

The Notion of Free Energy and Many-Sheeted Space-Time Concept

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Abstract

In this chapter a general vision about new energy technologies provided by the new ontology forced by TGD is discussed, some evidence for the new ontology is considered, and models explaining some "free energy" anomalies are discussed.

There are close connections to the basic mechanisms of energy metabolism in living matter in TGD Universe and one cannot avoid even reference to TGD inspired quantum theory of consciousness. The point is that so called time mirror mechanism defines a mechanism of remote metabolism as sucking of energy from remote energy storage, a mechanism of memory as communications with geometric past, and mechanism of intentional action initiating neural activity in geometric past. At the level of technology time mirror mechanism would define a mechanism of energy transfer, communication, and remote quantum control.

1. The new ontology

The ontology of TGD Universe involves several new elements. The notion of many-sheeted space-time means that each physical system corresponds to a space-time sheet, its own sub-universe in geometric sense, and glued to a larger space-time sheet and containing subsystems as smaller space-time sheets glued to it. Many-sheeted space-time leads to the notion of field body distinguishing between TGD and Maxwell's electrodynamics. One can assign to each physical system a field body (or magnetic body) and in case of living matter it acts as intentional agent using biological body as a sensory receptor and motor instrument.

Zero energy ontology states that any physical system has a vanishing net energy so that everything is creatable from vacuum. Zero energy states decompose into positive and negative energy parts. The possibility of negative energy signals is one important implication and a considerable modification of thermodynamics is forced by the fact that different signs of energy correspond to different arrows of geometric time.

Negative energy signals propagating to the geometric past inspire a new vision about communications, energy technology, and remote control. The implications are especially important for the understanding of living matter where both time directions manifest themselves. In neuroscience a radically new view about memory based on the notion of 4-D brain emerges.

The hierarchy of Planck constants implies a generalization of the notions of imbedding space and space-time and macroscopic quantum coherence in all length and time scales at high enough levels of dark matter hierarchy assigned to the hierarchy of Planck constant. The consequences of this hypothesis are powerful: entire cosmos should be in a well-defined sense a living system with dark matter representing higher level conscious entities.

The original motivation for the p-adic physics were the highly successful calculations of elementary particle masses based on p-adic thermodynamics and conformal invariance. The only sensible interpretation of p-adic physics seems to be as physics of cognition and intentionality meaning that cognition is present even at elementary particle level. This implies a profound generalization of space-time concept implying that cognition and intentionality are literally cosmic phenomena but having experimentally measurable correlates in real physics.

2. The new view about energy

The basic idea is that quantum biology could teach us a lot about energy technology. The necessity to carry fuel is one of the drawback of standard energy technologies. Remote metabolism based on sucking of energy by sending negative energy signals to energy storage analogous to a population inverted laser defines what might be called quantum credit card. This is the basic metabolic mechanism of TGD inspired quantum biology. The mechanism could make sense also as an energy technology.

In biological systems the fuel serves as an energy storage and is recycled. Animal cells burn the fuel and plant cells reconstruct it using sunlight as an energy source. Similar recycling of the fuel could make it un-necessary to carry large amounts of fuel. The systems doing the recycling could be seen as primitive life forms and plasmoids are an excellent candidate in this respect. Fuel could be practically any quantum system with two or more states with different energies.

Large Planck constant phases would make it possible to communicate short wave length photons over long distances: say photons with energy of visible photon but having wavelength of EEG photon. This might help to achieve a lossless energy transfer. Topological light rays ("massless extremals") would be in a key role in making possible precisely targeted, dispersion-free and lossless energy and information transfer. They are ideal also for quantum control.

3. Evidence for the new ontology

There are surprisingly many well established anomalies supporting the new ontology and these anomalies have been a strong guiding line in attempts to construct a general theoretical framework.

a) There is a considerable support for the notion many-sheeted space-time quantified in terms of p-adic length scale hypothesis. One example is the radiation from interstellar dust having no generally accepted interpretation in terms of molecular transitions. The interpretation in terms of metabolic energy quanta liberated in dropping of electrons or protons to larger space-time sheets makes sense quantitatively.

b) The Bohr quantization of radii of planetary orbits and quantal effects of ELF em fields on vertebrate brain helped considerably to develop the ideas about the hierarchy of Planck constants. Later a lot of further anomalies have emerged supporting the quantization of Planck constant.

c) Living matter is a gigantic bundle of anomalies from the point of view of recent day physics and the notion of field body combined with p-adic length scale hypothesis allows to develop detailed models for how magnetic body controls biological body and receives sensory input from it. The notion of field body leads also to a concrete model for pre-biotic life based on the notion of plasmoid involving magnetic body controlling plasma phase. Recently a considerable empirical support for this notion has emerged.

4. Podkletnov- and Modanese-Podkletnov effects

The explanation of Modanese-Podkletnov effect shares many common elements with the model of Podkletnov effect and actually led to the correct track allowing to eliminate competing models.

The "dropping" of electrons to the space-time sheets of topological light rays emitted by a critical system would be the key mechanism besides rotation induced charging. During the discharge of the capacitor (Modanese-Podkletnov effect) this mechanism would induce the motion of test penduli. In the case of a super-conductor making repeatedly a transition to a non-super-conducting state (Podkletnov effect) this mechanism would induce the motion of air above super conductor and apparent loss of weight of test particles. Biefeld-Brown effect associated with lifters and corona wind can be explained by the same mechanism as Modanese-Podkletnov effect. Podkletnov effect is enhanced by the em and Z^0 charging induced by rotation and thus involves also the em and Z^0 variants of Searl effect.

5. Over unity effects

Over-unity effects are the basic claim of free energy research community. TGD indeed allows temporary over-unity effects: the basic mechanism is the dropping of particles on larger space-time sheets liberating zero point kinetic energy appearing as a basic metabolic mechanism in TGD inspired theory of living systems. This mechanism does not allow a perpetuum mobile: the particles must be kicked back to the smaller space-time sheets and in the ordinary living matter solar radiation takes care of this. There are also anomalies associated with the dissociation of water and hydrogen molecules. The hydrino atom concept of Mills is also closely related to these anomalies and TGD based justification for the notion is discussed in this chapter.

