s_1}{s_2}\right)^{\frac{2}{\pi^4(\pi^{1/3}+\pi^{1/\pi})}} = 1.0009853 \qquad (42)$$

$$q_6 = h_1 - h_2 \cong \frac{4q_0}{\pi^{\frac{1}{3}}(2(\sqrt{\pi}+2))^{16}} = 1.0704285 \cdot 10^{-15}\ \text{fm} \qquad (43)$$

$$\text{So } h_2 = \frac{1.0704285 \cdot 10^{-15}}{0.0009853} = 1.0863986 \cdot 10^{-12}\ \text{fm} \qquad (44)$$

And $h_1 = 1.087469\ 10^{-12}$ fm (45)
and the corresponding masses m_{48} and m_{49} are equal to:

$a_{48} \equiv h_1 \equiv (h\bar{h})_1 = 1.087469\ 10^{-12}$ fm $\quad m_{48} = 1.2293341\ 10^{12}$ GeV/c^2 (46)

$a_{49} \equiv h_2 \equiv (h\bar{h})_2 = 1.0863986\ 10^{-12}$ fm $\quad m_{49} = 1.2305662\ 10^{12}$ GeV/c^2 (47)

By the same procedure I shall determine the next possible zero-spin $q\bar{q}$ meson, let be called the $f\bar{f}$ meson where *f* stands for "final". I have:

$$\frac{f_1}{f_2} \cong \left(\frac{s_1}{s_2}\right)^{\frac{2}{\pi^5(\pi^{1/3}+\pi^{1/\pi})}} = 1.0003135 \qquad (48)$$

$$q_7 = f_1 - f_2 \cong \frac{4q_0}{\pi^{\frac{1}{3}}(2(\sqrt{\pi}+2))^{32}} = 9.7072181 \cdot 10^{-30}\ \text{fm} \qquad (49)$$

$$\text{So } f_2 = \frac{9.7072181 \cdot 10^{-30}}{0.0003135} = 3.0959174 \cdot 10^{-26}\ \text{fm} \qquad (50)$$

And the mass of M_{50} meson would be $7.3754618\ 10^{28}$ GeV/c^2. Since the limit of the masses, as it was determined above, is of the order of $5\ 10^{18}$ GeV/c^2 I may infer that there is no other zero spin meson and no other quark beyond the "high" one. I see therefore that the quark flavors are 8 and not 6 as the existing GUT's or other more advanced theories suggested it. So I write now the complete table of quarks as follows:

Up and ***down*** quark	charge: +2/3, -1/3
Strange *and* ***charm*** quark	" -1/3, +2/3
Bottom and ***top*** quark	" -1/3, +2/3
Extra and ***high*** quark	" -1/3, +2/3

The electric charge of the last two new quarks was set from symmetry reasons not only at the quark family but also from the two tables of mesons (TABLE I and III). It is however possible that the charge of the extra quark to be +2/3 and that of the high quark to be -1/3. In Table III below I have chosen the first choice but this matter should be solved experimentally (if sometimes possible).
A comment at this point is rather necessary. As a matter of fact, the existence of one more quark beyond the above eight would rather be embarrassing since experience has shown that the total number of the existing quark flavors has to be even.
The determination of the above maximum rest mass of the zero spin mesons has a crucial importance in the case of the mass, which collapses in the interior of huge black holes, as I have already discussed in Cosmology 2. In this previous paper I showed that the repulsive nuclear forces between the neutrons, which constitute the mass of the collapsing body are due to the exchange of zero spin mesons. If the distance between the mass centers of two neutrons, is becoming shorter than $1.0863986\ 10^{-12}$ fm, as I found in (45), when the collapsing mass is greater than a certain limit, then the neutrons are smashed by the greater gravitational attraction so that the quarks that constitute the neutrons constitute a new resisting agent and they undergo the opposite transformations to those which will be described in the paper Cosmology 4 (C4). The repulsive force between these quarks is much stronger than that between the neutrons because they are the basic representatives of the repulsive force in nature and are expressed by a Yukawa-type potential, whereas the gravitational potential is of the Newtonian type so that the former increases in strength faster than the latter as $r \to 0$. The details of this process will be given in C4.

DETERMINATION OF ZERO-SPIN MESON MASSES THAT CONTAIN THE *st, se, sh, ct, ce, ch, bt, be, bh, te, th and eh quark combinations*

I. <u>Determination of the mass of the M_{st} meson.</u>

Let us consider the following expressions:

$$\frac{uc+dc}{2sc} = 1.035619296 \cong \left(\frac{\pi}{3}\right)^{\frac{3^2}{2^2\times 3}} = \left(\frac{\pi}{3}\right)^{\frac{9}{12}} = 1.035193326\ , \qquad (51)$$

$$\frac{ub+db}{2sb} = 1.012637422 \cong \left(\frac{\pi}{3}\right)^{\frac{3}{2^2\times 3-1}} = \left(\frac{\pi}{3}\right)^{\frac{3}{11}} = 1.012656956\ , \qquad (52)$$

$$\frac{ut+dt}{2st} = \frac{0.015138667}{2st} \cong \left(\frac{\pi}{3}\right)^{\frac{3/3=1}{11-1=10}} = \left(\frac{\pi}{3}\right)^{\frac{1}{10}} = 1.00462241\ , \qquad (53)$$

As one can easily observe, the exponents of $\pi/3$ change in a regular manner as follows:
The numerator is divided each time by 3 and from the denominator I subtract each time the number 1 in the case of (51) and (52) which contain known lengths a_i. This is an indication for a hidden regularity. So I apply the same rule in (53) too where the unknown length is the *st* , since I am looking for such cases. I solve (53) for *st* and I find:
st = 0.007534505 fm and the corresponding mass is: (54)
$m_{28} = m_{st} = 115.317\ GeV/c^2$ (55)

As I will show immediately below, I will use expressions based on the same rule for the determination of two more new masses. As it is rather obvious, the mass of the *st* meson is pretty close to the mass of the *ut* and *dt* meson. This may be due to the fact that the effective mass of the *s* quark does not differ significantly from the masses of the *ut* and *dt* mesons (in ref. (5) the u and d quark masses in mesons are 310 MeV/c^2 and that of the *s* quark mass in mesons is 483 MeV/c^2. So their combination with the much greater mass of the *t* quark (>23000 MeV/c^2) will make an insignificant difference). We may also comment here that from (34) and (35) we may roughly suggest that a possible estimation of the top quark rest mass may be ~m_{tt} / 2 ≅ 120 GeV/c^2. This value does not differ considerably from the value of the *ut* or *st* mesons (115 GeV/c^2) where the predominant role is played by the *t* quark rest mass. Some older estimations[(8)] were about half of the above values for the top quark, but I think that mine is closer to reality.

II. Determination of the mass of the M_{se} meson

Application of the same rule as above to the exponent of π/3 in (53) permits the determination of the length *se* from the following relation:

$$\frac{ue+de}{2se} \cong \left(\frac{\pi}{3}\right)^{\frac{1/3}{10-1=9}} = \left(\frac{\pi}{3}\right)^{\frac{1}{27}} = 1.001709519\ , \qquad (56)$$

I solve (56) for *se* and I find:

se = 0.00006855 fm and the corresponding mass is: (57)

$$m_{se} \equiv m_{35} = 14315\ \text{GeV/c}^2 \qquad (58)$$

It is worth noticing once more time, the small difference of $m_{ue} \cong m_{de}$ with m_{se}. As I said before, the masses of the *u*, *d* and *s* quarks are of the same order of magnitude. The same happened, as I said above, with the masses of $m_{ut} \cong m_{dt}$ and the mass m_{st}. This result is very important since the *st* mass (and the following *se* and *sh* masses) was determined with an expression quite different from those used for the *ut* and *dt* masses, which means that two different ways of calculations yield similar results, so my choices are rather successful.

III. Determination of the mass of the M_{sh} meson.

In this calculation I consider the expression (56) which is repeated bellow and following the same rule I used in deriving (51), (52), (53) and (56)) I extrapolate (56) with application of the same rule and I obtain:

$$\frac{uh+dh}{2sh} = \frac{9.64077833333\cdot 10^{-8}}{sh} \cong \left(\frac{\pi}{3}\right)^{\frac{1/9}{9-1}} = \left(\frac{\pi}{3}\right)^{\frac{1}{72}} = 1.000640727\ , \qquad (59)$$

I solve (59) for *sh* and we find:

sh = 9.6346051 10^{-8} fm and the corresponding mass is: (60)

$$m_{sh} \equiv m_{43} = 1.14511304\cdot 10^{7}\ \text{GeV/c}^2 \qquad (61)$$

The mass of *sh* is again pretty close to the masses of *uh* and *dh* mesons from (21) and (22)

IV. Determination of the mass of the M_{ct} meson

Consider now the expression:

$$\frac{ub+db}{2cb}=1.1541275\cong\left(\frac{\pi}{3}\right)^{\frac{3(\pi+1)}{4}}=1.154018531 \qquad (62)$$

where the difference between the actual and the calculated value is : Δ = 0.00944%.
Consider also the expression:

$$\frac{ut+dt}{2ct}=\left(\frac{\pi}{3}\right)^{\frac{\pi+1}{3}}=1.065737201 \qquad (63)$$

where in (63) we applied to the exponent of 3(π+1)/4 the same rule as above i.e. we divided the numerator of the fraction in the exponent by 3 and we subtracted from the denominator one unit. So we may solve for *ct* and we obtain:

$$ct=\frac{0.0075693332}{1.065737201}=7.1024388\cdot 10^{-3}\ \text{fm} \qquad (64)$$

and $m_{29} = m_{ct} = 122.695\ \text{GeV/c}^2$
(65)

V. Determination of the mass of the M_{ce} meson.

I follow the same method again and I consider the relation:

$$\frac{ue+de}{2ce}=\left(\frac{\pi}{3}\right)^{\frac{\pi+1}{3(3-1)}}=\left(\frac{\pi}{3}\right)^{\frac{\pi+1}{6}}=1.0323454 \qquad (66)$$

We solve for *ce*:

$$ce=\frac{0.000068667}{1.0323454}=6.6515528\cdot 10^{-5}\ \text{fm} \qquad (67)$$

and $m_{36} \equiv m_{ce} = 14761\ \text{GeV/c}^2$ (68)

The above mass is again close to the m_{ue} , m_{de} , m_{se} masses.

VI. Determination of the mass of the M_{ch} meson.

With the application of the same rule as above we have:

$$\frac{uh+dh}{2ch}=\left(\frac{\pi}{3}\right)^{\frac{\pi+1}{9(2-1)}}=\left(\frac{\pi}{3}\right)^{\frac{\pi+1}{9}}=1.021449 \qquad (69)$$

We solve for *ch*:

$$ch=\frac{9.6407833333\cdot 10^{-8}}{1.021449}=9.4383399\cdot 10^{-8}\ \text{fm} \qquad (70)$$

and $m_{44} = m_{ch} = 1.1652712\ 10^7\ \text{MeV/c}^2$ (71)

The orders of magnitude for the masses of the *ct, ce, ch,* mesons are on the same level as for the *st, se, sh* ones though they were calculated by different expressions.

VII. Determination of the mass of the M_{bt} meson.

Up to this point of calculations, I could probably say "so far so good". For the determination, however, of the remaining meson masses I have not a point to start with. As we saw in the preceding cases, in the first group of mesons i.e. in the M_{sc}, M_{sb}, M_{st}, M_{se}, M_{sh}, the lengths a_i that correspond to the masses of the first two mesons M_{sc} and M_{sb}, could be expressed in terms of the basic numbers 1, 2, 3, π since the values of these masses (and those of M_{uc}, M_{dc}, M_{ub}, M_{db}) were known from experiment and so the corresponding a_i could be derived by the already described manner. The same was possible for the 2nd group of mesons i.e. for the M_{cb}, M_{ct}, M_{ce}, M_{ch} where the M_{cb} meson mass was also known. For the mesons of the 3d group of M_{bt}, M_{be}, M_{bh}, mesons, however and for the 4th of M_{te}, M_{th} and also for the 5th group that contains only one meson, the M_{eh}, I had no known meson mass to start with. For this reason it became necessary to search for other solutions.

Since I had already at my disposal the results of the first and second group I thought that I could possibly find how the second group can be inferred from the first one. One simple and logical way was to do a correspondence of the values of the first and second group, by placing them in a two dimensional graph, where the values of the first group would be placed on the x-axis and those of the second group on the y-axis. The resulting curve could probably give me an idea of how to find an analytical expression of the form y = f(x). What I really used as x and y were not the values of the a_i's but the values of the exponents of (π/3) since this expression seams to be of some special importance in the preceding calculations, its importance based on the fact that it remains unchanged. So the form of this graph gave a curve, as it is indicated in fig. 1 bellow, which at first glance only slightly differs from a straight line.

X	Y
0,75	3,106194
0,272727273	1,380531
0,1	0,690265
0,037037037	0,460177

Graph No 1 for Mesons

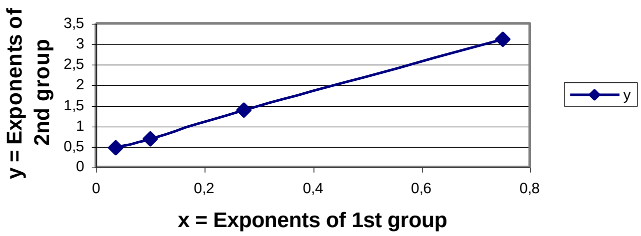

Fig. 1

It was a matter of using a curve-fitting program to get the required analytical relation. Since the graph of Fig. 1 indicated a straight line regression, I used the expression y = a+bx and I determined the value of a and b as follows: a = 0.333331521, and b = 3.710962358. So the analytical expression is:

$$y = 0.333331521 + 3.710962358x \qquad (72)$$

with a coefficient of determination R^2 = 0.999615297, pretty close to unity.

My first thought from the above result, was that this linear graph that connects the exponents of (π/3) of the first and second group of the four lengths a_i under consideration, could not be accidental. It might be the result of some hidden rule that governs these exponents and in extrapolation the corresponding lengths and consequently the corresponding masses. If such a hypothesis is valid, then it permits the extrapolation of (72) to the values of the exponents of the second and third group. So I can use the same straight line by placing on the x axis the exponents of (π/3) of the second group and so obtaining from (72) the y's of the third group. In the case of the M_{bt} meson we would have:

$$\frac{ut+dt}{2bt}=\left(\frac{\pi}{3}\right)^{11.86030235}=1.728006866 \tag{73}$$

where the exponent of (π/3) in (73) was found from (72) by setting: x = 3(π+1)/4 = 3.10619449. By a similar procedure I find that:

$$\frac{ue+de}{2be}=\left(\frac{\pi}{3}\right)^{5.456429669}=1.286129634 \tag{74}$$

and $$\frac{uh+dh}{2bh}=\left(\frac{\pi}{3}\right)^{2.894880593}=1.142826908 \tag{75}$$

I come now to the fourth group of lengths. For the exponents of (π/3) we use the same method as above and in (72) we put x = 11.86030235 and we get: y = 44.3464671 = exponent for *te*. Also for x = 5.456429669, y = 20.58193663 = exponent for *th*. For the 5th group we put x = 44.3464671 and we get y = 164.9014016 = exponent of *eh*. So we have:

$$\frac{ue+de}{2te}=\left(\frac{\pi}{3}\right)^{44.3464671}=7.730337307 \tag{76}$$

$$\frac{uh+dh}{2th}=\left(\frac{\pi}{3}\right)^{20.58193663}=2.583614684 \tag{77}$$

and finally:

$$\frac{uh+dh}{2eh}=\left(\frac{\pi}{3}\right)^{164.9014016}=2007.9235 \tag{78}$$

TABLE II

P	***sc***	0.75	P	***cb***	3.10619449	non P	***bt***	11.86030235	Non P	***te***	44.3464671	non P	***eh***	164.9014016
"	***sb***	0.272727273	non P	***ct***	1.380530885	"	***be***	5.456429669	"	***th***	20.5819366			
non P	***st***	0.1	"	***ce***	0.690265442	"	***bh***	2.894880593						
"	***se***	0.037037037	"	***ce***	0.460176962									
"	***sh***	0.013888889												

This Table contains all the exponents of (π/3) which lead to the calculation of known or unknown meson lengths a_i in fm and finally to meson masses in GeV/c^2.

The notation P stands for the word "Primary" (and the same for non P) and has the meaning that the corresponding exponent has been derived from experimentally known masses (a_i's in fact). The non-Primary notation is just the opposite of Primary.

The calculation of the corresponding a_i's and masses follows from the rules given up to now.

It is now a simple matter to calculate the lengths a_i and the corresponding masses from (74) up to (78). We find:

$a_{30} \equiv a_{bt}$ = 0.0043803836 and m_{bt} = 203.196 GeV/c^2

$a_{37} \equiv a_{be}$ = 0.000053390 and m_{be} = 18462 GeV/c^2

$a_{45} \equiv a_{bh}$ = 8.4359042 10^{-8} and m_{bh} = 1.3062555 10^7 GeV/c^2

$a_{38} \equiv a_{te}$ = 8.8827947 10^{-6} and m_{te} = 1.1450345 10^5 GeV/c^2

$a_{46} \equiv a_{th}$ = 3.7315077 10^{-8} and m_{th} = 2.9947221 10^7 GeV/c^2

$a_{47} \equiv a_{eh}$ = 4.8013673 10^{-11} and m_{eh} = 2.6090877 10^{10} GeV/c^2

There is no other zero-spin meson mass to be found (except the already determined mass of the two "highonia"). I gather, therefore, all the results of the new mesons I found, in Table III below:

TABLE III

Serial Number for	Electric charge	Length a_i Fm	Masses In GeV/c^2	Characterization of mesons from their quark content	Quark Content of Mesons
1	2	3	4	5	6
M_{26}	(0)	0.007569337	114.76	Top	$u\bar{t}, t\bar{u}$
M_{27}	(±)	0.0075693295	114.76	Top	$d\bar{t}, t\bar{d}$
M_{28}	(±)	0.007534505	115.317	Top-strange	$s\bar{t}, t\bar{s}$
M_{29}	(0)	0.007102439	122.695	Top-charmed	$c\bar{t}, t\bar{c}$
M_{30}	(±)	0.0043803836	203.196	Top-bottom	$b\bar{t}, t\bar{b}$
M_{31}	(0)	0.003765492	237.728	Toponium	$t\bar{t}$
M_{32}	(0)	0.003729068	240.135	Toponium	$t\bar{t}$
M_{33}	(0)	0.000068667	14290	Extra	$u\bar{e}, e\bar{u}$
M_{34}	(±)	0.000068667	14290	Extra	$d\bar{e}, e\bar{d}$
M_{35}	(±)	0.00006855	14315	Extra-strange	$s\bar{e}, e\bar{s}$
M_{36}	(0)	0.000066516	14761	Extra-charmed	$c\bar{e}, e\bar{c}$
M_{37}	(±)	0.000053390	18462	Extra-bottom	$b\bar{e}, e\bar{b}$
M_{38}	(0)	8.8827947 10^{-6}	1.1450345 10^5	Extra-top	$t\bar{e}, e\bar{t}$
M_{39}	(0)	3.6385127 10^{-6}	2.83883 10^5	Extraonium	$e\bar{e}$
M_{40}	(0)	3.6272721 10^{-6}	2.847777 10^5	Extraonium	$e\bar{e}$
M_{41}	(±)	9.6407783333 10^{-8}	1.1403871 10^7	High	$u\bar{h}, h\bar{u}$
M_{42}	(0)	9.6407783333 10^{-8}	1.1403871 10^7	High	$d\bar{h}, h\bar{d}$
M_{43}	(0)	9.6346051 10^{-8}	1.1411304 10^7	High-strange	$s\bar{h}, h\bar{s}$
M_{44}	(±)	9.4383399 10^{-8}	1.1652712 10^7	High-charmed	$c\bar{h}, h\bar{c}$
M_{45}	(0)	8.4359042 10^{-8}	1.3062555 10^7	High-bottom	$b\bar{h}, h\bar{b}$
M_{46}	(±)	3.7315077 10^{-8}	2.9947221 10^7	High-top	$t\bar{h}, h\bar{t}$
M_{47}	(±)	4.8013673 10^{-11}	2.6090877 10^{10}	High-extra	$e\bar{h}, h\bar{e}$
M_{48}	(0)	1.087469 10^{-12}	1.2293341 10^{12}	Highonium	$h\bar{h}$
M_{49}	(0)	1.0863986 10^{-12}	1.2305662 10^{12}	Highonium	$h\bar{h}$

In Table III the masses of zero-spin mesons in GeV/c^2 are presented, which contain the top quark with all combinations of lighter quarks as well as the masses of zero spin mesons which contain all combinations of the new quarks “extra” and “high” with the lighter quarks. I hope that with the under construction new accelerators it will become possible the determination of masses up to m_{32} = 240.135 GeV/c^2 i.e. up to the mass of the toponium. Beyond this mass the new masses of Table III are too big to be determined even by these new machines. Their determination may be verified, however, by the so promising superstring theory or by an as yet unknown theory or even by experiments involving rare events in which the probability to spot a zero spin meson is within the limits of experimentation.

APPENDIX I.

As I explained in the main text, the determination of the heavier than the $B_c(\pm)$ meson masses could not be achieved by the solution of Schrödinger’s equation of the deuteron for the reasons I have already talked about. So it became necessary to find another method to do the job. Since I had 23 experimentally known meson masses and I could determine their a_i lengths from Schrödinger’s equation, I thought that if I place the lengths a_i in fm and the corresponding masses in MeV/c^2 in a two dimensional diagram, and if I had a suitable curve fitting computer program, I could probably find an analytical expression that would connect fairly good the masses and the a_i lengths. So I constructed a program remotely based on the least square method, and from a graphical representation of the a_i’s versus masses I found (after some trial and error) that a good function to do the job could have the form:

$$y = \frac{b_1 \exp(-b_2 x^{b_3})}{x^{b_4}} \qquad \text{(AI.1)}$$

where y is the required mass and x is the a_i .

By running the program, I determined the four coefficients and I found them equal to:

$b_1 = 8.3319892\ 10^2$

$b_2 = 2.1199666$

$b_3 = 0.80227012$

$b_4 = 1.0171636$

So I have an analytical expression, which helps to find the mass of a zero-spin meson in MeV/c^2 if the corresponding length a_i is known. The fitting of the above expression was best working to shorter a_i values i.e. to heavier masses. The computer program is not presented here but it is available on request. Quite roughly I could say that to the masses of table III would be acceptable to attach for various reasons an uncertainty of the order of $\pm 0.2\%$.

Table III seems to fill the so-called “desert region” between 10^{-17} and 10^{-35} m at least from the contribution of zero-spin mesons. If beyond the top quark exist two more new and heavier quarks, the extra and the high as I called them, it is more than certain that they will combine by 3 to create an immense number of new baryons. It is already known that there exist such combinations of known quarks as e.g. the

$\Lambda_c^+ = udc$, the $\Sigma_c^0 = ddc$ and many more combinations. So it would be rather curious why not *teh* or *ube* and so on combinations. Since there are 8 quarks their combinations by three with repetition of each at most 3 times gives 120 such combinations. I find it tempting to try a method, which may reveal how many of these combinations give probable baryons. This method is based on two different ways that permit the determination of the electric charge of a baryon. If both ways give the same charge then the baryon rather exists. If not, its existence is rather impossible.

The first and simplest way to find the electric charge of a baryon is to add the electric charges of its constituents i.e. of the quarks it contains. So a proton being a combination of *uud* quarks has a charge 2/3 + 2/3 –1/3 = 1.There is however another way to find the charge of the proton. We may use an extension of the known Gell Mann-Nishijima formula as follows:

$$Q = I_3 + ½ (B_a+S+C+B+T+E+H) \qquad \text{(AI.2)}$$

Where I_3 is the third component of the isotopic spin, B_a is the baryon number and S,C,B,T,E,H the quark flavor numbers attached to them. All these numbers are contained in table IV below:

TABLE IV

Quark	Spin	Electric Charge	Baryon Number B	S	C	B	T	E	H	I	I_3
U	½	2/3	1/3	0	0	0	0	0	0	½	½
D	½	-1/3	1/3	0	0	0	0	0	0	½	-½
S	½	-1/3	1/3	-1	0	0	0	0	0	0	0
C	½	2/3	1/3	0	+1	0	0	0	0	0	0
B	½	-1/3	1/3	0	0	-1	0	0	0	0	0
T	½	2/3	1/3	0	0	0	+1	0	0	0	0
E	½	-1/3	1/3	0	0	0	0	-1	0	0	0
H	½	2/3	1/3	0	0	0	0	0	+1	0	0

The next step is to create a new Table, which will contain all the possible combinations of the 8 quarks by 3 as I explained above.

TABLE V

Quarks	I_3	Baryon Number B_a	S	C	B	T	E	H	q	Q	Particle
Uuu	3/2	1	0	0	0	0	0	0	2	2	Δ^{++}
Ddd	-3/2	1	0	0	0	0	0	0	-1	-1	Δ^-
Sss	0	1	-3	0	0	0	0	0	-1	-1	Ω^-
Ccc	0	1	0	3	0	0	0	0	2	2	
Bbb	0	1	0	0	-3	0	0	0	-1	-1	
Ttt	0	1	0	0	0	3	0	0	2	2	
Eee	0	1	0	0	0	0	-3	0	-1	-1	
Hhh	0	1	0	0	0	0	0	3	2	2	
Uud	1	1	0	0	0	0	0	0	1	1	p, N^+,Δ^+
Uus	1	1	-1	0	0	0	0	0	1	1	Σ^+
Uuc	1	1	0	1	0	0	0	0	2	2	Σ_c^{++}
Uub	1	1	0	0	-1	0	0	0	1	1	
Uut	1	1	0	0	0	1	0	0	2	2	
Uue	1	1	0	0	0	0	-1	0	1	1	
Uuh	1	1	0	0	0	0	0	1	2	2	
Ddu	-1	1	0	0	0	0	0	0	0	0	n,N^0,Δ^0
Dds	-1	1	-1	0	0	0	0	0	-1	-1	Σ^-
Ddc	-1	1	0	1	0	0	0	0	0	0	Σ_c^0
Ddb	-1	1	0	0	-1	0	0	0	-1	-1	
Ddt	-1	1	0	0	0	1	0	0	0	0	
Dde	-1	1	0	0	0	0	-1	0	-1	-1	

Ddh	-1	1	0	0	0	0	0	1	0	0	
Ssu	½	1	-2	0	0	0	0	0	0	0	Ξ^0
Ssd	-1/2	1	-2	0	0	0	0	0	-1	-1	Ξ^-
Ssc	0	1	-2	1	0	0	0	0	0	0	Ω_c^0
Ssb	0	1	-2	0	-1	0	0	0	-1	-1	
Sst	0	1	-2	0	0	1	0	0	0	0	
Sse	0	1	-2	0	0	0	-1	0	-1	-1	
Ssh	0	1	-2	0	0	0	0	1	0	0	
Ccu	½	1	0	2	0	0	0	0	2	2	
Ccd	-1/2	1	0	2	0	0	0	0	1	1	
Ccs	0	1	-1	2	0	0	0	0	1	1	
Ccb	0	1	0	2	-1	0	0	0	1	1	
Cct	0	1	0	2	0	1	0	0	2	2	
Cce	0	1	0	2	0	0	-1	0	1	1	
Cch	0	1	0	2	0	0	0	1	2	2	
Bbu	½	1	0	0	-2	0	0	0	0	0	
Bbd	-1/2	1	0	0	-2	0	0	0	-1	-1	
Bbs	0	1	-1	0	-2	0	0	0	-1	-1	
Bbc	0	1	0	1	-2	0	0	0	0	0	
Bbt	0	1	0	0	-2	1	0	0	0	0	
Bbe	0	1	0	0	-2	0	-1	0	-1	-1	
Bbh	0	1	0	0	-2	0	0	1	0	0	
Ttu	½	1	0	0	0	2	0	0	2	2	
Ttd	-1/2	1	0	0	0	2	0	0	1	1	
Tts	0	1	-1	0	0	2	0	0	1	1	
Ttc	0	1	0	1	0	2	0	0	2	2	
Ttb	0	1	0	0	-1	2	0	0	1	1	
Tte	0	1	0	0	0	2	-1	0	1	1	
Tth	0	1	0	0	0	2	0	1	2	2	
Eeu	½	1	0	0	0	0	-2	0	0	0	
Eed	-1/2	1	0	0	0	0	-2	0	-1	-1	
Ees	0	1	-1	0	0	0	-2	0	-1	-1	
Eec	0	1	0	1	0	0	-2	0	0	0	
Eeb	0	1	0	0	-1	0	-2	0	-1	-1	
Eet	0	1	0	0	0	1	-2	0	0	0	
Eeh	0	1	0	0	0	0	-2	1	0	0	
Hhu	½	1	0	0	0	0	0	2	2	2	
Hhd	-1/2	1	0	0	0	0	0	2	1	1	
Hhs	0	1	-1	0	0	0	0	2	1	1	
Hhc	0	1	0	1	0	0	0	2	2	2	
Hhb	0	1	0	0	-1	0	0	2	1	1	
Hht	0	1	0	0	0	1	0	2	2	2	
Hhe	0	1	0	0	0	0	-1	2	1	1	
Uds	0	1	-1	0	0	0	0	0	0	0	Λ^0,Σ^0
Udc	0	1	0	1	0	0	0	0	1	1	Λ_c^+, Σ_c^+
Udb	0	1	0	0	-1	0	0	0	0	0	Λ_b^0
Udt	0	1	0	0	0	1	0	0	1	1	
Ude	0	1	0	0	0	0	-1	0	0	0	
Udh	0	1	0	0	0	0	0	1	1	1	
Dsc	-1/2	1	-1	1	0	0	0	0	0	0	Ξ_c^0
Dsb	-1/2	1	-1	0	-1	0	0	0	-1	-1	Ξ_b^-
Dst	-1/2	1	-1	0	0	1	0	0	0	0	
Dse	-1/2	1	-1	0	0	0	-1	0	-1	-1	
Dsh	-1/2	1	-1	0	0	0	0	1	0	0	
Scb	0	1	-1	1	-1	0	0	0	0	0	
Sct	0	1	-1	1	0	1	0	0	1	1	
Sce	0	1	-1	1	0	0	-1	0	0	0	
Sch	0	1	-1	1	0	0	0	1	1	1	
Cbt	0	1	0	1	-1	1	0	0	1	1	
Cbe	0	1	0	1	-1	0	-1	0	0	0	
Cbh	0	1	0	1	-1	0	0	1	1	1	
Bte	0	1	0	0	-1	1	-1	0	0	0	
Bth	0	1	0	0	-1	1	0	1	1	1	
Usc	½	1	-1	1	0	0	0	0	1	1	Ξ_c^+
Usb	½	1	-1	0	-1	0	0	0	0	0	Ξ_b^0
Ust	½	1	-1	0	0	1	0	0	1	1	
Use	½	1	-1	0	0	0	-1	0	0	0	
Ush	½	1	-1	0	0	0	0	1	1	1	
Dcb	-1/2	1	0	1	-1	0	0	0	0	0	

Dct	-1/2	1	0	1	0	1	0	0	1	1	
Dce	-1/2	1	0	1	0	0	-1	0	0	0	
Dch	-1/2	1	0	1	0	0	0	1	1	1	
Sbt	0	1	-1	0	-1	1	0	0	0	0	
Sbe	0	1	-1	0	-1	0	-1	0	-1	-1	
Sbh	0	1	-1	0	-1	0	0	1	0	0	
Cte	0	1	0	1	0	1	-1	0	1	1	
Cth	0	1	0	1	0	1	0	1	2	2	
Beh	0	1	0	0	-1	0	-1	1	0	0	
Ucb	½	1	0	1	-1	0	0	0	1	1	
Uct	½	1	0	1	0	1	0	0	2	2	
Uce	½	1	0	1	0	0	-1	0	1	1	
Uch	½	1	0	1	0	0	0	1	2	2	
Dbt	-1/2	1	0	0	-1	1	0	0	0	0	
Dbe	-1/2	1	0	0	-1	0	-1	0	-1	-1	
Dbh	-1/2	1	0	0	-1	0	0	1	0	0	
Ste	0	1	-1	0	0	1	-1	0	0	0	
Sth	0	1	-1	0	0	1	0	1	1	1	
Ceh	0	1	0	1	0	0	-1	1	1	1	
Ubt	½	1	0	0	-1	1	0	0	1	1	
Ube	½	1	0	0	-1	0	-1	0	0	0	
Ubh	½	1	0	0	-1	0	0	1	1	1	
Dte	-1/2	1	0	0	0	1	-1	0	0	0	
Dth	-1/2	1	0	0	0	1	0	1	1	1	
She	0	1	-1	0	0	0	-1	1	0	0	
Ute	½	1	0	0	0	1	-1	0	1	1	
Uth	½	1	0	0	0	1	0	1	2	2	
Deh	-1/2	1	0	0	0	0	-1	1	0	0	
Ueh	½	1	0	0	0	0	-1	1	1	1	

The existing baryons are indicated in the last column of the above table. They are 23 altogether, which correspond to 3-quarks combinations. So it remains the discovery of 97 more, rather heavier, baryons, at least, most of which contain *t*, *e* and *h* quarks. So the empty desert $10^{-17} - 10^{-35}$ m is enriched once again with unknown baryons (and their anti-baryons of course) along with the calculated zero-spin mesons. And most probably with vector mesons about which I can say nothing for the time being.

