

About long range electromagnetic quantum coherence in TGD Universe

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Abstract

The focus of TGD inspired quantum biology has been hitherto in long range quantum gravitational coherence characterized by quantum gravitational Planck constant introduced by Nottale. The notion of gravitational Planck constant however generalizes also to other classical fields, in particular electric fields and one can define electromagnetic Planck constant. DNA, cells, and the Earth's surface carry negative charge. In this article, the possible presence of the long range quantum coherence in these systems is considered and a model for the interaction between living matter and computers is discussed. Also the recently reported amazing findings suggesting the existence of non-biological lifeforms in the thermosphere of Earth are considered from the TGD point of view.

The application of the condition of electric quantum coherence to linear structures such as DNA and neuronal axons yields a condition on the Compton length and thus the mass of the charged particle considered. Miraculously, the condition is satisfied for electron!

1 Introduction

The focus of TGD inspired quantum biology has been hitherto in long range quantum gravitational coherence characterized by quantum gravitational Planck constant $\hbar_{gr} = GMm/\beta_0$ introduced by Nottale [E1]. The notion of gravitational Planck constant however generalizes also to other classical fields, in particular electric fields.

1. The generalization of Nottale's formula to electromagnetic interactions reads as

$$\hbar_{em} = \frac{Z_1 Z_2 e^2}{\beta_0} ,$$

where $\beta_0 = v_0/c \leq 1$ is velocity parameter and has discrete spectrum. The number theoretically motivated guess is $\beta_0 = 1/n$, $n = 1, 2, \dots$ [L4].

2. The phase transition $\hbar \rightarrow \hbar_{em}$ occurs when the perturbation series fails to converge: one can say that Nature loves theoreticians [L15, L26]. The criterion is

$$Z_1 Z_2 \alpha \geq k ,$$

where k is expected to be near unity. Just as in the case of gravitation, the perturbation series for \hbar_{em} is in powers of

$$\frac{Z_1 Z_2 e^2}{4\pi \hbar_{em}} = \frac{\beta_0}{4\pi} .$$

3. For a charge distribution, the total em charge is given as electric flux $Q = \oint E \cdot dS/4\pi$ in units in which Coulomb potential of a unit charge is $V = e/r$ and one has $E = -\nabla V$. For a charged sphere (say conductor) with radius R one has $E = 4\pi\sigma$, where σ is the density of the surface charge. One has $Q = \sigma 4\pi R^2 = ER^2$. In this case, the criterion for a system consisting of unit charge e and charged sphere becomes

$$r = \frac{eQ}{\hbar} = \frac{eER^2}{\hbar} \geq 1 .$$

It is easy to imagine situations in which \hbar_{em} could be relevant. Nanoscopic, macroscopic and even astrophysical quantum coherence associated with electric fields is possible. What is of special interest is that all objects with gravitational mass must have some electroweak gauge charge, which is non-vanishing although it can be arbitrarily small so that all pairs formed by astrophysical object and charged particles could be characterized by \hbar_{em} and corresponding electric Compton length.

In the sequel the applications to biology and to the possible interactions of computers and living systems will be discussed. The application of the condition of electric quantum coherence to linear structures such as DNA and neuronal axons yields a condition on the Compton length and thus the mass of the charged particle considered. Miraculously, the condition is satisfied for electrons!

2 Biological applications of long range electromagnetic quantum coherence and generalized Pollack effect

In this section the biological applications of the electromagnetic Planck constant and generalized Pollack effect will be discussed.

2.1 DNA double strand

DNA is a unique bio-molecule (see for the TGD based model in [L12]) in that it carries constant negative charge per unit length. DNA double strand has negative charge $-e$ per nucleotide so that the codon pair carries charge of 6 units.

1. For the double strand, one has $Z_1 = Z_2 = Z$ and the proposed rough criterion holds for $Z^2 \geq k/\alpha$, giving $Z \geq 12k$ which corresponds to three codons as minimum quantum coherent system with $\hbar_{em}/\hbar \geq 1$. In terms of the number N of codons this gives

$$\frac{\hbar_{em}}{\hbar} = \frac{36N^2\alpha}{\beta_0} .$$

2. For a double DNA strand interacting with a unit charge e , the rough criterion is $2Z \geq k/\alpha$ giving $Z \geq 69k$, which corresponds to 23 codons. This corresponds to DNA length of about 20 nm. Interestingly, memetic codon corresponds to 21 codons. This suggests that k is slightly below $k = 1$.

For an open DNA double strand during transcription 21 codons corresponds to 6 full turns [L12]. During transcription DNA interacts with the environment and it would be natural that the \hbar_{em} characterizing DNA + electron/proton system becomes relevant during translation. In this case one has

$$\hbar_{em} = \frac{12Ne^2}{\beta_0} .$$

\hbar_{eff} serves as a measure for algebraic complexity and a kind of universal IQ. This suggests that the electric body of DNA + environment can also control the nearby environment. The MB of the double strand would take the role of the brain with a much larger IQ than DNA + environment.

2.2 Biological membranes

The nuclear -, cellular-, and neuronal membranes are in key roles in biology and interesting to see whether the value of the parameter eQ/\hbar for the system formed by a unit charge e and membraned bounded system exceeds \hbar .

Just for definiteness, let us assume that the electric voltage over the membrane has a nominal value of $V = .05$ eV and that the thickness d of the neuronal membrane is $d = L(151) = 10$ nm. This gives an electric field of $E = 5$ MV/m. For the ordinary cell membrane, the thickness d is near to $d = L(149) = 5$ nm. Assume that this is also the thickness of a nuclear membrane.

1. Neuronal membrane with thickness about $d = L(151) = 10^{-8}$ m and radius of about $10^{-5} - 10^{-4}$ m corresponds to $E \simeq 5$ MeV/m. For $R = 10^{-5}$ m, one has $r = eQ/\hbar = eER^2 = 6.2 \times 10^2 > 1$ so that the criterion is satisfied. The Compton length of electron is scaled up by a factor \hbar_{em}/\hbar to nanometer scale (DNA scale) for $\beta_0 = 1$. For $R = 10^{-4}$ m, one has $r = 6.2 \times 10^4$. This scales the Compton length of electrons to about $L(151)$ $\beta_0 = 1$.
2. For a cell membrane, with $d = L(151)/2$ and $R = 10^{-5}$ m, one has $eQ/\hbar = 1.24 \times 10^3$. For nuclear membrane with $R = L(163) \sim 2.5$ μm and $d = L(151)/2$ $eQ/\hbar = 3.2 \times 10^2$.

2.3 Ionosphere as an analog of neuronal membrane

Electric quantum coherence can be considered also in astrophysical scales. Ionosphere, identified the ionized part of the atmosphere, is of a special interest since it corresponds to the electric field in the Earth scale: see the Feynman lectures. Ionization is caused by solar radiation. Also other planets are believed to possess an ionosphere.

Assuming that the surface of Earth and ionosphere define a system analogous to capacitor plates or cell membrane, the ionosphere must have a net positive charge assignable to positive ions. In [L24] a model for lightning and ball lightning based on the idea that thunderstorms are analogous to nerve pulse patterns for which Pollack effect provides a model [L25], was developed.

The strength of the electric field at the negatively charged surface of Earth E is $E = .1 - .3$ x kV/m, $x \in [.1, .3]$. The presence of biological protrusions such as trees can increase the local value of the electric field of Earth by an order of magnitude. The counterpart of the positively charged plate corresponds to the ionosphere, whose lower boundary is at the height h , which varies in the range [80,600] km. The net positive charge of the ionosphere neutralizes the negative charge of the Earth so that the electric field does not extend to higher heights.