1 Introduction

In this chapter the T(opological) G(eometro)D(ynamics) based vision about new energy technologies is discussed. There are close connections to the basic mechanisms of energy metabolism in living matter in TGD Universe and one cannot avoid reference to TGD inspired quantum theory of consciousness.

1.1 Basic new elements of TGD ontology

The ontology of TGD Universe involves several new elements. The assumption that space-times are 4-surfaces in 8-dimensional imbedding space $M^4 \times CP_2$ leads to the notion of many-sheeted space-time meaning that each physical system can be said to correspond to space-time sheet, its own sub-universe in the geometric sense, and glued to a larger space-time sheet and containing subsystems as smaller space-time sheets glued to it. p-Adic length scale hypothesis quantifies this notion.

Many-sheeted space-time leads to the notion of field body [F10, N1, J7] distinguishing between TGD and Maxwell's electrodynamics. One can assign to each physical system a field body (or magnetic body) and in the case of living matter it acts as intentional agent using biological body as a sensory receptor and motor instrument. This profoundly changes the view about what we ourselves are.

Zero energy ontology [C2] states that any physical system has a vanishing net energy so that everything is creatable from vacuum. Zero energy states decompose into positive and negative energy parts and positive energy ontology results in certain limit in a good approximation. The possibility of negative energy signals is one important implication and a considerable modification of thermodynamics is forced by the fact that different signs of energy correspond to different arrows of geometric time.

Negative energy signals propagating to the geometric past inspire a new vision about communications and energy technology. The implications are especially important for the understanding of living matter where both time directions manifest themselves. In neuroscience a radically new view about memory based on the notion of 4-D brain emerges.

The hierarchy of Planck constants [A9] implies a generalization of the notions of imbedding space and space-time and macroscopic quantum coherence in all length and time scales at high enough levels of dark matter hierarchy assigned to the hierarchy of Planck constants. The consequences of this hypothesis are powerful: entire cosmos should be in a well-defined sense a living system with dark matter representing higher level conscious entities.

The original motivation for the p-adic physics [E1] were the highly successful calculations of elementary particle masses based on p-adic thermodynamics and conformal invariance [F3]. The model explained not only the ratio of proton and Planck masses but also masses of particles with an excellent accuracy. The only sensible interpretation of p-adic physics seems to be as physics of cognition and intentionality meaning that cognition is present even at elementary particle level.

The necessity to fuse p-adic physics corresponding to different primes p forces a generalization of the notion of number by gluing different number fields together along common rationals and algebraics. This leads to a further generalization of the notions of imbedding space and space-time. The basic idea is that p-adic space-time sheets are representations for intentions and cognitions and their transformation to real ones in quantum jumps corresponds to the transformation of intention to action. Zero energy ontology is absolutely essential for this interpretation to make sense. p-Adic space-time sheets have literally infinite size in the real sense which means that cognition and intentionality are cosmic phenomena whereas cognitive representations defined by discrete intersections of real and p-adic space-time sheets obeying same algebraic equations have finite size.

1.2 Could living systems teach us something about energy technology?

One of the basic problems in energy technology is the necessity to carry fuel. This defines the most serious restriction to space travel.

Biological systems have resolved this problem by using sunlight as an energy source. The basic idea is very simple: solar radiation induces a dissociation of molecules to atoms which then re-associate and liberate metabolic energy. The hydrocarbons serving as fuel are recycled and there is a division of labor: animals cells burn the hydrocarbons to carbon dioxide and plants regenerate the hydrocarbons in photosynthesis.

Most of our energy technologies lack this kind of recycling. For instance, fuel in cars is burned to carbon dioxide and various wastes. If recycling were possible and if the density of potential energy sources in space were high enough, the amount of fuel would not depend on the distance travelled. This observation suggests self-organizing and perhaps in some primitive sense living technology and thus a connection with a fundamental problem of understanding how life has evolved. TGD provides a quantum model of both ordinary and pre-biotic life [N4, J7] and one can hope that this might help to develop a vision about "living" energy technology.

The recycling need not resolve completely the problems related to the fuel. The optimal solution would be "No fuel at all" with fuel serving only as an energy reserve. The system should be able to suck the energy from a system able to provide it. This is possible in TGD Universe [K6, J7]. Zero energy ontology implies that systems can get energy by sending negative energy signals to a system serving as an energy storage. Population inverted laser like system is the simplest system that one can imagine. Negative energy signals have interpretation as phase conjugate laser light. By the analog of stimulated emission negative energy quanta can also induce a cascade in population inverted laser like system so that system could send positive energy signal to the receiver. "Quantum credit card" is indeed the basic metabolic mechanism in TGD inspired quantum biology making possible instantaneous metabolic energy gain. The mechanism is also extremely flexible, which is a definite evolutionary advantage "in jungle".

The quantization of metabolic currencies is essential in living matter and this engineering principle is realized in TGD Universe at the fundamental level [J7]. The energies liberated in the dropping of particles to larger space-time sheets correspond to the increments of zero point kinetic energy (forgetting the interaction energy with matter) and by p-adic length scale hypothesis they are quantized. The basic metabolic energy currency of living matter, which is about .5 eV, corresponds to the dropping of proton from space-time sheet having atomic size scale.

One can also worry about how to transfer the positive quanta of radiation energy over large distances since also other systems than receiver could do it. Also negative energy signals intended to be amplified to much larger positive energy signals in population reverted laser might be absorbed during their travel. Here the quantization of Planck constant might come in rescue. For instance, if photons with energies equal to those of visible or UV photons or even of gamma rays, are transformed to dark photons with much longer wavelength, one can hope that only systems able to transform this radiation into ordinary photons can absorb it. It might well be that water, which is the basic element of living matter, is exceptional in the sense that it can induce the transformation to dark photons and back. The transformation of large Planck constant photons to ordinary ones makes also possible control of shorter length and time scales by much longer ones.