In a book of mine(8) I had made the hypothesis that the leptons are also composite particles. They are composed from 3 more elementary particles (the γ_x particles as I called them) where x stands for the 8 quark flavors (u, d, s….). They combine by 3 to constitute all kinds of leptons with the same manner that the quarks combine by three to constitute all baryons. The γ_x particles possess a lepton number, leptonic isospin, electric charge, leptonic strangeness, charm, beauty etc. just like the quarks but all the corresponding numbers have an opposite sign to the same quark number. How they emerge and how they gather by 3 to constitute leptons and by 2 (in $\gamma_x\bar{\gamma}_x$ configuration) to constitute leptonic mesons ($W^{\pm}$,Z^0 and photons γ) is a long story, which is still under investigation. The only I will say now is that the formation of the γ_x particles occurs at the moment when the emerging MWH are transformed into quarks and γ_x particles, at the very early stages of the Big Bang. **The above assumption for the leptons (i.e. that they are composite particles too, out of three more elementary ones) is the only one that guaranties 100% the zero electric charge of the whole Universe since it is the unique assumption that makes the number of protons equal to the number of electrons one by one.** Although all known theories accept the electrical neutrality of the Universe as a whole, none gives a fair explanation for the **exact** equality of the electrons and protons numbers. So the next step is to create a new Table, which will contain all the possible combinations of the 8 γ_x particles by 3 as I explained above. Before this table I present in table VI the necessary characteristic magnitudes of these particles. For simplicity in writing I used the notation u,d,…. instead of γ_u , γ_d …..etc. so there must be no confusion.

TABLE VI

γ_x Particles	Spin	Electric Charge	Lepton Number L	S	C	B	T	E	H	I	I_3
x=u	½	-2/3	-1/3	0	0	0	0	0	0	1/2	-½
x=d	½	1/3	-1/3	0	0	0	0	0	0	1/2	½
x=s	½	1/3	-1/3	1	0	0	0	0	0	0	0
x=c	½	-2/3	-1/3	0	-1	0	0	0	0	0	0
x=b	½	1/3	-1/3	0	0	1	0	0	0	0	0
x=t	½	-2/3	-1/3	0	0	0	-1	0	0	0	0
x=e	½	1/3	-1/3	0	0	0	0	1	0	0	0
x=h	½	-2/3	-1/3	0	0	0	0	0	-1	0	0

TABLE VII

γ_x Particles	I_3	Lepton Number L	S	C	B	T	E	H	Q	Q	Particle
uuu	-3/2	-1	0	0	0	0	0	0	-2	-2	
ddd	3/2	-1	0	0	0	0	0	0	1	1	
sss	0	-1	3	0	0	0	0	0	1	1	
ccc	0	-1	0	-3	0	0	0	0	-2	-2	
bbb	0	-1	0	0	3	0	0	0	1	1	
ttt	0	-1	0	0	0	-3	0	0	-2	-2	
eee	0	-1	0	0	0	0	3	0	1	1	
hhh	0	-1	0	0	0	0	0	-3	-2	-2	
uud	-1/2	-1	0	0	0	0	0	0	-1	-1	e
uus	-1	-1	1	0	0	0	0	0	-1	-1	μ
uuc	-1	-1	0	-1	0	0	0	0	-2	-2	
uub	-1	-1	0	0	1	0	0	0	-1	-1	τ
uut	-1	-1	0	0	0	-1	0	0	-2	-2	
uue	-1	-1	0	0	0	0	1	0	-1	-1	?
uuh	-1	-1	0	0	0	0	0	-1	-2	-2	
ddu	1/2	-1	0	0	0	0	0	0	0	0	ν_e
dds	1	-1	1	0	0	0	0	0	1	1	
ddc	1	-1	0	-1	0	0	0	0	0	0	ν_μ
ddb	1	-1	0	0	1	0	0	0	1	1	
ddt	1	-1	0	0	0	-1	0	0	0	0	ν_τ
dde	1	-1	0	0	0	0	1	0	1	1	
ddh	1	-1	0	0	0	0	0	-1	0	0	??
ssu	-½	-1	2	0	0	0	0	0	0	0	??
ssd	1/2	-1	2	0	0	0	0	0	1	1	
ssc	0	-1	2	-1	0	0	0	0	0	0	??
ssb	0	-1	2	0	1	0	0	0	1	1	
sst	0	-1	2	0	0	-1	0	0	0	0	??
sse	0	-1	2	0	0	0	1	0	1	1	
ssh	0	-1	2	0	0	0	0	-1	0	0	??
ccu	-½	-1	0	-2	0	0	0	0	-2	-2	
ccd	1/2	-1	0	-2	0	0	0	0	-1	-1	?
ccs	0	-1	1	-2	0	0	0	0	-1	-1	?
ccb	0	-1	0	-2	1	0	0	0	-1	-1	?
cct	0	-1	0	-2	0	-1	0	0	-2	-2	
cce	0	-1	0	-2	0	0	1	0	-1	-1	?
cch	0	-1	0	-2	0	0	0	-1	-2	-2	
bbu	-½	-1	0	0	2	0	0	0	0	0	??

bbd	1/2	-1	0	0	2	0	0	0	1	1	
bbs	0	-1	1	0	2	0	0	0	1	1	
bbc	0	-1	0	-1	2	0	0	0	0	0	??
bbt	0	-1	0	0	2	-1	0	0	0	0	??
bbe	0	-1	0	0	2	0	1	0	1	1	
bbh	0	-1	0	0	2	0	0	-1	0	0	??
ttu	-½	-1	0	0	0	-2	0	0	-2	-2	
ttd	1/2	-1	0	0	0	-2	0	0	-1	-1	?
tts	0	-1	1	0	0	-2	0	0	-1	-1	?
ttc	0	-1	0	-1	0	-2	0	0	-2	-2	
ttb	0	-1	0	0	1	-2	0	0	-1	-1	?
tte	0	-1	0	0	0	-2	1	0	-1	-1	?
tth	0	-1	0	0	0	-2	0	-1	-2	-2	
eeu	-½	-1	0	0	0	0	2	0	0	0	??
eed	1/2	-1	0	0	0	0	2	0	1	1	
ees	0	-1	1	0	0	0	2	0	1	1	
eec	0	-1	0	-1	0	0	2	0	0	0	??
eeb	0	-1	0	0	1	0	2	0	1	1	
eet	0	-1	0	0	0	-1	2	0	0	0	??
eeh	0	-1	0	0	0	0	2	-1	0	0	??
hhu	-½	-1	0	0	0	0	0	-2	-2	-2	
hhd	1/2	-1	0	0	0	0	0	-2	-1	-1	?
hhs	0	-1	1	0	0	0	0	-2	-1	-1	?
hhc	0	-1	0	-1	0	0	0	-2	-2	-2	
hhb	0	-1	0	0	1	0	0	-2	-1	-1	?
hht	0	-1	0	0	0	-1	0	-2	-2	-2	
hhe	0	-1	0	0	0	0	1	-2	-1	-1	?
uds	0	-1	1	0	0	0	0	0	0	0	??
udc	0	-1	0	-1	0	0	0	0	-1	-1	?
udb	0	-1	0	0	1	0	0	0	0	0	??
udt	0	-1	0	0	0	-1	0	0	-1	-1	?
ude	0	-1	0	0	0	0	1	0	0	0	??
udh	0	-1	0	0	0	0	0	-1	-1	-1	?
dsc	1/2	-1	1	-1	0	0	0	0	0	0	??
dsb	1/2	-1	1	0	1	0	0	0	1	1	
dst	1/2	-1	1	0	0	-1	0	0	0	0	??
dse	1/2	-1	1	0	0	0	1	0	1	1	
dsh	1/2	-1	1	0	0	0	0	-1	0	0	??
scb	0	-1	1	-1	1	0	0	0	0	0	??
sct	0	-1	1	-1	0	-1	0	0	-1	-1	?
sce	0	-1	1	-1	0	0	1	0	0	0	??
sch	0	-1	1	-1	0	0	0	-1	-1	-1	?
cbt	0	-1	0	-1	1	-1	0	0	-1	-1	?
cbe	0	-1	0	-1	1	0	1	0	0	0	??
cbh	0	-1	0	-1	1	0	0	-1	-1	-1	?
bte	0	-1	0	0	1	-1	1	0	0	0	??
bth	0	-1	0	0	1	-1	0	-1	-1	-1	?
the	0	-1	0	0	0	-1	1	-1	-1	-1	?
usc	-½	-1	1	-1	0	0	0	0	-1	-1	?
usb	-½	-1	1	0	1	0	0	0	0	0	??
ust	-½	-1	1	0	0	-1	0	0	-1	-1	?
use	-½	-1	1	0	0	0	1	0	0	0	??
ush	-½	-1	1	0	0	0	0	-1	-1	-1	?
dcb	1/2	-1	0	-1	1	0	0	0	0	0	??
dct	1/2	-1	0	-1	0	-1	0	0	-1	-1	?
dce	1/2	-1	0	-1	0	0	1	0	0	0	??
dch	1/2	-1	0	-1	0	0	0	-1	-1	-1	?
sbt	0	-1	1	0	1	-1	0	0	0	0	??
sbe	0	-1	1	0	1	0	1	0	1	1	
sbh	0	-1	1	0	1	0	0	-1	0	0	??
cte	0	-1	0	-1	0	-1	1	0	-1	-1	?
cth	0	-1	0	-1	0	-1	0	-1	-2	-2	
beh	0	-1	0	0	1	0	1	-1	0	0	??
ucb	-½	-1	0	-1	1	0	0	0	-1	-1	?
uct	-½	-1	0	-1	0	-1	0	0	-2	-2	
uce	-½	-1	0	-1	0	0	1	0	-1	-1	?
uch	-½	-1	0	-1	0	0	0	-1	-2	-2	
dbt	1/2	-1	0	0	1	-1	0	0	0	0	??
dbe	1/2	-1	0	0	1	0	1	0	1	1	

dbh	1/2	-1	0	0	1	0	0	-1	0	0	??
ste	0	-1	1	0	0	-1	1	0	0	0	??
sth	0	-1	1	0	0	-1	0	-1	-1	-1	?
ceh	0	-1	0	-1	0	0	1	-1	-1	-1	?
ubt	-½	-1	0	0	1	-1	0	0	-1	-1	?
ube	-½	-1	0	0	1	0	1	0	0	0	??
ubh	-½	-1	0	0	1	0	0	-1	-1	-1	?
dte	1/2	-1	0	0	0	-1	1	0	0	0	??
dth	1/2	-1	0	0	0	-1	0	-1	-1	-1	?
she	0	-1	1	0	0	0	1	-1	0	0	??
Ute	-½	-1	0	0	0	-1	1	0	-1	-1	?
Uth	-½	-1	0	0	0	-1	0	-1	-2	-2	
Deh	1/2	-1	0	0	0	0	1	-1	0	0	??
Ueh	-½	-1	0	0	0	0	1	-1	-1	-1	?

In the above Table we notice the following:

a) All combinations that result to charge values different from 0 or –1 are not forming leptons, since as it is known, the already existing leptons, heavier than the electron and the electron neutrino, decay finally to these two particles which have charge –1 and 0 respectively.

b) The particles marked by one (?) are negatively charged leptons and those with two (??) are all neutrinos.

c) I placed the known leptons e, μ, τ (and their neutrinos) to positions that most probably correspond to them.

d) This table contains 43 negatively charged leptons and 43 neutrinos. The 3 leptons and their 3 neutrinos are already known. So there remain 40 new leptons and their 40 new neutrinos to be discovered.

e) The acceptance of the idea that the leptons are composite particles (as the baryons) is very difficult to be swallowed because it abrogates the up to now belief (?) that there exists a correspondence of quark and lepton families one by one. The existing theories have arrived at the above correspondence because they consider the leptons as point-like particles. This opinion may be correct since no experiment has revealed something different, but no one can exclude the possibility that the γ_x particles may be amalgamated by three so strongly that they cannot be distinguished from a single structurless particle. This subject requires more elaboration and I hope that I will present more evidence about the composite nature of leptons. This will be done in C5. The possibility of lepton substructure is usually referred to as the *fermion family problem*[7]. This substructure has also been examined in ref. 9 and it is connected with the possible substructure of quarks. My theory on this subject accepts only the 50% of the truth (if any) of ref. 10. The reason is very serious. The protons and electrons and in general the hadrons and leptons are on the same level of **elementarity.** So since we have accepted that the hadrons have a second level of structure (that of quarks) it is reasonable to discuss the possibility of a second level of substructure for the leptons. But a substructure of the quarks themselves necessarily introduces a third lepton substructure too. This is ridiculous since it introduces an asymmetry between hadrons and leptons with respect to their elementarity and second because in this case we shall be obliged to introduce new messengers to transmit the interactions between the particles of the third level of hadrons (between the prequarks as they have been called by Haim Harari[9]) and the story will have never an end. So to my opinion, when the physics community will start searching for the substructure of the electron and the neutrino (and the heavier leptons) and for the forces that keep the leptons so strongly massive so that they behave as point-like particles, then I believe that one of the major problem of particle physics will find a solution. In Cosmology 5 I shall return again to this problem.

e) The above new leptons certainly make their contribution to the empty desert we referred to in the foregoing development.

f) One last comment is that the above tables must be completed with the masses, the decay times, the magnetic moments and other characteristics of the new particles. This task must be fulfilled by the experimenters, but it is rather improbable to be done with the existing machinery, since the required energies will probably be tremendous.

I think that this work would be unfinished if I would make no reference to the bosons that can be produced from the combination by two of the γ_x particles. But for space economy I do not present these combinations in detail. All possible combinations of 16 particles (8 particles and 8 antiparticles) by two are 36 altogether and among them the Photon, the $W^{\pm}$ and the Z^0 bosons could be produced as mixtures of the $\gamma_u\bar{\gamma}_u$ and $\gamma_d\bar{\gamma}_d$ of the form $n_1\gamma_u\bar{\gamma}_u+n_2\gamma_d\bar{\gamma}_d$ where n_1 and n_2 are integers or zeros.

g) One could reasonably argue that baryon and lepton number is not conserved since new baryons and leptons are created in the Universe during the initial stages of the Big Bang. The above argument may be anticipated by the introduction of a new conservation principle that of *particle number conservation.* If when the residue mass from a MWH splits into a quark and a γ_x particle, as I shall develop in C4, the quark attains a baryon number B equal to 1/3 and the γ_x particle, a lepton number L equal to –1/3 and if we define a particle number N equal to B+L then N will be conserved in all kinds of interactions. The idea also of negative lepton number for leptons and positive lepton number for anti-leptons is not quite new(10).

To the problem of non-zero spin mesons I hope to return in another paper.

CONCLUSION

In the present work I tried to study the possibility for the existence of new zero-spin mesons, since I had a basis to start with. This basis was the correlation of the masses of mesons, which mediate in the development of the repulsive nuclear forces with some lengths that express the separation of the mass centres of the two nucleons in the deuteron nucleus. These lengths are shorter than about 0.5 fm. The method I followed was partly arbitrary and partly was based on extrapolation of existing data. As I said from the very beginning, I tried to throw a little order in a region where there was no order, at least in a first level. One question that possibly will be raised is the following: How and why the nucleons have the possibility to approach each other to so short distances as the ones I have derived in my calculations? To this question I shall give the following answer.

The emerging from a MWH mass, however big, is an elementary particle, which is subject to the Uncertainty Principle. So even in its lowest energy state, it will have to possess an uncertainty of position and momentum, which usually is translated to a quantum mechanical harmonic oscillation (since the existing theory does not accept rotational motions of the quarks inside the nucleons). This motion leads to a centrobaric departure of the quarks from each other. Due to this departure on one hand and due to the fact that the emerging mass is distributed uniformly on the outer surface of a sphere with negligible thickness and with radius $\hbar/2mc$, on the other, the increase of this (quantum) radius will result to a decrease of the mass m. So it can be shown easily that when the mass centres of the nucleons are about 2.16 fm apart (c.f. my previous work[1]) which distance is usually considered as the range of nuclear forces in the deuteron, then the quantum radius of the u and d quarks inside the nucleons is approximately equal to the ¼ of the above distance. So the corresponding mass is equal to $m_q = 4\hbar / 2.16 \cdot 10^{-15} c = 6.5142 \cdot 10^{-28} kg = 365 MeV/c^2$ (m_q is the u or d effective quark mass inside nucleons). In the existing literature this effective mass of the u and d quarks is given equal to 363 MeV (c.f. reference 5 e.g.). The coincidence of the last two figures is obvious. So in a nucleon may exist three mini white holes with masses of the order I gave above, but the measurement of these masses can only be achieved if we may supply our suitable equipment with enough energy to penetrate into the nucleons at distances of the order of $\sim 10^{-35}$ m. The performance of a quantum simple harmonic oscillation of the quarks inside the nucleons, as I will explain in detail in C5, permits the mass of the proto-quarks (as I shall call them) to appear very small when the separation of these particles is the biggest possible. The result of this brief exposition is that although practically we cannot employ the necessary huge amount of energy for a straightforward measurement of the mass that emerges from a MWH, its measurability is achieved with an indirect method (i.e. when it appears as a quark mass inside a nucleon). More details about the naked masses of the u and d quarks will be given in C5. I add here that although the mass of the quarks inside the nucleons as well as the mass of the exchanged meson increases with decreasing the distance of the two nucleons separation, we cannot measure this heavier mass since the nucleons present themselves to our measuring devices when they are to their maximum separation distance. Alternatively, we can say that the increase of the nucleons masses when they are close to each other is the one that constitutes the mass of the exchanged zero spin mesons which is a virtual mass. The closer the nucleons come the greater is the exchanged mass.

To close this section I will summarize below briefly the outcomes of this work:

1) There are two and only two more (and heavier) quarks beyond the top quark to which I gave the name “extra” and “high”.
2) There are 24 new zero-spin mesons not yet predicted by other theories or discovered experimentally.
3) There must exist 120 baryons 97 of which wait for their experimental discovery.
4) There must exist 40 negatively charged leptons with 40 neutrinos. The 3 lighter leptons and neutrinos have already been discovered.
5) The first three zero spin mesons of Table III have a mass pretty near to the mass of the hunted Higgs boson at 115 GeV/c^2.

Is there something forgotten after the above investigation?

Yes it is. But I have not found some satisfactory answer up to this moment. We talk about four zero spin mesons, which have not been used, in the above calculations. These are the a_0 (with $m_0 = 948.8$ MeV/c^2), the $\pi(1300)$ (with $m_0 = 1300$ MeV/c^2) , the $a_0(1450)$ (with $m_0 = 1474$ MeV/c^2) and the $\pi 1800$ (with $m_0 = 1801$ MeV/c^2). The reason we did not deal with them was that all the four of them had a quark content of $u\bar{u}, d\bar{d}$. So although their mass is greater than the mass of the $K^{\pm}$ meson, in a way that one may expect that these four mesons may be messengers of repulsive forces between the two nucleons, there is a suspicion that they are excited states of the π^0 meson which is involved in the attractive part of the nuclear potential.

For this reason I leave this problem suspended for the time being, until a new idea may emerge which will permit the explanation of the use of these mesons.

Now I understand that the addition of the two new (and heavier than the top) quarks, which imposes the existence of not only new mesons but also new baryons and new leptons, violates the basis of the standard Model and of the accepted GUT's. The existence of only three generations of quarks and leptons has been established for two reasons: A) From the decay of the Z particle. It was found that Z decays into neutrinos, and the decay rate depends on the number of distinct neutrino species available in nature, so a careful measurement of the rate can be used to deduce the number of neutrinos. The answer came out to be three, which suggests that there are just three generations[*] B) From a mention I found in the Particle Physics Booklet of CERN, where it is written that the number of light neutrino types is three as it is found from a direct measurement of invisible Z width. To both the above deductions I contrast my theory from which it is deduced that the Heavy Z boson may be not the heaviest existing gauge boson that mediates the lepton interactions, so we cannot rely only on the decay modes of this particle to derive the above conclusions about the number of the lepton families. It is natural of course that the presented ideas of mine will encounter a serious polemic from the supporters of the above theories, which theories are supposed to be the best well established ones and generally accepted by the physics community. For this reason I dare to call the people who are involved in elementary particle research to present a better model that will fill the unknown desert between the 10^{-17} and 10^{-34} m. (or 100 and 10^{19} GeV/c^2) with particles, or at least to give an explanation why such a desert has to be completely empty of elementary particle masses.

By saying this, I by no means insist that the presented calculations are the final ones. It is certain that a new theory will be developed which will be based perhaps on non yet discovered mathematics and will find the masses of new particles beyond the up to ~100 GeV/c^2 known ones. But either a simple theory like the one presented above or the most complicated mathematical theory ever to develop, will confront the handicap of their experimental verification, since the required energies will probably be not available for at least the next 1000 or one million years to come. The (semi-empirical) method followed in the above theory may be considered as a basis or a guide for further investigation since it is very probable that somebody else may find better numerical expressions among the a_i's, which will lead to better estimations of the masses of new zero spin mesons. The experimenters too have also a basis to start looking for such masses instead of searching for regions where there are no masses at all. A confirmation of the resulted heavier zero spin meson mass, i.e. that of the *hh* zero spin meson, will come from C5 where the appropriate use of this mass yields results for the theory of inflation in accordance to other inflationary theories.

A! There is something more to be said. In this paper my references are too poor and not updated. The reason is that there are no works similar to this work, to do a comparison with them.

[*]The above argument is used by P. Davies in his book of ref. 11.

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COSMOLOGY 4 (C4)

WHAT IS THE ORIGIN AND NATURE OF THE ELECTRIC CHARGE?

By Nikiforos A. Sideris

Abstract

_*In the brief exposure of a solution to one of the as yet unanswered, though basic, questions in physics, I develop my opinion based on some other works of mine as the reader will soon realize. It is a neat, I hope, answer to the question in the title that does not come in any kind of contradiction with the existing literature on electricity or on elementary particle physics.*

When I decided to be involved with the above subject, I thought that it would be easy to find an answer in certain books on electromagnetism and on elementary particles books too, to avoid "bringing owl in Athens" as the ancient Greeks were characterizing those who were bringing already known ideas. For this reason I shall present what I found in some books that happened to exist in my little bookcase. So the reader will probably not loose time to look him/herself, elsewhere for the same reason since as far as I understood by searching in the books that follow, a neat answer about the origin and nature of the concept "electric charge" is still missing.

So:

1. In the book of William Scott under the title "The Physics of Electricity and Magnetism" 2nd edition, there is no reference about the nature of the electric charge.

2. In the book of Alonso Fin Vol. II under the title: "Fundamental University Physics- Fields and Waves" at p. 439 is written: "In the same way that we characterize the strength of the gravitational interaction by attaching to each body a gravitational mass, we characterize the state of electrification of a body by defining an **electrical mass**, more commonly called **electrical charge** or simply **charge,** represented by the symbol q". (*Note: this answer obviously does not solve the problem*).

3. In the book of John David Jackson, prof. of physics in the "University of Illinois", under the title: "Classical Electrodynamics 1962", no definition of the electric charge is given.

4. In the book of the professors Panofsky and Fillips 2nd edition 1964, under the title: "Classical Electricity and Magnetism" no definition of the electric charge is given.

5. In the book of the professor at the University of Berkley of California, Arthur Kipp under the title: "Fundamentals of Electricity and Magnetism" there is no mention about the nature of electric charge.

6. In the book of Frank Close under the title: "Quarks and the Nature of the Universe" is written at p. 108: "…The simplest explanation is to suppose that electrical charge is some sort of external agent, a property of space perhaps, that is attached to matter in discrete amounts".

7. In the book in Greek under the title "Electricity" of Professor D. Alexopoulos at p. 1 is written: "…Although we do not know the nature of the electric charge we may, non the less, describe the phenomena due to its presence…".

8. In the book in Greek under the title: Magnetism- Electricity- Atomic and Nuclear physics of Alkinoos Mazis (1967) at p. 27 is written: "When a body is electrified we say that this body carries electric charge". (*Note: this phrase could be written inversely too*).

9. In the book under the title: "The Accidental Universe" by Paul Davies is written at p. 12: "…It is found that electric charge is always attached to certain subatomic particles…".

10. Finally in the book under the title "Particle Physics" of Stanley Livingstone at p. 110 is written: "…Electric charge is assumed to be a unique and fundamental property of matter in our theory of Electromagnetism. However no theory has yet been able to explain the origin of electric charge and why it exists. The modern Quantum electrodynamics has removed the inconsistencies of erlier theories of electromagnetism, but it has nothing to say about the origin of charge. .."

I do not think that is necessary to continue this endless reference. The reader who will be not satisfied with the solution of the problem I will present here may search him/herself to find an answer to the posed question. Unfortunately most of my references are about 50 years before the present time and I do not know whether some of the mentioned authors are still alive. I apologize to them wherever they are. As a matter of fact I have several books on particle physics but I have met nowhere a reference about the origin or nature of the electric charge. This fact made me to conclude that in physics prevails complete ignorance on this subject and probably for this reason most physicists do not mention it. Of course one may find in some modern books on electricity a better definition of the concept "electric charge" and its origin. But allow me to doubt about this eventuality. The electric charge is the first and most basic concept that should be known to those who developed the theories of electricity. But from the little catalog of books I mentioned above, it is evident that in the development of electromagnetism by the great minds of the past, this subject was put aside, though its use was repeated in most pages of books or published papers in scientific journals.

For the forty years I work on, basically, unsolved problems of physics, I was exclusively occupied in my free time (from my work as a civil engineer) searching for solutions to such problems, which even up today remain unsolved by the official Physics. For this reason I will give in the ensuing development some of the problems I hope I solved in my works. The solutions of some of them will be used in the present work.

The last problem I decided to deal with, is relative with the origin and nature of the electric charge and I will quote what I found, which satisfies any curiosity, I suppose.

I will start from a result that came from my work(1) in which I solved the following unsolved problems:

a) I found the expression of the central potential of the two nucleons in the deuteron nucleus, which explains not only why the proton and the neutron attract each other, so they constitute this nucleus, but I also found why they repel each other when they come at distances ≤ of 1/2 fermi. In the same paper I determined the white holes metric, about which, quite wrongly the whole of the physics community had the opinion that it is the same with the Schwarzschild black holes metric. This idea was accepted because in the Schwarzschild metric the time element dt appears squared $(dt)^2$. In the Black Hole metric this time element is put dt^2 so in the white hole metric it should be put –dt (since their actions are opposite in time) so that $(-dt)^2 = dt^2$ again. Nobody however, thought that if the two metrics are similar then neither black nor white wholes could exist since one would destroy the action of the other.

In the same work it was determined the maximum mass that could posses any elementary particle in the universe, the minimum possible real length and the minimum real time that can be measured in the 3+1 space, (if the appropriate instruments can be found) et al.

For the solution of this problem became necessary the introduction of a dimensionless, abstract sub-quantum space that is in contact with all points of the 3+1 space we live in, in which the time is imaginary and from which emerged the mass of the inflationary Universe (a tiny part of which is our little universe). Look at references(1) and (2) and at chapter 5 of the present work..

The mass that emerges from this Sub-Quantum Space (SQS)*, (where this space was first introduced in a work of H. Atmanspacher(3) under the name Sub-Quantum Regime (SQR)) is a quantum particle and it is the maximum possible mass as I said above, equal to(1) $5.04378884\ 10^{-9}$ kg. Quite paradoxically however, **from the continuing analysis resulted that when such masses are emerging in our 3+1 space via the white holes process, they emerge by three simultaneously.**

This fact made me think that these emerging by three each time masses, might be the masses of the constituting the nucleons, quarks, which are also connected by three with each other. This thought led to the explanation of the asymptotic freedom and the infrared slavery of quarks inside the nucleons that explains why so big masses when they constitute the nucleons appear so little, they cannot be taken out from the hadrons and to many other things. The above processes will permit to solve the nature of the electric charge.