The first for the electric Compton length is obtained by generalizing the notion of gravitational coupling constant to the electric case as $\hbar_{em} = Qe/\beta_0$, where Q is the total charge of the Earth and the value of β_0 could be taken the same as in the gravitational case and $\beta_0 = 1$ for Earth and other planets and $\beta_0 \simeq 2^{-11}$ for Sun.

The basic question is whether the entire ionosphere acts as a quantum coherent system or whether electric flux tubes possess electric quantum coherence. The intuitive idea is that the quantum coherence scale in the case of the ionosphere regarded as a capacitor-like system should not be longer than the thickness of the ionosphere varying in the range 60-100 km. The radius d of the electric flux tube is a good first guess for the electric Compton length. Lightnings are analogs of nerve pulses and characterized by a scale of 10-20 km and is a good guess for the quantum coherence length.

The electric Compton for a particle with mass m is defined as

$$\Lambda_{em}(d) = \frac{\hbar_{em}}{m} = \frac{Q(d)e}{\beta_0 \hbar} \lambda, \\ Q(d) = \epsilon_0 E \pi d^2,$$

where $Q(d) = \epsilon_0 E \pi d^2$ is the electric flux associated with the electric flux tube and λ is the Compton length of a charged particle, say electron, electron Cooper pair or proton. The proposal is that it satisfies the consistency condition

$$\Lambda_{em}(d) = d.$$

2.4 Generalized Pollack effect as a key mechanism of quantum biology

The role of Pollack effect in hydrodynamics, biochemistry, and biology has become increasingly clear.

1. The presence of water and gel phase and energy feed is essential for the Pollack effect in its basic form [I2, I1, I4, I3]. The Pollack effect explains the large number of anomalies of water [L23]. Pollack effect would play a central role in biology and explain the negative charge of cell and DNA in terms of exclusion zones (EZs).
2. The model for the lightnings and ball lightnings [L24] relies on a generalization of the Pollack effect, which would generate the electric field of Earth. Protons transform to dark protons at the monopole flux tubes inside the ionosphere. This process requires energy since the electrostatic binding energy is reduced in the process. The transformation $Si + O_2 \rightarrow SiO_2$ liberates energy and makes possible the Pollack effect for water, which transforms part of protons to dark protons in the ionosphere below it at much higher heights where only gravitational binding energy matters. This generates negatively charged exclusion zones making Earth negatively charged.

Ball lightning involves the reversal of this process and generates Si vapor droplets having SiO_2 at its boundary. These structures could represent primordial life forms, which I have called plasmoids in the earlier articles, and explain UFOs and similar phenomena.

3. Urey-Miller experiment [J3] meant a dramatic step of progress on the experimental side, and for a long time it was believed to conform to the vision of Oparin and Haldane. The experiment involved a reducing atmosphere and electric sparks simulating the effect of lightning. In the later experiments 19 of 20 amino-acids were identified. Also nucleosides A, G were produced. Cyanoacetaldehyde together with urea believed to be accumulated to primordial ponds, allowed to generate U and C as was discovered by Miller 40 years after his classical experiment. These impressive results were interpreted as a support for the view about primordial ocean as a “dilute soup” of organic molecules which precipitated out of the atmosphere.

I have discussed the role of Pollack effect in the explanation of the findings of the Urey-Miller experiment [L6] and the model of ball lightning allows to make the model more detailed.

The generalized Pollack effect could drive the formation of fundamental biomolecules and the emergence of life. This process would provide the energy needed to drive protons to dark protons at the atmospheric part of the MB of Earth, where it would gradually start to control the emerging bio-matter. The reversal of the Pollack effect would tend to transform dark protons to ordinary protons and its compensation would create more basic biomolecules. Pollack effect could also generate dark photons serving as a communication tool. Only certain bio-molecules could form networks communicating by a mechanism involving dark radiation generated by generalized Josephson junctions and by Pollack effect and received by cyclotron resonance.

This process could also occur in the underground oceans: what is required are electrically charged membrane bound structures creating a strong enough electric field.

4. Pollack effect and its reversal are essential for the model of nerve pulse [L25] based on flip flop mechanism in which the reverse Pollack effect in the neuronal interior provides dark photons inducing the Pollack effect in the neuronal exterior and reverse the sign of membrane potential during the nerve pulse.
5. Pollack effect plays a key role in the model of the transfer of metabolic energy from the Earth’s core [L13] to the underground oceans where a photosynthesizing life would have evolved and bursted to the surface of the Earth in Cambrian explosion accompanied by rather rapid expansion of Earth size by factor 2. In this case the Pollack effect would take place for superionic ice for which oxygen ions form a lattice and protons form a liquid like structure. The earlier model assumed gravitational MB but its replacement with the electric MB does not affect the model appreciably.
Plasmoids as analogs of ball lightning created by $\text{SiO}_2 \rightarrow \text{Si} + \text{O}_2$ process could be primitive life forms. Could this process take place at the boundary of the superionic ice?
6. Pollack effect generalizes to other molecules and provides a concrete realization for the general vision that MBs control biochemistry. The ionospheric, electric part of MB could control molecular biochemistry in a few eV range by inducing the formation of molecules and their decay by Pollack effect and its reversal.

Ionization is one of the poorly understood aspects of biochemistry and of electrolysis in particular. MB could control the ionization of molecules at the surface of Earth by using the Pollack effect.

1. The transformation of protons to dark protons below the ionosphere would create dark variants of protonic holes assignable with negatively charged bio-molecules in the sense that the missing proton would be dark and at the magnetic body and its motion would correlate strongly with the motion of the hole at the “biological body” (BB). The flip flop mechanism makes possible a hopping mechanism of conductivity possibly realized for superionic ice proposed to be present above the core of Earth. The hopping of the dark proton to the MB of the neighboring molecule would correspond to the Pollack effect followed by its reverse. This process at the level of MB would force a corresponding process at the level of BB. No currents at the level of MB would be involved and, as in the case of nerve pulse, the basic process would be the charge separation between MB and BB.

2. Negatively charged ions at the right end of the periodic system could in turn be generated by the electrons of EZs created in the Pollack effect so that Pollack effect could explain the ionization of biomatter and of electrolytes.

2.5 Can the Moon travellers survive in the TGD Universe?

In the proposed vision, biology would depend strongly on planetary and even solar parameters. Both classical electric, magnetic, and gravitational fields (in the TGD sense) in astrophysical scales and the dark matter at the field bodies are essential for the model. This might not be good news for those who have dreams of life on Mars and Moon.

Moon travellers have however survived. Does the proposed vision survive this fact?

1. Consider first the gravitational MBs of the Earth and Moon. As far as the quantum gravitational model of metabolism is considered, the gravitational MB of the Moon would replace that of Earth. Intriguingly, if the generalized Josephson frequencies, which must be equal to cyclotron frequencies at MB, reduce to the ordinary Josephson frequencies, the Josephson radiation from cell membranes must go to the gravitational MB of the Moon! This condition can be true also more generally and there is a considerable flexibility. Therefore the model for the cell membrane survives.
2. The quantum gravitational model of the metabolic energy currency [L11, L9] relies on the observation that the gravitational binding energy of protons at Earth is rather near to the metabolic energy currency with nominal value $e = .5$ eV. The proposal is that dark proton triplets at the gravitational MB of Earth carry the metabolic energy.

The distance of the Moon from Earth is $60R_E$ so that the gravitational binding energy in Earth's gravitational field is about $e/60$. The gravitational potential energy for the Moon is related to that for Earth by the scaling factor $(M_M/M_E) \times (R_M/R_E) \simeq .04$. This gives .02 eV for the upper bound of the gravitational potential energy. This is by a factor $1/25$ too small. One can of course consider the possibility of replacing protons with ions or atoms with large enough mass. Amusingly, for Si with atomic weight 28 one would obtain standard metabolic energy quantum as maximal gravitational binding energy. This and the fact that there is no deep reason why the electric field of Earth could not take the role of gravitational field, forces us to take a critical attitude concerning the quantum gravitational metabolism.