1.3 Various anomalies as support for the picture

There are surprisingly many well established anomalies supporting the new ontology and these anomalies have been a strong guiding line in attempts to construct a general theoretical framework.

1. There is a considerable support for many-sheeted space-time quantified by p-adic length scale hypothesis. Quite recently I learned about an anomalous radiation from interstellar

dust having no generally accepted interpretation in terms of molecular transitions. The interpretation in terms of metabolic energy quanta liberated in dropping of electrons or protons to larger space-time sheets makes sense. A characteristic fractal spectrum involving period doubling is predicted.

2. The Bohr quantization of radii of planetary orbits [42, D7, D8] and quantal effects of ELF em fields on vertebrate brain [M3] helped considerably to develop the ideas about the hierarchy of Planck constants. Later a lot of further anomalies have emerged supporting the quantization of Planck constant. For instance, in gravitational sector Allais effect [67, D4] and accelerating cosmic expansion [D6] support the view about quantum coherence and quantum transitions in astrophysical and even cosmic scales [D7, D8]. Inflationary cosmology is replaced by quantum critical cosmology in TGD framework [D6].
3. Living matter is one gigantic bundle of anomalies of recent day physics and the notion of field body combined with p-adic length scale hypothesis allows to develop detailed models for how magnetic body controls biological body and receives sensory input from it [J7]. In particular, a successful model for EEG results [M3] and involves hierarchy of Planck constants in an essential manner. One can say that field body applies remote mental interactions to biological body and the so called paranormal phenomena [H9, H10] differ in no essential manner from those encountered in bio-control. The notion of field body leads also to a concrete model for pre-biotic life [N4] based on the notion of plasmoid involving magnetic body controlling plasma phase [N1, J7].
4. The so called "free energy" phenomena have as bad reputation as cold fusion and homeopathy among most physics professionals: ironically all these disputed anomalies seem to find a natural place in TGD based world order [G2, F9, K5], which suggest that theoreticians should take experimentalists much more seriously. Typically "free energy people" make claims about over-unity production of energy but more or less as a rule the results fail not been reproducible.

Over-unity effects are the basic claim of free energy community. TGD indeed allows temporary over-unity effects [G2]: the basic mechanism is dropping of particles on larger space-time sheets liberating zero point kinetic energy appearing as basic metabolic mechanism in TGD inspired theory of living systems. This mechanism does not allow a perpetuum mobile: the particles must be kicked back to smaller space-time sheets and in ordinary living matter solar radiation takes care of this. Rotating magnetic systems [87] define one especially interesting and complex case discussed thoroughly in [G1].

1.4 Free energy anomalies

The models for "free energy" phenomena developed much before the recent overall view summarized above had emerged. I know quite well that the reality of these phenomena is debatable and the poor quality of data makes models speculative. I however feel that these models might serve as good theoretical exercises.

1. Podkletnov- and Modanese-Podkletnov effects

The explanation of Modanese-Podkletnov effect [73] shares many common elements with the model of Podkletnov effect and actually led to the correct track allowing to eliminate competing models.

The "dropping" of electrons to the space-time sheets of topological light rays emitted by a critical system would be the key mechanism besides rotation induced charging. During discharge of the capacitor during discharge (Modanese-Podkletnov effect) this mechanism would induce the

motion of test penduli. In the case of a super-conductor making repeatedly a transition to a non-super-conducting state (Podkletnov effect) this mechanism would induce the motion of air above super conductor and apparent loss of weight of test particles. Biefeld-Brown effect associated with lifters and corona wind can be explained by the same mechanism as Modanese-Podkletnov effect. Podkletnov effect is enhanced by the em and Z^0 charging induced by rotation and thus involve also the em and Z^0 variants of Searl effect [G1].

5. *Over unity effects*

Over-unity effects are the basic claim of free energy research community. TGD indeed allows temporary over-unity effects: the basic mechanism is dropping of particles on larger space-time sheets liberating zero point kinetic energy appearing as basic metabolic mechanism in TGD inspired theory of living systems. This mechanism does not allow a perpetuum mobile: the particles must be kicked back to smaller space-time sheets and in ordinary living matter solar radiation takes care of this. There are also anomalies associated with the dissociation of water and hydrogen molecules. The hydrino atom concept of Mills is also closely related to these anomalies and TGD based justification for the notion is discussed in this chapter.

Since consciousness (memory and intentional action in particular), biology, and new views about energy, communication, and control are tightly related in TGD framework, I will discuss all these topics as a single coherent whole in the following in the hope of demonstrating the unifying power of this conceptualization.

2 Basic ontology of TGD

TGD leads to an ontology which is new in many respects. The notion of space-time generalizes in several manners. One ends up to the so called zero energy ontology, which means that negative energies are possible and all possible universes are creatable from vacuum. Planck constant, which in the standard quantum theory is a genuine constant, has a discrete spectrum of values and the values can be arbitrarily large [A9, J7]. This means that Universe is a macroscopic quantum system in all scales.

Dark matter could be identified as ordinary matter for which Planck constant differs from its ordinary value so that the interactions with ordinary matter differ in their character from ordinary interactions. Note that TGD predicts also new forms of matter completely dark with respect to electro-weak interactions [F4, D8].

Dark matter with a large Planck constant is in a key role in the TGD based model of living matter [9]. Because the new ontology is so central from the point of view of TGD inspired theory of consciousness and living matter, I will represent the basic ideas of TGD using applications to quantum biology to concretize their implications.

2.1 T(opological) G(eometro)D(ynamics) very briefly

TGD is a unified theory of fundamental interactions which has developed during 28 years [1] and at the same time expanded to a theory of consciousness providing a model of quantum biology. The key ideas of TGD are following.