The data I will start with are the following:

1) The emergence from the Sub Quantum Space (SQS) masses, enter simultaneously in the 3+1 space in groups by three of them. This was shown in my work(1) as I said. But they emerge in regions of **no space**, for reasons I have explained in ref. (2). These regions the only feature they possessed was that if there were a beginning, whatever emerged from the eternal SQS was mater in maximum condensation and time from zero to the order of $\sim 10^{-43}$ sec. The 3+1 space started to be created when the condensation started to be diminished for certain reasons, not be presented here, leaving emptiness in which the continuously appearing masses were returning to the SQS leaving behind a kind of empty bubbles of Planck order of magnitude that consist the empty space we live in. I understand that the realization of the concept "no space" is hard to be grasped by the human mind but it can be understood by a simple definition. Let the minimum possible diameter of the emerging from the SQS spherical "protomasses" at their maximum condensation, be defined as D_{min}. So the in between them space that will have dimensions smaller than this diameter may be called no space. By the acceptance of this definition two things become clear: a) The observed expansion of the universe is not due to stretching of space as General Relativity implies, but to the continuous space creation by the addition of no more materialized Mini White Holes (MWH) as I called them in my work(1). A non materialized MWH leaves behind an empty space bubble and the continuous

* This space is also denoted in previous parts of this book by (SPS) meaning Sub Planckian Space. The two notations are equivqlent.

aggregation of such bubbles constitute the 3+1 space. This idea is developed in my paper[1] and in my book[2] but I will give here the opinion of three distinguished physicists on this subject: So, P.Davies in his book[4] p.202 quotes: *"...The idea of space created might seem exotic, yet in a sense it is happening around us all the time. Expansion of the Universe is nothing but a swelling of apace…".* Also P. Davies and J. Gribbin in another book[5] write: " *Some physicists believe that at the Planck length spacetime breaks up and takes on features more akin to those of a foam than a smooth continuum. In particular, "bubbles" of "virtual" spacetime will form and vanish again in much the same way the virtual particles come and go in the vacuum*". One more reference on the same subject is that of E. Barkin[6]: "*In a typical mathematical treatment of small-scale space-time structure, one may define a discrete topology on a smooth, continuous manifold using a collection of 3-balls with radius of Planck length L_p. For the purposes of the following rather simplified discussion, though, we may as well consider something easier to visualize, a random three dimensional lattice of packed spheres that are L_p in diameter".* For the above quotations, I will do two comments: A) These quotations from distinguished authors, are all on the right way for an explanation of the constitution of what we use to call Space, (but not spacetime, which is a misleading concept as I have explained in two works of mine [7,8]) and of the expansion of the universe which is due to the continuous space creation and not to the stretching of this "unknown" entity called "spacetime" by those who work with the theory o General Relativity. What is missing from the above quotations is the origin of the space bubbles. This gap is covered by my theory about the emergence of space bubbles, which appear through the Mini White Holes process when the density of the emerging masses from the SQS starts to diminish leaving gaps among them so that the emerging masses retrieve back to the SQS leaving behind the empty space bubbles. An extended presentation of all these processes is given in my book[2]. The result is that the picture of space creation is based on more firm grounds and consistency than the above mere speculations by the mentioned authors, who probably rather by intuition are on the right track for an explanation of the nature of empty space. B) The idea that space and time have some **minimum limits** of magnitude is unavoidable. Because otherwise any kind of universe (open, closed, in equilibrium etc.) would be an infinite number of dimensionless points or moments of time something that nobody can accept as an existing reality. This means that space is not a smooth continuum that can be curved or stretched, but a (perhaps infinite) collection of minute space bubbles. A gross example of such a space may be an extended sandy beach. Even the sand grains, if they are melted and coalesce with each other do not constitute any more a "sandy beach" (a **space** in our case) but a piece of glass probably.

2) Taking into account the Principle of the Geometrical Mean (PGM) which is probably one of the most important principles (or laws) of Physics because it finds application in very significant cases (as I will show in Appendix A), I thought that since both the time and the mass that are going to appear in the 3+1 space are imaginary in the SQS i.e. (im) and (it) quantities, this fact cannot be ignored. Indeed in the SQS are taking place various processes in imaginary time that are described in my works[1,2], which cannot be perceptible by our senses or scientific instruments, in the same manner we cannot see a table with dimensions ix, iy, iz. When however the emerging masses (im) became real then they appear simply by m and the time (it) by t. So I put to myself the question: What happened to the imaginary unit (i) that was in front of the m and t when it enters the 3+1 real space?

The definition of the imaginary unit (i) is given by $i = \sqrt{-1}$. Nobody, however, may prevent me to write the above expression as follows:

$$i = \sqrt{(-1) \times (+1)} \qquad (1)$$

Nothing changes. This second expression, however, allows me to say that the imaginary unit is the geometrical mean of the plus and minus real units. Well, then what happens?

Do we throw to the rubbish this fact? Or these numbers +1 and -1 which are, I could say, the determining factors of (i) when this imaginary unit enters in the real space, are finally those, which made us to call ELECTRIC CHARGE, this up to now unknown entity? And why not, since we have positive and negative electric charges. And of course, since these numbers accompany the emerging from the white hole, mass.

The ensuing development will show whether I am right to assert that the electric charge is nothing else but the positive and negative numerical unit into which splits the imaginary unit when it comes out from the SQS. I suppose that somebody may argue that if the unit of the electric charge is nothing but the numbers ±1, this fact is nothing more than a kind of mysticism. This could possibly be true. At this point I think that a comment may be of great interest and everybody must spent a little thinking: What we know about the imaginary unit introduced by the mathematicians to make possible the determination of the square root of (-1) or the solution of the simple equation $x^2 + 1 = 0$. The familiar expression of this solution is $x = \sqrt{-1} = i$. Every body may say: ”I have 1 pencil” and everyone else will understand this phrase. But if you tell: “I have an (i) pencil” this is a meaningless expression. But the basic relation that connects the ±1 real units with the imaginary unit (i) that is used in many branches of physics cannot be ignored. We must not forget that if we use the numerical mean of the above two units we obtain the symbol of “non existence”, since (-1+1)/2 = 0 and zero is the symbol of non existence. In the present work the imaginary unit acquires two physical meanings: A) It is the unit of the Sub-quantum Space and all the processes that occur in this space are expressed in (i) units and B) when something that is expressed in (i) units enters the 3+1 real space we live in, determines the (+) and (-) of a real entity we use to call Electric Charge. A little philosophy sometimes helps to give answers to non solved problems of nature. In my book(2) I used the concept of Probability for the emergence from the SQS of an amount of mass and by its continuous appearance started the creation of the universe. And one cannot forget that the concept of Probability is the **only** concept that does not require another probability for its existence. Also the Probability is also a concept that can be treated in Macrocosmos, in Microcosmos and in the SQS by different but in any case, mathematical methods. It resembles to the concept “Idea” of Plato but this last one cannot be treated mathematically. We must not forget that for everything to come to existence it is required a probability different from zero. I return again to my subject, the electric charge.

3) I also took into account what Steven Weinberg mentions in his book under the title “THE FIRST THREE MINUTES”. Well, he writes at page 7 : “…*The proportions were roughly one proton and one neutron for every thousand millions electrons*…”. And at page 104: “… *There are a small number of nuclear particles at the time of the first frame.* (*note: that is, when the time is defined to the first one hundredth of one second from the beginning (i.e. from t=0)*), *about one proton or neutron for every*

1000 million photons or electrons or neutrinos…". About the mentioned electrons and neutrinos I have basic doubts on the above opinion but I will not discuss this subject here. Naturally one would expect to emerge four triads together to produce the antiprotons and antineutrons. This however is not necessary for the following reason:

The quarks in the nucleons are of two kinds. Either u or d quarks. The triads that can be formed from these two quarks are:

1) uuu

2) ddd

3) uud

4) udd

These are the combinations (the permutations do not play any role in our case) of two things by three). It is obvious that the combination uuu and ddd does not cover the case of the proton and the neutron simultaneously since if e.g. u=1/3 then the proton may be 1 but the neutron cannot be zero whichever the value of $d \neq 0$ is.

So the only combinations that remain for the two nucleons are uud and ddu. But in nature nothing is thrown to any wastepaper basket without a previous examination.

So the four combinations of the u and d quarks are all used in the case of the Δ particle. But for now let us see what we can do with these uud and udd combinations.

If the u and d represent electric charges then must be:

$2u + d = 1$ (proton) and

$2d+u = 0$ (neutron)

Another case is:

$2u+d =0$

$2d+u = 1$

From the first case solving for u and d values, we have:

$u=2/3$

$d=-1/3$

From the second case we obtain the same result by only changing u by d and vice versa. Namely $u=-1/3$ and $d= 2/3$. So it's a matter of simple naming only.

So keeping the already posed name to quarks as it resulted from the Special Unitary(n) group theories, we observe that with the simplest of mathematics and the expression $i = \sqrt{(-1)\times(+1)}$, plus the fact that from my theory[(1)] , the emerging from the SQS masses through the white hole process come out by three together, we find the charges of the u and d quarks but now we know where the electric charges are coming from and what is their meaning. The difference between the present theory of mine and the way the necessity of quarks to be gathered by three to build a nucleon, is due to the fact that to the nucleons has been attributed a spin ½ so that they require at least 3, ½ spin particles for their existence. But this requirement does not exclude the possibility to be constructed by 5, ½ spin particles since then the spin would be a half integer spin particle again. In my derivation it is not the spin that makes the nucleons to be built up by three other particles but the fact that my theory about the mini white holes provided the emergence of three mini white holes to come out from the SQS together each time. The spin of the quarks has also been derived in my book[(2)] by a consideration of the rotation of a hollow sphere with all its mass distributed over its surface and the velocity of rotation at the "equator" of this sphere being equal to the maximum velocity in the universe according to Special Relativity i. e. the velocity of light[*]. For this reason the existence of quarks as the descendants of the mini white holes is based on more solid grounds than the existing theories, which do not explain also the generation of the electric charge. On the other hand the repelling nature of the white holes has been taken into account in my paper[(1)] and has been confronted in this work by the release of part of their masses in the form of radiant energy so that the missing mass develops a constant square well negative potential that holds the three masses in equilibrium when in contact with each other (asymptotic freedom) while when they are pulled away from each other their repulsive force diminishes while the attractive potential remains constant, so that is needed an energy of the order of $6.7\ 10^{17}$ GeV to pull apart the three quarks. So they are in an infrared slavery. This brief exposition is given analytically in my paper[(1)] and ofcourse in the fifth part of the present electronic book..

Now it is obvious that if there are antiquarks too, it is natural to get the antiproton and antineutron putting -u in place of u and -d in place of d. So the 2u+d becomes equal to -1 and the 2d+u becomes equal to (-0=0). So we have:

The proton is 2u+d=1

The neutron is 2d+u=0

The antiproton is –(2u+d) = -1

The antineutron is -(2d+u) = 0

If during the solution of the deuteron potential the condition that the masses emerging from the SQS via the white holes process was not taken into account and if it was unnoticed that $i = \sqrt{(-1)\times(+1)}$ then the above solution would be unattainable. But both presuppositions exist, so the origin and physical nature of the electric charge have been determined. At this point I think that will be useful to present briefly another work of mine developed in my book[(2)] that is related to the present subject and particularly covers the existence of the other quark flavors and gives some new zero spin meson masses as in the (C3).

I hope that the above table may help the experimentalists since they will already know what they are looking for. The findings of the zero spin mesons masses make it reasonable to expect that exist 119 altogether different baryons that wait the experimental determination of their masses. I end this brief exposition in the realm of elementary particles since all the details can be found (among other interesting discoveries in physics and cosmology) in my book[(2)] and in the present electronic edition..

I come now to examine what happens to the antiparticles of the proton and the neutron. According to the previous development, one would expect that as the +1 unit comes out from the SQS by the same way the -1 unit should be passing from the SQS to the 3+1 space building the antiprotons and antineutrons. If something like

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[*] The above determination of the nucleon spin is also described analytically in C5.

this happened, there would be no universe. These antiparticles would pretty soon de-materialize the positively charged particles and the universe would be an eternal furnace. Why this does not happen? I will try to give a probable answer. The +1 is a positive quantity something that means that it represents a positive electric charge and at the same time, an excess of energy that transforms into mass. The -1 however is a negative quantity which must represent a negative electric charge and at the same time a **lack** of energy to transform into a massive particle. That is, something is missing in this case. As it is known when enough energy is concentrated in a small volume it may create a pair of antiparticles. In the case of nucleons and antinucleons, the energy carried by the protons and neutrons is an uninterrupted process that leads to the creation of these particles. On the contrary the creation of their antiparticles is a process that happens occasionally whenever the appropriate amount of energy (in the form of photons) is concentrated in small regions allowing the appearance of antinucleons in the 3+1 space. I hope that the above argumentation covers the up to now unanswered question why our universe is consistent mostly of matter and not antimatter. Closing this discussion I must say that the picture I gave above has some resemblance to the initial proposition of Dirac about the holes in the negative energy sea, but this negative is simply the -1 unit charge that does not emerge in the 3+1 space without the addition of positive energy, whereas the +1 unit emerges by three MWH from the SQS (according to my theory [(1)]) and forms the quarks via the white hole process.

APPENDIX A.

I will give Some examples of the applicability of the Principle or Law of the Geometrical Mean (LGM), to show the importance of this law that permitted, in the present case, the understanding of the concept of electric charge. I wonder whether many people in the physics community have given the due appreciation to the ensuing examples of application of this, to my opinion, so important (and partly inexplicable) law.

I gather some applications of the LGM without details in this section.

<u>a. The Planck length</u>

If the quantum radius is $r_q = \dfrac{\hbar}{2mc}$ and the Schwarzschild radius is $r_s = \dfrac{2Gm}{c^2}$

then:

$$L = \sqrt{r_q \times r_S} = \sqrt{\frac{\hbar}{2mc} \times \frac{2Gm}{c^2}} = \sqrt{\frac{\hbar G}{c^3}} \equiv L^* = PlankLength \cong 1.616 \cdot 10^{-35} m \qquad (1)$$

<u>b. Lengths related in atomic scale</u>

If r_e is the classical radius of the electron and r_B is the first Bohr radius in the hydrogen atom, application of LGM to the above lengths provides a length r_c which is the quantum diameter of the electron or equivalently, the reduced Compton wavelength of it. In fact:

$$r_c = \sqrt{r_e \times r_B} = \sqrt{\frac{e^2}{4\pi\varepsilon_0 m_e c^2} \times \frac{4\pi\varepsilon_0 \hbar^2}{m_e e^2}} = \frac{\hbar}{m_e c} \quad . \qquad (2)$$

<u>c. Relation between microcosmos and megacosmos through the LGM</u>

The Schwarzschild radius of the proton is $r_s = 2Gm_p/c^2$. Its half Compton wavelength is: $r_p = h/2m_pc$. From these two marginal lengths which both are defined as functions of the proton rest mass, we may construct a new length D by applying again the LGM as follows:

$$r_p^2 = R_s D \text{ from which we obtain: } D = \frac{r_p^2}{R_s} = \frac{h^2}{8Gm_p} = 1.7578 \times 10^{23} m = 5.68 \text{ Mpc} \qquad (3)$$

According to observations by Abell and Zwicky[9] the diameters of clusters of galaxies are between 2 and 10 Mpc. Thus D as obtained above, may be considered as an average diameter of clusters of Galaxies.

d. The golden ratio:

If we consider a length AB and a point C in between A and B then if AC<BC we may define through LGM the relation:

$$(BC)^2 = AC \times AB \text{ or equivalently: } \frac{BC}{AC} = \frac{AB}{BC} \qquad (4)$$

Relation (4) defines the so called Golden Ratio, which from the times of ancient Greeks was considered as possessing aesthetic and even mystical meaning.

e. Lengths relative to Earth and Sun connected through the LGM.

The average diameter of the Earth is equal to: $D_E = 1.274\ 10^7$ m.

“ “ “ “ “ Sun “ “ “ : $D_S = 1.391\ 10^9$ m

“ “ Earth – Sun distance “ “ “ : $R_{ES} = 1.4961\ 10^{11}$ m

If we apply the LGM to the above first and third important lengths we find the following relation:

$$R_{13}=(D_E \times R_{ES})^{1/2} = 1.381\ 10^9 \text{ m} \qquad (5)$$

We observe that R_{13} coincides with an approximation of 0.7% with the average present diameter of the Sun D_S. For the other planets R_{13} differs significantly from D_S. We must not forget that the diameter of the sun given above is an average quantity

Is it an accidental coincidence that the only planet for which the LGM gives meaningful results, is the one where intelligent life or simply life in general developed, as far as we know it today or this coincidence is in fact a necessary (but not sufficient) condition for the development of intelligent life or, as I said, simply life on a planet? I advise the astronomers to search for inhabited planets that are at the earth-sun distance in other planetary systems

f. The value of the velocity of light is given by:

$$c = \sqrt{\frac{1}{\varepsilon_0} \times \frac{1}{\mu_0}} \qquad (6)$$

g. Even John Gribbin and Martin Rees in their book[10] express their appreciation to the Geometrical Mean Law (or Rule) and write: *The size of a human being is the geometric mean of the size of a planet and the size of an atom;* Also *the size of a planet is the geometrical mean of an atom and the size of the Universe.*

h. For the two “spaces” connection I gave the appropriate example in the foregoing development.

I suppose that after the above examples, it is not so easy to say that the LGM is one of the laws of nature that can be ignored.

CONCLUSION:

I think that whatever I had to say is already said about the origin and nature of the electric charge. After the electronic presentation of this little but basic work I would be much obliged to any reader if he/she has to indicate to me where I can find a better explanation for the origin and nature of this charge. I really want to learn about the origin of this so common “quantity” we meet lots of times in various writings. But what is more important beyond the above success is that once again the idea of the existence of the Sub-Quantum Space or Sub-Quantum Regime or Sub-Planckian Space is confirmed from the present work as well as from other works of mine in cosmology, elementary particles et al. Look in the following references [(1), (2)]. At this point I must say that the creation of electrons and electron neutrinos is a secondary process that takes place immediately after the formation of the nucleons as I have shown in my book[(2)] and in the next (C5).

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COSMOLOGY 5 (C5)
WHAT HAPPENED TILL THE END OF INFLATION

Abstract
In Cosmology 2 (C2) I dealt with the fate of the mass of a star, which has collapsed under its own gravity and has ended in a Black Hole (BH) formation. My subject was the investigation of the happenings in the interior of this BH and particularly, what is the fate of this mass when it is inside the event horizon. The results of my calculations were gathered in Table I of C2 and the most striking outcome was the existence of a limit for the volume into which the total mass of the BH ends up, however big this mass might be (although there is a limit for the mass that can be incorporated in this marginal volume as I shall show in the ensuing development). This limit of volume is a sphere concentric with the event horizon, of radius R = 4167.4 m, which is greater for masses smaller than the probable mass of the observable Universe[*]*. The existence of the above limit made me to think that since all the acceptable nowadays cosmological models start with the Big Bang model i.e. with the existence of a (nearly) zero time in the life of the observable universe, the total mass that appeared in the very beginning from somewhere (about which see Cosmology 1 (C1)) although it was not a single White Hole (WH) but an assembly of Mini White Holes (MWH), would necessarily occupy the above limiting volume after certain transformations. In fact this mass underwent certain transformations for the acquisition of electric charge, spin and other properties that characterize the elementary particles we know. So from the first appearance of the MWHs, the total mass that emerged simultaneously from the Sub-Planckian Space (SPS) required a certain time to be transformed for the formation of the basic known elementary particles. All the details will be given in the ensuing development of the subject. As a corollary, the existence of a limiting volume in the case of mass that collapses in the interior of a Schwarzschild BH, will play a basic role too, when matter is gushing from the SPS. So the existence of the limiting volume and mass in the newly created Universe is a good point to start with. On the basis of the above thoughts, I shall investigate in the ensuing development the problem of the first moments of the Universe after the 1.1631835 10^{-43} seconds, i.e. when the real time started to run.*

Key words: Real time, Mini White Holes, Protoquarks, Paraquarks, Quarks, Discrimination Principle, Color, Asymptotic Freedom, Infrared Slavery, Law of Geometrical Mean, Inflation, Fractal structure, Big- Bang, Little universes, Big Universe.

1. INTRODUCTION

This introduction will be a little lengthy and perhaps tedious for the reader because I shall try to explain how it is possible, from an abstract space to emerge a

[*] As a matter of fact, from Table I of C2 it is inferred that the radius at which the collapsing matter stops, presents some small variations with the mass of the star, i.e. from 3 Sun masses the radius increases with increasing mass up to ~2000 Sun masses and after that it decreases until it reaches the referred limit of ~4167.4 m. This is most probably due to the form of the nuclear potential that contains one repulsive and one attractive term, which at certain distances of interaction, have different influence on the strength of the potential.

real Universe. How is possible, the creation of matter and time to precede the creation of space, as we perceive it now. How is possible, the emerging from a MWH matter, to acquire the basic characteristic features we have attached to the known elementary particles (electric charge, spin, flavors et al.). How is possible, the newly created Universe, to start expansion either in an inflationary mode or in the more modest Big Bang way. For this reason in this introduction I shall develop a scenario of how all the above miracles may have happened and in the following sections I shall introduce the necessary calculations to support my model.

In my previous works(1,2) I postulated the appearance of an amount of mass through the process of a MWH and I calculated this amount equal to m_x = 5.0437884 10^{-9} kg = 2.829358 10^{18} GeV/c^2. I also calculated the mass defect m_r = 3.979578 10^{-10} kg = 2.2323797 10^{17} GeV/c^2 of the mass m_x, that is needed to counterbalance the repulsive force between **three** MWHs and keep them tightly in contact with each other. This amount of energy m_rc^2 is released under the form of radiation, which is enough to produce particles and antiparticles of mass ≤ ~2.23 10^{17} GeV/c^2. In this previous paper(1) I first had taken as an experimental fact that the number of quarks inside the baryons is three, and because for other reasons I connected the emerging from the Sub Planckian Space (SPS), MWHs, with the quarks, I proceeded to my calculations on this basis. But in Appendix C of the same paper I had shown that the MWHs must emerge in groups of three each time, in order to transfer one bit of information from the SPS to the real quantum world*. So my initial hypothesis (based on the experimental data for the quarks) was proved correct. The three MWHs, as they appear in the quantum level, have to be arranged for symmetry reasons at the corners of an equilateral triangle so that the separations of their mass centers are equal. On the other hand, since space had not yet been created, as I shall show further on, the emerging groups of three MWHs, had to be in a close packed assembly and as such I have chosen the Face-Centered Cubic (Fcc) system which presents the maximum packing fraction equal to $\pi\sqrt{2}/6$. In this system each particle has 12 nearest neighbors which all are apart from each other and from the central one the same distance equal to $a/\sqrt{2}$, where (a) is the length of the edge of the cubic lattice. So they form a three-dimensional network of equilateral triangles i.e. the best to accommodate the appearing MWHs, which are in the corners of equilateral triangles. I conclude therefore that the grouping of the quarks by three to constitute all baryons is due to the initial close packed system of their generators i.e. of the MWHs and to the way they emerge from the SPS. This explanation could be given even before the introduction of the quarks as constituents of the hadrons (and in the case under discussion, of the baryons, since for the hadronic mesons I shall talk later on). This is an a priori and not an a posteriori explanation, never being mentioned in the literature of the quarks theories. And as I have pointed out elsewhere(1), this mechanism explains the asymptotic freedom and the infrared slavery of the quarks, which according to P.Davies(4) p.127, *constitutes a major theoretical challenge if we try to*

* For the reader who possibly has no access to the above paper, I say that to arrive at the above argument, I used an idea presented in a paper by H. Atmanspacher(3), according to which the transfer of one bit, i.e. of the minimum amount of information, from a sub-quantum level to the quantum level, an amount of energy ΔE that corresponds to an amount of mass equal to 1.088 10^{-8} kg, is needed. I had, however, already defined in the main text that the amount of mass that emerges from the SPS through the process of a MWH is equal to 5.0437884 10^{-9} kg.. To attain the 1 bit, 2.176 MWHs at least are necessary. Since the above number must be an integer, the nearest to the number 2.176 integer is 3 since it cannot be less than the needed 2.176. So I concluded that each time three MWHs emerge together.

understand the quark confinement in terms of gauge field theory. My approach to this problem is the simplest explanation that can be given and follows the same process of nucleons inside nuclei when they give part of their mass to confront the repulsive electrical forces between the protons. Once the acquisition by the MWHs, of their close packed state and the avoidance of their dispersion as free particles away from each other, is satisfied, the next step is the continuation of their transformations. Now it is time to show that most of the basic features of the MWHs are hidden in a latent state in the SPS and they present themselves as soon as the above amount of matter emerges from the SPS.

The emergence of the MWHs from the SPS started at the 1.1631835 10^{-43} sec. (which time is the zero real time of the creation of the Universe). From C2 I concluded that the least volume, in which the collapsing mass in the interior of a Black Hole can be squeezed, has a marginal radius equal to 4167.4 m. So this volume will also be used in what follows, as a start point for the initiation of the inflationary period, before which however, a milder expansion took place. The MWHs were repelling each other as I proved in my previous work(1). If they were left alone (i.e. without any combination with each other) the repulsion would remove them apart so that no Universe as we know it would have been created. Perhaps this situation would result in a real unimaginable explosion, but no protons, electrons, neutrons, photons etc would ever appear. The next solution would be the grouping of the MWHs and as I showed above this really happened.

For the sake of completeness I shall give a brief description of how Quantum Chromodynamics (QCD) explains the existence of three quarks in baryons.

A simple description of how this happens, in plain words, is given in ref. (5) p.p. 62,107. But in this description, it is taken for granted that the baryons have half-integral spin and mesons have integral spin. It is also used the experimental knowledge that the Δ^{++} baryon has electric charge 2, the Δ^{+} has electric charge 1, the Δ^{0} has electric charge 0 and the Δ^{-} has electric charge –1. Since the baryons have half integral (1/2, 3/2….) spin and since they cannot be a two quark system, because then their spin would be 0 or an integer, the simplest possibility for baryons is a three quark system. I shall not repeat here the arguments presented in the mentioned book(5), because all these arguments come from our experimental knowledge about the spin and the charge of baryons and leptons, so that the quark flavors and the later introduced concept of colors were adjusted to satisfy this preexisting knowledge (by the introduction of the QCD). Since the main feature of my cosmological model is based on the acceptance that all the basic properties of matter were hidden in the SPS as potentialities, I shall try to extract as much information as possible from this fact.

Suppose that the appearing MWHs carry with them the hidden property, coming from the relation of the geometrical mean expression*: $i^2 = (+1) \times (-1)$ of the plus and minus (or positive and negative) unit, which is interpreted in the real world as the two forms the electric charge exhibits**, so they are neutral in the beginning. When they have materialized, however, they had to exhibit their (+) and (-) electric nature. Apart from that, they also should exhibit the two different kinds of motion: translational and rotational. The former, however, could not be developed since space had not yet been created. The appearing MWHs were in a close packed system that did not permit the existence of empty space between them. So only the performance of the latter motion was permitted. The above two requirements, i.e. the appearance of

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* About the importance of the LGM I have already given very charactreristic examples in (C4) p. 75

** I have already explained in (C4) why the (+) and (-) is attributed to electric charge and not to matter – antimatter. On this point I shall return later on in the present part (5).

electric charge and spin, could be achieved simultaneously by a procedure I shall describe bellow. Apart from the above two basic features that the MWHs had to acquire, there is also another one, which will explain that they are subject to the Pauli Exclusion Principle, because otherwise the existence of the Δ^{++} baryon would be unattainable.

As it is known, the introduction of color in the quark theories was imposed by two reasons: a) To avoid violation of the Pauli Exclusion Principle in the case of quarks inside baryons and b) To find a way for an explanation of the forces that hold the quarks tightly confined inside the baryons. So, the developers of the QCD attributed to each one color, the concept of a new charge, which plays the same role (but much more complicated) as the electric charge in QED. The above two requirements, may be anticipated by my theory in a much simpler way, which permits the explanation of the quark forces without the introduction of so many new concepts as the gluons, the color charges, gauge invariance, etc. as well as so much more difficult mathematical treatment. To the first requirement I shall present a new concept that can substitute the Pauli Exclusion Principle quite satisfactorily. Such concepts (or principles) are sometimes introduced in physics as the general requirements of nature to satisfy certain basic laws. As an example I quote the following sentence from P. Davies[(4)] again, p.126: "…*From the stand point of QCD the strong force is nothing more than* **Nature's insistence on maintaining an abstract symmetry,** *in this case all hadrons remain white even when internal color changes occur*…". The bold words, (differentiated by me) give us the right to express an idea in a similar manner, i.e. as a requirement imposed by Nature as though Nature is a kind of a person. This idea has as follows:

Nature, among other things, **needs** (and not **insists**) the application of a concept for a better functioning of its laws, which may be called **discrimination.** Discrimination is a property closely related with the Pauli Exclusion Principle and with Entropy too. So the fact that the former imposes that no two fermions in a quantum system can exist in the same quantum state can be interpreted as a partial application of the principle of discrimination. This is so because according to discrimination, no two quarks (which have spin ½ as we shall show later on) can have the same quantum numbers in a hadron or two electrons in the same quantum state in an atom. On the other hand, if there is no discrimination at all (in space and time) among all the entities of the Universe, entropy is a maximum and vice versa. Discrimination produces the differences in nature, i.e. it liberates an evolving nature from uniformity, which is a static concept if applied in general. **Evolution,** i.e. development in time, occurs only in systems whose composite members are in a kind of conflict or differentiation among each other (compare with the Heraclitus "war is the father of everything"). Following therefore my basic rule that the basic features of the real quantum world, are hidden in a latent state in the abstract space of probability, I may assert that the abstract concept of discrimination was also residing in this space and this can be expressed in the real quantum level by an attachment to the quarks of the three colors used by the QCD, which colors, however, have nothing to do with the forces that bind the MWHs and finally the quarks, inside the hadrons. The strong forces between the MWHs and between the quarks have found a very clear interpretation in the new repulsive force field I introduced (the fifth field of nature) due to the new metric I found that governs the case of the MWHs. I do not need any more of the concept of gluons, broken symmetries, and colors to explain the forces that keep the quarks tightly arranged inside the hadrons. My theory, therefore, proves that QCD is a phenomenological theory for the explanation of the real inter-quark and in extension, of nuclear forces.

Let us return now to expose the way the MWHs are eventually transformed to quarks.

After the release of the amount of mass m_r from each MWH, the mass of it reduces to $m_x – m_r$. Due to the reduction of this mass, the quantum radius of the MWH increases and becomes equal to $r_a = \hbar /2(m_x – m_r)c = 3.7858455\ 10^{-35}$ m. The lifetime of this new mass is equal to r_a / c = 1.2628221 10^{-43} sec. This is the first transformation of the MWHs after their appearance in the quantum level as particles, which can be characterized as a proto-quark state*, since they are the ancestors (or progenitors) of quarks, as I shall show further on. The increase of the radius by the above amount, results in a departure of the mass centers of these proto-quarks (PQS1) from each other. This however, cannot be manifested as a translational motion of these mass centers, because it does not take place in a background of empty space, since space had not yet been created.

Now these pre-particles to be transformed completely into quarks, must acquire:

1) Electric charge and
2) Spin

For the time being I postpone the question of what kind of quarks the MWHs will end up.

About the electric charge the question I had to put, by accepting the above idea, was how the positive and negative unit would appear in the quantum level (apart from their pure mathematical meaning). One choice was that it appears under the form of matter and antimatter and the second choice was under the form of (+) and (-) electric charge. Since there was no up to that time explanation of the origin of the electric charge in nature, this property remained for me mysterious. Yes, we know almost everything about the behavior of electric charges, electric fields, electric potentials electric current and so on, but we have the slightest idea of how electric charge came into existence in the first place and what is its essence. In (C4) I believe that I gave a satisfactory answer about the nature and origin of the electric charge in a fundamental level. So the Idea in the sense of the Platonic philosophy, of both matter and electric charge, can be accommodated in the SPS in the form of a potentiality and is manifested in our space under the above names. I think that we have no other alternatives about the origin of matter and electric charge, since if we not accept them in the way I described previously, any alternative hypothesis for their nature is only the labels “MATTER” and “ELECTRIC CHARGE” attached to two otherwise inconceivable entities. About the appearance of antimatter I shall talk again later on.