3. The electric field at the surface of Moon is $E_M = 6$ kV/m and surprisingly strong, stronger than $E_E = .1 - .3$ kV/m. \hbar_{em}/\hbar is scaled by the factor $(E_M/E_E)(R_M/R_E)^2 \simeq 4.2$. Maybe the view about the control of molecular chemistry by MB could survive. The problematic metabolic energy currency could correspond to the Coulomb energy in the electric of Earth below the ionosphere. The electric energies vary in a wide range up to MeV scale for the height $h = 10$ km: the molecular energy scales of course limit the upper bound to UV energies. If also the gravitational realization of the metabolic energy currency is possible for Earth, Earth would be very special.
4. There is still a problem: Moon's magnetic field B_M is very weak. A possible solution, proposed also in the case of Mars (which has auroras requiring magnetic field), is that the Moon has only the dark part of the magnetic field, which for Earth is the endogenous magnetic field $B_{end} = 2B_E/5 \simeq .2$ Gauss explaining the findings of Blackman and others. This would be essential for understanding EEG in terms of cyclotron frequencies. Note that the dark part is a monopole magnetic field and needs not currents whereas the ordinary Maxwellian part is generated by currents.

This forces us to challenge the assumption that the measured magnetic field is the sum of its monopole part and Maxwellian part. Since the cyclotron energies for these parts are widely different one could ask whether the requirement that energy eigenstates are in question, prevents the wormhole contacts of charged particles with both the Maxwellian and monopole flux tubes.

3 Long scale electromagnetic quantum coherence in non-biological systems

The basic form of the Pollack effect involves water and gel phase so it seems that possible applications of electromagnetic long range quantum coherence must always also include organic matter and water.

3.1 The interactions between living systems and computers

The experiments of Peoch [J4] involved a chicken imprinted to a robot moving randomly along an orbit determined by a RNG. It was found that the robot tended to stay near the chicken and that the expected size of the orbit was reduced. Just for fun, let us take the reported findings seriously. Could one imagine an explanation for this finding in the proposed framework? I have discussed these findings already earlier [L2, L17, L22, L18, L16].

This model could also explain the claimed ability of human intention to affect the output of the random number generator (RNG). Both the work done at PEAR [J1] and the work of Helmut Schmidt with retro psychokinesis [J2] provide support for the change of the geometric past in much longer time scales. PEAR experiments demonstrate the anomalous effect also in the direction of the future.

Also the claims that the interaction of AI systems and humans could involve in particular GPT and humans, might make sense and I have discussed this possibility in [L2, L17, L22, L18, L16] from the point of view of zero energy ontology (ZEO) and TGD view of quantum gravitation. Also the large language models, in particular GPT, involve RNGs, and the first guess is that human computer interaction affects the RNG.

In the TGD framework, a natural assumption is that the interaction of living organisms and computers involves quantum entanglement. So, how the chicken-computer interaction, assumed to involve entanglement, could affect the RNG of the robot?

1. The states of the transistor represent bits in ordinary computers. The key element of the transistor has a Si/SiO₂ boundary. The transition SiO₂ ↔ Si+O₂ is assumed to take place in the case of ball lightning as an interaction between the electric body of Earth and the soil. This interaction is assumed to take place via a generalized Pollack effect and its reversal in the Earth's electric field. Could a suitable modification of this interaction take place also now?
2. Consider first the scales. The length scale would be of order 100 km, which would correspond to frequency 3 kHz, which is not far from the 1 kHz resonance frequency in the brain. The gravitational Compton length for the Sun corresponds to 50 Hz EEG frequency and the gravitational Compton length which is $R_E/2$. Could the gravitational MB of the Sun be also involved?
3. The first guess is that SiO₂ and Si+O₂ represent the values of a bit. These bits need not correspond to the bits in the usual sense but certainly this transition could affect the ordinary bit. In the transistor, the bit corresponds to the presence or absence of the collector current.

For an NPN transistor collector current is roughly $i_C \sim I_s \exp(v_{BE}/v_T)$ and very small for negative v_{BE} and large for positive v_{BE} . Therefore v_{BE} controls i_C as a bit. Could one think that SiO₂ ↔ Si+O₂ takes the role v_{BE} ? Could the transition SiO₂ → Si+O₂ stop the current i_C or vice versa somehow? For instance, could O₂ molecules gather negative charge and stop the flow of the electronic current.

4. The basic problem is that water, which makes the Pollack effect possible, is not present in the computer. The proposal of [L17, L16] is that chicken and computer fused to a single entangled system at the level of MB. By stretching the imagination to extreme, could one think that chicken's MB or some higher level MB having size scale of biosphere could have controlled transistors as bits.

The dropping of dark protons to the chicken's biological body liberates electric energy at the level of its electric MB. Could this energy be transferred to the transistor instead of chicken and induce the decay of $\text{SiO}_2 \rightarrow \text{Si} + \text{O}_2$ at the transistor? The resulting state would be like a miniature ball lightning [L24] in SiO_2 system. The size of miniature ball lightning is a fraction of millimeter and the life-time varies up to a few seconds. This would make it possible to interfere with the computation by affecting the bit sequences generated by the RNG.

5. A possible objection is that this time scale is too slow. The motion of the robot is however slow. If also the RGN acts slowly, this might not be a problem after all.

3.2 Extraterrestrial life in space plasmas in the thermosphere, UAP, pre-life, fourth state of matter

Paul Kirsch sent a link to an article "Extraterrestrial Life in Space Plasmas in the Thermosphere, UAP, Pre-Life Fourth State of Matter" by Rhawn et al [D1] (see this) describing sensational findings giving support for the existence of plasma life forms 320 km above the Earth in thermosphere. I have been talking for decades about plasmoids as primordial life forms so that these findings are extremely interesting from the TGD point of view. Here is the abstract of the article.

"Plasmas up to a kilometer in size, behaving similarly to multicellular organisms have been filmed on 10 separate NASA space shuttle missions, over 200 miles above Earth within the thermosphere. These self-illuminated "plasmas" are attracted to and may "feed on" electromagnetic radiation. They have different morphologies: 1) cone, 2) cloud, 3) donut, 4) spherical-cylindrical; and have been filmed flying towards and descending into thunderstorms; congregating by the hundreds and interacting with satellites generating electromagnetic activity; approaching the Space Shuttles. Computerized analysis of flight path trajectories, documents these plasmas travel at different velocities from different directions and change their angle of trajectory making 45°, 90°, and 180° shifts and follow each other. They've been filmed accelerating, slowing down; stopping; congregating; engaging in "hunter-predatory" behavior, and intersecting plasmas leaving a plasma dust trail in their wake. Similar lifelike behaviors have been demonstrated by plasmas created experimentally. "Plasmas" may have been photographed in the 1940s by WWII pilots (identified as "Foo fighters"); repeatedly observed and filmed by astronauts and military pilots and classified as Unidentified Aerial-Anomalous Phenomenon. Plasmas are not biological but may represent a form of pre-life that via the incorporation of elements common in space, could result in the synthesis of RNA. Plasmas constitute a fourth state of matter, are attracted to electromagnetic activity, and when observed in the lower atmosphere likely account for many of the UFO-UAP sightings over the centuries."

To my best knowledge, this article, published in the Journal of Modern Physics, is the first article mentioning UFOs and UAPs. Its impact factor is .86 but I am more interested in facts rather than impact factors. This is because during the last decades in theoretical physics, the journals publishing mostly about superstring theory and related fashions and fads have had tragically high impact factors, which has led to the stagnation of the field.