1. TGD can be seen as a generalization of either hadronic string model or super-string model (M-theory). The 1-dimensional (1-D) strings moving in 10- or 11-dimensional space are replaced with 3-D surfaces moving in 8-D space. This means that the 2-D orbits of strings are replaced with 4-D surfaces identified as our 4-D space-time but in a widely generalized sense. A further assumption is that these 3-surfaces are "light-like". This assumption bringing in mind esoteric teachings has a purely geometric meaning, and makes it possible to generalize and extend the conformal

symmetries responsible for the miraculous mathematical properties of super-string models. These symmetries are in a central role in the formulation of quantum TGD.

2. Another manner to end up with TGD is via a search for a modification of general relativity solving the so called energy problem of general relativity. In general relativity the notions of energy and momentum are not well-defined since the translational symmetries responsible for their existence are lost as space-time becomes curved. If one assumes that 4-dimensional space-time is a 4-D surface in a higher-D space obtained by replacing the points of the empty space-time of special relativity (Minkowski space) with certain internal space- call it S - having a very small size, the basic symmetries of Minkowski space become those of higher-D space and energy and momentum continue to be well-defined and one obtains a description of gravitation in terms of space-time curvature.

3. The surprise was that this leads to a unified theory for all known interactions - electromagnetic, weak, strong, and gravitational - if one chooses the space S suitably. The proper choice is $S = CP_2 = SU(3)/U(2)$, the complex projective space of 2 complex dimensions.

2.2 Many-sheeted space-time and the notion of field body

Many-sheeted space-time is one of the basic implications of TGD.

1. Both 3-space and 4-D space-time consists of sheets forming a hierarchical structure ordered with respect to the size of the sheet. Each sheet can be identified as a subsystem, which can correspond to any object of our nearby environment, astrophysical object, cell level system, atom, etc... My own body defines my own private space-time sheet. Quite generally, the topology of space-time codes for various physical structures.

2. Every system is accompanied by various kinds of fields such as electromagnetic and gravitational fields. These fields cannot be assigned to any particular subsystem in standard physics. In TGD the situation is different: one can assign to each system a "field body" consisting of field quanta. For instance, magnetic body consists of quanta of magnetic flux (tubes, sheets,..) realized as space-time sheets much larger than the system. One can also speak about field bodies which mediate interactions and connect different systems ("relative field bodies").

3. In TGD inspired theory of consciousness field body is the "intentional agent" which receives sensory information from the biological body and utilizes it as a motor instrument. The finding of Libet [19] that our sensory data has age which is a fraction of second could be understood in terms of time lapse resulting from the communication of sensory data to the magnetic body using EEG. From Uncertainty Principle one can conclude that in the case of EEG the size scale of magnetic body is of order of size of Earth. As a matter fact, magnetic body is predicted to have onion-like fractal structure and communications to various layers of the onion would take place using fractal variants of EEG. The existence of fractally scaled variants of some parts of EEG (alpha band and its harmonics in particular) is a testable prediction of the model.

4. What is also new and highly non-trivial is that field body and biological body are essentially four-dimensional structures. The brain and body of geometric past still exist as conscious entities having mental images which we experience as memories. Biological death means only the arrival of a particular wave of consciousness to the time-like boundary of a 4-D body. Consciousness at the level of 4-D body does not cease: our past lives.

5. Many-sheeted space-time leads also to a generalization of the notion of subsystem which in TGD inspired theory of consciousness corresponds to a subself experienced by self (system) as a mental image. What is new is the paradoxical sounding prediction that even in the case that two systems are unentangled, subsystems can entangle. Entanglement of subelves can be interpreted as giving rise to sharing and fusion of mental images giving rise to a kind of stereo consciousness (stereovision would be one example of this). Consciousness would not be completely private and there would exist a pool of shared and fused mental images making for instance possible

to assign universal meaning to the symbols of language. This new view about entanglement was originally motivated by the observation that two space-time sheets condensed at larger space-time sheets can be connected by bonds while the larger space-time sheets can remain unconnected (see Figure 3). By quantum classical correspondence the bonding of the space-time sheets serves as a space-time correlate for entanglement. Much later (only a couple years ago) the generalization of quantum measurement theory by introducing the notion of finite measurement resolution allowed to mathematicize this concept [A8, A9]. Entanglement is always defined with respect to a resolution characterizing the system and the entanglement of subsystems is not visible in the resolution characterizing the system. The notions of quantum groups and non-commutative geometry emerge naturally in the description of finite measurement resolution [C3].

2.3 The hierarchy of Planck constants and of dark matter

The hierarchy of Planck constants is a relatively new element of TGD. The idea emerged as I constructed a model of topological quantum computation [O3] and after learning about the work of Nottale [42] I realized that the notion is more or less forced by quantum classical correspondence implying that space-time sheets define regions of macroscopic quantum coherence and by the fact that they can have arbitrarily large size.

2.3.1 Physical motivations for introducing the hierarchy of Planck constants

There are several reasons to consider the possibility that Planck constant \hbar is actually not a constant but can have a set of quantized values which can be arbitrarily large.

1. One observation is the quantization of the radii of planetary orbits (also those of exo-planets) in the same manner as in the case of hydrogen atom [42]: now however the value of Planck constant is gigantic: $\hbar/h_0 = GMm/v_0$, where M and m are the masses of Sun and planet, G is Newton's constant and v_0 is a dimensionless constant (in units $c = 1$), whose favored value is $v_0 = 2^{-11}$. Also other values are possible. In TGD based model [D7, D8] the gravitational Planck constant is assigned with the "relative field bodies" connecting Sun and planet and mediating gravitational interaction between them. The interpretation is that gravitational Planck constant is associated with dark matter, which is macroscopic quantum phase in astrophysical scales. Visible matter condensed around dark matter would reflect the quantal properties of dark matter.