For the electric charge I may say: so far so good. But in our 3+1 dimensional space there is one more characteristic, which does not exist in the SPS. This is the concept of “motion”. If the reader remember, in C1 I replaced the spatial variable of the one-dimensional Klein-Gordon (or relativistic Schrödinger’s equation) by the wave function $\Psi(t_i)$ which determines the probability $P(t_i)$ as a function of the imaginary time $t_i = it$. When the probability for matter creation has fulfilled its objective purpose and the Potentialities become realities under the name of matter and electric charge, it is quite reasonable to expect that the Klein-Gordon equation must return to its well known representation, i.e. to its four-dimensional form, time included. So the spatial dimensions are introduced and the real time starts running. Since time is running only when changes occur in a system that contains everything, i.e. in a Universe,

* For reasons that will be explained further on, this state will be called Proto-Quark State 1 (PQS1)

whichever this Universe may be, these changes can only be manifested as motions of any kind. Sometimes we may think that nothing changes if we cannot observe this change. This macroscopic idea is certainly wrong, since as it is known, motions of any kind take place in the quantum level continuously, either as a result of existing forces or as the result of the Uncertainty Principle, which does not permit the simultaneous measurement of position and momentum with absolute accuracy. From this principle we may infer that if the momentum of a particle (so its velocity) is measured with absolute accuracy, i.e. if $\Delta p = 0$, its position is absolutely uncertain i.e. the particle at any moment can be anywhere which may be translated that it can move from one position to another instantaneously. If again its position is measured with absolute accuracy in a frame of reference, its momentum (so its velocity) can take any value $\neq 0$ so the particle is obliged to move.

The motions in space are of two basic kinds: translational motions (of any kind) and rotational motions. Any other motion may be performed by a composition of the two basic ones. So the existence of real space and time guaranties the generation of the motion of matter either in a macroscopic or in a microscopic level and vice versa. D.C.Atkins(6) writes that according to P. Erhrenfest, the number of possible rotational motions is equal to the number of translational motions (three in each case). The same author (Atkins) in his book gives certain arguments, why the number of spatial dimensions must be 3, neither 2 nor 4 (or more). Let us see, however, if it is possible to give a more solid cause for which the spatial dimensions are 3.

As it is known, the three-ness of the spatial dimensions is supported a posteriori, because our examination of the case of 2 or 4 dimensions leads to unacceptable results about the possibility of existence of matter or stable matter in 2 or 4 dimensions respectively. A simple exposition of the above conclusions is given by Atkins(6), Hawking(7) et al. In C1 I characterized the SPS as an abstract (so dimensionless) space in which the probability for the appearance of matter through a MWH process is developed. The question that is raised is HOW and WHY from an abstract space emerges a Universe which is characterized by 3 spatial and 1 temporal dimension plus its matter-energy content in the first place. If we can answer this question, then any other follows as e.g. why the laws of physics or the basic physical constants are the ones they are and not some different ones. Let us see what answer can be given to the above question.

As I said in C1, for everything to "exist", a probability different from zero is necessary. The word "exist", apart from its usual meaning that everything to exist must be in or refer to space and time, can be extended not only for the content of the Universe in a frame determined by the three spatial dimensions and the dimension of time, but also for an existence of space and time themselves. I think that it is a general acceptance that before the zero time, neither space, nor time, nor Universe existed. It was however something that existed independently of the above concepts and this was the probability for the appearance of a Universe, as we know it. And as I proved in C1, this probability could exist in the SPS and could develop in a strict mathematical way. When the science of Cosmology puts such questions of How and Why this Universe came into existence, many times has turned to find an eternal entity that can create Universes (Creator), only by expressing its (or His) will. About this entity, no one has the slightest idea of how He is, how He looks like, how He works, where He was or He is (before and after the creation of the Universe) etc. So the existence of a Creator of the universe is guessed for two basic reasons. First from the up to now incapability of the physical sciences to give an acceptable logical explanation of how and why this universe came into existence and second, from the inability of man from his first steps on earth, to understand the causes of the physical phenomena he observed, so he attributed them to some higher power that finally took the general name God. So as long as there will be inexplicable phenomena in nature, man will ascribe them to God and as a guide he/she will use his/hers faith. On this subject I cannot say anything more since it is outside the purpose of this paper. The only thing I must say, however, is that the supporters of the so called Anthropic Principle who, among other things, believe that this Universe exists as we observe it, because it has being created just to be observed by the human beings, should, at least, take into account the possibility of existence of other beings, like or unlike us, in other parts of the Universe, that may claim the same thing, i.e. that the Universe was created for them to observe it and so giving existence to it. One thing is however certain. As we said before, for everything to exist in space and time or even out of space and time a probability different from zero is required. So the question that is automatically raised is the following: Is the Creator the one who governs the development of probabilities for the creation of universes, or even the Creator needs a probability different from zero as a presupposition of His existence? I leave the reader think on that. The only I can say, as far as I can think of, is that the only concept that has no need of a probability to exist, is simply the Probability itself. So this concept is eternal and has the ability to create anything, from space and time, to Universes of any kind, to Man (and perhaps similar entities in other planets) and to a beautiful rose, by changing its value in the abstract SPS where it develops in a strict mathematical formalism as I described in C1. If we can realize this simple idea then the understanding of everything else will become easier.

Accepting the above idea, it becomes easier to show that the space created by the concept of probability, has to be a 3-dimensional one. According to C1, a MWH, when it emerges as a particle (in not yet preexisting space) has a definite shape. In my previous work(1), I suggested that a MWH appears in the form of a sphere with its total mass distributed over its outermost spherical surface and I had explained the reason. Because some readers may have not easy access to this work of mine, I shall repeat the reason here.

The emerging from a MWH mass is the quantum of this mechanism. So if we consider that this mass starts from the central singularity of the MWH (which is only an instantaneous singularity, something that does not hold for the black holes) then it cannot occupy, as it expands, the whole volume from the center of the MWH up to the radius $r_q = 3.4871365\ 10^{-35}$ m. because in this case there is no mechanism to prevent the continuous emission of this mass, something that would lead to the formation of huge White Holes. Such monstrous entities could be created continuously even today in our near neighborhood, but this, thank God, does not occur. In contrast, if the whole mass is distributed uniformly on the surface of the swelling sphere, this guaranties the quantum character of this process, for which, by the way, I used the Uncertainty Principle when I studied it.

Now, since we have accepted the spherical form of the appearing mass, and since a sphere is an original geometrical shape, which presents an extraordinary amount of symmetry among all other possible symmetric geometrical structures*, we have to take into account that a sphere extends in three spatial dimensions. So we may

* We must not forget that all points on the surface of the sphere are at the same distance from the center of symmetry of this three-dimensional shape, something that holds solely for the sphere.

infer that the three-ness of space has originated too from the SPS where it was hidden in the form of an abstract symmetry. Here is Plato again.

We are now in a position to do some mathematical calculations of how the announced transformations of the MWHs were performed.

2. SOME CALCULATIONS

Before saying anything else, I must explain to the reader, that my cosmological model in this first course of six papers, is dealing with the period of time from the 0_i time when the probability for the creation of the Universe started to develop in the SPS as it was described in C1, up to the time when the inflation of the primitive Universe came to an end and the Universe started to grow according to the Big Bang theory. In a new course I hope to present some ideas concerning the creation of stars, galaxies etc. and particularly I shall try to cover some points of the existing theories, which may differ from my basic model.

The period that will be covered first is between the 1.1631835 10^{-43} sec. till the time when the inflation started. Then I shall develop my theory from the start, up to the end of the inflation and with this I shall close this first course

In the beginning of this paper, I explained how the transformations of the initial MWHs started and I used the outcome from my previous paper(1) about the necessary amount of energy to keep 3 MWH grouped together. As I explained in the above paper of mine, since the MWH exert repulsive forces between each other, the only way to keep 3 of them tightly connected when they are at their closest approach, is at the expense of a part of their rest mass. This idea solves once and for all the problem of asymptotic freedom and the infrared slavery of quarks inside the nucleons.

From Table I of Cosmology 2 (C2) it is evident that there is a limit for the volume into which the collapsing mass is squeezed inside a BH irrespective of the amount of this mass. This limit is a sphere with radius ~4.1674 10^{3} m. The basic role in our equations for the collapsing mass in the interior of a BH is played by the "radius" of the neutrons as they are squeezed during the collapse. This radius is half the average distance between their mass centers. In Cosmology 3 (C3) I have found that two nucleons cannot approach each other at distances less than 1.0863986 10^{-27} m and at the same time keep their nucleon character. At this distance their interaction takes place by the exchange of the heaviest zero spin meson which has a mass equal to 1.2305662 10^{12} GeV/c^2 according to my calculations. This meson may or may not be the heaviest Higgs boson and its formation required the introduction of two new quark flavors to which I gave the name "extra" and "high". The reason that this zero spin meson may be a Higgs particle is the following: The lightest zero spin meson I found in C3 (beyond the known ones) had a mass equal to 114.76 MeV/c^2, which is pretty close to the experimentally hunted lightest Higgs boson of ~115 MeV/c^2. If there exist scalar Higgs particles with zero spin, I thought that all the zero spin mesons in Table III of C3 (or some of them) could very probably be Higgs particles. Which ones may play the role of Higgs particles (if any) cannot be inferred from my work. I simply state that the calculated masses are undoubtedly zero spin mesons and if the masses of some of them can be verified by the experimenters, it is their duty and of the theoreticians too, to decide whether these particles are Higgs bosons or not. There is also another possibility, that the zero spin mesons of Table III in C3 acquire their mass from Higgs particles of the same mass. The heaviest zero spin meson (or Higgs boson) consists of a combination of a high and an anti-high quark. The details about the introduction of two more quark flavors are presented in the referred work of mine C3. For the exchange of this meson (the highonium as I called it) the two nucleons (neutrons in our case) must come at the above referred distance of the 1.0863986 10^{-27} m. It is therefore natural to assert that this exchange takes place when the neutrons have reached the maximum permissible compression in the interior of the BH, being in a tightly packed assembly, since we could not find a heavier zero spin meson to mediate the repulsive force between the nucleons. So I shall examine how many neutrons can be accommodated in the sphere of radius 4167.4 m with packing fraction $\pi\sqrt{2}/6$. This number is obviously given by:

$$A = \frac{4167.4^3}{(1.0863986 \cdot 10^{-27}/2)^3} \frac{\pi\sqrt{2}}{6} = 3.3437328 \cdot 10^{92} \text{neutrons} \quad (1)$$

So the A such particles have a mass equal to:

M_{tot} = 3.3437328 10^{92} × 1.6749271 10^{-27} = 5.6. 10^{65} kg (2)

where 1.6749271 10^{-27} kg is the neutron rest mass.

The Schwarzschild radius that corresponds to the above mass is equal to:

$R_{sinfl} = 2GM_{tot} / c^2$ = 8.3158391 10^{38} m. (3)

At this point I ask the permission of the reader to accept a brief “intermezzo” in the course of the development of the main subject of this book, and allow me to tell a little story.

In a physics conference where I was participating with a presentation of mine, a very distinguished and respectable professor of physics had a speech (after a special invitation by the organizers of the conference), about the current developments in physics and cosmology. When he finished his speech he asked if there were any questions, as it is usually done in such cases. Among other people who asked various things, I asked the permission to put a question. My question was the following: “ As it is generally accepted, the prevailing theory for the creation of the universe is the Big Bang type creation and not the Steady State Theory. So the total mass of the universe appeared only once and most probably in a very short time and occupied a tiny volume with tremendous density. To this colossal amount of mass corresponded a Schwarzschild radius of the order of about 10^{26} m or so, according to the well known expression of this radius*. If the expansion of the universe reaches to the above radius what will happen? Will it be reflected back so that it will start contracting or it will find a mechanism to penetrate through the above event horizon?”. The profound answer I got was the following: ‘things are not so’. And nothing else. So a word to the wise is enough. No further comments from me. Although however I did not get an answer I tried to search myself for an answer. The data are given. The initially appeared amount of mass of the universe remains the same since continuous creation of matter is not acceptable. So the Event Horizon of this mass remains constant. The initial volume occupied by this mass according to the official cosmology was very small. Space was curved according to General Relativity and this curvature decreases resulting to an increase of the dimensions of the universe. This is usually called the stretching of space. The question is: what will happen when these dimensions (the cosmic radius as is usually called) will become equal to the initial Schwazschild radius? Will the expansion continue? I think that I have an answer that explains what will happen. But I will not give it now. I leave it as a conandrum for the reader. To help the reader I will give one only information. When the expansion reaches the initial event horizon the density of the matter in the universe remains constant but the

* This mass corresponds approximately to our visible universe, according to the up to now estimations. The total mass however that appeared from the SPS is of the order given in relation (2) above.

expansion continues. Think on it. The answer is easy but the complete answer is difficult.

Returning again to the development of my main subject, I must distinguish three time sub-intervals in the first stages of the history of the Universe. The first sub-interval starts from the imaginary time zero (0_i) up to the time 1.1631835 10^{-43} sec. During this period the time was imaginary, i.e. not measurable, and the above figure determines the moment at which the real time started to count[*] The meaning of an imaginary time needs a little discussion. This time in C1 was taken axiomatically as the time of an abstract space, which space was identified with the Sub-Planckian space i.e with a space that is the limit of the 3-dimensional space we live in, downwards. The imaginary time was denoted by $t_i \equiv it$, t being the real time. The possible processes that took place during that time have been described in C1. For this reason I called the time of 1.1631835 10^{-43} sec the real zero (0), which has the meaning that it represents the second zero of time, which separates the imaginary time from the real time when the real processes start. The imaginary time, therefore, has the characteristics of time in the sense that any kinds of processes that take place either in the real or the imaginary time require duration different from zero to occur. But t_i cannot be measured or even be conceived by us in the same way that we cannot notice a chair, which extends in three imaginary directions ix, iy, iz. So whatever happens in the above abstract space has no temporal duration for the beings, which are outside of this space. This is a very important property of the imaginary time, because if we could one way or another intrude in this space, it would be possible to send messages from one point of the real space to another instantaneously, for two reasons: 1) Because for us the imaginary time is non-countable so that whichever is the duration for the transmission of this message in this abstract space, this duration does not exist, i.e. is zero for us and 2) Because, since this space is the limit of the 3d-space downwards at any point, it is as though it extends as a substratum everywhere of the 3d-space.

The second time sub-interval starts from (0) up to the initiation of the inflation. During this period a first stage of expansion takes place, but not an inflationary expansion. This period lasted only for the time necessary to the appearing MWHs to acquire electric charge and spin. Then a third sub-interval follows until the initial triads (i.e. the groups of MWHs by three) started to expand until they attained the dimensions of the neutrons at their maximum squeeze inside the sphere of 4167.4 m. This process also cannot be characterized as inflation. As soon as the gathering of the total mass of the universe reached the concentration in the referred critical volume of radius 4167.4 m, the tremendous inflation started which lasted until the radius of the Big Universe[**] became equal to the Schwarzschild radius given in relation (3). All these stages will be discussed in detailed immediately below.

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[*] A question may be raised here: For us who observe the Universe and we study the laws that govern this unimaginable structure, which is the so-called zero time? The time at which the universe came into existence with the laws that accompany this existence, or the zero time inside a MWH when the probability for the appearance of an amount of mass started to develop in the abstract Sub-Planckian Space from a zero value to the value 1, as I analytically described in C1? To get out of the above dilemma I shall denote the former by a simple zero 0, and the latter by the 0_i , where the subscript i denotes that this zero refers to the imaginary time of the Sub-Planckian Space. **Counting however backward in time from any later epoch our clock will stop counting at the indication of 1.1631835 10^{-43} sec**. Thus the only way to understand this is that the clock stoped running since it was adjusted to count real and not imaginary time.

[**] From now on the inflating Universe will be called Big, to distinguish it from its parts that constitute universes like our own observable universe, as will be explained further on.

I have already shown that a) The MWH started emerging from the SPS with their predicted rest mass as in our previous work[1] and necessarily in groups by three of them, as I also explained in the foregoing discussion and in ref. (1). b) The appearance of these MWHs in an as yet non-existing space, as we understand our three-dimensional space we live in, theoretically should have no restrictions in either their number or in the time they appeared. So there could have appeared an infinite number of them simultaneously. But taking into account the results of my C2, the total number of neutrons that can be accommodated in a sphere with radius of 4167,4 m when a non infinite amount of mass may collapse in a Black Hole, is found equal to $3.347328\ 10^{92}$ neutrons as in eq. (1). Since the neutrons consist of 3 quarks and since the MWHs are considered by my theory[1] as the progenitors of the quarks, the number of the MWHs that emerged simultaneously from the SPS and materialized, i.e. they acquired a certain amount of mass, must be equal to $3 \times 3.347328\ 10^{92} \cong 10^{93}$ proto-quarks (PQS1). Since they gave up an amount of mass equal to: $m_r = 3.979578\ 10^{-10}$ kg each, in order to remain in contact by three, their mass became equal to:
$m_x - m_r = 4.67583\ 10^{-9}$ kg. This mass, therefore, had to be used in order to complete the next tasks, i.e. the acquisition of electric charge and spin first. This could be achieved simultaneously as follows:

For the above two processes we shall present a brief description which has a remote resemblance to the case of nuclear fission. As it is known, unstable nuclei may undergo spontaneous or stimulated fission, which partly may be explained by use of the liquid drop model of nuclei. What here matters is that by complete fission, an initially spherical nucleus follows some deformations, which finally lead to the formation of two spherical and lighter nuclei (fig 1).

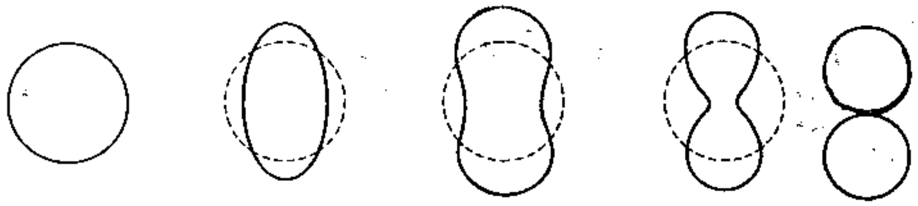

Fig.1

We suggest a similar process by which a spherical MWH after certain deformations concludes to the formation of two lighter spheres with equal radii in contact with each other. Of course the causes of this process are completely different from those of nuclear fission. In this last case the basic role is played by the balance of the electrostatic (Coulomb) repulsion of the protons and the surface tension of the nucleus. In the MWHs the reason that each one of them has to split into two parts is the already referred need for the acquisition by the MWHs of electric charge and spin, something that was hidden in a latent state in the SPS. The necessity for the existence in the real quantum world of two opposing tendencies in the emerging matter, are characterized as positive and negative electric charge, for the reasons we discussed in the previous development. Similarly the need for the existence in the real world of rotational motion led to the development of spin, which also can appear in two different helicities. As it is known, particles of half-integral spin may be placed in two different categories. Those with mass different from zero, although they possess the property of left or right-handedness, they do not conserve this property, which depends on the velocity between them and the observer. This means that for them this property is not Lorentz invariant. Those, however, that have a zero rest mass (so they can always travel at the velocity of light, conserve their helicity (as in the case of neutrinos). This fact, however, does not deprive the fermions from presenting two and

only two ways they can "rotate" along the direction of their motion. Whether they conserve or not their helicity is immaterial for our theory, which examines the spin as due to a rotational property of the particles. So when the MWHs had been grouped by three, each one of them started the predescribed deformations until they were split in two equal spheres in contact with each other. At this moment it was easy for both of them to acquire electric charge and spin. Since the total electric charge and the total angular momentum in the newly emerged Universe were zero, one of the two spheres attained a (+) electric charge and the other a (-) electric charge. By the same way, in one sphere the spin was heading up and in the other down, something that is differently translated as right and left helicity of the two spheres which started rotating tangentially one to the right and the other to the left, i.e. in opposite directions.
The acquisition of charge and rotation required an amount of energy to be spent. The only available source of energy was again the rest energy of the MWHs equal to $(m_x - m_r)c^2$.
Let us calculate the energy for the acquisition of electric charge and spin of each one of the two spheres in which the initial MWH was split.

A. The Electric Charge

Let Q be the electric charge attached to each one of the spheres. Since the surface of the sphere is impenetrable from outside to inside, due an almost infinite density of the mass which, as I said before, was distributed uniformly on the surface of the MWH with negligible thickness, we may suggest that the electric charge was distributed uniformly out of the surface of the sphere with a thickness $d = r_e - r_0$, where r_e is the external radius of the sphere up to which the charge was distributed and r_0 is the radius of each one of the new impenetrable spheres as in fig.2 below.
The electrostatic energy required to build a spherical charge distributed uniformly throughout the volume of a spherical shell of thickness $d = r_e - r_0$, can be easily found and this is done in Appendix I. The result is:

$$E_e = \frac{3Q^2}{40\pi\varepsilon_0}\frac{2r_e^5 - 5r_e^2 r_0^3 + 3r_0^5}{(r_e^3 - r_0^3)^2} \tag{7}$$

This energy must be provided, as I said above by the rest energy $E_t = (m_x - m_r)c^2$.
But here we must distinguish between the case of a neutron and that of a proton. The motive for the above distinction between protons and neutrons, was raised from S. Weinberg suggestion[(8)] p.124 that: "…*the universe probably started with equal numbers of neutrons and protons, not pure neutrons*…".
We shall refer again to fig. 2.

1) The neutron case:

In this case, after the split of the three proto-quarks, we have 2 new particles with charge 1/3, two with charge –1/3 and two with charge +2/3 and –2/3 respectively[*]. For the six particles to acquire the above electric charges, they need energy, according to eq. (7), which will be provided by the rest mass of the three protoquarks. We suppose that the radius r_0 will be the same for all the six new particles and also the radius r_e for the same reason. So what will be different is the fraction $A = 3Q^2/40\pi\varepsilon_0$. So for 4 of the new particles with $Q = \pm 1/3$ it will be: $A_1 = e^2 / 30\,\pi\varepsilon_0$.

[*] The requirement that the electric charges must be +e and –e was imposed by convention, before the introduction of fractional charges for the quarks. Since the electric charge, according to my theory, is coming from the condition $i^2 = (+1) \times (-1)$, and since the MWH appear in groups of three, it is reasonable to ascribe ±1/3 and ±2/3 electronic charges to the protoquarks, as we called them.

For the two particles with Q = ±2/3 it will be: $A_2 = e^2 / 15\pi\varepsilon_0$

So the total energy for the fulfillment of the requirement for acquisition of electric charge for the 6 new particles is:

$$E_n = \frac{e^2}{10\pi\varepsilon_0} \frac{2r_e^5 - 5r_e^2 r_0^3 + 3r_0^5}{(r_e^3 - r_0^3)^2} \tag{8}$$

2) The proton case:

By similar as above, considerations, we obtain for the proton:

$$E_p = \frac{3e^2}{20\pi\varepsilon_0} \frac{2r_e^5 - 5r_e^2 r_0^3 + 3r_0^5}{(r_e^3 - r_0^3)^2} \tag{9}$$

B. The Spin

As it is known, the quarks and the electrons (and all fermions) have a half-integral intrinsic angular momentum (Spin) in units of ħ. So the sphere, which remained grouped with the two others and is, according to my theory, the progenitor of quarks that have spin ½, has to have also spin ½. Conservation of angular momentum in this very early Universe requires the total angular momentum of this Universe (which angular momentum at this stage is solely represented by spin since translational motion had not yet started) to be equal to zero. So the other (partner) sphere (which from now on will be called "paraquark") has to have also spin ½ and rotation in the opposite direction to the first one (fig. 2)

The half-integral spin with opposite helicities might also be the result of the principle of discrimination we developed in the foregoing discussion, since this is in accordance to the Pauli Exclusion Principle.

Let us find the energy required for one of the spheres to start spinning.

If m_0 is the rotating rest mass of the newly created particle, I_0 its moment of inertia about the axis of rotation and r_0 the radius of the sphere, then for a hollow sphere as the one under consideration, we have:

$$I_0 = m_0 r_0 \tag{10}$$

Since the particle is a quantum mechanical object, it will attain a quantum radius:

$$r_0 = \hbar / 2m_0 c \tag{11}$$

If now ω is the constant angular velocity of the rotating particle it will be:

$$\omega = c / r_0 \tag{12}$$

Since the maximum tangential velocity at the equator of the sphere has to be a maximum (in the poles it is zero) and the only such maximum is the velocity of light c in a so much fundamental level, it is reasonable to expect that the velocity v = c. So by use of 9,10,11 relations it is inferred that the angular momentum of the rotating particle will be equal to:

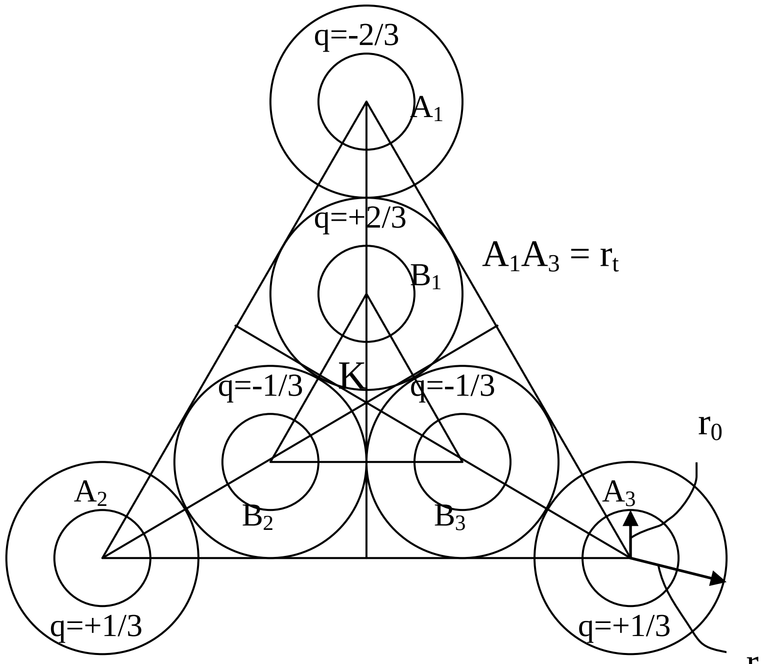
q=-2/3
A1
q=+2/3
B1
A1A3 = rt
K
q=-1/3
q=-1/3
r0
A2
B2
B3
A3
q=+1/3
q=+1/3
re

Fig. 2a

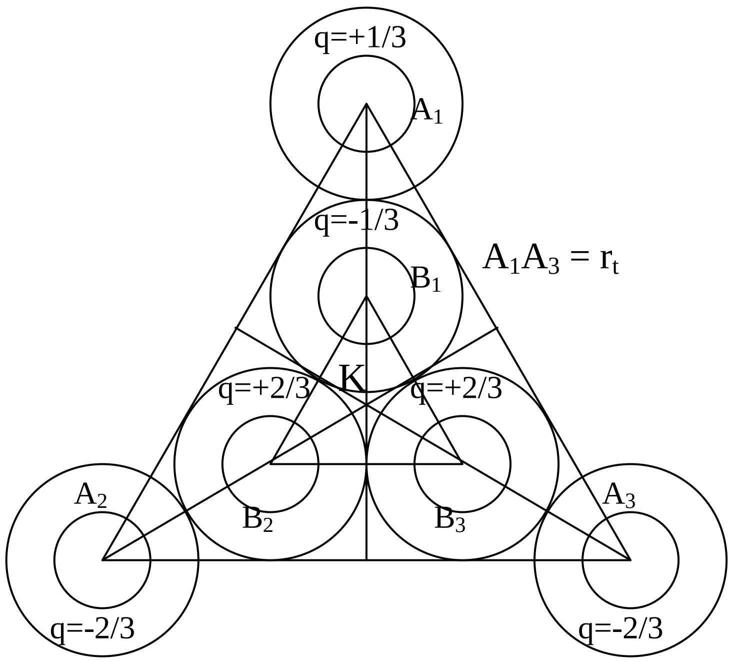
q=+1/3
A1
q=-1/3
B1
A1A3 = rt
K
q=+2/3
q=+2/3
A2
B2
B3
A3
q=-2/3
q=-2/3

Fig. 2b

$J = I_0\, \omega = \hbar / 2$ (13)
i.e. the well-known value of spin for all fermions. It has to be emphasized that among the various possible distributions of the mass of a sphere (solid sphere with uniform or radially varying density et al) a hollow sphere with its mass distributed over its surface is the only one that gives the correct value of spin. So once more seems that our initial hypothesis about the distribution of mass in the case of an emerging MWH[(1)], leads to the right choice for the spin of the quarks.
We may now determine the kinetic energy of the rotating particle, which will be equal to:
$E_s = ½\, I_0\, \omega^2 = ½\, m_0\, c^2$ and for the 6 particles it will be $6E_s = 3m_0\, c^2$ (14)
The above energy must also be supplied by the rest energy E_t of the initial particle (before splitting in two).

C. Separation of the three external particles from the central triad.

We need next to separate the two newly created proto-quarks, since they have equal and opposite electric charges, so they are attracted towards each other. Their closest approach happened just at the time of their formation when the two spheres were in contact with each other i.e. at a distance $2r_e$ between their mass centers, where r_e is the radius of the outer surface of the charge distribution as defined in relation (7). The amount of energy to be supplied is given by Coulomb's Law applied between an external particle (the paraquark) and the rest particles present in the triad (the proto-quarks) fig. 2. Here we must do two different calculations, one for the case that the final central triad will end up in a neutron and another case that it will end up in a proton*. So the situation is the one presented in fig. 2a and 2b. If someone comments that we have to do with more than two particles, so the problem is unsolvable, we explain that our intention is not to find the future evolution of six particles that interact with each other via electric forces, but to have an instantaneous picture and estimation of the energies required to counterbalance the electrostatic energies developed between the three exterior particles (paraquarks) between the central triad and also between each other. The calculation is rather trivial and for this reason I shall give the final results. So in the case of a proton (as a final state of the central triad) the existing total potential energy is equal to: $P_p = \frac{-e^2}{4\pi\varepsilon_0 r_3}$ and in the case of the neutron is equal to $P_n = \frac{-e^2}{12\pi\varepsilon_0 r_t}$. These two (attractive) potential energies must be nullified by an equal amount of kinetic energy for the 3 paraquarks so that they will momentarily be free of the attractive (or repulsive) forces that act upon them. As it is to be expected, the above energies will again be supplied by the only existing rest energy equal to 3 $(m_x – m_r)c^2$. Finally from the same source, the rest masses of the 6 new particles must develop. So we conclude to the following energy balance equations:
For a neutron:

* According to the general opinion (e.g. from ref (8)) the numbers of protons and neutrons were equal in the first stages of the Big Bang.