As becomes clear from the article, many of the findings have been known. Article says that there is still secrecy and fears related to the observations of plasma structures (plasmoids in the sequel) on Earth which are often interpreted as UFOs-UAP sightings. People do not want to get the label of a mad scientist. After 46 years as a mad scientist without funding and research positions, I understand their fears!

For more than 10 years ago (2007) I participated a conference held in Hessdalen, Norway, where "UFOs" appear regularly and learned that they behave like living intelligent beings and considered these objects in TGD framework [K6, K1]. The findings related to plasmoids in the thermosphere support this kind of behavior both at the level of individuals and collectively. The structures involved can be very large: size scales range up to kilometer scale.

The article of Rhawn et al [D1] contains a detailed summary of both the history of the development of the theoretical ideas related to plasmoid as a self-organizing structure bringing in mind prebiotic life forms and discusses various findings supporting these speculations made in both lab and in thermosphere. The experiments carried out in the thermosphere satisfy stringent scientific requirements so that it is very difficult to dismiss the findings.

3.2.1 Plasmoids and biological life

The difference between plasmoids and biological life forms might not be as large as one might think. Biology involves cold plasmas.

1. Negatively and positively charged ions play a key role in the physics of cell membrane. One of the mysteries is what ionizes them! We have thought that electrolysis is understood. At least I find that I cannot understand it in terms of standard chemistry. The energies of ions gained in the electric fields involved are quite too small to induce ionization of atoms.

Intriguingly, also "cold fusion" [?], so bitterly hated by colleagues, appears in electrolytic systems and would involve formation of dark nuclei as dark proton sequences at monopole flux tubes decaying to ordinary nuclei and liberating almost all nuclear binding energy [K2] [L3]. Magnetic flux tubes with large h_{eff} would allow dissipationless acceleration of say dark charged particles to very high energies making it possible to ionize that atoms.

2. In the TGD Universe, the charged ions communicate with the magnetic body of the system using "dark" (in the TGD sense) Josephson radiation and cyclotron radiation [L25]. Resonance, generalizing to multi-resonance, would be the basic mechanism. Same communications and control mechanisms would be realized in plasma life in which chemical realization of genetic code is not yet present. The genetic code could be realized in terms of dark protons and dark photons with genes realized as sequences of dark proton or dark photon triplets realizing genetic codons [L1, L5, L7].

The proposal is that genetic code is universal and based on so called completely unique icosahedral tessellation of hyperbolic 3-space H^3 involving tetrahedra, octahedra, and icosahedra and appearing naturally in the TGD framework [L7, L12]. This tessellation could be realized in the plasma phase where crystal lattices are reported to appear. Information theoretically, biological life and plasma life could be very similar. Besides the basic morphologies of plasmoid mentioned in the abstract of the article, helical structures are formed and could serve as analogs of DNA and RNA and amino-acids: the information would be stored by the dark DNA realized as sequences of dark proton triplets.

The universality of both genetic code and information molecules (both DNA, RNA, amino-acids and tRNA are predicted to have dark counterparts) and the appearance of primitive metabolism already at the level of dark matter would solve various hen-egg paradoxes of standard biology.

3. One fascinating discovery is that the plasmoids seem to behave as if they were moving in water. Water is a key element of biological life. The temperatures in the thermosphere are in the range 200-500 Celsius and beyond the boiling point of water. What could serve as the plasma counterpart of water?

Long range coherence (mystery in the biology-as-nothing-but-chemistry approach) is required, in fact several scales of coherence are needed. In the TGD framework, the quantum coherence of the monopole flux tube network, making it behave more like a liquid rather than gas, would induce the coherence of water. Could the monopole flux tube network also transform the plasma phase to a liquid-like system?

What could make possible quantum coherence at such high temperatures? TGD suggests that cell membranes realize high T_c superconductivity [K3, K4, K5]. High T_c superconductivity would be based on the hierarchy of $h_{eff} > h$ phases at monopole flux tubes for which cyclotron energies are scaled up by factor h_{eff}/h . The most recent version of the model of superconductivity [L29] suggests that the transition to high superconductivity could quite generally involve the generation of what I call half-monopole flux tubes (possible as Maxwellian flux tubes requiring a current at the boundary to generate the magnetic field) with a disk-like cross section at a critical temperature T_{c1} higher than T_c . At T_c , half-monopole flux tubes would fuse along their boundaries to monopole flux tubes with a spherical cross section (possible only for homologically non-trivial space-time surfaces) and requiring no current. The difference between the total cyclotron energies associated with these configurations would be proportional to h_{eff}/h and the critical temperature would increase with h_{eff}/h .

4. The plasmoids are reported to have a double layered structure with both layers consisting of plasma with the inner layer carrying a negative charge and outer layer a positive charge. This structure is very similar to the double lipid layer associated with the cell membrane. Also these structures could be generalized Josephson junctions such that the voltage between the layers would define the counterpart of membrane potential.

The layers could be super conductors forming a generalized Josephson junction [K5, L25]. There would be monopole flux tubes transversal to the layers and the difference of energies for charged particles at the two sides of the structure would be sum of Josephson energy ZeV and the difference of cyclotron energies $h_{eff}ZeB/m$. The structure would communicate to its magnetic body by dark Josephson radiation. The communicated information would be about the electromagnetic environment coded by the modulations of the membrane potential in turn coded to frequency modulations of the Josephson radiation. The message would be received by cyclotron resonance generating as a response a sequence cyclotron resonance pulses analogous nerve pulse patterns sent to the biological body where they would act as control commands. Neural system would rely on this mechanism. The response would generate an analog of stochastic resonance whereas the Josephson radiation would generate the analog of the reversal of stochastic resonance [L28].

5. Also a gel-like behavior has been observed. Gel phases (see this) are essential in biology and involve a network plus medium (see the Wikipedia article). The medium can be gas, liquid, or solid and also the network can be one of these phases. Also the plasma phase could serve in the role of medium in the recent situation. The network formed by the monopole flux tubes and carrying dark particles as $h_{eff} > h$ phases of ordinary particles could play the role of the network and together with the plasma phase forming the medium give rise to a gel-like phase.

In the TGD framework, the Pollack effect, generating a gel phase by transferring ordinary protons to dark protons at monopole flux tubes and in this way creating negatively charged exclusion zones (EZs, such as cell interior and DNA double strand), would be a building brick of key mechanisms of quantum biology. Pollack effect requires energy and solar radiation provides it and Pollack effect would be a key mechanism of also photosynthesis.

As I developed a model for ball lightning [L24], I realized that the Pollack effect [I2, I1, I4, I3] generalizes. The particles could transform to dark particles at the magnetic body, not only by absorbing a photon, but by a formation of a molecular bound state. Pollack effect and its reversal could control transformation of silicates (quartz) to silicon in a liquid phase: the energy of lightning would provide this energy and in this way generate ball lightning as a primitive life form. Is the generalized Pollack effect one of the key mechanisms of plasma life?

6. Quite generally, the energies of dark particles increase with h_{eff} and h_{eff} tends to decrease spontaneously. The basic purpose of metabolic energy feed is to compensate for the decrease in the value of h_{eff} . Plasmoids should use electromagnetic radiation as a metabolic energy source just as biological life forms use. Can one imagine a plasma counterpart of photosynthesis?

Pollack effect is essential in the TGD based model of photosynthesis and defines a prebiotic form of photosynthesis, which would temporarily store energy to the magnetic body of the system, where dissipation is extremely small. The same temporary storage could take place when the metabolic energy, extracted from metabolites, is temporarily stored to MB in $ADP \rightarrow ATP$ transformation.

It is known that plasmoids radiate even at the dark side of the Earth. This supports the view that they are able to store metabolic energy. The long term storage of metabolic energy could emerge when the charged dust particles interact with plasma and form colloidal gel phases (see this) with it. The molecules of the dust particles would store the energy for longer periods of time.