2. Second motivation comes from the observed effects of ELF radiation on vertebrate brain [18], which can be both physiological and affect behavior. These effects appear at harmonics of cyclotron frequencies of biologically important ions (in particular Ca^{++} ion) in a magnetic field of $B = .2$ Gauss (the nominal value of Earth's magnetic field is .5 Gauss) and are very quantal. These frequencies are in EEG range (harmonics of 15 Hz for Calcium ion). Standard quantum mechanics does not allow quantal effects since the energy of EEG photons is extremely low and much below the thermal energy at body temperature. If the value of \hbar is large enough, the effects of ELF photons are not masked by thermal noise, and the effect can be understood [M3].

3. If EEG consists of photons with large Planck constant, one can understand the correlation of EEG with the state of brain and contents of consciousness [M3]. In particular, temperature ceases to be a restriction for life: for sufficiently large Planck constant even the interiors of planets and Sun could serve as seats of life of some kind. This kills a central counter argument against the claim of a Romanian group of physicists that since the plasmoids created in electric circuits possess some basic features assigned usually to life, they indeed represent primitive life forms [57].

4. The mathematization for the notion of Planck constant hierarchy [A9] involves a further generalization of the space-time concept discussed in the Appendix. The basic prediction is that Planck constant corresponds to a discrete subgroup of rotation group acting as the symmetries of the field body of the dark matter system. A hierarchy of favored values of Planck constant and

symmetry groups emerges from simple number theoretic arguments. For instance, $h = nh_0$, $n = 5, 6$, correspond to the favored values of Planck constant. In this case the symmetry group would correspond to the symmetries of 5- and 6-cycles appearing in polycyclic aromatic hydrocarbons [36, 37] known to be important for life. Examples are the cycles appearing in DNA, in some aminoacids, in most hallucinogens except alcohol, and PAHs in the interstellar space [36, 37] believed to result via photosynthesis and believed to be predecessors of aminoacids and other bio-molecules.

5. The basic prediction is that large values of Planck constant correspond to discrete symmetries: typically discrete group of symmetries acting as rotations around a fixed symmetry axes. These symmetries acted as symmetries of dark field body. In the original view about generalized imbedding space (Appendix) these symmetries would be almost continuous symmetries for larger values of Planck constant. The breaking of these symmetries at the level of visible matter condensed around dark matter could lead to much smaller subgroups of these symmetry groups and structures analogous to those appearing in molecular physics could be the outcome. The further generalization of imbedding space (Appendix) allows also discrete symmetry groups Z_n for dark matter with small value of n and also genuinely three-dimensional symmetry groups (tetrahedral, octahedral, icosahedral, and octahedral). There is evidence for this kind of symmetries. For instance, there is a strange hexagonal structure appearing at the North pole of Saturn [43]. Planetary rings is second example and some of them even contain helical structures analogous to DNA double strand [44].

6. Large Planck constant photons at radio frequencies could interact strongly with living matter and it would become possible to communicate with living matter over very long distances. This mechanism would involve a de-coherence of large Planck constant photons to ordinary ones with same energy or a bundle of ordinary photons with much smaller energy. This brings in mind the recent discovery that the irradiation of salt water by radio waves at harmonics of frequency 13.4 Ghz makes it "burn" that is emit burning gases [68]. A possible explanation is that radio wave photons are transformed in water to photons of same frequency but much larger Planck constant and in de-coherence to ordinary photons with same energy become microwave photons which excite rotational excitations of NaCl (in equilibrium with Na^+ and Cl^- ions) and in this manner heat it just like microwave oven does [F10]. The required value of Planck constant would be by a factor $2^{10} = 1024$ larger than normal Planck constant. This value is one of the number theoretically simple values defined as ratios of integers defining polygons constructible using only ruler and compass [A9]. For water molecules the needed value of Planck constant is obtained from the microwave oven frequency 2.45 GHz and would be with .1 per cent accuracy equal to $h/h_0 = n = 187 = 11 \times 17$: n does not belong to the set of number theoretically simple values of n but one cannot of course exclude it.

2.3.2 The notion of field body and dark matter

The conclusion would be that each physical system is accompanied by a field body with a fractal, onion-like, structure formed by field bodies. This leads to the following vision about the nature of living matter.

1. Each layer of the onion is characterized by the value of Planck constant telling its position in the hierarchy of dark matter.

2. At the surface of the onion the value of Planck constant is largest and in some sense defines the "IQ" of the system. At the level of molecules one expects rather low values of Planck constants. For instance, the magnetic body assignable to the ordinary EEG as has of order Earth size and the lifetime of human (say 70 years) would correspond to a layer with size of order light-life (70 light years). Even higher layers might be present: transpersonal states of consciousness would indeed naturally correspond to these layers.

Field body receives information from the biological body and quantum controls it.

1. In the case of ordinary living matter field body would naturally receive information from cell membranes, which are full of receptors monitoring the state of environment. This leads to the idea that cell membranes are Josephson junctions and that Josephson currents code this information and communicate it to some layer in the onion formed by magnetic bodies. Dark matter hierarchy suggests even the existence of fractally scaled up counterparts of cell membrane and the TGD based model of EEG relies on this assumption. What is encouraging that the model predicts correctly the decomposition of EEG into bands, in particular alpha band, explains why high arousal correspond to chaotic looking activity in beta band, and predicts also correctly the positions of narrow sub-bands in beta and theta bands [21]. The strange findings challenging pump-channel paradigm [24] (ionic currents seem to be quantal and same even for artificial membranes; currents continue to flow in absence of metabolism) support superconductivity hypothesis and suggest that ordinary Ohmic currents are only for the purposes of measuring the concentrations of various ions in cellular environment and that metabolic energy goes to the communications to the magnetic body using generalized EEG.