$E_n + 6m_0\, c^2 + 3\, m_0\, c^2 = 3\,(m_x - m_r)c^2 - P_n$ (15)

For a proton:

$E_p + 6m_0\, c^2 + 3\, m_0\, c^2 = 3\,(m_x - m_r)c^2 - P_p$ (16)

a) In the above equations the unknowns are five: The electric charge Q that however has been taken equal to -1/3 or 2/3 as the case may be. The radius r_0, which is given by relation (11). The distance r_3, which by a consideration of fig. 2 is found equal to: $r_3 = 2(1 + 1/\sqrt{3})r_e$ and by a similar consideration the distance r_t is found equal to: $2(1+\sqrt{3})r_e$. So we are left with only two unknowns: The rest mass m_0 and the radius r_e. In the absence of another condition to reduce the unknowns to only one, we resorted to a condition that may look arbitrary at first glance, but has a certain basis rising from a rule or law which although inexplicable till now, seems to govern many domains of physics and astronomy. This rule, or law called Law of Geometrical Mean (LGM), is stated by the general relation: z^2 = x. . y, where z, x, y, are any three numbers. z is the geometrical mean of x and y. I have already given some examples of the application of LGM in C4.

I could refer to many more applications I have discovered, of the LGM, but they are in other fields of science (c.f. ref. (9), so we restrict our references to the above 7 cases, which are very characteristics and apply to both microcosmos and megacosmos.

I thought that there are some similarities between the atomic structure and the structure indicated in fig. 2. In both cases we have a central core (or nucleus) surrounded by certain peripheral particles, which in the case of the atom are the electrons and in fig.2 are the three paraquarks that surround the central core that is supposed to end up in a proton or a neutron. This similarity may be attributed to a fractal structure in this quantum level, where small structures imitate big structures and vice versa. In the system of Fig.2 we may distinguish three basic lengths. One is the radius r_0 as defined above. The other is the radius r_e up to which extends the electric charge distribution and the third is the radius r_3, which defines the distance between the mass center of the core and of any one of the 3 surrounding particles. Since $r_0 < r_e < r_3$ it is reasonable to chose the radius r_e as the GM of the other two lengths. In this case we have:

$$r_e^2 = r_0 \times r_3 = \frac{\hbar}{2m_0 c} \times 2(1 + \frac{1}{\sqrt{3}})r_e \qquad (17)$$

from which we obtain:

$$r_e = (r_0 \times r_3)^{1/2} = \frac{\hbar}{m_0 c} \times (1 + \frac{1}{\sqrt{3}}) \qquad (18)$$

So the only unknown in eqs (15) and (16) is the m_0. These eqs can be solved numerically and the obtained results are the following:

In the neutron case:

m_0 = 1.547933347 10^{-9} kg = 8.68327 10^{17} GeV/c^2

r_0 = 1.136247956 10^{-34} m

r_e = 3.584522204 10^{-34} m

r_3 = 1.130809360 10^{-33} m (19)

r_t = 1.958619266 10^{-33} m

a_8 = 2.450645408 10^{14} GeV
m_{en} = 3.172115958 10^{15} GeV/c^2
In the proton case:
m_0 = 1.547415906 10^{-9} kg = 8.6803675 10^{17} GeV/c^2
r_0 = 1.136627906 10^{-34} m
r_e = 3.585720668 10^{-34} m
r_3 = 1.131187492 10^{-33} m (20)
r_t = 1.959274209 10^{-33} m
a_8 = 1.272967704 10^{15} GeV
m_{ep} = 4.75658338 10^{15} GeV/c^2
(I have kept only 9 from the 14 decimal digits given by the computer program).
From the above results we may derive some very important conclusions:
1) The maximum electrostatic interaction length is the r_t in the proton case. Since the electromagnetic interactions are transmitted at the velocity of light c, we may determine the time taken for the achievement of all the above transformations. This time $T_1 = r_t / c$ = 6.5354352 10^{-42} sec.
2) To my opinion, the most important (and unexpected) outcome of the above calculations is the a_8 parameter. It represents the necessary energy released from the mass ($m_x - m_r$), which is the unique source for all the pre-described transformations, in order to counterbalance the electrostatic attraction or repulsion between the various external particles of fig. 2. This amount of energy is just the right one for the creation of the alleged super-heavy X and Y gauge bosons, introduced by the SU(5) model of the GUTs to maintain the larger gauge symmetry, which mixes quarks with leptons. And this energy of 10^{14} up to 10^{15} GeV is the one at which the unification of the electroweak and nuclear forces occurs (obviously this energy scale is a threshold energy for the unification of the three different kinds of forces; so above this energy they are not distinguished among each other). We give below some estimations of the mass of these particles from the existing literature.
a) In J.E.Dodd[(10)] p. 162: The value of the mass of the X bosons is about 10^{15} GeV. As this author says: "…*At energies well above 10^{15}GeV all gauge bosons (including the Xs) can be produced freely and all forces are apparent. Qquarks transform into leptons as easily as they change colors. At about 10^{15}GeV energy the SU(5) symmetry breaks down to separate SU(3) and SU(2)×U(1) symmetries and the grand unified force separates into the strong color force and the electroweak force, whilst the 'new' quark-lepton transforming force becomes unimportant…*
b) In Ta-Pei Cheng and Ling-Fong Li[(11)] p. 441, the mass of the X gauge boson is given equal to: $M_X \simeq 4\ 10^{14}$*GeV.* And at p. 473 is referred that: *"…In the SU(5) model, we have $M_X >\sim 10^{14}$ GeV which implies a very heavy monopole mass ~10^{16} GeV…".*
c) In P. Davies[(4)] p. 133, it is mensioned: *"… Using the best available estimates for the half-life of the proton and working backwards, the mass of the X comes out at about 10^{14} proton masses…"* and further on: "…*The X exists, remember, for the minute duration, only while it is being exchanged between quarks, which happen to brush very close to each other…".*
d) In H.Fritzsch[(5)] p.195: "…(above 10^{15} GeV) *Only one type of unified interaction is observed. Even the difference between leptons and quarks disappears- they are manifestations of one and the same type of underlying basic fermion…".*
We must also not forget that the mass m_r released initially by each MWH to form a triad with two more such MWHs, as it was calculated in our previous work [(1)], was found equal to 3.979578 10^{-10} kg ≅ 2.23 10^{17} GeV/c^2, enough for the production of the

alleged magnetic monopoles of mass $\sim 10^{16}$ GeV/c^2, if such monopoles were finally formed.
But, behold, the coincidence of the obtained results after the solution of the above equations, with the scale of masses at which the grand unification occurs, do not stop only at the a_8 outcome. The m_{en} and m_{ep} masses correspond to the energy E_e spent to accumulate the electric charge around the protoquarks and paraquarks cores, in the case of proto-protons and proto-neutrons. So to a proto-proton and a proto-electron the amount of mass-energy that is attached to them in order to acquire an electric charge +e and –e respectively is 4.75688338 10^{15} /2 = 2.3784416 10^{15} GeV/c^2. In the case of a proto-neutron and a proto-neutrino the corresponding energy-masses are equal to: 1.5860579 10^{15} GeV/c^2.

I really wonder if there exist another so simple theory which provides the same results, which otherwise are extracted in rather dubious ways from the extremely more complicated theories of GUTs. And something more. The tantalizing question whether the electron rest mass is totally of electromagnetic origin or partially inertial and partially electromagnetic receives a final answer that the last case is the right one.
Of course the reader may reasonably ask: Is it not premature to identify the proto-protons with the protons and the proto-electrons with the electrons and similarly the proto-neutrons with the neutrons and the proto-neutrinos with the neutrinos which are the basic constituents of matter we know today, before explaining how this happens?
One more question that may be raised is the following: Since the neutron and the neutrinos are electrically neutral, why is it necessary to spend energy in order to finally acquiring a zero electric charge? As it is known, although the neutron does not posses a net electric charge, its internal structure out of three charged quarks on one hand and its magnetic moment on the other, guaranties its connection with electromagnetism. For the neutrino, although its mass is still under question whether is zero or a very tiny one, the performed experiments on this subject, give only upper limits for its mass and its magnetic moment (c.f. data in the 2000 Blue Particle Booklet of CERN). So an answer to the second question imposed to my theory could provide, at least in principle, a basis to the electron problem i.e. whether it is a point-like particle or it possesses an internal structure and whether its mass nature is mechanical or electromagnetic or a mixture of them. As I said above, the proto-electron is a particle with the basic characteristics of the electron (mass, spin) but with a tremendous rest mass compared to that of the electron. But in a much milder manner, the same problem has not found a solution in the case of the muon and the τ lepton. Both have everything similar to the electron except from their mass that is mach heavier than that of the electron. Our proposal about the formation of the proto-electron in the very first stages of the Universe, and the conclusion of the results of C3 where we postulated the existence of a variety of leptons composed by more elementary entities we called γ_x particles, where x stands for all existing quark flavors (8 flavors according to my theory instead of the known 6 ones) may help for a solution in the case of the lepton mystery. Of course such a solution can only be achieved if we can find how the proto-particles (protons, neutrons, electrons, neutrinos) are transformed to the same particles without the prefix “proto”. I shall try to find an answer, in my usual simple mathematical way, but somebody else upon keeping the basic idea, could probably work a more sophisticated solution in the framework of the GUTs.

D. Investigation about the way the primordial proto-particles transformed to ordinary elementary particles such as protons, neutrons, electrons and neutrinos.

I could continue giving more estimations for the mass and the role played by the X, Y, bosons, but all existing theories agree on this subject and the above quotations are enough to indicate that my calculations have provided similar and perhaps more accurate values for the mass of these bosons. My theory, however, besides its lack of more powerfull mathematics, reveals one more point that is of uttermost importance but requires extensive investigation, something that is out of the subject of the present work. From (a) to (d) quotations (and in all existing theories, I suppose) it is believed that the X, Y bosons mediate the transformations between quarks and leptons, so that these two distinct categories of elementary particles at low energies, are indistinguishable at energies above 10^{14} or 10^{15} GeV. In COSMOLOGY 3 (C3), I asserted that leptons too, may be composite particles out of three more fundamental ones, I called γ_x particles, where the subscript x corresponds to the quark flavors, u, d, s….. My theory for the way the Universe came into existence imposed the necessity for electric charge and spin acquisition of the appearing from the SPS Mini White Holes. This requirement and the necessity of a three-dimensional space, led me to the formation of the pre-described triads with the release of the three peripheral particles that have the opposite properties to those of the proto-quarks and for this reason I called them paraquarks. So the situation at the moment when the above transformations came to an end is the following:

We have an equal number of triads, which eventually will end up to an equal number of protons and neutrons. Attached to each one triad are three paraquarks in a state of just touching the corresponding protoquarks of the triad, which by the addition of the slightest kinetic energy may escape away from the triad. We also have the very high energies of the radiation that has been released by the pre-described transformations. We have therefore a “soup” that contains all the basic ingredients for the ensuing transformations. But now a new factor enters the arena. The MWHs at the moment of their simultaneous appearance, had a diameter of $2r_q = 6.974273\ 10^{-35}$ m, as I have determined it in my previous paper(1). Due to the non-existence of space they were arranged in a close packed assembly of equal spheres, as I have already said and all of them occupied a spherical volume of radius ~$3.86\ 10^{-4}$ m*. But now the diameter of the proto-quarks is equal to $2r_e = 7.17\ 10^{-34}$ m on the average for the neutron and proton case, which is about 10 times greater than the $2r_q$. So the empty spaces left between the spheres of the protoquarks and paraquarks, could be filled up by the continuously appearing MWHs. Now, however, the situation was not the same as in the first time. The new appearing MWHs had not to be accumulated in a non-existing space. So since the situation was different, we suggest that their mass returned back inside, most probably in the interior of their quantum radius, leaving, however, behind massless spheres with dimensions they had at their appearance. These tiny empty spheres are, to my opinion, the basic components or units of our 3-dimensional space. Their continuous creation or not, about we shall talk further on in detail, is recognized macroscopically as the expansion of space. So no stretching or curvature of space is necessary for the explanation of the observed expansion. Of course is reasonable for someone to ask: Since space is expanding everywhere, from the very little to the very big dimensions, why this expansion is not noticed in ordinary terrestrial distances. The reason is simple. Things (elementary particles or massive bodies) do not follow the expansion of space at short distances, because electromagnetic, nuclear or even gravitational forces prevent the removal of these objects from their positions. At

* This number comes from the relation: $x = 3.487136\ 10^{-35}\ (3 \times 3.347328\ 10^{92})^{1/3}\ (6/\pi\ 2^{1/2})^{1/3} = 3.8599\ 10^{-4}$ m.

astronomical distances, however, where the only practically existing force is gravitation, the big astronomical objects (mainly clusters of galaxies) are continuously separated from each other thanks to this continuous creation of space, since their mutual gravitational attractions are very feeble.
To the above picture I will return later, but it is worth noticing that this picture of space creation is not so novel as it appears. Other people have suggested such a grainy picture of space. So: P.Davies[(4)] p. 202 quotes: "…*The idea of space created might seem exotic, yet in a sense it is happening around us all the time. The expansion of the Universe is nothing but a continual swelling of space…".* Davies and J. Gribbin[(12)] p. 157, also refer: "…*Some physicists believe that at the Planck length spacetime breaks up and takes on features more akin to those of a foam than a smooth continuum. In particular, 'bubbles' of 'virtual' spacetime will form and vanish again in much the same way the virtual particles come and go in the vacuum*…". One more reference on the same subject is that of E. Barkin[(13)]: "…*In a typical mathematical treatment of small-scale space-time structure, one may define a discrete topology on a smooth, continuous manifold using a collection of 3-balls with radius of Planck length L_p. For the purposes of the following rather simplified discussion, though, we may as well consider something easier to visualize, a random three dimensional lattice of packed spheres that are L_p in diameter…".*

My picture of space creation is based on more firm grounds and consistency than the above mere speculations by distinguished authors, who probably rather by intuition are on the right track for an explanation of the nature of empty space. In Appendix 2 the reader may find a rather picturesque comparison of space with a sandy desert.

Let, however, return to the exposition of the happenings after the 6.5354352 10^{-42} sec, when the three-dimensional space as we know it started to exist.

The copious appearance of the MWHs after the above time (which from then on were becoming space bubbles) on one hand and the high energy content of the Universe on the other, it is naturally expected to help the separation of the triads from their surrounding paraquarks. So the thinning out of the universal content, gave rise to the initiation of various interactions between the ingredients of the universe. According to the already presented picture of the formation of, say, the proto-protons and proto-neutrons, the outer three paraquarks in each case were: From a proto-proton 2 paraquarks with charge -2/3 and one paraquark with charge +1/3. From a proto-neutron 2 paraquarks with charge –1/3 and one paraquark with charge +2/3. These particles were pretty close to each other in the primordial space so that their electric charges and the color they had been endowed at the moment of their formation were exactly the right ones for them to be united in new triads which had the following characteristics: The triads coming from a proto-proton had electric charge –e, spin ½ and mass equal to that of the proto-protons. Those coming from a proto-neutron had electric charge 0 spin ½ and mass that of the proto-neutrons. As a result of these new formations, the conservation of electric charge in the Big Universe was not violated, since the final components of this stage were an equal number of proto-protons, of proto-neutrons and fermions with charge –1 which will be called from now on proto-electrons and particles with charge 0 which will be called from now on proto-neutrinos. The rest mass of the proto-electron is equal to that of the proto-proton and the rest mass of the proto-neutrino is equal to that of the proto-neutron. Up to this point we have given the unique explanation of the neutrality of the Universe as a whole. It is worth to quote at this point Steven Weinberg's words for the neutrality of the Universe[(8)] p. 97: "…*the fact that the universe has no electric charge tells us*

immediately that there is now **precisely** (the emphasis is mine) *one negatively charged electron for each positively charged proton*…”. From the above sentence an immediate question is raised: Who measured or ordered the exact number of protons and electrons in a universe for which we are not yet certain whether it is finite or infinite and deduced the above exact equality? Or what mechanism made possible this equality? And even more, how such exact equality can be achieved since the protons are composite particles out of three more elementary ones (the quarks) whereas the electrons are considered as point-like particles without some internal structure? But the same author in p. 7 of the same book writes: “…*The proportions were roughly one proton and one neutron for every thousand million* ***electrons*** *(the emphasis is again mine) or positrons or neutrinos or photons*…”. The questions are again pressing: If the number of positrons were equal to the number of electrons then the protons (after the annihilation of the electron – positron pairs) would add an overwhelming amount of positive charge in the Universe and the charge conservation would be violated. If again the electrons and the protons constituted hydrogen atoms, then the positrons would remain the basic constituents of the Universe. What can someone believe from the above controversial quotations? I think that my theory provides the unique answer and the unique mechanism that avoids the above complications. Since the three particles that surround the triads which are the proto-protons have the exact opposite electric charges to the ones of the proto-quarks in the triad, and since from what we described earlier, were just free to disconnect from their neighboring proto-quarks, they could meet by three to constitute the electrons (from the proto-protons) and the neutrinos (from the proto-neutrons). If we accept this simple idea, the electric charge is conserved globally (it is zero in fact). Of course any proposition that gives answers in existing problems carries in it the possibility to impose new problems.
I shall present three basic ones.

a. Which is the force that kept tightly packed together the three paraquarks that formed the electrons and neutrinos?
b. What happened to the colossal mass they were carrying along with them (the m_0), from the solution of eqs. (15) and (16)?
c. Why the neutrinos are overwhelmingly more than the basic particles of ordinary matter (protons, neutrons and electrons)?

I shall try to make a few speculations only, on these subjects since a detailed exposition of the solution is still missing and may be the subject of extended studies for elementary particle physicists. What will be said for the leptons holds for the baryons too.

The escaped from the triad, particles, are supposed to possess electric charge, spin, and a big inertial mass m_0. They rather were not subject to the forces, which held the particles in the triad, as I determined them in my previous paper(1). The only reason that they might carry color is that color conservation requires the existence of anti-colors for the three colors of the particles in the triad. Although the color in my theory is not responsible for the interquark forces, it is a property (a new quantum number) imposed by the principle of **discrimination**, as it was stated earlier, which property made the quarks to obey the Pauli exclusion principle. For the baryons, the existence of the Δ^{++} particle imposed the introduction of color in baryons and more generally in hadrons. In the case of leptons, from what it is known up to now, is that all known leptons decay finally to electrons and electron neutrinos or heavier neutrinos. The existence, however, of the heavier leptons and neutrinos than the electron and the electron neutrino, has baffled the particle physicists. The situation is absolutely clear with my present theory and I immediately explain why:

In C3 I calculated the rest masses of zero spin mesons beyond the experimentally known ones. From this calculation I found that there exist much heavier zero spin mesons than the known ones. The (theoretically) predicted mesons imposed the introduction of two more quark flavors, beyond the six known from the GUTs. This fact led me to the reasonable conclusion that if there exist new, not yet discovered zero spin mesons, it is also absolutely reasonable to expect the existence of new baryons and in accordance with what is said up to now, there must exist new composite leptons too much heavier than the τ lepton and of the electron of course. The problem of the composition of the electron has detained distinguished physicists a long time ago (Poincaré, Dirac, Wheeler, Feynman, Bopp et al) especially if its mass is totally electromagnetic in nature or it also possesses inertial mass.

The situation in my case may be described briefly as follows:

The proto-protons have a rest inertial mass equal to 1.547415906 10^{-9} kg plus a mass of electromagnetic origin equal to E_p / c^2 = 8.479379163 10^{-12} kg = 4.75658338 10^{15} GeV/c^2. The proto-neutrons too, have a rest inertial mass equal to 1.547933347 10^{-9} kg plus an electromagnetic mass equal to 5.65480972 10^{-12} kg = 3.172115958 10^{15} GeV/c^2. The first thing I may notice is that the above electromagnetic masses are of the same order of magnitude as the masses released during the separation of the original MWHs in two equal parts in their predetermined course to acquire electric charge and spin. What I have not said, though it is self evident, is that the protoquarks are themselves elementary particles, perhaps the most elementary ones. So they must be subject to the laws of Quantum Mechanics, and certainly to the most basic law known as Uncertainty (or indeterminacy) Principle. Thanks to this law, their position and momentum could not be determined with absolute accuracy simultaneously; the more precisely is determined one of them the less accurate is becoming the determination of the other. The protoquarks are confined by three to form a proto-proton and a proto-neutron as I have shown in the foregoing development. Before the appearance of the space bubbles, as I also described above, they had no space to move so that their momentum was zero and their position was absolutely definite. This situation, however, that may be said to be the unique one at which the Uncertainty Principle was violated, was instantaneous and never happened since then. As space was created in a flooding manner by the accumulation of space bubbles, the obedience to the Uncertainty Principle would make the protoquarks to perform a translational motion within the limits of the existing forces that have been already explained and as a result of the application upon them of the uncertainty principle. The simplest such motion would be that of a simple quantum harmonic oscillator, for each one protoquark. The solution of the motion of this oscillator with application of Schrödinger's equation yields the energy of it equal to $E_n = (n+1/2)\hbar\omega$ which means that even in its ground state (n = 0) the harmonic oscillator has not a zero energy but its energy is equal to $\hbar\omega/2$. When each protoquark performs this harmonic motion being confined in the triad, this motion has a result that the three particles come to the closest possible approach and to the maximum departure with each other, periodically. Since their confinement requires that they must all the time be in contact with each other, their separation is measured between their mass centers. So it is as though this kind of motion may be translated as a continuous inflation (swelling) and deflation of them (we must not forget that their inertial mass is distributed on the surface of a sphere, as I have already explained). Being quantum mechanical particles, their quantum radius is given by the known expression $r_q = \hbar / 2m_0c$. Since the only variable in the above expression is the rest mass m_0 this means that when r_q increases m_0 decreases and vice versa. So as the density of the surrounding space decreases thanks to the addition of more and more space bubbles, the amplitude of oscillation increases and the protoquark mass decreases. If we want to measure the mass of the protoquarks, the closer we penetrate to do our measurement, the heavier their mass will be found. This penetration requires the expense of an amount of energy, which in the case of deep penetration may be of the order of 10^{16} GeV or more, something unattainable of course with our measuring devices (accelerators – particle colliders) which may provide only 100 or 200 GeV for the time being. Even 1000 GeV would be utterly inadequate compared with the 10^{16}. Let us therefore see what this oscillation brings in.

The ground state energy (n=0) for a simple (linear) quantum mechanical harmonic oscillator is given by: $E_0 = \hbar\omega/2 = hf/2 = h / 2T_0$, where T_0 is the period of oscillation. Let r_u and r_d the amplitude of oscillation for the u and d quarks respectively. (I thus accept that the proto-quark mass centers undergo simple harmonic oscillatory motion inside the nucleons). Let us think a scenario how the radii of the proto-quarks increase. This is the inevitable result of the two terms I put above. These terms allow the mass centers of the particles to depart from each other as they perform the oscillatory motion, on one hand and on the other their surfaces on which their mass is distributed, should remain in contact thanks to the strong potential I described in my previous work[1] (usually mentioned as infrared slavery). So the increase of their dimensions has as a result the decrease of their mass. The time required by their mass centers to cross the distances r_u and r_d , provided that the velocity v of oscillation in both directions will be equal, will be equal to $t_u = r_u/v$ and $t_d = r_d /v$. Then the period of oscillation will be respectively $T_u = 2t_u$ and $T_d = 2t_d$. The corresponding frequencies will be: $f_u = 1/T_u = 1/ 2t_u = v/ 2r_u$ and $f_d = v / 2r_d$. The ground state energy will then be equal to: $E_u = h/ 4t_u$ and $E_d = h/4t_d$. If we divide the last two equations with each other we obtain:

$$\frac{E_u}{E_d} = \frac{t_d}{t_u} = \frac{r_d}{r_u} \tag{21}$$

and if we replace the E_u and E_d by the relativistic expressions $m_u c^2$ and $m_d c^2$ respectively, we may write:

$$\frac{m_d}{m_u} = \frac{r_u}{r_d} \tag{22}$$

Let us see now what the masses m_u and m_d may represent. To find this we must determine somehow the values of the amplitudes r_u and r_d. Since these two lengths are referred to some internucleon dimensions, and since, as I have shown in my previous work[1], the mesons π^0 and $K^{\pm}$ are responsible for the formation of the nuclear potential in the deuteron ground state, and in another work of mine[14], that the $\pi^{\pm}$ and the K^0 mesons also are responsible for the formation of the attractive part of this potential, I thought that it is a challenge to relate the restricted Compton wavelengths $\hbar/ m_0 c$ of the above mesons to the r_u and r_d amplitudes. So we identify first the r_d with $R(K^{\pm}) = \hbar/ m(K^{\pm})\, c$ (since it is known that the d quark is heavier than the u one so that $r_d < r_u$ and $R(\pi^0) > R(K^{\pm})$) and r_u with $R(\pi^0) = \hbar/ 2m(\pi^0)\, c$. The 2 in the denominator in the last expression resulted from an analysis by a computer program, of the attractive part of the nuclear potential into two Yukawa-type potentials plus some others of simpler form. All this analysis is given in detail in my previous work[14]). Replacing the above relations in eq. (22) we finally obtain:

$$\frac{m_d}{m_u} = \frac{m(K^{\pm})}{2m(\pi^0)} = \frac{493.677}{2 \times 134.9766} = 1.828750317 \tag{23}$$

By the same argument, from the combination of the K^0 and the $\pi^{\pm}$ mesons we obtain:

$$\frac{m_d}{m_u} = \frac{m(K^0)}{2m(\pi^{\pm})} = \frac{497.672}{2 \times 139.5708} = 1.782873677 \tag{24}$$

So the most sensible conclusion from (22) and (23) is that most probably the final value of the ratio m_d / m_u could be the arithmetical average of the above two values i.e.:

$$\frac{m_d}{m_u} = \frac{1}{2}\left(\frac{m(K^0)}{2m(\pi^{\pm})} + \frac{m(K^{\pm})}{2m(\pi^0)}\right) = 1.8058 \tag{25}$$

(It is worth noticing that due to the proximity of the above two values, their geometrical mean would be 1.8057 that is no different from the numerical mean).

So I found the ratio of the bare masses of the u and d quarks. As it is known (e.g. from ref. 11 p.167) there is an improved Gell-Mann-Okubo relation, which also gives the above ratio by the formula:

$$\frac{m^2(K^+) - m^2(K^0) - m^2(\pi^+)}{m^2(K^0) - m^2(K^+) + m^2(\pi^+) - 2m^2(\pi^0)} = \frac{m_d}{m_u} = 1.8035 \tag{26}$$

Comparison of the results of relations (25) and (26) requires no comments. It is in fact amazing not only the coincidence of the two estimations but the way these two formulae were derived. Our derivation was based on all the pre-described processes for the transformations of the proto-quarks to quarks and the idea that the quarks perform a simple harmonic motion inside the baryons. On the contrary the derivation of formula (26) is based on considerations of the SU(3) symmetry as it is shown in the above ref. 11. Apart from the completely different ways of the above derivations, it is once more amazing the fact that in both formulae only the rest masses of the four zero spin K and π mesons are involved. Even the $2m(\pi^0)$ mass appears in both formulae. The possibility of an accidental coincidence has much less a chance from the almost certainty that our derivation is also correct.

The next step is of course to find a way to calculate the bare masses of the u and d quarks.

These masses can be found if we can determine one more relation between m_u and m_d. From the quark content of the nucleons and mesons which, (the last ones), have been used in (23) we obtain:

m(n) – m(p) = 2d+u-2u-d = d – u = 1.29333 MeV/c^2

$|m(\pi^{\pm}) - m(\pi^0)|$ = u + d –2u , or u + d –2d = | d –u | = 4.59358 MeV/c^2 (27)

$m(K^0) - m(K^{\pm})$ = d+s-u-s = (d-u) = 3.995 MeV/c^2

In the above equations the u,d, notation stands for the mass of the corresponding quarks.

For the π mesons I used the absolute value of the difference because the quark content of the π meson is half the time $\bar{u}u$ and half the time $\bar{d}d$. By adding the left and the right hand sides of the above equations we obtain:

$m(n) - m(p) + m(\pi^{\pm}) - m(\pi^0) + m(K^0) - m(K^{\pm}) = 3(m_d - m_u) = 9.88191$ MeV/c^2 (28)

So finally an average value for $m_d - m_u$ is:

$\langle m_d - m_u \rangle = 3.293997$ MeV/c^2 (29)

From (25) and (29) we may solve for m_u and m_d and we obtain:

$m_u = 4.0878257$ MeV/c^2 (30)

m_d = 7.3817957 MeV/c^2 (31)
The corresponding masses given in ref. 11 are: m_u = 4 MeV/c^2 and m_d = 7 MeV/c^2. In ref (15) the same masses are given as: m_u = 4.2 MeV/c^2 and m_d = 7.5 MeV/c^2.
In the Blue Booklet of CERN the corresponding masses are given as follows:
m_u = 1 to 5 MeV and m_d = 3 to 9 MeV.
I think that the coincidence for these two masses we those obtained by different methods is again extraordinary. In my book(14) I have done a more detailed calculation that permitted the determination of the bare masses of the u and d quarks inside the neutron and the proton but the differences are not particularly significant and for this reason I shall not enter in these calculations. I only notice that the above masses are slightly greater inside a proton than in the neutron. We must not forget however, that these masses correspond to the energy of the ground state of the simple harmonic quantum oscillation of the quarks inside the nucleons (and most probably in mesons too). The most interesting result, however, of the above analysis is that **the bare quark masses are coming from the energy of oscillation of the proto-quarks through the generally accepted transformation m = E/c^2.** From my little knowledge on Superstrings, this theory claims that the elementary particle masses are nothing more than **vibration modes** (i.e. a kind of oscillations) of some mathematical entities called open or closed strings, the existence of which has not yet experimentally been proved, with all the theoretically attached properties to them. In ref. 11 the bare masses are characterized as the parameters of the chiral symmetry breaking. In contrast, the constituent or effective quark masses appear as parameters in (non relativistic) bound state calculations of hadrons, but the problem of the bound state has not been solved from first principles and so the connection between these two types of quark masses has not been rigorously established. So in both references 11 and 15 is expressed the unanswered question: Why do the bare quarks have the particular masses they do? I think that my interpretation of the oscillating quarks gives the required answer. About the effective quark masses I have already given an estimation of them inside the baryons in C3, but in my book(14) I also have calculated the effective masses of the u and d quarks inside the nucleons and I found that M_d = effective mass of the d quark ≅ 343 MeV/c^2 and also M_u ≅ 306 MeV/c^2, but these numbers may be slightly different since in the mentioned book of mine the values of the physical constants I used have been slightly changed with more accurate ones in the present work. Having completed the above step in the evolution of the proto-quarks to quarks, one might think that it is time to return to Cosmology again. But as I said in abstract, researches in Cosmology and Elementary Particles are tightly interrelated with each other and for this reason I must finish the last step of the pre-described transformations.
We are left with 3 paraquarks in a practically free existence, which if they could meat each other by three again, they would produce the other two basic proto-particles, i.e. the proto-electron and the proto-neutrino. From the way they were formed (the paraquarks) they would inevitably joined in triads, having electric charge –2/3, -2/3, +1/3 giving a total charge of –1 if they were coming from a proto-proton triad, and –1/3, -1/3, + 2/3 giving a total charge equal to zero, if they were coming from a proto-neutron triad. Any other combination of them would produce particles having either non integral charge (e.g. –2/3-2/3+2/3 = -2/3, or –1/3-1/3+1/3 = -1/3 etc.) or if they were combining by any other way, they would finally might produce some particles with integral charge but in the whole number of them, some inevitably would produce various kinds of non integral charge particles and a complete chaos would result. For these reasons we must accept that only the possibilities of production as many charges

–1 as charges 0 is correct and this conclusion is in favor of the idea that at least the triads of paraquarks could be the progenitors of the electron and the electron neutrino. So let us start with the electron case. Let us consider three paraquarks that have the appropriate charges and come close to form a triad that could be a proto- electron. In the absence of the potential that makes the u and d quarks unable to escape from their confinement inside the nucleons, the only force that could dictate over the evolution of the proto-electrons is the electrostatic force. Referring to figure 3, we have:

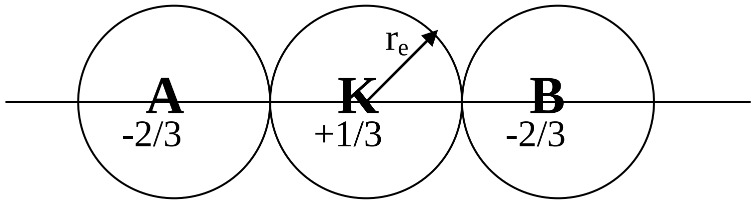

Fig. 3

a) This arrangement of the three particles as in fig. 3 is the most symmetrical one for the present case. The reason is that in the absence of the confining potential of the three proto-quarks, the position of the three paraquarks on the corners of an equilateral triangle (as in the case of the proto-quarks), would posses less symmetry than the one indicated in fig. 3 as it is easily understood. Now thanks to the uncertainty principle, the three particles cannot be at rest. Remembering the case of the Bohr atom, the first motion of the two outer paraquarks we can think of is a revolution around the center of the central one. On the other hand, as we discovered in the proton and neutron case, the three quarks perform an oscillatory motion and it is the mass that corresponds to the energy of this motion that is characterized as the bare mass of the quarks. So I thought that it would be reasonable to add an oscillatory motion to the revolution made by each one of the two outer paraquarks. The problem of course seems to become more complicated, but fortunately the resulting trajectory may be represented exactly by a closed curve called "cardioeidal" (hart-like), which is described by a point on the perimeter of a circle when this circle moves around and in contact with another circle of equal radius (fig. 4).

b) The equations of this curve in the xOy frame of reference (fig. 5) are given by:

$$x = r_0 (2\sin\varphi - \sin 2\varphi) \qquad (32)$$

$$y = r_0 (2\cos\varphi - \cos 2\varphi) \qquad (33)$$

These equations determine the position of the point M for any angle φ.