7. Plasmoids are found to gather above thunderstorms and descend to them. Thunderstorms involve large charges and strong electric fields and therefore give rise to MBs with very

large values of $h_{eff} = h_{em}$, which has an interpretation as a measure for number theoretical complexity and also serves a universal IQ. Thunderstorms could also serve as metabolic energy storages. The acceleration of dark particles in the strong electric fields at monopole flux tubes would increase the value of h_{eff} of the particles.

3.2.2 Did plasmoid life serve as a midwife for biological life?

Somehow the plasmoid life should have evolved to biological life. The natural guess is that biomolecules evolved in the dust particles interacting with the plasmoids. For instance, they are known to become electrically charged. Carbonaceous chondrites (see this) are especially interesting dust particles since they contain water, silicates, and basic organic molecules such as amino acids serving as natural candidates for the storage of metabolic energy. Chondrites also contain glass balls, which must have emerged from liquid silicon, which suggests the occurrence of dielectric breakdowns. The TGD based model of ball lightning [L24] involves the transformation of silicate to silicon in liquid phase. The presence of the molecules pairing with their dark analogs (in information theoretic sense) could have led to the evolution of the chemical metabolic energy storage.

Could carbonaceous chondrites associated with double plasma membranes with layers having opposite charges have evolved in the thermospheres of the planets and stars from systems involving mostly silicates and water to systems containing basic information molecules like DNA, RNA, amino acids and tRNA? Could plasmoids have served as midwives in the process?

Here the theory of Oparin (see) and the support for it provided by Miller-Urey experiment (see provide guidelines. Oparin suggested that life evolved in a strongly reducing (able to donate electrons and thus becoming easily oxidized) atmosphere lacking oxygen and containing methane, ammonia, hydrogen and water vapor.

In the Miller-Urey experiment a system assumed to simulate an ancient ocean containing very simple organic molecules was studied. Also heat gradient was involved. Lightnings were simulated as dielectric breakdowns in a strong voltage. Almost all amino-acids necessary for life emerged in the process. I have commented on the more recent findings related to this experiment from the TGD point of view in [L6, L10]. This leads to a long series of questions.

1. In the thermosphere the scale is that of a protocell. Could the protocell be realized as a double plasma membrane containing carbonaceous chondrites?
2. Could carbonaceous chondrite act like a strongly reducing atmosphere? Could the chondritic water take the role of the ocean in the Urey-Miller experiment and could the thermal gradient of the thermosphere replace the thermal gradient? Could dielectric breakdowns in the voltage of the double plasmoid membrane replace the lightnings?

Pollack effect requires energy feed. Could generalized Pollack effect induce the formation of the basic biomolecules such as amino-acids as bound states [L24]. Could the binding of oxygen to silicon to form silicates by the generalized Pollack effect make the chondrites strongly reduced by removing the free oxygen?

3. Did proto cellular life evolve in this way and migrate to the surface of Earth? At the surface of Earth the possibly existing oceans had a very low oxygen content and the energy flux from the Sun was too low (faint Sun paradox). It seems that the oxygen based photosynthesizing multicellular life could not evolve at the surface of the Earth. This conforms with the presence of multicellular fossils before the Cambrian explosion that occurred about 500 million years ago.
4. TGD suggests that the photosynthesizing, oxygen based multicellular life actually developed in the underground oceans below the surface of Earth, in the womb of Mother Gaia, where the conditions for the development of photosynthesis and multicellulars were more favorable [L8, L19]. It bursted to the surface of Earth in the Cambrian Explosion in which photosynthesizing multi-cellulars suddenly appeared. In the TGD Universe, the dark photons from the core of Earth might have provided the metabolic energy: the thermal radiation from the core is in the same energy range as solar radiation.

3.2.3 Tether experiment

One especially interesting experiment involves a charged conductor wire (a tether connecting a module to the satellite) carrying an Ohmic current making the wire charged. The charge generates a radial electric field.

1. The nearly orthogonal motion of tether in the Earth's magnetic field B_E gives rise to Faray effect generating a voltage along the tether, which in turn induces an ohmic current and charge density creating a radial electric field. The current flows out at the other end of the tether. It is also possible to generate a current to the tether. The charge moving along the tether experiences Lorenz force orthogonal to B_E and tether which induces the motion. The article provides a quantitative view about the currents flowing along the tether, electric field strengths and total charges possible for the tether.
2. What is observed is that plasmoids gradually appear around this structure and make contacts with the wire. It is not clear whether they arrive from outer space or whether artificial prebiotic life forms are created as a response to the electromagnetic fields and electric current created by the electrons running in the tether!

In the TGD framework, the wire carrying a charge could give rise to a very large electric Planck constant $h_{eff} = h_{em} = QZe^2/\beta_0$, where the velocity parameter β_0 satisfies $\beta_0 = v_0/c < 1$, is defined as generating large scale quantum coherence [L14]. Qe is the charge of the large object and Ze is the charge of the small object.

This proposal generalizes the notion of gravitational Planck constant introduced by Nottale [E1]. I wrote just a few weeks ago two articles relating to this. The first one [L24] proposed a model of ball lightning and lightning. The second article [L14] discusses large scale quantum coherence in presence of electrically charged objects carrying large electric charge (Earth is the basic example and the charged wire second one).

Plasmoids would gather around the tether since this would increase the value of "personal" h_{eff} since the acceleration in the strong electric field would provide metabolic energy making it possible h_{eff} increasing phase transition. The presence of a tether's magnetic body would also help to reach a higher level of collective consciousness.

One can estimate the value of h_{em} for the tether system using the data provided in the Wikipedia articles (see this).

1. The current density can be written as $j = \rho v$, where ρ is the average charge density of the tether and v is the velocity parameter assignable to the electrons. This gives for the current I the expression $I = \rho v S$, where S is the cross sectional area of the tether. One can solve ρ as $\rho = I/vS$ and from this the total charge of the tether as $Q = \rho SL = IL/v$.
2. One can use the length $L = 20$ km of the tether and the reported typical values of the Ohmic current I and estimate v from a typical electron energy E as $v = \sqrt{2mE}$. From the Wikipedia article, the typical values $I = 100$ mA and $E = 10^2$ eV. The latter gives $v = 2 \times 10^{-2}c$. This would give $Q = .33$ mC, that is $Q \simeq 2 \times 10^{15}e$. The value of $h_{em}/h = Qe^2/\beta_0$ would be for $Z = 1$ and $\beta_0 = 1$ equal to $8\pi\alpha \times 10^{15} \simeq 1.4 \times 10^{14}$. 10 Hz alpha frequency would correspond to the energy of order .06 eV which happens to correspond to the Coulomb energy assignable to the cell membrane potential. This value of h_{eff} is near to the minimal value for which the cyclotron energy is above the thermal energy at room temperature.

4 How to define electric Compton lengths for planets and Sun

The simplest proposal for the electric Planck constant h_{em} for the pair determined by a relatively small charge Z and the charged system with large charge Q , is as a generalization of the gravitational Planck constant determined by the formula $h_{em} = Qe^2/\beta_0$, where $\beta_0 = v_0/c < 1$ is a velocity parameter.

For the Earth, there are reasons to believe that $\beta_0 \simeq 1$ holds true in the gravitational case. This implies that h_{em} has minimal value. For the inner planets of the Sun, Mercury, Venus, and Earth, one has in a good approximation $\beta_{0,S} = 2^{-11}$ as was deduced by Nottale [E1]. For the outer planets, one would have $\beta_0 = 2^{-11}$ but with principal quantum numbers coming as multiples of $n = 5k$, $k = 2$ for Mars, or $\beta_0 = 2^{-11}/5$. It turns out that the option $\beta_0 = 2^{-11}$ for all planet-Sun pairs is correct [L27].