2. Magnetic body controls biological body through the genome. This inspires the hypothesis that magnetic flux sheets go through DNA strands and genes form what could be regarded as text lines at the page of book defined by the flux sheet. The quantization of magnetic flux with unit proportional to Planck constant implies that for large values of \hbar the flux sheets are very wide and can go through a large number of genomes. One ends up with the notion of super genome meaning that coherent collective gene expression becomes possible in the scale of organ and organism. Hyper genome would in turn fuse the super-genomes to a larger structure making possible coherent collective gene expression at the level of species and population [M3, L1]. This would bring to the theory of evolution completely new "synergetic aspect" and evolution would be much more than fight for survival.

3. The interaction between field body and biological body is essentially remote mental interaction so that paranormal phenomena would differ from normal biological basic interactions only in that field body uses external biological body to remote viewing or psychokinesis.

4. There are good reasons to assume that field bodies have developed magnetic immune systems to prevent the use of their private biological bodies by alien field bodies. Hypnosis would be example of this kind of possession by a foreign field body. This immune system can be compared to fire wall in computer world (assuming that we have created computers as our own images).

1. The height of the fire wall depends on individual. For very sensitive persons it is very low and these people are very sensitive to suggestions, hypnosis, spiritual experiences, and even encounters of ETs. Very high fire wall makes it impossible to receive even useful information and the fire wall of skeptic might be too high.
2. In the case of computers viruses and cookies are very simple programs making possible for an external computer to partially "possess" the computer via web. Their role is to serve as kind of mediums or couriers. In the case of field body viruses and cookies would correspond to very simple life forms to which immune system does not bite: plasmoids are natural candidates in this respect. This would suggest that anomalous light phenomena ("UFOs") are actually plasmoids (unidentified moving processes rather than objects).

Plasmoids could quantum entangle the brains of the sensitive person to some conscious entity at some higher level of hierarchy and the person would fall in a trance like state able to share mental images of this entity. Patterns of magnetic pulses can be used to generate alternative states of consciousness [22] and the patterned motion of the magnetic body of plasmoids (kind of dance like motor expression!) consisting of flux tubes and sheets with respect to the observer could generate this kind of pulse patterns.

It has been observed that some moving light balls indeed involve magnetic pulses with maximal field strength of about .3 Gauss and typical strength which is 10 times weaker [64]. The prediction

is that the durations of pulses should be inversely proportional to the velocity of motion of the light balls. Also the motion of a magnetometer with respect to living system might course similar pulses.

2.4 Zero energy ontology

In standard physics the sign of energy is positive. This leads to philosophical problems. The problematic question is what are the values of the conserved quantities of the universe (energy, em charge, quark and lepton number). An additional difficulty is caused by the fact that they are very naturally infinite in positive energy ontology. These questions cannot be answered with the framework of standard physics. On the other hand, TGD inspired cosmology led to a different interpretational problem: the density of non-conserved gravitational mass was non-vanishing as in standard cosmologies but the density of inertial energy vanishes [D6]. The construction of quantum TGD [C2, A1, A2] finally led to so called zero energy ontology which resolves this problem and also the problems due to the positive energy ontology.

1. All quantum states possess vanishing net values of conserved quantum numbers such as an energy. Or stating it otherwise: every physical state is creatable by intentional action from vacuum.

2. Zero energy states decompose into positive and negative energy states such that negative energy state is in the geometric future. If the temporal distance between positive and negative energy states is long as compared to the time scale of perception, the usual positive energy ontology works well. In the opposite case the zero energy state can be interpreted as a quantum fluctuation having no importance for the world as we perceive it.

2.4.1 Zero energy ontology and unification of the notions of S-matrix and density matrix

Zero energy ontology states that physical states have vanishing net conserved quantum numbers and states decompose into positive and negative energy state and that the latter one can be said to be located in the geometric future of the positive energy state at the time-like boundary of the space-time sheet representing the system. It is possible to speak about energy of the system if one identifies it as the average positive energy for the positive energy part of the system.

The matrix ("M-matrix") representing time-like entanglement coefficients between positive and negative energy states unifies the notions of S-matrix and density matrix since it can be regarded as a complex square root of density matrix expressible as a product of real squared of density matrix and unitary S-matrix. Essentially matrix valued Schrödinger amplitude is in question with S-matrix representing its "phase". An open question is how universal S-matrix is. The system can be also in thermal equilibrium so that thermodynamics becomes a genuine part of quantum theory and thermodynamical ensembles cease to be practical fictions of the theorist. In this case M-matrix represents a superposition of zero energy states for which positive energy state has thermal density matrix.

1. If the positive energy parts of zero energy states appearing in the superposition have only single value of energy, the notion of remote metabolism is certainly well-defined. Even in the case that the system is thermalized remote metabolism makes sense since average energy can be increased by remote metabolism. One can even imagine a statistical variant of the process in which the temperature increases.
2. The critical question is whether crossing symmetry prevails in the sense that the positive energy signal propagating to the geometric future is equivalent to a negative energy signal propagating to geometric past. The eigen modes of the modified Dirac operator appearing

in the first principle formulation of quantum TGD are characterized by the eigenvalues λ , which are complex. $|\lambda|^2$ has interpretation as a conformal weight mathematically analogous to a vacuum expectation value of Higgs field [B4, C3]. There are reasons to believe that the eigenvalues relate closely to the zeros of Riemann zeta and/or its generalizations [C3]. If the eigenvalue and its complex conjugate correspond to a state and its phase conjugate, crossing symmetry fails and would mean also breaking of time reversal symmetry.

2.4.2 Time mirror mechanism

Zero energy ontology gives justification for the time mirror mechanism which is the fundamental mechanism of TGD inspired model of quantum biology. To avoid confusion one must distinguish between two times: geometric and subjective time. The latter corresponds to a sequence of quantum jumps giving rise to the conscious sensation of flow of time [10, K1, H5]. Geometric time corresponds to the time of physicist identified as the fourth space-time coordinate. These times are only loosely related and their identification is only approximate and makes sense only in some states of consciousness. Indeed, subjective time is irreversible and no subjective future exists whereas geometric time is reversible and both future and past exist.