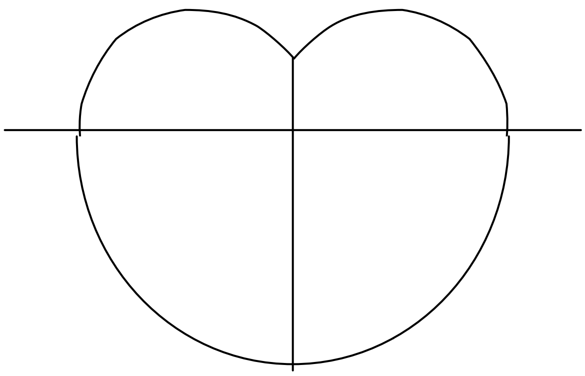

Fig.4

Of course in our case we deal with spheres instead of circles, but the argumentation remains the same since we consider only circles determined by the radius of the sphere.
Now suppose that we use the shape of the cardioeidal as the trajectory of the center of a circle (or a sphere), which at any moment has the same radius with the circle (sphere) at the center and is all the time in contact with the central one. (fig. 5).
The difference with the initial determination of the cardioeidal is that in the former case the outer circle is rolling in contact with the central one with equal radii which remain the same at any position, whereas in the latter case the contact is preserved, the radii remain equal with each other but at any position of the circles the radii are greater or smaller than they were in a previous or next position, as the case is. So the radii start from a (practically in fact) zero length, reach a maximum length and then they decrease again to (nearly) zero (in fact to $3.54\ 10^{-34}$ m). This continuous motion

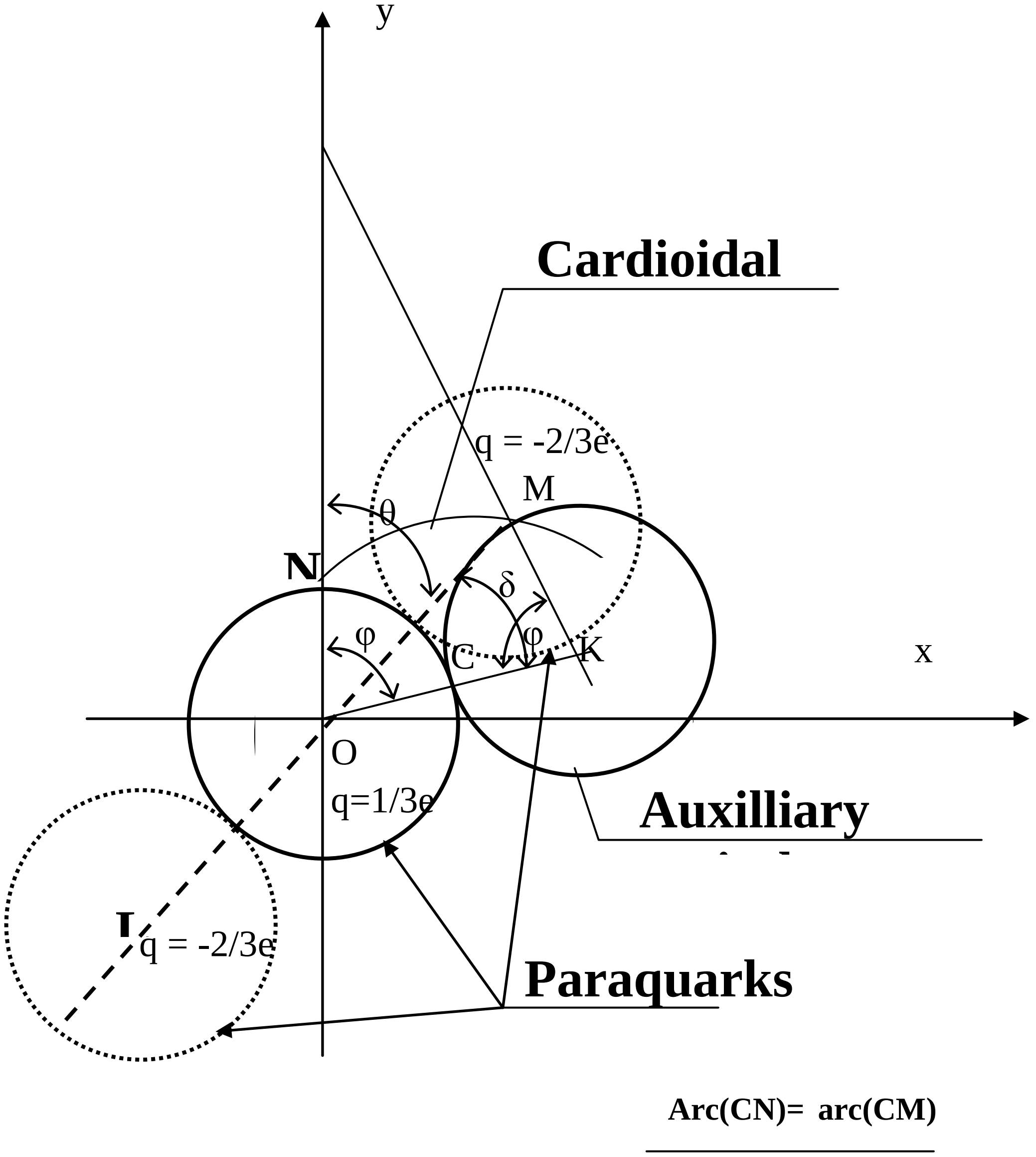

Fig. 5

resembles to an oscillatory motion in a simple harmonic mode so that we can use the results of the theory of the simple harmonic quantum oscillator. But the paraquark, apart from the above motion performs a revolution about the point O, which, as the angle θ decreases it approaches the point N. As it is obvious, the period of the motions of the two outer paraquarks is the same, but they differ in phase in such a way so that their trajectories do not lead to a collision between each other. In fact the two outer paraquarks move in two different cardioeidal curves, each one of which is the mirror image of the other (fig.6) and for this reason they never collide with each other in their eternal motion.

I examine first the revolution of the paraquarks around the central one staying continuously on the cardioeidal trajectory. I work in a similar way as in the case of the motion of the electron around the proton in the Bohr's model of the hydrogen atom.

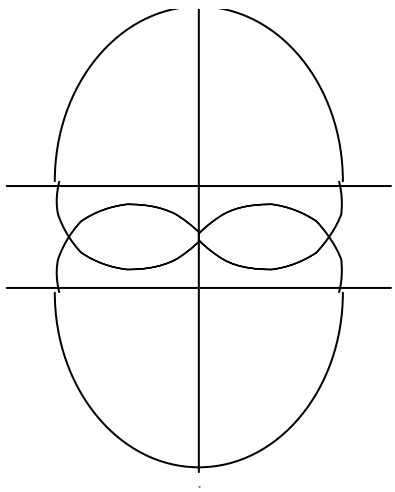

Fig.6

From fig. 3 I consider the Coulomb force applied to the paraquark at B from both the paraquarks, the one at the center and the other at A.

The force from A on B is:

$$F_1 = \frac{4e^2}{9 \times 4\pi\varepsilon_0 (4r_0)^2} = +\frac{e^2}{144\pi\varepsilon_0 r_0^2} \qquad (34)$$

The force from K on B is:

$$F_2 = -\frac{2e^2}{9 \times 4\pi\varepsilon_0 (2r_0)^2} = -\frac{e^2}{72\pi\varepsilon_0 r_0^2} \qquad (35)$$

So the total force applied on B from the center K putting KB ≡ r = $2r_0$ is:

$$F = F_1 + F_2 = -\frac{e^2}{36\pi\varepsilon_0 r^2} \qquad (36)$$

The same force is applied on A by the other two paraquarks.

Since the paraquarks revolve about K, the condition for orbit stability between the Coulomb force and the centripetal force is:

$$\frac{mv^2}{r} = \frac{e^2}{36\pi\varepsilon_0 r^2} \qquad (37)$$

from which solving for v we get:

$$v = \frac{e}{6\sqrt{\pi\varepsilon_0 r m_0}} = \frac{e\sqrt{c}}{6\sqrt{\pi\varepsilon_0 \hbar}} = 8.53655445 \cdot 10^6 m/\sec \qquad (38)$$

where in the above expression I replaced r by $2r_0 = \hbar / m_0 c$, since the paraquarks as elementary particles have a quantum radius equal to $r_0 = \hbar / 2 m_0 c$ (c.f. ref. 16 p. 951 where this radius defines the amplitude of the peculiar oscillation of the electrons (and all the fermions) in addition to their rectilinear motion, which additional motion has been referred as Zitterbewegung). The r may be also defined as the minimum Compton wavelength of the paraquark if the reduced or restricted or minimum Uncertainty principle $\Delta x. \Delta p \geq \hbar / 2$ is taken into account. What is important in (38) is that the velocity of revolution is a constant independent of the mass or the distance between the interacting particles. The total energy of the revolving particle is given by the expression:

$$E = T + P = 1/2\, m_0 v^2 - e^2 / 36 \pi \varepsilon_0 r = - e^2 / 72 \pi \varepsilon_0 r = (-e^2 c / 72 \pi \varepsilon_0 \hbar)\, m_0 \qquad (39)$$

Since the energy E is negative the paraquark (A or B) remains always coupled to the system of the other two. At any point, however, of its trajectory, this energy, being a function of the rest mass m_0, has a different value. The maximum value occurs of course, when m_0 has its maximum value, which from relations (20) is equal to $1.547415906\ 10^{-9}$ kg. $=8.6803675\ 10^{17}$ GeV/c^2.

The next step in my investigation is to find the frequency of revolution of the paraquark, following the cardioeidal trajectory. To find it, I calculate first the length of this trajectory.

From fig. 4 and from eqs (32) and (33), I have the expressions of the coordinates of any point M say, on the cardioeidal, as functions of the angle φ. Since on M I have transposed the center of the revolving circle (sphere), I need to express the coordinates of M as functions of the angle θ. From the geometry of the shape of fig.4 it is:

$$\varphi = \pi/3 + \theta/3 \ \rightarrow d\theta/d\varphi = 3 \qquad (40)$$

The length of the cardioeidal is given by the general expression:

$$s = \int_0^{2\pi} \left[\left(\frac{dx}{d\phi} \right)^2 + \left(\frac{dy}{d\phi} \right)^2 \right]^{1/2} d\phi \qquad (41)$$

Taking into account (40) we find successively:

$$\frac{dx}{d\phi} = \frac{dx}{d\vartheta} \cdot \frac{d\vartheta}{d\phi} = 3\frac{dx}{d\vartheta} \text{ and } \frac{dy}{d\phi} = \frac{dy}{d\vartheta} \cdot \frac{d\vartheta}{d\phi} = 3\frac{dy}{d\vartheta} \qquad (42)$$

After a little algebra I may replace the angle φ by the angle θ and I obtain:

$$s = \int_0^{2\pi} \left[\left(\frac{dx}{d\vartheta} \right)^2 + \left(\frac{dy}{d\theta} \right)^2 \right]^{1/2} d\theta = \frac{4r_0}{3} \int_0^{2\pi} \sqrt{1 - \cos(\frac{\pi}{3} + \frac{\vartheta}{3})} d\theta = 9.79795898\, r_0 = \qquad (43)$$

$$1.7233004 \cdot 10^{-42} / m_0$$

To find the period of oscillation or revolution (which are equal) I divide the trajectory by the velocity from (38).

$$T = \frac{s}{v} = \frac{2.0187306 \cdot 10^{-49}}{m_0} \sec \qquad (44)$$

and the frequency of oscillation is: $f = \frac{1}{T} = 4.9536078 \cdot 10^{48} m_0 \sec^{-1}$ (45)

The energy of the linear quantum oscillator is given by:

$$E = (n + 1/2)hf \qquad (46)$$

In the present case I have 3 such oscillators, since even the central paraquark by having its mass distributed over its outer surface is swelling and un-swelling i.e. its mass oscillates too.
Now from fig. 3, comparison of the quantum radius of the paraquark to that of the electron yields:

$$\frac{\hbar}{2m_e c} = \frac{6\hbar}{2m_0 c} \rightarrow m_0 = 6m_e \qquad (47)$$

Substituting in (46) the relation (45) for f, multiplying also by three for the three oscillators (paraquarks) and replacing m_0 from (47), the total energy from (46) becomes:

$$E_o = (n+1/2)\times 5.9081301\cdot 10^{16} m_e \text{ J} \qquad (48)$$

If to the above energy I add the total energy of the two revolving paraquarks as it is given in (39) i.e.:

$$E_q = -2\times(e^2 c / 72 \pi \varepsilon_0 \hbar)\, m_0 = -\frac{2e^2 c\times 6m_e}{72\pi\varepsilon_0\hbar} = -\frac{e^2 c m_e}{6\pi\varepsilon_0\hbar} = -4.3723555\cdot 10^{14} m_e \text{ J} \qquad (49)$$

the total energy (not mass) content of the electron is equal to:

$$E_{tot} = E_o + E_q = \{(n+1/2)\, 5.9081301\, 10^{16} - 4.3723555\, 10^{14}\}\, m_e \qquad (50)$$

If I divide the above energy by c^2 I shall obtain the corresponding to this energy, amount of mass. Let m this mass. So I shall have:

$$E_{tot} / c^2 = \{(n+1/2)\, 0.65736812 - 0.004864902\}\, m_e = m \qquad (51)$$

To have $m = m_e$, the number in the brackets must equal 1. By putting it 1, I solve for n and I obtain:

n = 1.0286182 with a difference from unity equal to 0.0286182 = 2.86 % (52)

I think that the proximity of n to 1 is not accidental. It represents the first excited state of a particle we use to call electron. This small difference may be due to the omission of some minor energies in the pre-described system of the three paraquarks as e.g. the requirement for the alignment of the spin and the orbital angular momentum of the two paraquarks in order to give a final angular momentum equal to ½ $\hbar$ to the electron, that implies an amount of energy to be spent. Also energies due to the magnetic moments of the spinning paraquarks etc. Since my main subject is Cosmology and not elementary particle physics, I shall not proceed to more details on this subject. I believe that I have proved with enough credibility that my model for the transformation of the proto- and paraquarks to the quarks and to the particles that constitute the electron, works with unexpected accuracy. One would probably expect that the electron calculations would provide a way to understand the μ and τ leptons, which apart from their mass, do not differ in anything else and to their behavior, from the electron. Things, however, are not so clear to give an easy explanation about these leptons and perhaps to many more ones that have not yet been discovered. The reason is simple. I have been dealt up to this moment with the four basic particles in nature, the three of which are considered as having a, perhaps, infinite lifetime. This was done because I examined the u and d quarks only and the corresponding paraquarks γ_u and γ_d . The μ lepton, however, according to Table III of C_3 consists of two γ_u paraquarks and one γ_s paraquark. The τ lepton also consists of two γ_u paraquarks and one γ_b paraquark. My investigation, however, has not been extended to the other three families of quarks and so to paraquarks too) (s, c), (b, t), (e, h), according to C3. So for the time being, I cannot say anything about particles, which in their quark components are s, c, b, t, e, h, quarks (and the corresponding γ_x paraquarks too). I leave therefore the subject open, not because it lacks interest, but because probably the unstable baryons and leptons, did not play a crucial role in the first moments of the Universe.

But unfortunately I have to continue a little more with elementary particles, since I have claimed that the neutrino too has to be a composite particle (fig.7)

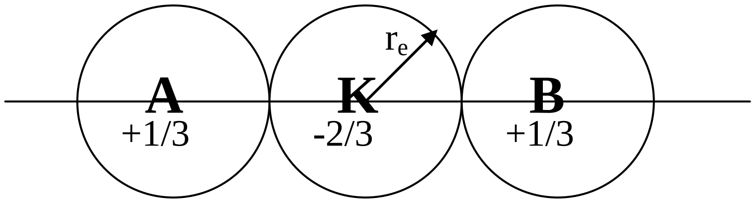

Fig. 7

By repeating my calculations for the electron, but for the paraquarks as in the configuration of fig. 7, I obtain successively:
From fig. 5 I consider the Coulomb force applied to the paraquark at B from both the paraquark at the center and the paraquark at A.
The force from A on B is:

$$F_1 = \frac{e^2}{9\times 4\pi\varepsilon_0 (4r_0)^2} = +\frac{e^2}{576\pi\varepsilon_0 r_0^2} \tag{53}$$

The force from K on B is:

$$F_2 = -\frac{2e^2}{9\times 4\pi\varepsilon_0 (2r_0)^2} = -\frac{e^2}{72\pi\varepsilon_0 r_0^2} \tag{54}$$

So the total force applied on B from the center K putting KB ≡ r = $2r_0$ is:

$$F = F_1 + F_2 = -\frac{7e^2}{576\pi\varepsilon_0 r_0^2} \tag{55}$$

The same force is applied on A by the other two paraquarks.
Since the paraquarks revolve about K, the condition for orbit stability between the Coulomb force and the centripetal force is:

$$\frac{mv^2}{r} = \frac{e^2}{576\pi\varepsilon_0 r^2} \tag{56}$$

from which solving for v I get:

$$v = \frac{\sqrt{7}ce}{12\sqrt{\pi\varepsilon_0\hbar}} = 1.1292786\cdot 10^7 m/\sec \tag{57}$$

where in the above expression I replaced r by $2r_0 = \hbar / m_0 c$, since the paraquarks as elementary particles have a quantum radius equal to $r_0 = \hbar / 2 m_0 c$ (c.f. ref.16 p .951).

$E = T + P = 1/2\, m_0 v^2 - 7e^2/576\pi\varepsilon_0 r = 7e^2/576\pi\varepsilon_0 r - 7e^2/576\pi\varepsilon_0 r = 0$ (58)

This result must make us cautious. What is the meaning of a particle, which has a zero charge and a zero total energy of its orbiting constituents?
If the total energy (Kinetic + Potential) of the orbiting particles is zero these particles will be in contact with the central one but in a limiting state of balance, since being practically free, they could be very easily removed from the central one in the highly energetic environment of the initial stages of the universe where they were embedded. We must not forget the existence of the X and Y super-heavy bozons, produced from the energy released when the MWHs were transmuted into protoquarks. So the

paraquarks would not be allowed to orbit around the central one since then the composed particle that was colorless (white) would split into three colored particles, whose existence is prohibited by the acceptance that only color singlets can exist in nature. The not permission of orbiting, would result to a non- permission of oscillation contrary to the electron case. So if my postulate that the (bare) mass presented to us by the baryons and the electron is nothing more than the internal energy (and not the rest mass) of the quarks in the way I described above, is correct, the neutrino by not possessing such energy would present a zero mass to our measuring devices. But it will still be a composite particle. So although is a lepton too, it will not perform the peculiar motion of Zitterbewegung. The most probable situation is that in the absence of orbital motion, the three paraquarks will inevitably fall on each other something that will have two effects: a) their electric charges will neutralize each other so that the final charge will be zero. The rest masses of the three paraquarks which are really too heavy (~1.5 10^{-9} kg) will come close to each other with dimensions of the order of 10^{-34} m, and so undetectable from our devices which are far too weak to penetrate in such small regions. So in fact the neutrinos will behave as point-like chargeless particles with spin ½ since the intrinsic angular momentum of the paraquarks will be preserved and with an appropriate alignment of their spins the resulting particle can have spin ½. To close the above analysis, I must emphasize the logic of my derivations, compared to that of the existing GUTs. In all basic theories, from the Standard model to the GUT and to a possible TOE perhaps, it is persistently accepted that the quark families correspond to the three lepton families, so that the following scheme is valid:

First generation	Second generation	Third generation
ν_e u	ν_μ c	ν_τ t
e^- d	μ^- s	τ^- b

I have shown that in the first generation there is the following correspondence:

n (udd) $\nu_e(\gamma_u\, \gamma_d\, \gamma_d)$ (γ_x is a brief notation for the paraquarks, c.f. C3).

p (uud) $e^-(\gamma_u\, \gamma_u\, \gamma_d)$

You may decide which model is the most appealing one to our logic. You must not forget that: 1) In the standard families of the quark lepton model, the electron neutrino and the electron i.e. two fermions with charge 0 and -1 respectively, are related to the u and d quarks, which are fermions with charge –2/3 and +1/3 i.e. two entities with completely different electric behavior. 2) The electron and its neutrino are met in a free real state whereas the u and d quarks are confined inside the baryons (or hadrons in general) never being spotted free. 3) The ν_e and e^- are considered as autonomous point-like particles whereas the u and d quarks (and the corresponding γ_x) are constituents of composite particles like the proton and the neutron. Such discrepancies are missing from my classification of the first (and the next I suppose) families.

For the other two generations, although I have not examined the case, I believe that a similar correspondence will be valid. We must not forget that the model of proto- and paraquarks is based on the energy states of the simple harmonic quantum oscillator. So since the energy contains the factor (n + ½), by increasing n we get more energy to produce higher excited states with heavier masses of course. I have already shown in Cosmology 3 that there are four quark generations so that we should expect one more generation of leptons. Our model creates generations of leptons by simply accepting the introduction of the paraquark concept as described above. Of course the subject is far more complicated than one can think of, and has to be examined thoroughly in another occasion. Especially for the neutrino according to P.C. Davies[(4)] again "*…Neutrinos come close to being pure nothing, except for a vital*

property called spin…”. For me the most mysterious problem about neutrinos is that the overwhelming abundance of neutrinos with respect of the other elementary particles (protons, electrons etc.) cannot be the result of the previously developed calculations with the paraquarks. There the number of neutrinos should be equal to the number of electrons. So the only way for their appearance in the universe is by creation in neutrino-antineutrino pairs inside the stars or elsewhere. The question then is: Since these particles come from all directions, why we do not see neutrino-antineutrino annihilations as the case of electron-positron is? If this question is absurd, I apologize to the reader.
By having, however, the necessary supplies of particles, I may continue to the development of my cosmological model.

An absolutely reasonable question that may be raised is this: O.K. you have said a lot about protons, neutrons, electrons, quarks, etc., but we have heard nothing about antimatter and about gravitation; do they not play any role in the development of a cosmological model? The answer to this question will be given immediately below, starting with gravitation.

Since the newly created two particles from the one protoquark, have been endowed by all the characteristic properties of the ordinary matter, i.e. by electric charge and spin (and color for the quarks and the paraquarks), the question that is raised is whether these particles will start gravitating with the rest particles in this very small Universe or not. I have published a book[17] under the title: “The Machinery of Newtonian Gravitation and the fallacies of General Relativity”, in which I developed a theory of gravitation as an extension of Newton’s Law. This book, however, is written in Greek, so for the sake of the reader of the present paper, I have presented the revised Newton’s Law of gravitation, in C2. It is in my intention to to translate it in English very shortly. What is important for the present, is this: My theory of gravitation has connected the gravitational interactions with the peculiar motion exerted by the known elementary particles, and most probably, by the fermions, called Zitterbewegung. Apart from anything else, this connection may be the bond between Quantum Mechanics and gravitation, so desperately pursued by all quantum theories of gravity. From what I said in the foregoing discussion, the quarks and paraquarks perform oscillatory motions inside baryons and leptons and the energy of these motions, if expressed in their corresponding amount of mass, reveal the quark bare masses, the electron rest mass and the neutrino zero rest mass. So if gravitation is due to the above peculiar motion, it is very probable that only particles that perform this motion are subject to gravitation. The quarks and the paraquarks alone, although are the oscillating particles, since they cannot be met free, they must be not gravitating particles themselves. Only when confined in baryons and leptons, by performing the oscillations I described above develop for the composite particles the gravitational interactions among each other. Another reason that excludes the development of gravitational interactions among free quarks is due to the fact that the protoquarks are descendants of the MWH, which exert repulsive forces as I have shown in my previous paper[1]. So they cannot simultaneously perform attractive gravitational interactions. Of course one may ask: The bosons are composite particles too. Are they gravitating or not? To this question I have not a ready answer. But I may speculate a little on this subject. First we must notice that we have not long living bosons, so that we cannot perform experiments between bodies that consist of bosons in bulk to see whether they are subject to gravitational interactions or not. On the other hand the photon is a boson and according to GR is subject to gravitation (red shift near strong gravitational fields, bending of light rays when pass near strong fields too etc.). The well known four tests of General relativity are treated more accurately with my new Newtonian theory of gravitation.What I can say for the moment is that the bosons with zero spin must perform Zitterbewegung since the Klein-Gordon equation, which is the generator of the zero spin mesons, accepts both positive and negative energy eigenvalues. According to Messiah[(16)], "*The Zitterbewegung term vanishes if the packet (*of free waves*) is a superposition of only positive or only negative energy waves".* From our experience of the photons, which have spin 1 and definitely are subject to gravitational interactions, must also perform the Zitterbewegung but this remains to be proved in another work. More about this subject, however, may be found in my mentioned book[(17)]. The above idea for the generation of gravitation from this peculiar motion of almost all particles, leads automatically to the conclusion that since the paraquarks do not oscillate inside the electron neutrinos, these particles will not perform the Zitterbewegung, so that they will not gravitate too. So since we also concluded that the electron neutrinos have a zero mass, we cannot expect that their presence will have any effect on the expansion of the universe. But the muon or tauon (and probably heavier) neutrinos may possess mass and for this reason may gravitate. As I said above, however, we cannot deal for the time being with other particles that contain heavier than the u and d quarks (and the γ_u and γ_d paraquarks).

Let us see the anti-matter problem now.

In p.8 of the present paper I found the number of neutrons, which are closely packed in a sphere of radius R_i = 4167.4 m. This number is 3.3437328 10^{92} neutrons and the corresponding mass was equal to 5.6 10^{65} kg. The above estimations came from C3 where the minimum centrobaric distance at which two neutrons may come close to each other is 1.0863986 10^{-27}m. At this distance they exchange the heaviest possible zero spin meson to transfer the repulsive force between them.

One outcome of my investigation in these very early moments of the appearance of the Universe from the SPS, is that since the above marginal radius is the limit of collapse of the very massive Schwarzscild Black Holes downwards, it has also to be a step in the evolution of the primordial "soup" as I described it in the foregoing discussion. If we follow the idea of a big U-Universe that for a very short time interval underwent a tremendous inflationary period, this period must have started at the moment when all the above material was concentrated in the volume of a sphere of radius R_i. Then the material started splitting outwards in smaller fragments, which later on became small u-universes as our own observable universe. The first thing I must explain is that apart from the initially formatted neutrons, the existing protons, electrons and neutrinos, under the high temperatures and pressures of this period, turned to neutrons through reactions of the following type:

$$p + e^- \rightarrow n + \nu_e \qquad (59)$$

$$p + \nu_e \rightarrow n + e^+ \qquad (60)$$

Since at that time the antiparticles of the proton, electron and neutrino had not yet appeared, the first reaction is more probable than the second.

Although the existence of antimatter is not given a priority over the absolutely necessary appearance of the plus and minus electric charge, as I explained earlier, the creation of antimatter could be achieved wherever was enough energy with high density to be concentrated in small regions of space, for the creation of pairs of particles and antiparticles.

This process has two basic benefits: 1) the matter and antimatter been created in pairs can be annihilated only in pairs, leaving untouched the initial stuff of the Universe (protons, neutrons, electrons and electron neutrinos). So the matter antimatter problem does not need the very tiny excess of matter over antimatter, which finally remained to fill the Universe. 2) The creation of a pair of particle and antiparticle from energy concentrated in volumes of dimensions of the order of MWHs, or less, satisfies once again the requirement of the equation $i^2 = (+1) \times (-1)$, but at any time till now and for ever. So the necessity for the existence of a positive and an equal negative entity in the Universe must be fulfilled eternally. As I have said in C1, this necessity is raised not only from the above basic equation of the imaginary unit, with the + and – real units, but also from the requirement for discrimination which is also basic and emerges too from the SPS. As I said, evolution needs the existence of both the positive and negative entities, since otherwise there would be no evolution. As an example, I present the necessity for the existence of the two complementary concepts of good and bad. The existence of only good (or only bad) forbids the characterization of an entity as good or bad. As the reader understands, philosophy may still be helpful to physics. Returning to our main subject, the existence of the high energy released during the transformations of the MWHs to quarks, could produce any pair of particles and antiparticles by imitating the already formed particles, as the protons, electrons, neutrons etc. With the above notations I continue the scenario of my cosmological model.