4.1 About the definition of electric Compton length

The definition of the electric Compton length is far from obvious.

1. The simplest definition of the electric Compton wavelength is given by

$$\begin{aligned} h_{em} &= \frac{Qe}{\beta_0} \text{ per}, \\ \Lambda_{em} &= \frac{h_{em}}{m} = \frac{h_{em}}{h} \lambda . \end{aligned}$$

Proton Compton length $\lambda_p = 1.32 \times 10^{-15}$ m and the Compton length of electron is by factor $m_p/m_e \simeq 2000$ longer.

2. From $C = 6.24 \times 10^{18}e$ and using $E_E = x \times 10^2$ V, $x \in [1, 3]$, one obtains for proton $h_{em,E} \sim (4\pi\alpha_{em} \times 2.75x \times 10^{25}e^2/\beta_{0,E} \sim 10^{24}$, $x \in [1, 3]$. From $h_{em,E}/\hbar \sim 10^{24}$ the order of magnitude of $\Lambda_{em,p}$ for Earth is $\Lambda_{em,p} \sim 6.7 \times 10^9$ m $\sim 10^3 R_E$. Note that one has $AU \sim 215 R_S = 215 \times 109 R_E \sim 2.34 \times 10^4 R_E$.

From the point of view of the ionosphere, this estimate looks unrealistic. Ionosphere forms a capacitor-like structure and Λ_{em} should be smaller than the height 60-100 km of the ionosphere. The reason could be that the size scale of the quantum coherence region is overestimated.

3. Could one estimate the radius d of the disk defining the quantum coherence region at the surface of the Earth from the first principles? The natural guess is that d satisfies apart from a numerical factor the condition $d = \Lambda_{em}(d)$, where electromagnetic Compton length $\Lambda_{em}(d)$ is for either proton or electron.

The interpretation would be that flux tubes carrying the electric flux are basic units and their cross section cannot span the entire area of the Earth. Electrons are the most important for the conductivity in the ionosphere so that they are favored. The conditions

$$\begin{aligned} \Lambda_{em} &= \frac{Q(S=\pi d^2)e}{\hbar\beta_0} \times \lambda , \\ Q(S) &= \epsilon_0 E_E \pi d^2 , \\ \Lambda_{em}(d) &= d . \end{aligned}$$

Here $\epsilon_0 = 8.85 \times 10^{-12}$ C/Vm is the dielectric constant of vacuum. One Coulomb corresponds to $C = 6.24 \times 10^{18}e$. One can restrict the consideration to the surface of the system so that $E(R)$ is the electric field at the surface, S is the surface area of the sphere, and R is the radius of the sphere.

4. The conditions give

$$\begin{aligned} \frac{1}{d} &= X \times \frac{E_E}{\beta_0} \lambda , \\ X &= \pi\epsilon_0 \times 4\pi\alpha \frac{C}{e} . \end{aligned}$$

where $\lambda = h/m$ refers to either the Compton length of proton or electron. $\Lambda_{em}(d) = d$ depends only on the value of the electric field for given particle so that one has

$$\frac{d(X)}{d(Y)} = \frac{E_Y}{E_X} \frac{\beta_0(X)}{\beta_0(Y)} .$$

This gives the scaling law $d \propto \lambda/E$ so that one has $d = \Lambda_{em}(d) \propto m$ unlike the ordinary Compton length $\lambda \propto 1/m$.

This formula applies to any planet and also to the Sun. It could apply also to ordinary capacitors and also to axons. The additional condition is that the electric Compton length in the case of capacitor type structures is smaller than the distance between the plates.

4.2 The electric Compton length of the Earth

Consider first the electric Compton lengths for the Earth and restrict the consideration to proton and electron (the original version of the article contained a stupid error giving a wrong but reasonable looking estimate for the electric Compton wavelength of proton).

1. Assuming $E_E = 100 \text{ V/m}$ this gives for the proton $d_{p,E} \sim 8.5R_E > R_E$ so that the argument fails for protons in the case of Earth. This does not of course exclude the possibility that this notion makes sense in long length scales.
2. For the electron this gives for $E \in [1, 3] \times 10^2 \text{ V/m}$ gives $d = 4.25x \times 10^{-3}R_E$, $x \in [1.3]$, giving $d \in [9.2, 27.5] \text{ km}$. This corresponds to the thickness of that part of the atmosphere where thunderstorms appear and size scales assignable to lightning. Lightnings could be seen as the analogs of action potentials if one takes seriously the analogy between cell membrane and ionosphere. The ionosphere has a lower boundary at height $h \sim 60 - 100 \text{ km}$, which is roughly twice the upper bound for d (which is of course determined only modulo a numerical factor of order 1).
3. Interestingly, $\beta_0 \simeq 2^{-11}$ characterizing Sun would give for d the same estimate for in the case of protons. Could the protonic magnetic body correspond to the gravitational magnetic body of the Sun, which is in resonance with the electric body of Earth?
4. The radius of the thermosphere is about 340-350 km, roughly 5 times larger than the estimate of Λ_{em} for electrons. Λ_{em} represents however only a lower bound for the electric Compton length. The thermosphere is the area where the terrestrial plasmoids live so one can ask whether quantum coherence electrons could be involved.
5. If one knows the electric field E_P for the planet P , one can estimate the ratio $h_{eff,E}/h_{eff,P}$ and the d_P . In the case of gravity, $\beta_{0,E} = 1$ and $\beta_{0,S} = 2^{-11}$ and a good guess is that this is the case also for all planets [L27].

Note that the gravitational Compton length of the Earth is same for all particles and given by $\Lambda_{gr} = .5 \text{ cm}$. One has for $E_E = 10^2 \text{ V/m}$

$$\frac{\Lambda_{em,e}}{\Lambda_{gr}} \sim 6.1 \times 10^6 .$$

In the number theoretic sense, the electric body would be considerably smarter than the gravitational body.

4.3 The electrical Compton length of the Sun

In the Zoom session, Ville Saari made a question related to the Sun as an astrophysical quantum system, and I realized that although I had estimated the electric Planck constant h_{em} for the Sun. For the Earth one has $E_E = x \times 10^2 \text{ V/m}$.

Consider first the electric Compton lengths for the Sun.

1. For the Earth one has $E_E = x \times 10^2 \text{ V/m}$, $x \in [1, 3]$. The value of the electric field at the surface of the Sun is $E_S = 1.5 \text{ V/m}$: this gives $E_E/E_S = (x/1.5) \times 10^2$, $x \in [1, 3]$.
2. For the electric Compton length $\Lambda_{ef}(d) = d$ of Sun one obtains from the scaling law

$$d_S = \frac{E_E}{E_S} \frac{\beta_0(S)}{\beta_0(E)} d_E .$$

This gives $d_S \simeq .033d_E \simeq .3 \text{ km}$ for $E_E = 10^2 \text{ V/m}$.

3. For the proton, the range of d_S would increase by a factor of $m_p/m_e \sim 2^{11}$ to about [66, 198] km. Also this makes sense. Could the electric flux tubes relate to the solar wind? Not in any obvious way: the lower bound for the solar spot size is 1500 km.

One can also estimate the charge $Q_S(d_S)$ for the Sun. If one uses also in the case of the Sun the scaling law and the condition $d = \Lambda_{em}$ and assumes the same values of β_0 in the gravitational and electric case and that electrons are in question, one obtains the estimate

$$\frac{Q_S(d_S)}{Q_E(d_E)} = \frac{E_E}{E_S} \times \frac{\beta_0(S)}{\beta_0(E)} .$$

This gives $Q_S(d_S)/Q_E(d_E) = .033$.