1. Symbolic (declarative memories) can be understood as communications of some onion layer of magnetic body with the brain of the geometric past [H6]. A signal consisting of negative energy phase photons (identifiable as phase conjugate photons in nonlinear optics) with larger Planck constant represents a question to the brain of the geometric past which responds automatically by sending a positive energy signal to the magnetic body in the geometric future. Episodal memories which correspond to literal re-experiences result by time-like quantum entanglement for subsystems representing the mental images.
2. Time mirror mechanism makes possible to realize intentions by sending negative energy signals to the brain of the geometric past and inducing neural activity leading to a motor response in the brain of geometric future [H1, J7]. This kind of mechanism allows more or less instantaneous reaction and provides an evolutionary advantage in "jungle". The mechanism explains Libet's findings[20] that neural activity is initiated in brain already before the conscious decision. In the usual ontology the interpretation would be that free will is only apparent. In the recent context "before" refers to the geometric rather than subjective time, so that free will is possible and assigned to the quantum jump identified as a moment of consciousness. Dark matter hierarchy implies infinite hierarchy of moments of consciousness with moments of consciousness giving rise to the analog of dark matter hierarchy at the level of conscious entities.
3. The system can receive positive energy as a recoil energy by sending negative energy to a system of geometric past able to receive it. A system analogous to a population inverted laser having more particles in a state of higher energy, is ideal provider of energy. The resulting quantum credit card makes it possible to react very rapidly in situations encountered in "jungle". I have christened this mechanism remote metabolism and magnetic body could use it to suck metabolic energy from brain or body to its own purposes by sending phase conjugate dark (generalized) EEG photons to the biological body. In the case of declarative memories the excited state of the laser like system would naturally correspond to bit 1 and ground state to bit 0 [H6]. Metabolic energy would be needed to restore the mental image since the process of memory recall would tend to reduce the population of excited states. Note that remote metabolism would be tailor made for say space travel since there would be no need to carry the fuel: if "UFOs" exist they might apply this kind of energy technology.
4. Many-sheeted space-time provides a concrete realization of the laser like systems as many-sheeted lasers. The "dropping" of particles from smaller to larger space-time sheets liberates

zero point kinetic energy [J7]. If the interaction energy with the matter at the space-time sheet can be neglected, p-adic length scale hypothesis makes precise predictions about the maximal liberated energies. The standard metabolic energy currency of about .5 eV of living matter corresponds to the dropping of proton from a space-time sheet of atomic size. Actually a fractal hierarchy of universal metabolic currencies is predicted and should be present already during the pre-biotic evolution so that the chemical storage of energy is not necessary for a primitive metabolism [N4].

The transitions corresponding to the dropping of particles should be visible in astrophysics and there are indeed exist three kinds of narrow bands of radiation in both visible and infrared range without identification in terms of known molecular transitions (see discussion below). The energies of the photons in question are consistent with p-adic length scale hypothesis and allow an interpretation in terms of proposed transitions assuming that there is some binding energy with the matter at the smaller space-time sheet [39].

2.4.3 More detailed view about time mirror mechanism in zero energy ontology

The notion of negative energy signals and time mirror mechanism emerged before zero energy ontology. Since the mechanisms of remote metabolism, of memory, and of intentional action rely on time mirror mechanism, one should check that this mechanism is indeed consistent with zero energy ontology. Zero energy ontology could also yield new insights to these mechanisms.

1. *Is zero energy ontology consistent with time mirror mechanism?*

Energy conservation and geometric arrow of time poses strong conditions on the mechanism. If positive energy part of state sends negative energy signal, then negative energy part of state must send a compensating positive energy signal. Furthermore, positive (negative) energy signals propagate towards geometric future (past).

1. If only single space-time sheet is involved, either negative energy signal $S_-: X_-^4 \rightarrow Y_-^4$ or positive energy signal $S_+: X_+^4 \rightarrow Y_+^4$ is possible. The energy of both states is reduced in magnitude. For instance, this process tends to reduce destroy long term memories represented as bit sequences with bit represented by population inverted laser system.

2. Second possibility is that X^4 and Y^4 are disjoint and X^4 is in the geometric future of Y^4 .

The first possibility is $S_+: X_+^4 \rightarrow Y_+^4$ and negative energy signal $S_-: X_-^4 \rightarrow Y_-^4$: the energy of both X^4 and Y^4 is reduced in this case.

Second possibility is $S_-: X_+^4 \rightarrow Y_+^4$ and $S_+: Y_-^4 \rightarrow X_-^4$. X^4 would suck energy from Y^4 in the geometric past. This option could correspond to both remote metabolism, memory recall, and intentional action. The presence of topological light ray connecting two systems would be also a correlate for time-like quantum entanglement making possible sharing and fusion of mental images and creating a sensation about flow of time just like it creates sensation of depth in stereo vision by fusion of right and left visual fields. Depending on the sign of the energy of the signal one would have memory or precognition. Precognition would require use of metabolic energy and this might be one reason for why it is rather rare.

3. Suppose next that the zero energy space-time sheet, call it X^4 , is inside larger space-time sheet, call it Y^4 : $X^4 \subset Y^4$. In this case one can have $S_-: X_+^4 \rightarrow Y_+^4$ accompanied by $S_+: X_-^4 \rightarrow Y_-^4$. $X^4 \subset Y^4$ would suck energy from a larger system Y^4 . It is of course possible to replace signals with signals of opposite energy in opposite time direction.

A possible interpretation is as a metabolic charging of smaller space-time sheets by sucking energy from longer scales or by active pumping of energy to shorter scales. The transformation of long wavelength photons with large Planck constant to short wavelength photons

with smaller Planck constant is an analogous process and might realize metabolic charging in biology. For instance, Sun-Earth system could correspond to Y^4 and biosphere to X^4 .

To sum up, zero energy ontology completes the picture in the sense that it also provides a process making possible metabolic charging.