By accepting axiomatically the inflationary model, I shall try to find some basic characteristics of this model. So during the initiation of the inflationary expansion, let us accept that the whole mass in the sphere of radius R_i = 4167.4 m started to split in x equal fragments, which started to depart from each other thanks to the continuous intrusion of MWHs, which from then on were turning into space bubbles, for the reason I have given in the foregoing development. These fragments cannot be isolated neutrons, since then it would be impossible to develop the accumulations of matter, as we know them in our own universe. Because we do not know the number of the x fragments, we will appeal in a hypothesis, which is based on the fact that there is a possibility this number x to be in such a relation of magnitude with respect to the big Universe, as there are other smaller fragments which were created in our universe with respect to this universe. This means that I basically accept a fractal structure where the smaller structures are repetitions of bigger structures.

In our own universe, unambiguous big structures, held gravitationally are the galaxies. Of course there exist the clusters and super-clusters of galaxies, but in these heavenly structures other factors may play some role, apart from gravitation, which contributed to their formation.

As it is known, there exist various types of galaxies, as e.g. ellipticals, spirals, irregulars or anomalous etc. as well as big galaxies or monsters, as Hoyle[(18)] has called them, and small galaxies known as dwarfs and of course galaxies with intermediate masses and sizes. What I actually need for my rather rough calculations is an average value of the galaxies' masses, all over our universe. I suppose that very probably, in the beginning of their formation, they all would have the same mass, (we use Occam's razor here, although this well known principle of simplicity does not always reflects the real situations). The different masses we observe today may be due to other reasons (as e.g. to different rates of rotation, to gravitational interactions with neighboring galaxies and to other reasons which for our purpose is not necessary to be referred).

So taking as average values of masses for the big and small galaxies from various references in books of Cosmology, we have:

For Monster Galaxies we take an average value of mass equal to $3\ 10^{11}$ Solar masses.

For Dwarf Galaxies the average value of their mass is taken equal to 2 10^8 Solar masses. (The solar mass equal to 1.9889 10^{30} kg will be indicated from now on by M_o)

The first choice corresponds to the galaxy M31 often known as the Andromeda Nebula. For the dwarf galaxies I took an average estimation of their mass given in ref. (18) p.263. There may exist galaxies with greater than the monsters or considerably smaller than the dwarfs, masses. But these cases may be considered as exemptions from the main rule. Since I am interested for a general average mass of galaxies, I could take either the numerical or geometrical mean value of the two average masses. I have already express my opinion about the importance of the geometrical mean in many fields of microcosmos and megacosmos. Apart from that if the two quantities under consideration differ significantly, their numerical mean will be closer to half the value of the greater quantity so that the influence of the minor value will be insignificant i.e. as though this value to be near to zero. For this reason I apply in the present case once again the LGM. I thus obtain:

$$M_g = (3\ 10^{11} \times 2\ 10^{8})^{1/2} \times M_o = 1.54\ 10^{40} \text{ kg.} \qquad (61)$$

where M_g is the required average value of the mass of a typical galaxy in our universe. Let now the total mass of our universe be m_u. Let it be distributed uniformly either in galaxies grouped in clusters or to isolated ones. We also suggest that in this mass is included, apart from the luminous matter, any kind of invisible matter, cold or hot matter, black holes etc. So the number of galaxies that constitute our universe is:

$$n_1 = \frac{m_u}{M_g} \qquad (62)$$

The mass m_u will have a Schwarzschild radius equal to:

$$R_u = 2Gm_u / c^2 \qquad (63)$$

If now I rise to the scale of the big Universe, according to the fractal structure of this Universe* I must have:

$$\frac{M_u}{m_u} = \frac{m_u}{M_g} \qquad (64)$$

where I supposed that the fragments to which the big Universe splits, are smaller universes like our own. From the fact that I know the total mass of the big Universe from relation (2), which is equal to 5.6 10^{65} kg and the mass M_g from (61) I may find from (64) the mass m_u of our universe and of her sisters universes. So I find:

$$m_u = (1.54\ 10^{40} \times 5.6\ 10^{65})^{1/2} = 9.29\ 10^{52} \text{ kg.} \qquad (65)$$

Is it not curious that the fractal concept led me to the LGM? Is it possible the fractal structures to be a consequence of the LGM or vice versa? If something like this is true then it may be the greatest discovery in the realms of Physics (and mathematics). Think of it.

So with the condition that the small universes are confined inside their own Schwarzschild radii, I find this radius for our universe, which is equal to:

$$R_u = 2G\ 9.29\ 10^{52} / c^2 = 1.379\ 10^{26} \text{ m} \qquad (66)$$

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*An idea of the fractal structure of the big Universe is also used by A. Guth[19] and is attributed to the formation of the infinite number of Pocket-Universes in such a way that a fractal space is created i.e. a sequential process of false vacuum and Pocket-Universes is endlessly repeated in smaller scales. The extension I made for the fractal structure of the big and small universes by using masses rather than lengths, may be new, but if one takes into account uniform densities for the big mass and for the initial fragments of it, the masses can be turned into lengths through the relation: $R = (3M/4\pi\rho)^{1/3}$, where R is the radius of the initial spherical shape of the corresponding mass (of the big or small universes).

The above condition is equivalent to a close universe, which is always a Black Hole in the sense that nothing can escape through the event horizon. The idea of our universe being a BH has been proposed by some authors[20,21].
The radius R_u can be used for a determination of the present value of the Hubble's parameter H_0 from the relation:
$H_0 = c / R_u = 2.1736\ 10^{-18}\ sec^{-1} = 67\ Km\ sec^{-1}\ Mpc^{-1}$ (67)

The present value H_0 of H is not yet settled mainly due to the difficulties in determining the distances to galaxies that are far enough away from us. For this reason this value is given as being in the range $50 \leq H_0 \leq 100$ Km sec^{-1} Mpc^{-1}. It is absolutely clear that the obtained value lies within the above limits and from some information I had in a scientific conference where I participated, it was said by another speaker that the most recent probable value of H_0 is 65 km sec^{-1} Mpc^{-1}. Curiously enough, in my book[14] I had found 68 km sec^{-1} Mpc^{-1} from a quite different way of calculations. So a value of 67±2 km sec^{-1} Mpc^{-1} is probably the best estimation of Hubble's parameter. What is important here, however, is not the finding of a rather correct value for H_0 (something that might be correct if we had exact average values for the masses of galaxies in our universe) but that we are able to show that my model of cosmology leads to acceptable results for H_0. This fact guaranties that it is very probable that the mass contained in the sphere of radius R_i = 4167.4 m, splits in smaller parts which contain mass (on the average again) equal to the mass of our observable universe. So when the mass M_u exploded, the fragments were little universes and their number is:
$n_2 = M_u / m_u \equiv m_u / M_g = 6.028\ 10^{12}$. (68)

Somebody may argue that during the inflation, the initial total mass of the big Universe split into fragments of different sizes and masses. This cannot be excluded, but at this stage of my model, there are two reasons that make me to work with average quantities. A) My calculations would be impossible if I had to deal with a fragmentation of the initial mass in parts of unequal sizes and masses. B) The fragmentation into equal parts does not forbid the differentiation of these parts to become unequal, from the presence of very small initial irregularities or in the course of their interactions with each other.

The various models of the inflationary theory as it was developed by Guth, Borde, Vilenkin, Linde et al, have introduced new concepts as e.g. **bubbles** of ordinary matter that develop in the **false vacuum** of various sizes, **Pocket Universes** created from the fragmentation of the false vacuum and so on. It is also a general opinion that the inflation never stops, once it has started*. My model gives more reasonable answers to the above arguments than the ones from the founders of the inflationary theory. What I mean by saying this is that the uncertainties coming from the introduction of new concepts in both theories are less in my model than the ones in A.Guth's et al, inflationary theory.
Let us see now how inflation started.

In C2 I proved that there exists a limit for the mass that collapses inside a black hole. In C3 I found that the heaviest zero spin meson that can be exchanged by two nucleons has a mass equal to $1.2305662\ 10^{12}\ GeV/c^2 = 2.1936832\ 10^{-15}$ kg. This meson is probably the heaviest Higgs boson and its formation required the introduction of two new quark flavors to which I gave the name "extra" and "high". This particle consists therefore by a high and an anti-high quark. For the exchange of

* As a matter of fact, it is not quite clear that inflation never stops and simultaneously it ended at about 10^{-35} sec after the beginning.

this meson (the highonium as I called it) the two nucleons (neutrons in our case) must come at a distance of 1.0863986 10^{-27} m. It is therefore reasonable to claim that this exchange takes place when the neutrons have reached centrobaricly at this distance either from above by the action of gravitation that develops their maximum permissible squeezing in the interior of a black hole or from below when the continuously appearing space bubbles increase their separation up to the above distance.

If inflation took place, the radius of the big Universe before the inflation as given in relation (1), was equal to 4167.4 m and at the end of the inflation it became equal to 8.3158391 10^{38} m as in relation (3). So at the end of the inflation, which occurred when the increasing radius of the big Universe became equal to its Schwarzschild radius the compactified Universe became greater than its initial value by:

$$\frac{8.3158391 \cdot 10^{38}}{4167.4} = 1.99545 \cdot 10^{35} \, times \qquad (69)$$

So it underwent the following number of doublings:

N_{doubl} = ln1.99545 10^{35} / ln2 = 117.26419 (70)

I may now find how much lasted each doubling.

As I said above, the exchanged heavy zero spin meson between the neutrons has a mass equal to 2.1936832 10^{-15} kg. The first I have to notice is that all the exchanged mesons between nucleons in nuclei, are virtual particles and unless the right amount of energy is supplied to the system, they cannot appear as free particles. This happens with the above zero spin meson, which is exchanged between the much lighter neutrons thanks to the energy supplied by the gravitational field, as they are squeezed. But the compactification of the neutrons is so high, that there is no space for the highonia to escape as free particles. They are immediately absorbed. So they remain virtual*. The highonium, however, has a certain lifetime between its emission and its absorption. This time is given by the quantum time expression: $\hbar / 2mc^2$, from which, using the rest mass of this particle we find:

T_{high} = 2.674427 10^{-37} sec. (71)

What is the meaning of this time in the inflationary theory? I suppose that inflation started as soon as the total number of the neutrons concentrated in the pre-described sphere of radius 4167.4 m. As I have shown in my work(1), the nuclear forces at distances less than about 0.5 fm are repulsive. This repulsion produces the separation of the nucleons to longer distances, and this is played continuously inside nuclei and hypernuclei as in the above minimum sphere. So the inflation, which is an expansion process, should have started at the moment of the first interactions between the neutrons that took about 2.674427 10^{-37} seconds from the beginning of the real time to start. The lifetime of the highonium characterizes the initiation of the inflation. For every doubling, therefore, which is as a new beginning, the above time interval was needed. This means that this time interval stamped the rhythm of each doubling. Perhaps this situation may be characterized somehow as a tremendous earthquake, which split the mass of the marginal sphere with radius 4167.4 m into the parts of eq. (68). For the 117.26419 doublings, therefore the total time that had to pass would be equal to:

T_{tot} = 117.26419 × 2.6744269 10^{-37} = 3.136145 10^{-35} sec. (72)

* The discrimination between virtual and real particles is not quite sharp, as David Griffiths explains in his book(15) p. 60.

Comparison of the above times, as well as of other characteristics of the inflationary theory of Guth et al, with my results is given in TABLE I.
But let me continue a bit further my investigation.
I found (in relation 68) that the number of little universes as our own, is n_2= 6.028 10^{12}. If we consider n_2 similar spheres in a close packing assembly, contained in a huge sphere of radius 8.3158391 10^{38}m, then we may find the radius of each one such small sphere from the relation:
$R_{fictitius}$ = 8.3158391 10^{38} $(\pi\ 2^{1/2} / 6)^{1/3}$ / $(6.028\ 10^{12})^{1/3}$ = 4.1338324 10^{34}m (73)
The above value of $R_{fictitius}$ compared to the cosmic radius 1.379 10^{26} from (66) tells us that for a uniform distribution of the little universes inside the big Universe, will take quite a long time for them to come in contact with each other. This is due to the tremendous increase of the radius of the inflating Universe in comparison to the very slow increase of the radius of the little universes, which proceeds with the velocity of light. It is generally accepted by the supporters of inflation that the rate of recession of the big Universe does not violate Special Relativity since it is due to the "stretching" of space, as it is usually characterized by GR and not to a movement of the little universes in space. My model instead of a "stretching", predicts space creation in the form of space bubbles (or better of non materialized MWHs). So if the cosmic radius of our universe continues to increase with the speed of light, it will take about 4.3725 10^{18} years to reach the $R_{fictitious}$ i.e. to come in contact with the other little universes, provided that the inflation is a unique process and not an eternal one. We have reasons to believe that expansion continues only inside the little universes, up to the above time of 4.3725 10^{18} years, and not outside of them. Although I cannot support mathematically this idea I shall give some arguments in support of it*.

As we saw in the foregoing development, the marginal sphere of radius 4167.4 m was contained in its Schwarzschild radius of 8.3158391 10^{38}m where the inflation came to an end at the determined above 3.136145 10^{-35} sec. During this period the big Universe inflated and at the same time the marginal sphere split into the pre-described little universes. A first point is that the initial radius of the little universes can be found at just the moment they were formed by considering a number of little spheres close packed inside a big one. The following relation gives this radius, in our case:

$$R_{in} = \left(\frac{\pi\sqrt{2}}{6}\right)^{1/3} \frac{4167.4}{(6.028\cdot 10^{12})^{1/3}} = 0.20716289\, m \qquad (74)$$

So our universe started with the above radius and now its radius is given by (66) and its mass by (65).
Up to this point it is worth to compare my results with the results of the various versions of the inflationary theory. I found the necessary information in Alan Guth's book under the title "*The Inflationary Universe*" without any resort to original papers since only some numerical values were necessary for the comparison of the two outcomes. The little Table I below shows this comparison:

* The above conclusion, however, does not prevent the increase of the radius of the big Universe at the velocity of light (not in an inflationary manner) thanks to the increase of the mass of the little universes, which are enclosed in the big one.

TABLE I

Interesting results	From Guth's Inflation Theory	From the presented theory of mine
Number of doublings during the inflationary period	~100	117.26419
Time of each doubling	~10^{-37} sec.	2.674427 10^{-37} sec
Duration of the inflation	~10^{-35} sec.	3.136145 10^{-35} sec
Initial mass of the big Universe	Not given	5.6 10^{65} kg.
Present mass of the little universes	Not given	9.29 10^{52} kg
Initial radius of the big Universe	3 10^{-29} m	4167.4 m
Number of little universes	Not given (perhaps infinite)	6.028 10^{12}
Radii of the little universes at the beginning of inflation	10^{-52} m	0.20716289 m
Radii of little universes after the end of inflation	Not given	~0.20716289 m
Present radius of the little universes	Not given	1.379 10^{26}m.
Radius of the big Universe just after the inflation	3.2695499 10^{49}m	8.3158391 10^{38}m.

As it is evident the first three rows of the table present an almost excellent agreement of my results with those given in Guth's book, at least in order of magnitude. And these values are the most important in the inflationary theory. In row 6 I have an unabridged difference between Guth's results and ours. If Guth's figure of 3 10^{-29}m for the radius of the Big Universe before the inflation could be correct then let's see how many "particles" with radii half Planck's length could be accommodated in a sphere with radius 3 10^{-29}m. The Planck length is 1.616 10^{-35} m so that the radii which are supposed to have the smallest Planck spheres will be equal to this length, and being in a tightly close assembly their numbers in the primordial Universe would be equal to

$$A = \frac{(3\cdot 10^{-29})^3}{(1.616\cdot 10^{-35})^3}\left(\frac{\pi\sqrt{2}}{6}\right) = 4.7375\cdot 10^{18} \qquad (75)$$

Since the Planck mass is equal 2.176 10^{-8} kg the total mass of the universe would be equal to: 4.7375 10^{18} × 2.176 10^{-8} = 1.03 10^{11} kg = $\frac{1}{5.8\cdot 10^{13}}$ of the mass of the Earth!!! No comment.

On the above basis the same author estimates that the size of the observable Universe before the inflation was equal to 10^{-52} m. The mass of the observable universe is roughly equal to 10^{53} kg. If we squeeze this mass in a volume of $(10^{-52})^3$ m^3 we get a density equal to 10^{209} kg/m^3 !!! No comment again.

The Schwarzschild radius of the steadiest elementary particle, the proton, is equal to 2.48 10^{-54} m. So in this radius, which is pretty close to the figure of 10^{-52} m can be squeezed (theoretically) the mass of one only proton, not the mass of a whole Universe. My figure for the same radius (before the inflation) is 0.20716289 m, which yields a density of 10^{55} kg/m^3. Not bad.

The above comparisons could not be left uncommented, since our predictions seem to be more logical than the ones of the classical inflationary theory. These subjects however require more extensive discussion in some future work.

The fact that the present value of Hubble's parameter, as found in (67) agrees with other estimations, has the meaning that at the present age of our universe, the expansion has reached a point that cannot be overtaken, since nothing can escape from the event horizon of a BH. The question then is: Since the frontiers of our universe have reached the event horizon, the expansion has come to an end? Recent astronomical observations affirm a rather accelerating expansion. Where is the error? I think that there is no error. Since the Schwarzschild radius is proportional to the mass of a BH the only way that this radius may increase, is by increasing the contained mass. Since outside of this radius is only empty space, as I proved by comparison of the present radius of our universe with $R_{fictitious}$ given in (73), the only way for the universal mass to increase continuously, is by mass **created** inside our little universe. I must declare clearly that this mass creation has nothing to do with the Steady State Theory for two reasons: A) The creation was not necessary as long as the actual radius of our universe was smaller than its Schwarzschild radius. B) The creation of new matter is following a completely different route than the one proposed by Hoyle (1980), i.e. creation from white holes with magnitudes compared to those of galaxies. As I have proved in my previous work(1), only Mini White Holes can be created (with Planck dimensions). So my new proposal to this problem is the following:

In my previous works (ref. (1) and C1) I proved that the only source from which matter can emanate is the SPS. If the density of the emerging mass is the highest possible, the appearing MWHs are materialized in the form of super-heavy elementary particles as I described in the foregoing development of my theory. In less dense environments they finally become space bubbles that contribute to the expansion of our universe through the creation of new space. Very dense environments do exist in our universe and they are in the interior of star-like or even galaxy size BH. There the MWHs are again becoming particles. So the radius of the BHs increases with increasing mass of them and the total mass of the little universe increases too resulting to an increased radius of it. There is no more problem of the critical density. The density remains critical with $\omega = \rho/\rho_c = 1$. About this last case I shall give more details in the ensuing section. The details, however, for matter creation in the central regions of the BHs, will be examined in a next paper. Of course it is reasonable to expect that the radius of the big Universe will increase too, thanks to the new mass that is accumulated inside the little universes. The increase, however of the above radius will not be done in an inflationary manner.

At this point I cannot, however, help it from saying: Has anybody doubt that my model yields results compatible with other much more complicated theories, which are still in circulation among the people of the Physics community and are discussed seriously as ones that are closer to reality?

E. Hubble's Law and the universe as a black hole

The simple form of Hubble's Law is the well-known expression:

$$cz = Hr \tag{76}$$

where z = v/c given by the Doppler expression, is the relative red shit of a spectral line coming from a recessing galaxy. When v approaches the velocity of light the relativistic Doppler formula is applicable i.e.:

$$z = \sqrt{\frac{1+v/c}{1-v/c}} - 1 \qquad (77)$$

If we use second order terms for the derivation of Hubble's Law the simple formula (76) is given by the expression[(22)]:

$$cz = Hr + (H^2r^2/2c)(q-1) \qquad (78)$$

where q is the deceleration parameter.

Let us see what we obtain from application of (76) and (77) expressions. Let M be the total mass+energy content of the universe. Since the Big Bang theory does not accept continuous matter creation, this means that in the beginning the total mass that emerged from somewhere, has not increased since then, but due to the expansion of space, this mass+energy is continuously diluted. When we have an amount of mass, irrespectively whether it belongs to a star or to the whole (observable?) universe, it possesses an event horizon defined as the surface of a sphere with radius equal to the Schwarzschild radius $r_s = 2GM/c^2$. Since according to all indications the mass of the Universe started from a point with infinite density, or according to quantum cosmology from a very small volume with a very high but not infinite density, its Schwarzschild radius would be much greater than the radius of the initial volume occupied by this mass. So the mass started to expand inside a BH. Similar thoughts for a Universe as a Black Hole have been expressed by other people too as I already mentioned in Cosmology 2 and in the references of the present paper. The horizon of the observable Universe may be given by either the simple or the more precise Hubble's law (78). In the first case we have:

$R_c = c / H$, and $r_s = 2GM/c^2$. So after a time t_s these two radii would become equal. So from this equality we infer that $M = c^3/2GH$. The average density of this mass would then be:

$$\rho_c = M / V = 3c^3 H^3 / 2GH\, 4\pi c^3 = 3H^2/8\pi G \qquad (79)$$

Expression (79) is characterized by all versions of cosmological models based on the Big Bang theory as the *critical density* for the Universe to be closed.

In the second case I solve (78) for $r \equiv R_c$ taking into account that the deceleration parameter q for a closed Universe is equal to ½, and z for v = c is equal to 1 and I find: $R_c = 2c/H$.

With a similar procedure as in (79) for $R_c = 2c/H$ the critical density is:

$$\rho_c = M / V = 3H^2/32\pi G \qquad (80)$$

The same result is obtained by the authors of ref. (23) p. 456 but as they say this result is valid if the pressure p in the universe due to the existence of massless particles cannot be neglected. But since in the present epoch p may be neglected compared to ρ as it is generally accepted, the critical density can be given by (79). For this reason, in our consideration of the value of Hubble's parameter H in Cosmology 2, I used the $R_c = c / H$ expression.

At this point it is perhaps interesting to present a different derivation of the expression of the critical density of the observable Universe. This derivation is based on an application by M. Berry[(24)] of Mach's Principle for the development of a theory (first introduced by D.Sciama[(25)]), which will explain the inertial properties of matter and will prove that Mach's principle acts additionally to GR. This theory is supposed to lead to a better understanding of these inertial properties of matter through the influence of the remote matter in the Universe.

According to Newton's Laws, a force $\overline{F}$ which is applied to a body, develops an acceleration $\overline{a} = \overline{F}/m$ relative to an inertial reference frame f. If the body is considered from an accelerating reference frame f′ that is moving with the body, the body will have an acceleration with respect to the system f′ equal to $\overline{a} = 0$. According to Mach's Principle this must be explained as due to the action of forces $\overline{F}'$, which will be expressed by the relation:

$$\overline{F}' = -\overline{F} \tag{81}$$

The force $\overline{F}'$ is developed from the acceleration of the rest of the Universe, which acts on the body, since this acceleration is present in f′ and absent in f. The value of $\overline{F}'$ is:

$$\overline{F}' = -\overline{F} = -m\overline{a} \tag{82}$$

If now I introduce the principle of inertial induction, in analogy to the case of electromagnetism, this yields the followings: The force between two charges q_1 and q_2, which are mutually accelerated, is:

$$\overline{F}_{acc} = \frac{4}{3}\frac{U}{c^2}\overline{a} = \frac{4}{3}\frac{q_1 q_2}{4\pi\varepsilon_0 r c^2}\overline{a} \tag{83}$$

where $\overline{a}$ is the relative acceleration.

In (83) I made the first modification in M. Berry's derivation by introducing in it the factor 4/3. The presence of this factor was imposed to show that we make use of the pure electromagnetic mass $4U/3c^2$ which corresponds to the energy of the field and so we derive the gravitational analog of (83), i.e. we do not take into account the non electromagnetic mass $-U/3c^2$ which is necessary for (83) to agree with Special Relativity, (c.f. ref. 26 p. p.383, 385) since in the case of gravitation the inertial mass is the same with the gravitating mass.

The gravitational analog of (83) will be the force $\overline{F}'$ we are looking for and its magnitude will be equal to:

$$\overline{F}' = \frac{4}{3}\frac{GMm}{rc^2}\overline{a} \tag{84}$$

where M are all the masses in the universe that act on m. According to Mach's Principle we shall have:

$$|\overline{F}| = |\overline{F}'| = |m\overline{a}| \tag{85}$$

Thus considering the magnitudes of the forces we may write:

$$F' = \Sigma\frac{4}{3}\frac{GMm}{rc^2}a = 2\frac{4}{3}\frac{Gm\rho}{c^2}\int_0^R\int_0^{\frac{\pi}{2}}\int_0^{2\pi}\frac{dr}{r}r^2\sin\theta d\theta d\varphi \tag{86}$$

where R is the every time maximum radius of the Universe. (This is the second modification to M. Berry's derivation).

Thus:

$$F' = \frac{8\pi GR^2}{3c^2}\rho m a \tag{87}$$

We see that for F′ to be equal to *ma* we need:

$$\rho = \frac{3c^2}{8\pi GR^2} \tag{88}$$

From (88) two important results become apparent:

a. If in (88) we replace R by its equivalent from Hubble's Law: R = c/H (since R is the maximum radius of the Universe where the recession velocities are equal to c) we obtain:

$$\rho = 3\,H^2 / 8\pi G \tag{89}$$

which is the critical density for the Universe to be closed according to GR. We thus conclude that the density is in fact all the times (after the time t_s which will be defined in a next paper) equal to the critical density for the universe to be closed and at the same time to expand indefinitely confined in its Schwarzschild sphere (case of the parameter $\omega = \rho_{existing} / \rho_{critical} = 1$ and also case of k = 0 in the Robertson-Walker metric).

b. If the volume occupied by a sphere of radius R (case of the observable universe) is $V= 4\pi R^3/3$ we may find from expression (89) the mass of the universe. It is:

$$M = \rho V = Rc^2/2G \tag{90}$$

and $$R = 2GM/c^2 \tag{91}$$

i.e. R is the Schwarzschild radius of the universe and since R is observationally found that increases, one expects that M should increase too. Hence the need for continuous matter creation after $t = t_s$ i.e. after the time when the expansion of the little universes reached the initial event horizon is necessary. In a next paper on Cosmology the t_s will be determined among many other parameters. The above derivation as it is presented here has not been done by anybody else, as far as I know, because nobody used the factor 4/3 in (83) and (84) justifiably, so that all other derivations did nod lead to our crucial results.

I recapitulate what is the situation of the Universe when the transformations of the MWHs came to an end. I repeat, the transformations, not the emergence of the MWH from the SPS since this is an eternal process that never stops. The appearance, since then, however, of the emerging MWH, increases the number of the space bubbles so increases the dimensions of space. The appearance of MWH that are matterialized occurs after a certain time from the beginning, in regions of "no space" after few billions years from the beginning. I leave the reader a conundrum to think where are such "no space regions". The answer is hidden somewhere in this work. Now for the Universe the following picture represents the existing situation:

The content of the Universe includes a) Protons, neutrons, electrons and neutrinos in equal numbers. All these particles are embedded in a very energetic environment thanks to the existence of the huge amounts of energy released during the pre-described transformations. This energy could act as a generator of the X and Y gauge bosons and their antiparticles. As I have already said, from the SPS only matter can emanate so that it is no problem from the annihilation of matter by the antimatter, something that made cosmologists to introduce the minute difference between the number of particles and antiparticles, which explains the idea that our universe is made only from matter. My explanation of the above fact, is that antimatter may be generated not only in these primeval epochs but occurs all the time whenever enough amount of energy is available and can be concentrated in a point in space. Here I shall make a hypothesis which may be correct or not, but explains why the particle-antiparticle appearance occurs in the generation of known particles and no to particles of any arbitrary mass. For some reason, not completely understood, the available energy seems as though it imitates the originally formed particles, and if there exist an excess of energy not enough to create one more pair of particles-antiparticles, this energy is given as kinetic energy of the newly created particles. This is my opinion on the creation of antimatter, but it should be taken as a mere speculation for the time being.

3. EPILOGUE

In this fifth course of six papers I presented my model about the very early stages of the appearance of the Universe.
The reader who had the patience to go through all the presented material about the way the Universe came into existence, must have in mind the following general ideas in order to get a better understanding of the reason the presentation of them was done that way.

Every theory for an explanation of as yet unexplained phenomena or situations starts with a model or scenario, which is expected to give answers to unanswered questions.

Particularly, in the case of physics or cosmology, the majority of researchers start with a fundamental idea of how they will succeed to get answers or solutions of the appearing problems that call for an explanation.
I do not intend to start recapitulating the proposals made by the human beings, even in their first steps as sapient entities, in their struggle for an understanding of the phenomena they observed around them.

In modern physics, the discoveries were supported by observation and experiment. The latter is a repetitive observation. As an example I shall give only the knowledge we got for the problem of the constitution of the material world. So starting with Mendeleyev's Table of chemical elements, we came to the idea of atoms and their interpretation. The Thomson's atom was proved incorrect and we came to the Ratherford's atom with the nucleus at the center and electrons revolving around it. But this again came to a basic snag, since the electrons, by losing energy (as any accelerated charge does) would inevitably and pretty soon reach the central nucleus. So no atom could survive for long. Then Bohr developed his known quantum theory, which offered a first solution to this problem and the development of Quantum Mechanics followed, giving answers and a better understanding of how things work.
But then the examination of the atomic nucleus gave rise to the development of various explanations of how things work inside the nucleus. These explanations, however, were not enough for a complete description of the strong nuclear forces. The new concept introduced for a better understanding of the nuclear forces was based on new entities called quarks. The unification of the four force fields of nature became the central problem of physics. Theories developed for this problem, based on continuously more advanced and more complicated mathematics, such as the Standard Model, the GUTs and various TOEs. Gravity, however, could not be united with the three other forces, and new models were proposed such as Supersymmetry and Supergravity. These theories have not yet succeeded to unify QM with GR. So with them, the final explanation was not obtained.

"Superstrings" is a new model that will probably give the final answer. But for the time being, although many very strong brains are working on it, the results are still missing. Some people say that this theory has to wait for the discovery of new mathematics for the solution of its equations.

Things having so, I started thinking how would it be possible to get a better understanding of some unsolved problems of physics. And since the fact that physics is unbreakably tied with Cosmology, something that has received a general acceptance, I started developing my cosmological model that has been presented in six diferent parts. The outcomes of this investigation are numerous and compatible with the results of other more complicated (mathematically) theories. I also have predictions that wait for their experimental or observational verification. While the superstring theory accepts as the fundamental entities of matter, a kind that resembles with an ordinary string but in more than four dimensions, my theory is based on the idea of the MWHs, introduced in ref. (1), which have a different metric than the BH as I proved in my previous work[(1)]. By no way I assert that I solved everything. But this simple theory of mine may be a guide to the superstring theory, if it will be exploited further on (and if the supporters of superstrings spend little of their precious time to read the present work of mine). The presented theory on Cosmology has the title: "The first 10^{-35} seconds". Of course the theory has a lot of missing points that should be discussed. There are also questions for which I have not yet found answers. An example is the following: Both Guth's theory and my own have concluded that inflation stopped after $\sim 10^{-35}$ sec from the beginning. On the other hand the former theory accepts that inflation never stops. And the latter, by introducing the matter creation after a certain time inside the little universes, puts the problem of whether this increase in mass has any effect on the Schwarzschild radius of the Big Universe, something that would probably lead to a continuous expansion (not inflation). But we must have in mind that this is a first approach to such an extended subject that may be revised many times in the future by me or other people. My next task will be a new course of papers to cover the evolution of our own universe after the end of inflation till the present time (if my age will permit me to do that).