4.4 Electric Compton length for capacitor-like systems

To get some perspective and to test the idea it is useful to consider capacitors. In this case $\Lambda_{em}(d) = d$ should be smaller than the distance between the capacitor plates.

1. Aluminium capacitors can have a maximum charge of about $Q = 10^3$ C whereas the maximal charge of a van de Graaff generator is about .14 C. If one assumes $d = \Lambda_{em}(d)$, d_C is obtained by scaling as $d_C/d_E = E_E/E_C$. If the capacitor corresponds to a sphere of $D = 1$ mm with charge $Q = 10^3$ C, the electric field is $E_C = Q/4\pi\epsilon_0 D^2$ at the surface of capacitor and gives for $D = 1$ m $d_C = (E_E/E_C)d_E \sim 10^{-8}$ m for $E_E = 10^2$ V/m.
2. For a capacitor with capacitance of 1 μ F and at voltage 1 V, the charge would be 1 μ C. For $\beta_0 = 1$ would have the upper bound $\Lambda_{em,p}/\Lambda_{gr} \sim 2.9 \times 10^{-3}$ so that one would have $\Lambda_{em,p} \sim 1.5 \times 10^{-5}$ m. This gives an upper bound for the value of $\Lambda_{em,p}$ since the parameter d must correspond to a solid angle smaller than 4π . Could electronic systems be intelligent and conscious at least on this scale?

Neuronal axon is also a capacitor-like system and it is interesting to check what the criterion $\Lambda_{em}(d) = d$ gives in this case. The natural guess for d as quantum coherence length is as the length of the axon idealized as a cylindrical capacitor. Using $Q = E2\pi R d$ and the condition $Q(d)e/\beta_0 = d$ one finds that the conditions does not depend on d at all so that it allows all lengths for axons, which is a very nice result from the point of neuroscience.

The condition however fixes the Compton length of the particle considered. Are there any chances of satisfying this condition for protons or electrons? The condition reads as

$$E \times 2\pi R \epsilon_0 \times (C/e)4\pi\alpha = \frac{1}{\lambda} .$$

Here R is the radius of the axon taken to be $R = 1$ μ m. Using $E = V/D$, where $D \simeq 10$ nm is the thickness of the neuronal membrane. and assuming $V = .05$ V, one obtains $E = 5 \times 10^6$ V/m.

For $\beta_0 = 1$, the estimate for λ_e is in a good approximation $\lambda_e = 10^{-12}$ m to be compared with the actual value $\lambda_e = 2.4 \times 10^{-12}$ m. The equation $d = \Lambda_{em}(d)$ is fixed apart from a numerical factor of order 1 so that the proposal seems to make sense.

If one assumes that Cooper pairs of electrons are the charged particles, one obtains $\lambda_{2e} = 1.2 \times 10^{-12}$ m. If one scales down D with a factor 1/2 to 5 nm, one obtains $\lambda_e = 1.2 \times 10^{-12}$ m, which could be true in absence of superconductivity. The thickness of the cell membrane indeed varies in these limits and is larger for neuronal membranes. One can wonder whether the dynamics is such that the quantity ER stays constant so that the condition remains true.

One can perform the same estimate for DNA strand having the 3 nucleotides per nanometer carrying unit charge. The condition $\Lambda_{em}(Qe)\hbar\lambda/\beta_0 = (dn/dl)\alpha \times 4\pi(d/\beta_0) = d$ gives

$$\lambda = \frac{dn}{dl} \frac{\beta_0}{4\pi\alpha} .$$

The condition is satisfied for electron if one assumes $\beta_0 \simeq 2^{-11}$: one obtains $\lambda = 1.5 \times 10^{-12}$ m to be compared with the actual value $\lambda_e = 2.42 \times 10^{-12}$ m. The Compton length for a Cooper pair would be $1 \lambda_{2e} = 1.21 \times 10^{-12}$ m.

4.5 Could classical electromagnetic and gravitational fields give rise to collective consciousness in even historical time scales?

Paul Kirsch made an interesting question about whether the proposed gravitational and electric collective levels of consciousness assignable to Sun and planet could carry information about the history of biosphere and human kind. It is interesting to consider this question quantitatively by using the basic length and time scales predicted by TGD inspired quantum biology.

1. For the gravitational magnetic body of Earth the gravitational Compton length is $L_{gr,E} = GM/\beta_0 \simeq .5 \text{ cm}$ ($\beta_0 = 1$). For Sun one has $L_{gr,S} \sim R_E/2$ ($\beta_0 = 2^{-11}$ for the inner planets), R_E the radius of Earth. The corresponding time scales are rather short: .16 ns for the Earth and 10 μs for the Sun.
2. For the electric fields of Earth and Sun the values of "IQ" defined by the electric Planck constant $h_{eff} = \hbar_{em}$ can be considerably higher than for the corresponding gravitational fields. The condition $\Lambda_{cr}(d) = d$ for the radius of the flux tube as coherence region restricts however strongly the value of h_{em} .

- (a) The electric Compton length $L_{e,em}(d) = d$ for electron in the case of Earth corresponds to the range 9 – 27.5 km assignable to the lightnings and the fact that the upper bound is roughly one half of the height of the ionosphere. This scale is only the lower bound for the transversal quantum coherence scales and one can argue that the flux tubes could be longer but shorter than the height of the ionosphere so that this scale could closely relate to the plasma life.

If one does not pose the condition $\Lambda_{em} = d$, the electric Compton lengths for the Earth are much longer. For protons one obtains $\Lambda_{em,p} \simeq 10^3 R_E$. For electrons one has $\Lambda_{em,w} \simeq 2 \times 10^6 R_E$ to be compared with $AU \simeq 2.34 \times 10^4 R_E$, the distance of Earth from the Sun.

- (b) For the Sun, the electric Compton length for electron defined by $\Lambda_{e,em}(d) = d$ are rather short: .3 km for electron and 66 km for proton assuming $E_E = 10^2 \text{ V/m}$ in the scaling. If one gives up the condition $\Lambda_{em}(d) = d$, one has $\Lambda_{em}(S) = 2 \times 10^8 R_E$ to be compared with $A = 2.2 \times 10^4 R_E$.
- (c) For a pair formed by say charge Z and mass M and Sun, the electric Compton length and time are scaled up by a factor Zm_p/M from those of protons. This factor is in general smaller than one so that historical times scales cannot be obtained by increasing the charge.

The natural guess is that the electric and gravitational fields correspond to collective consciousness of some kind. Could it be the collective consciousness of the human kind or of the biosphere? Could our understanding of our physical environment rely on direct sensory experience of these collective levels of consciousness about their electromagnetic and gravitational bodies? Could our science based conscious information be represented on astrophysical scales so that the target of science could determine the scale of the corresponding cognitive representations?

Consider first the gravitational magnetic bodies.

1. For the Milky Way the mass is about $1.55 \times 10^{12} M_S$, the gravitational Compton length $L_{gr,MW}$ would be for $\beta_0 = 1$ about $L_{gr} \sim 1.55 \times 10^{12} \times \beta_0(Sun) \text{ km} \sim .8 \times 10^9 \text{ km}$, which would give $T_{gr} \sim .8 \times 10^7$ seconds, which is rather near to year which is 3.2×10^7 seconds! For $\beta_0 = 1/4$ one would obtain a year.
2. To get historical time scales in the gravitational case, one should have a larger astrophysical object, perhaps a local galaxy cluster. Galaxy clusters have masses $10^2 - 10^3$ times the mass of the Milky Way. This would give a time scale of 100-1000 years, which is historical.