Addendum

In C2 where I dealt with the fate of mass inside a BH, I used Newtonian gravitation instead of GR, which cannot give an answer to this problem. In supporting my choice, I forgot to make reference to a paper by Stanislaw Bażański[(27)] where the author shows that "*…the behavior of the cloud of particles freely falling into the center of attraction is, contrary to what one would rather expect, in each of the two theories* (GR and Newtonian) *exactly the same…*". This paper, however, was mentioneded in C1 for the same purpose.

APPENDIX 1

Determination of the energy required to built a spherical charge, distributed uniformly throughout the volume of a spherical shell of thickness $r_e - r_0$. The symbols have the same meaning as in the main text.
The charge density in the volume of the shell is:

$$\rho = \frac{3Q}{4\pi(r_e^3 - r_0^3)} \tag{A1.1}$$

At radius r ($r_0 < r < r_e$) the charge contained between r_0 and r is:

$$q = \frac{4}{3}\pi(r^3 - r_0^3)\rho = \frac{Q(r^3 - r_0^3)}{r_e^3 - r_0^3} \tag{A1.2}$$

and the electric potential at r is:

$$V = q / 4\pi\varepsilon_0 r \tag{A1.3}$$

To increase the radius by an amount dr, i.e. adding a new shell of thickness dr, we must add a charge dq that can be obtained from A1.2 by differentiation:

$$dq = \frac{3Qr^2 dr}{r_e^3 - r_0^3} \tag{A1.4}$$

and the energy required to add this charge is:

$$dE_e = Vdq = \frac{3Q^2 r^2 (r^3 - r_0^3)}{(r_e^3 - r_0^3)} dr \tag{A1.5}$$

Thus the total energy is obtained from A1.5 by integration:

$$E_e = \int_{r_0}^{r_e} dE_e = \frac{3Q^2 r^2 (2r_e^5 - 5r_e^2 r_0^3 + 3r_0^5)}{40\pi\varepsilon_0 (r_e^3 - r_0^2)^2} \tag{A1.6}$$

APPENDIX 2

As I promised in the main text, I shall present a rather picturesque comparison of our three-d space with a sandy desert.

We may say that the grains of sand belong from the point of view of chemical composition in a theoretical group, which can be ascribed by the silicon dioxide i.e. by the quartz. So if we melt the sand at very high temperature, we will get the homogeneous material we call glass, not to refer to other versions that have their main constituent the quartz.

If we transfer now the above properties of sand in the case of the SPS and of the 3-d space, it is possible to get the following correspondences:

1) Isolated grains of sand	Space bubbles of Planck-like dimensions
2) Sand in bulk concentrations (desert)	The finite ensemble of the above bubbles, which are at a close contact with each other and constitute the 3-d space we know.
3) The hardness and the dimensions a material must have, as well as the force that has to be applied for the intrusion in a grain of sand may be compared with:	the energy needed for the intrusion in a space bubble (about 10^{19} GeV), whereas the motion of ordinary bodies in a sandy desert is much easier and the motion of material bodies through the space bubbles is much easier than the intrusion in them
4) The chemical constitution of the grains of sand, which is completely different from the properties of the desert (sand in bulk)	may be compared with the properties of the interior of the space bubbles, which differs completely from the properties of the 3-d space

So a sharp steel knife when used in the sandy beach it needs very little force to penetrate into it. But to penetrate (e.g. to cut a single grain of sand) requires a much stronger force on it. The same holds in the case of the penetration into a space bubble.

Perhaps one of the most interesting problems in the future of physics is the finding of a way for the intrusion in a space bubble or in other words, in the SPS. Impossible you may say. I have an idea but it is too premature to present it, so the answer to this case has to wait.

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P.S. When I finished this paper (C5), I tried to read again certain popular books on fractals and chaos, since I had already made mention of these structures in this last paper. I refer to three such books: 1) *Turbulent Mirror* by John Briggs and F. D. Peat 2) *Chaos-Making a New Science* by James Gleick and 3) *Does God play Dice?* By Ian Stewart. The question I shall put to the reader who possibly has a better mathematical knowledge than me on these subjects, may seem mystical or even absurd, but I really would like to have an answer by someone. The question is: The cardioeidal curve I used to explain the motion of the paraquarks in the electron case has anything to do with the cardioeidal shape of the Mandelbrot's set? Is this shape the limiting one when it reaches the electron dimensions? Is this coincidence accidental, irrelevant or it requires further scrutiny? THANK YOU.

COSMOLOGY6 (C6)
THE ANTHROPIC PRINCIPLE PROBLEM

Abstract

When I finished the already presented four+1 papers on Cosmology, I realised that this first course would be incomplete if there were no mention about the so called ***Anthropic Principle*** *(AP) as it was baptised by its founders (and supporters) B. Carter, J, Barrow, F. Tippler, G. Ellis et al. Few of the books that deal with the* ***Anthropic Principle*** *can be found in the bibliography at the end of this paper. The reader may find in these books further information on the various confrontations of this rather controversial subject by eminent scientists. What I am going to show in this paper is that in view of my cosmological model, as it was presented in the four+1 papers, the Anthropic Principle is not necessary for the explanation of the appearance in our u-universe, as well as in the other ~6 10^{12} u-universes that were created simultaneously with our own, of life in general and more specifically, of intelligent life. This explanation will emerge from the proof I shall present, that the so importantly required by all versions of the Anthropic Principle,* ***fine tuning*** *of the laws of physics and of the basic physical constants, is inevitable for all the u-universes contained in the Big U- Universe as it was generated as the result of my model on the way the inflation started and ended. So the Anthropic Principle will remain as an example of the attempt of the various scientists to explain something that could not be explained by the knowledge we have gained up to the present days on the realm of Physics, Astronomy and finally of Biology. The pursued explanation of life and intelligence by use of this principle by its supporters has some resemblance with the explanation of the planetary motions developed by the well-known Ptolemaic system. In both cases the ignorance of the true laws that govern the corresponding situations led to the development of false solutions.*

1. INTRODUCTION

In the SETIcon 02 Technical symposium on April 2002 in the College of New Jersey Ewing, New Jersey of USA, I presented an article with the title: “SETI vs. THE ANTHROPIC PRINCIPLE”, where I developed my ideas on this subject. Most of the arguments I shall present here, come from the above article, but the cosmological model I presented in the previous five papers, strengthens my argumentation in three basic points:

a) According to the supporters of the AP, a physical explanation of the AP can be based on the idea that the probable multiplicity of u-universes gives support to the possibility that at least in one of them, the laws, the basic physical constants and the initial conditions of this exceptional universe were the right ones for the development of life and in extension, of intelligence in it. If such a multiplicity does not exist, the only way to explain life in this unique universe is through the intervention of some supreme or omnipotent being that can predetermine the necessary conditions (laws and constants) for the development of life in it. My cosmological model, however has already confirmed that the multiplicity of u-universes is one of its predictions, and their number (6 10^{12}) may be statistically enough for the development of life in at least one of these u-universes where the fine tuning was achieved. And quite accidentally this little universe is the one we live in. The difference of my explanation with the above requirement is that these laws, constants etc. are the same in all u-universes and consequently life is common in all of them besides the fact that we cannot communicate with them (at least for the time being). I remind you that in C5 the Big U-Universe splits in the mentioned above number of u-universes, which posses equal masses with the same stuff of particles, energy and initial conditions, so that it would be very improbable for these u-universes to be governed by different physical laws and physical constants as well as strengths of the 4 (or rather 5)* force fields which are present in our universe. Common logic requires that all slices cut from the same loaf will have in general the same taste, apart from some minor unimportant differences.

b) The appearance of life in our u-universe is a fact. In the mentioned presentation of mine I accepted for a moment that the argumentation of M.H.Hart[(2)] that the probability for the creation of the DNA molecule is very tiny (about 1 to 10^{90}) and the probability for the 100 different genes to be formed spontaneously in 10 billion years is equal to 10^{-3000} is saved only in one and only one trivial way, proposed by Hart. Yes, this very improbable fact occurred on earth and in an infinite number of other planets that are not in any kind of communication with each other. This argument may be valid only if there is an infinitely Big Universe, where anything, one can think of, may happen (as e.g. one of Shakespeare's works may be written by a monkey who uses a typewriter eternaly).

But is indeed this explanation a serious one? I doubt that anyone who respects his/her logic will accept it. The possibility, however, for the creation of life in even one planet in our u-universe can be used as an undeniable proof that life under certain very probable conditions may be very abundant in our u-universe. Everybody who thinks about the creation of life takes it for granted that this very improbable fact occurred for the first time on Earth. I shall use the same arguments as Hart, to show that **at least in the supercluster where our galaxy belongs, intelligent life and life in general are very common events.** Well I accept the rarity of DNA molecules formation in the observable universe, but since Hart accepts that life has occurred at least once (on Earth), I simply transpose this unique event from Earth to one of the planets of the first generation of stars (population II), which possessed the suitable conditions for the development of life. The probability for the formation of a DNA molecule may be considered the same if we use either 10 billion or 3 billion years since the multiplier is 10^{-90} in the above calculation of Hart. The important condition that is accepted by any relevant theory is that planetary systems, which contain solid planets, presuppose events of supernovae explosions in the galaxies, since the heavy chemical elements are manufactured in such explosions.

According to what is known from our own planet, the elapsed time from the beginning of its formation from the gaseous masses and the dust, which both were circulating around in the intergalactic space and which started to condense under the action of gravity, up to the present epoch, is of the order of 4.6 billion years.

The age of the Universe is estimated between 15 to 20 billion years. I shall take as an average figure 17±2 billion years. For a little portion of time, according to the Big Bang theory (for about 1 million years in round numbers), the density of radiation

* The fifth force field I refer to, is the repulsive one of very short range that exists between the quarks inside the nucleons, as I explained in my previous works[(1)].

dominated over the density of matter. After the above time the density of matter became greater than that of radiation (de-coupling era) and the following recombination of electrons with protons resulted in the formation of hydrogen atoms. Although even now the details of the formation of stars and galaxies are not completely understood, the general opinion is that immediately after the recombination era the conditions for the formation of stars were ideal and during this period most of the stars were formed[(3)]. These stars were basically small (of the order of sun mass) but big stars (up to 1 million sun masses) were also formed. These giant stars had a short lifetime and eventually exploded (as huge supernovae), spreading around heavy elements (up to iron and beyond). These elements were mixed with the background hydrogen and helium and contributed to the creation of planetary systems in which some of the planets could develop solid crust permitting the development of life as it happened on Earth. Under conditions similar to those on Earth, intelligent life could have appeared after a period of about 5 billion years from the Big Bang time. If the formation of the proto-stars started after two billion years from the Big Bang it can be expected that the first civilization in the universe appeared after 7 billion years from the Big Bang.

So in one such planet that belonged to a galaxy of our Supercluster, at about 2 or 3 billion years after the Big Bang, this very rare event of the spontaneous formation of a DNA molecule just happened. The planet then would have an age of one billion years after the beginning of the condensation of the whole planetary system and the historical development of life very probably followed the same steps as on Earth. So after about 4 to 5 more billion years of planetary age, life on this planet achieved the creation of intelligence.

Somewhere between 6 and 7 billion years after the Big Bang the intelligent beings of this planet developed a technological civilization comparable to ours. At this period their sun, being a main sequence star, would have at least 4 or 5 billion years before turning into a red giant. If this civilization managed to overcome catastrophes due to internal and/or external causes (basically, according to my opinion, because of the achievement of telepathic communication among its members) it is rather absolutely certain that it had at least 4 billion years before being obliged to evacuate its planet. During this period of time it would have the opportunity to develop intergalactic travels at luminal or perhaps superluminal velocity and to explore and colonize its galaxy first and the rest of galaxies of its supercluster next. With these capacities this civilization will have today an age of 7 or 8 billion years ahead of us. So life on Earth may not be the first and unique in the Universe but it may have been implanted by this old civilization when realized that Earth (as well as many other planets) was a good place for the development of life and intelligence. In a not yet published book of mine, I explain in detail the relation between the members of the most advanced civilization with the primitives, us. It is amazing that this so simple argument that although accepts the difficulty for the spontaneous creation of a DNA molecule, by transposing this fact that happened on Earth to a planet of the first generation that started to condensate 2 or 3 billion years after the Big Bang, and by accepting that the civilisation that developed after 4 or 5 billion years later, succeeded to developing interstellar travels and to conquer a whole galaxy or more, seeded a lot of existing planets with the ingredients for life generation, making the dispersion of life in our u-universe a very common fact. Was it so difficult to be mentioned by even one scientist who has been involved in the problem of creation of life? Our civilisation, which has developed in, say, five or ten millenniums and has progressed so rapidly in the last 300 or 400 years, has already started interplanetary voyages. If the cold nuclear fusion will be achieved (pretty soon I hope since I am working on this subject) the interstellar travels will start inevitably. Since the other u-universes have a similar history as our own, life in them will also be abundant. In another presentation of mine (SETIcon 01 Technical symposium on April 2002 in the College of New Jersey Ewing, New Jersey of USA), by using certain very peculiar big number coincidences, I believe that I gave a very strong argument that in our universe – at least in the supercluster where our galaxy belongs- may exist civilisations the members of which may seem at least as semi-gods compared with us.

c. The idea that the laws of physics, the values of the basic constants and initial conditions cannot be different in the other u-universes is my immovable thesis. Many scientists wonder whether such a situation may be valid. I shall show that this is inevitable after the ideas I developed in my cosmological model in this book. For this reason let us see more analytically how all these ambiguities can receive a logic explanation on the basis of my model.

2. THE FINE TUNING

The question here is: Is the fine tuning given or made or predetermined by a super-intelligence or omnipotent being, or is it the result of the appearance of matter from the SPS via a MWH process? Let us examine first the role played by the three basic physical constants c, $\hbar$, G. This has already been analytically done in my SETIcon2 presentation and is contained in the proceedings of this symposium. I will summarise here my thesis that this fine tuning is inevitably a result of the way matter as we know it, appeared in the beginning i.e. when the Big U-Universe was born (i.e. came into existence in ordinary time). The new basic element I introduced in this investigation was the new metric I found in a previous paper of mine[(1)], which governs the White Holes (WH). This metric that governs the radial motion of an amount of mass from the center of the WH outwards, has the form:

$$ds^2 = +c^2 (1 + r_s/r)\, dt^2 + (1 + r_s/r)^{-1} dr^2 \qquad (1)$$

and differs basically from what was accepted till then by the Physics community i.e. that the metric of the WHs is the same with that for Black Holes (BH). This opinion was based on the idea that a WH was the time reverse of a BH, since mass is sinking inside a BH whereas mass is gushing out of a WH. So if we put in the BH metric (I speak about non rotating and electrically neutral BHs) instead of dt, -dt the metric remains unchanged since dt appears squared in (1). This however would lead to two unacceptable situations. If WHs exist in the universe as BHs do, then mass should emerge unceasingly from a WH and this effect could be observed not only in some remote galaxies (e.g. in quasars) but also in our nearby galaxies and why not in our bedroom. Since such phenomena have not been observed, something must be wrong with the way the WHs were treated. For this reason I came to the conclusion that huge WHs cannot exist. I cannot say the same, however, for the small or Mini White Holes (MWHs) as I called them, which cannot disobey the basic law of QM, i.e. the Heisenberg's Uncertainty Principle. So the appearance of an amount of matter that emerges from a MWH will not violate the law of mass-energy conservation since the Uncertainty Principle permits the existence in time of an amount of mass-energy, as long as the energy-time uncertainty relation is obeyed. Of course, as I showed in C5, the described transformations of the appeared MWHs made their existence permanent as the basic ingredients of the ordinary matter.

In deriving relation (1) I introduced the idea that inside a MWH*, time is imaginary, since we cannot observe what happens in this region, where all laws of physics break down, according to a general acceptance. This general acceptance refers to dimensions of the order of Planck length. So the MWHs should have dimensions of this order of magnitude. For this reason, in deriving eq. (1) from the Schwarzschild solution for BH, I replaced t with (it). In my previous work I obtained from eq. (1) the relation:

$$dr/dt = c(r_s/r)^{1/2}(1+r_s/r) \tag{2}$$

Integration of the above equation with initial conditions t=0, r=0, leads to an expression of t in terms of r:

$$t = (2r_s/c)\{(r/r_s)^{2/3}/3 - (r/r_s)^{1/2} - \tan^{-1}(r_s/r)^{1/2} + \pi/2\} \tag{3}$$

The time t is the real time the outgoing spherical surface requires to cross the distance r from the center of the MWH. In my work(1) I identified this time with $\Delta t = \hbar/(2m_x c^2)$ that determines according to the Uncertainty Principle, the time needed for a mass m_x to cross a distance $r_q = \hbar/(2m_x c)$ with velocity c. The radius r_q is the quantum radius of a mass m_x. More details of the calculations may be found in my previous work(1).

What I managed to get out from these calculations were the following:

The mass $$m_x = \frac{1}{2\sqrt{x}}\left(\frac{\hbar c}{G}\right)^{1/2} = 5.0437884\cdot 10^9\,kg = \frac{1}{2\sqrt{x}}M_{Pl} \tag{4}$$

where $x = r_q / r_s = 4.65621955$ and has to be a universal numerical constant. I managed (in Ref.1) to relate this constant with another numerical one, discovered by M. Feigenbaum, which is equal to 4.669201609, by a simple formula. The meaning of this relation may hide some deeper message, which requires further investigation. But this cannot be done in the present discussion. Using the above value of m_x I found:

$r_q = 3.4871365\ 10^{-35}$m = 2.1579 L_{Pl} (L_{Pl} is the Planck length $\left(\frac{G\hbar}{c^3}\right)^{1/2}$ as it is given by definition). Similarly M_{Pl} is the Planck mass given by the expression $\left(\frac{\hbar c}{G}\right)^{1/2}$). It was also found that:

$$r_s = 7.4892003\ 10^{-36}\,m = r_q / x. \tag{5}$$

The radius r_s, however, is only a parameter and if we replace it by its equivalent r_q / x, ceases to play any significant role since we are dealing with a white hole and not with a black hole

What is important from the above analysis is that r_q and m_x are of the same order of magnitude with the Planck length and Planck mass. Since on the one hand, the Planck units have been derived by using dimensional analysis among the constants c, ħ, G, whereas on the other hand the corresponding magnitudes m_x and r_q are the result of

* The WH has an event horizon, just like the BH, as long as the amount of mass m_x that starts from the center of the WH has not crossed the distance $r = 2Gm_x/c^2$, which by definition is the Schwarzschild radius. This horizon, however, is surpassed by the emanating mass and since according to what is said in previous papers, the emanating mass is distributed on the surface of an expanding sphere, when it crosses the above horizon, inside remains no mass, an absolute emptiness I could say.

the new metric I introduced for the MWHs, it is very probable that m_x and r_q correspond to existing physical magnitudes. As it is known, dimensional analysis cannot determine a possible numerical constant that may be a multiplier of the result of dimensional analysis.

Let us see now how the above results may help our basic problem that is the fine tuning hypothesis.

Relation (4) expresses the maximum mass that can emerge from a MWH. So this is the mass of the heaviest elementary particle that can be created in the universe. Since $r_q = \hbar / 2m_x c$, replacing expression (4) in this relation we obtain:

$$r_q = \sqrt{x}\left(\frac{G\hbar}{c^3}\right)^{1/2} = \sqrt{x}L_{Pl} \tag{6}$$

Similarly:

$$t_q = \frac{r_q}{c} = \sqrt{x}\left(\frac{G\hbar}{c^5}\right)^{1/2} = \sqrt{x}T_{Pl} \tag{7}$$

In (4), (6), (7) the quantities in brackets raised to the ½ power are nothing else than the Planck units. From (4), (6), (7) therefore we solve for c, $\hbar$, G and we obtain:

$$\hbar = \frac{2m_x r_q^2}{t_q} \tag{8}$$

$$G = \frac{r_q^3}{2xm_x t_q^2} \tag{9}$$

$$c = \frac{r_q}{t_q} \tag{10}$$

What do expressions (8), (9) and (10) say is that the basic universal constants of nature are not original. They are derivable from some more primary ones that are expressions of the maximum elementary particle mass, the minimum length and the minimum time interval that may be measured (although we do not posses for the time being the means to perform such measurements. This cannot be impossible for a civilization one million or billion years ahead of us). Can it be denied that the concepts of mass, length and time and particularly as they were used in (8), (9), (10) are more fundamental than the concepts of the maximum velocity c, the least action $\hbar$, and the constant of gravitation? If not, then the c, $\hbar$, G do not need a special fine tuning to allow the creation of the universe or the appearance of life in it. In addition, the magnitudes of m_x, r_q, and t_q were determined from a theory on MWH, which involves two basic relations: The new metric I found for the MWH and the Uncertainty Principle. This last one in its most general expression does not contain the Planck constant $\hbar$, as it is shown in APPENDIX 1 below. In the first one too, the velocity of light c may be replaced by its expression (10) and the gravitational constant G only implicitly enters through the Schwarzschild radius r_s (which radius can also be measured in principle by an advanced civilization). So both these relations do not require a fine tuning. If we take into account the results of C1 of this book, the existence of an abstract space where the development of the probability for the appearance of an amount of matter in the quantum level occurs in a strict mathematical formulation, then this space is the generator of our u-universe as well as of the U-Universe as I described in C5. In C1 the Klein-Gordon equation I used contains also the constants c, $\hbar$, which also can be replaced by their equivalent expressions (9) and (10). So the fine tuning of the basic constants of nature that has puzzled so many scientists does not need any external or supernatural intervention. And as I explained in C3 and C5 the concept of the electric charge and of the spin of elementary particles was hidden in a latent state in the SPS.

CONCLUSION

From the foregoing discussion, I hope that I have presented enough evidence that the fine tuning of the basic physical constants (c, $\hbar$, G, electronic charge e and spin $\hbar/2$ for quarks and leptons) are the inevitable results of my cosmological model. The only laws I used were the new metric for the MWHs and the uncertainty principle, which as is shown in Appendix 1 does not necessarily involve any physical constant in its general expression. About the abundance of technological civilizations in our u-universe, I would advise the reader to read my mentioned presentation in the Proceedings of the SETIcon 1 of 2001 Technical Symposium, where the ideas I develop about some very curious numerical coincidences, make the balance to turn decisively towards the existence of trillions of advanced civilizations in our u-universe. So the Anthropic Cosmological Principle, which for several decades is in the middle of controversial discussions among physicists, cosmologists (and philosophers), about its necessity for the explanation, not only of life based on chemical processes but also on the ways the physical laws and the basic constants of nature are somehow fine tuned, may be utterly abandonedr. For a better understanding of the above proposition, I will give a brief summary of my theory as it is presented in this book.

The appearance, not only of our u-universe, but of the Big Universe too, is the result of the development of the PROBABILITY in the SPS for the emergence of what I have called "protomass", which as I described in the previous papers, undergoes certain self-supported transformations that finally lead to the mass as we perceive it now. What is the stuff that consists the protomass do not ask me or any body else. The unique definition I can attach to it is that it is "something" or better a "Potentiality" that emerges from the SPS through a MWH process and finally constitutes the whole stuff of what we call UNIVERSE. All the basic characteristics of the formatted elementary particles are hidden in a latent state in the SPS. This Platonic-like point of view, in no way can be taken as a return to the conflict between idealism and materialism of the philosophy of the past. The IDEA is replaced by the PROBABILITY, which is a mathematical concept that permits the generation of matter in a complete deterministic manner. The reader is called to choose which of the following sources that have been usually mentioned as the state (or "place") where the stuff of our universe came from, is more logically acceptable; the vacuum, the false vacuum, the chaos, the zero, the "nothing", the effect of the will of an unknowable supreme being etc., or the SPS that has allowed the development of the abstract concept called Probability for the appearance of the stuff of the universe?

Someone, of course, may reasonably ask: The values of the minimum length and time and of the maximum elementary mass cannot be considered as fine tuned by some unknown supreme being? My answer to this question is: The equations I used were: a) The new metric for the MWHs. As I showed in the preceding sections the appearing velocity of light c and the Schwarzschild radius r_s, do not require a fine tuning. The r_q is taken as the unit of the minimum measurable length. In fact it separates two quite distinct spaces. The SPS and the 3+1 ordinary space we live in, i.e. an abstract imaginary space from a three-dimensional real space. As the concept of Probability is eternal in the sense that it does not require another probability in order to exist, it is natural to expect that the SPS is eternal too and so is the radius r_q, i.e. the existence of this minimum length is imposed by the eternal existence of the probability in the SPS b) The Uncertainty relation as it is derived in Appendix 1 below, but in its time-energy form. If such a relation as the one in expression (A14) of Appendix 1 must be considered as due to some fine tuning then any mathematical relation such as e.g. $a^2 - 1 = 0$ should be expected to be fine tuned, since it is valid only for the special values for $a = \pm 1$. 3) The Klein-Gordon Equation of the relativistic QM. So everything depends on the acceptance of the existence of the SPS. If its existence is accepted then the origin of the Big Universe and of the small universes becomes clearer than before the presentation of my cosmological model.

APPENDIX 1

Although what follows, can be found in various versions in most textbooks of Quantum Mechanics, a derivation of mine, which is contained in a book I published in Greek under the title "Elements of Quantum Mechanics" supports my claim that the Uncertainty Principle is a more general one than its usually referred versions that involve position and momentum or time and energy. (I make use of the Dirac notation)

If we denote by $<A>$ the average of a series of measurements of the magnitude A and $\hat{A}$ is a random measurement, then the quantity:

$$\Delta A = (<(\hat{A} - <A>)^2>)^{1/2} \qquad \text{(A1)}$$

is called mean square deviation or uncertainty and the $(\Delta A)^2$ is called the Variance of the measured magnitude, where the brackets <> under the square root, mean an average quantity.

Let now $\delta\hat{A} = \hat{A} - <A>$. So:

$$\Delta A = (<(\delta \hat{A})^2>)^{1/2} \qquad \text{(A2)}$$

We already know that the average value of an observed magnitude is given by the relation:

$$< \hat{X} > = <\Psi| \hat{X} |\Psi> \qquad \text{(A3)}$$

We define the vectors:

$$|\alpha> = \delta\hat{A}|\Psi> \quad \text{and} \quad |\beta> = \delta \hat{B} |\Psi> \qquad \text{(A4)}$$

$$\text{So: } \Delta A = \sqrt{< \Psi\left|\delta\hat{A} \cdot \delta\hat{A}\right|\Psi >} = \sqrt{< \alpha|\alpha >} \qquad \text{(A5)}$$

$$\text{since } <(\delta \hat{A})^2> = <\Psi|(\delta\hat{A})^2|\Psi> = < \Psi\left|\delta\hat{A} \cdot \delta\hat{A}\right|\Psi > \qquad \text{(A6)}$$

and similarly: $\Delta B = \sqrt{<\Psi|\delta\hat{B}\cdot\delta\hat{B}|\Psi>} = \sqrt{<\beta|\beta>}$ (A7)

So if we multiply (A5) and (A7) with each other we obtain:

$$\Delta A\cdot\Delta B = \sqrt{<\alpha|\alpha><\beta|\beta>} \quad \text{(A8)}$$

By using the Schwartz inequality expressed by: $|<\alpha|\beta>|^2 \leq <\alpha|\alpha><\beta|\beta>$ as well as the fact that: $|<\alpha|\beta>|^2 \geq [\text{Im} <\alpha|\beta>]^2$ (Because let $<\alpha|\beta> = x+iy$ hence $|<\alpha|\beta>|^2 = x^2 + y^2$ and Im $<\alpha|\beta>$ is the imaginary part of $<\alpha|\beta>=y$, i.e. $(\text{Im} <\alpha|\beta>)^2 = y^2 \leq x^2 + y^2$) we obtain:

$$<\alpha|\alpha><\beta|\beta> \geq (\text{Im} <\alpha|\beta>)^2 \quad \text{(A9)}$$

But $\text{Im} <\alpha|\beta> = \frac{1}{2i}\left[<\alpha|\beta> - <\beta|\alpha>\right]$ (A10)

(since Im(x+iy) = (1/2i) [x+iy-(x-iy)]) so that:

$$\text{Im} <\alpha|\beta> = \frac{1}{2i}\left[<\Psi|\delta\hat{A}\delta\hat{B}|\Psi> - <\Psi|\delta\hat{B}\delta\hat{A}|\Psi>\right] \quad \text{(A11)}$$

Where the left hand side of the above equality is the average value of the permutator $[\delta\hat{A},\delta\hat{B}]$. So:

$$\text{Im} <\alpha|\beta> = \frac{1}{2i}<\left[\delta\hat{A},\delta\hat{B}\right]> = \frac{1}{2i}<\hat{A},\hat{B}> \quad \text{(A12)}$$

This means that: $(\Delta A\cdot\Delta B)^2 \geq \left[\text{Im}<\alpha|\beta>\right]^2 = \left[\frac{1}{2i}<\hat{A},\hat{B}>\right]^2$ (A13)

Or: $\Delta A\cdot\Delta B \geq \frac{1}{2i}<\left[\hat{A},\hat{B}\right]>$ (A14)

The above expression (A14) is the most general statement of the Uncertainty Principle. If the observed magnitudes are compatible i.e. if $[\hat{A},\hat{B}] = (\hat{A}\hat{B} - \hat{B}\hat{A}) = 0$ then ΔA and ΔB may simultaneously be equal to zero, i.e. the quantities A and B may be determined simultaneously with any precision we like. Else if $[\hat{A},\hat{B}] = (\hat{A}\hat{B} - \hat{B}\hat{A}) \neq 0$, the more accurately we determine A the less accurately we can measure B. What is important to be noticed is that in (A14) none of the basic constants of nature are involved. So this basic law (or Principle) of nature does not require any fine tuning. The Planck constant $\hbar$ is introduced in (A14) when the A and B magnitudes correspond to the position and momentum of a particle (or the energy and the time duration one particle may posses it, although for this last case there are some different points of view) since these physical magnitudes are not compatible as e.g. the x and y coordinates of a particle.

(The fact that $\left[\delta\hat{A},\delta\hat{B}\right] = \left[\hat{A},\hat{B}\right]$ results as follows:

$$\delta\hat{A}\delta\hat{B} - \delta\hat{B}\delta\hat{A} = (\hat{A} - <a>)(\hat{B} - <B>) - (\hat{B} - <B>)(\hat{A} - <A>) = \hat{A}\hat{B} - \hat{A}<B> -$$
$$<A>\hat{B} + <A><B> - \hat{B}\hat{A} + \hat{B}<A> + <B>\hat{A} - <B><A> = \hat{A}\hat{B} - \hat{B}\hat{A} = [\hat{A},\hat{B}])$$

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