What about the electric Compton time for the Milky Way in the case of dark protons? Galaxy is estimated to have a Coulomb charge of about 10^{31} Coulombs. The radius of the Milky Way is 52,850 ly. Using the definition $\Lambda_{em}(d) = d$ and $\beta_0 = 1$ one would obtain $\Lambda_{em}(p) \simeq .42 \text{ cm}$ which happens to be rather near to the gravitational Compton length .5 cm for the Earth. For

electrons one obtains $\Lambda_{em}(e) \simeq 2.1 \mu\text{ m}$, which corresponds to the size scale of the cell nucleus. Quite generally the condition $\Lambda_{em}(d) = d$ implies that Λ_{eff} is small and decreases with the size of the system.

5 James Webb Space Telescope is also revolutionizing biology

JWST continues to make discoveries revolutionizing not only cosmology and astrophysics, but also the views about the evolution of life. The talk "Nobody Expected JWST To Find Signs of Oceans on Makemake and Eris + More From Kuiper Belt" of Anton Petrov (see this) told about the newest findings related to the Kuiper belt and about surprising findings related to the dwarf planets Eris and Makemake.

5.1 Second Kuiper belt?

Consider first the discoveries related to the Kuiper belt made by satellite New Horizons. The Kuiper belt seems to be either much thicker than thought or that there are actually two of them. According to the findings of New Horizons satellite, the latter option looks more plausible. The candidate for a new Kuiper belt consists of a very dense dust. Solar wind could have blown the dust from the inner Kuiper belt to this region but this explanation is not very plausible.

TGD view of the formation of astrophysical objects [L20, L21] suggests the possibility of belt like structures and even spherical layers. The empirical findings suggesting that ionosphere involves plasmoids as primitive non-biological life forms suggests the symbiosis of biomolecules associated with the dust particles with plasmoids led to the development of primordial life forms [L14].

What came as a surprise to me was that the Kuiper belt is the most colored object in the solar system. The explanation would be the presence of organic molecules emitting light at visible frequencies. This also explains the reddish color of the belt. Also Pluto and many dwarf planets have turned out to have relatively young surface layers with an organic chemistry involving highly complex organic molecules, in particular molecules with ring structures. This suggests that the chemical life developed at the outskirts of the solar system and then moved inwards.

5.2 Dwarf planets are not we expected them to be

JWST provided information suggesting that Eris and Makemake have oceans and complex surface chemistry. This makes them candidates for the seats of primordial chemical life. Orcus, Pluto, Haumea, Quaoar, and Makemake are dwarf planets in the Kuiper belt extending from the distance 30 AU of Neptune to the distance of 50 AU. Also some solar system's moons such as Neptune's Triton and Saturn's Phoebe might have originated in the Kuiper belt. Even the Moon could have emerged by a collision of an object possibly coming from Kuiper belts with Earth. Eris, at a distance of 68 AU and Makemake at a distance of 46 AU are examples of dwarf planets located outside the Kuiper belts.

In a sharp conflict with expectations, Pluto, dwarf planets and many moons are very active and involve a complex organic chemistry giving them their reddish colors. For instance, Pluto is very active. It possesses a thin exosphere and 5 moons creating tidal effects, which also can provide metabolic energy. JWST has now managed to provide information of elements present at the surface of Eris and Makemake and even isotope ratios D/H and C13/C12 at the surface of Eris and Makemake. This allows us to conclude that the surface is very young. An interesting question is how the active surface structure has emerged. Also evidence for geochemical processes, solid state convection, and subsurface oceans have been found. These oceans seem to resemble Enceladus, which is a moon of Saturn regarded as a strong candidate for simple extraterrestrial life. All that is needed by life on the Earth, including oceans, seems to be present.

Object	M/M_E	R/R_E	$\Lambda_{gr}/\mu m$	e_{gr}/eV
Earth	1	1	5e+03	2.48e-03
Pluto	.00218	0.18	10.9	0.11
Eris	.0028	.182	14.0	.09
Ceres	1.57e-04	.07	0.79	1.58
Enceladus	1.8e-05	.04	.09	13.8
Titan	0.023	.4	115.0	0.01
Ganymede	.025	.413	125.0	.001
Moon	.0123	.2727	61.5	.02

Table 1: The table gives for Earth, Pluto, some dwarf planets, and some moons of the solar system, their masses M and radii R using Earth mass M_E and radius R_E as units. Also gravitational Compton lengths $\Lambda_{gr} = \hbar_{gr}/m = r_s/2\beta_0$ for $\beta_0 = 1$ and corresponding energies $E = h/\Lambda_{gr}$ (h is ordinary Planck constant) are given.

5.3 The TGD view of the findings

In the TGD view of life, the TGD counterparts of both gravitational and electromagnetic fields, differing many aspects from their Maxwellian counterparts, have a fundamental role, in particular the long range electric and magnetic fields of both Sun, Earth, and other planets would be important [L14]. The electric body of Earth provides electric fields in the ionosphere, which is in many respects analogous to the cell membrane.

One of the very first predictions of TGD was that any body with gravitational mass must have electric charge although it can be arbitrarily weak. The negative electric charge generating electric fields can be generated by the Pollack effect transforming protons of ordinary matter to dark protons at the magnetic bodies of various objects [L14]. Dark particles have an effective Planck constant which can be much larger than ordinary Planck constant. Darkness in this sense explains the missing baryonic matter and plays a key role in TGD based biology. Galactic dark matter in turn can correspond to what colleagues call dark energy and would be associated with long cosmic strings, whose thickening to monopole flux tubes is the TGD counterpart for the decay of the inflaton field generating ordinary matter.

Negative charges are a basic aspect of living systems: DNA, cell, and Earth itself are basic examples. The delicacy is that the charge separation generated in this way is between the biological body and magnetic body rather than the system and its environment in the ordinary sense. Charge separation is like loading of a battery and requires energy. The formation of biomolecules as bound states of simpler constituents could provide the energy needed by this process. Water and the formation of silicates would be essential ingredients. Also galactic cosmic rays could have served as a source of this energy in Kuiper belts.

In the TGD based model for terrestrial life the role of quantum is central. The gravitational Planck constant $\hbar_{gr} = GMm\beta_0$ introduced by Nottale defines gravitational Compton length $\Lambda_{gr} = \hbar_{gr}/m = r_s/2\beta_0$, $r_s = 2GM$ as a fundamental scale to which one can assign gravitational Compton frequency $f_{gr} = 1/\lambda_{gr}$ and gravitational Compton energy $e_{gr} = h/f_{gr}$ as biologically interesting parameters. The following table gives these parameters for $\beta_0 \simeq 1$ assignable to the magnetic body of Earth and possibly also for other planets, their moons and dwarf planets. For the system formed by the Sun and inner planets one would have $\beta_0 \simeq 2^{-11}$. For the system formed by the Sun and outer planets one would have $\beta_0 \simeq 2^{-11}/5$. The following table gives these parameters for $\beta_0 \simeq 1$ assignable to the magnetic body of Earth. Scaling gives the values of these parameters assignable to the magnetic body of the system formed by the object and Sun.

Note that for Earth the gravitational Compton energy is 2.48 meV. For the Earth the gravitational Compton frequency, possibly associated with a fundamental biological rhythm, is especially high. For the Earth the Λ_{gr} is for solar gravitational magnetic body with $\beta_0 \simeq 2^{-11}$ equal to $R_E/2$ and corresponds to $f_{gr} = 50$ Hz which is EEG frequency. For Mars $\beta_0 \simeq 2^{-11}/5$ one has $\Lambda_{gr} \simeq R_E/4 \sim R_{Mars}/2$ and the gravitational Compton frequency $f_{gr} \sim 100$ Hz is at the top of EEG spectrum. In a good approximation, one obtains from the table estimates for Λ_{gr} and e_{gr} by

the replacement $eV \rightarrow .1 \text{ meV}$ and $\mu\text{m} \rightarrow 1 \text{ cm}$

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