2. *Thermodynamical considerations*

It is not at all obvious whether the proposed picture is consistent with the standard thermodynamics. The transfer of energy from long to shorter length scales making possible to gain metabolic energy and realize the mechanism of long term memory indeed seems a genuinely new element. This process resembles dissipation in the sense that energy is transferred from long to short length scales. In an approach to thermal equilibrium temperature gradients are however reduced whereas remote metabolism favors the active generation of "hot spots".

These considerations relate closely to the notions of entropy and syntropy by Italian mathematician Luigi Fantappie [26] assigned with the two arrows of time. I learned from the work of Fantappie in SSE conference held in Rörös from Antonella Vannini [27] and Ulisse Di Corpo [28]. The discovery of Fantappie was that in living systems entropic processes seem to be accompanied by syntropic processes which seem to be finalistic. He assigned these processes to the advanced solutions of wave equations.

It would seem that entropy and syntropy do not relate directly to the notion of remote metabolism.

1. Syntropy growth would indeed be the mirror image of entropy growth associated with negative energy mirror image of positive energy dynamics. This dynamics could be seen as sequences of downwards scalings leading from long time scale to short time scale. This sequence would define time sequences proceeding in opposite directions of time for positive and negative energy parts of states. Thus entropy growth would be accompanied by syntropy growth.
2. Syntropy growth could be also seen as a consequence of generalized second law applying with respect to subjective time and growth of syntropy would be growth of entropy but manifesting itself at space-time level in reversed direction of geometric time. For instance, the spontaneous assembly of bio-molecules from their parts could be seen as a decay process in the reverse direction of geometric time controlled by phase conjugate control signals.
3. Remote metabolism as generation of "hot spots" does not seem to reduce to these notions and might represent a genuine breaking of standard thermodynamical view about the world.

One must also distinguish the notions of entropy and syntropy from the notion of number theoretic entanglement negentropy N assignable with quantum entanglement with algebraic entanglement probabilities [H2].

1. N is defined as the maximum of the p-adic entanglement negentropy $N(p)$ as a function of the p-adic prime p and thus assigns to an entangled system a unique prime p_{max} . $N(p)$ is obtained by replacing in the definition of the Shannon entropy the argument of logarithm with its p-adic norm. N is in general positive and thus defines a genuine measure of information.
2. The non-negative negentropy defined in this manner characterizes entanglement as a carrier of information rather than the state of either of systems and has nothing to do with the ordinary (non-positive) entropy characterizing the lack of knowledge about the state of either subsystem. Negentropy Maximization Principle [H2] favors the increase of the number theoretic negentropy and thus formation of entanglement quantum systems and generation

of quantum coherence. Depending on the character of entanglement negentropic entanglement might be interpreted as a correlate for some conscious experience with positive content: say experience of understanding (time-like entanglement implying causal structure), of love (space-like entanglement), etc...

It is not obvious to me whether the remote metabolism as a manner to build hot spots and diversity could be reduced to NMP or whether it should be regarded as something completely independent.

2.5 p-Adic physics as physics of cognition and intentionality

p-Adic number fields are completions of rationals to a continuum as are also ordinary real numbers. In the case of real numbers one adds to the rationals algebraic numbers and transcendentals like e and π . In the case of p-adic numbers one adds numbers, which are infinite as real numbers. To every prime $p=2,3,5,7,\dots$ one can assign a p-adic number field and an infinite number of algebraic extensions analogous to complex numbers.

1. One can assign also to p-adic numbers a physics (what this physics is far from obvious). The basic motivation for p-adics in the case of TGD was that p-adic thermodynamics makes possible to understand elementary particle masses and reduces the fundamental mystery number defined by the ratio of Planck mass to proton mass to number theory [F1, F2, F3, F4, F5]. It took a long time to get convinced that p-adic physics can be interpreted as the physics of cognition and intentionality and that p-adic physics can be seen as a simulation of real physics.
2. The challenge is to "glue" real physics and various p-adic physics to single coherent whole. To achieve this it is necessary to generalize the notion of number by "gluing" together real numbers and various p-adic number fields by along common rationals (and possibly also common algebraics) [E1]. Also the notions of space, manifold, and space-time generalize. It becomes possible to speak about p-adic space-time sheets as correlates for intentions and cognitions [H8]: this would be the geometric counterpart for the "mind stuff" of Descartes. Note however that space-time and quantum states are zombies: consciousness is in the quantum jump.
3. Rather remarkably, every p-adic space-time sheet has literally infinite size in the sense of the real topology. This means that cognition and intentionality are cosmic phenomena and cannot be localized to brain or even field body. The intersections of field bodies and p-adic space-time sheets consist of discrete sets of points and provide material representations for cognitions and intentions. The larger the size of field body (the larger the value of Planck constant), the larger the number of points in this intersection, and the better the cognitive representations and the more precise the intentional grasp on the material world. Thus the evolution of cognition involves growth of the largest Planck constant associated with the system characterizing also the time scale of long term memories and planned action.
4. The theory is testable. The p-adic topology should reflect itself as an effective p-adic topology of real space-time sheets serving as correlates for matter and p-adic continuity means p-adic fractality with characteristic long range correlations combined with local chaos in the real topology. The success of p-adic mass calculations supports this view and suggests that cognition and intentionality are present already in elementary particle scales. Also the successes of the applications to biology and even cosmology support the theory.
5. The essential ingredient of the theory is p-adic length scale hypothesis: primes which are near powers of two are physically preferred. In particular, prime powers of two and Mersenne

primes $M_n = 2^n - 1$ and their complex analogs (Gaussian Mersennes) are especially favored. For instance, most important elementary particles correspond to Mersenne primes and a number theoretical miracle occurs in biologically important length scale range: in the length scale range between cell membrane thickness (10 nm) and size of cell nucleus (2.5 μm) there are as many as 4 Gaussian Mersennes [J7]!

3 Many-sheeted space-time, universal metabolic quanta, and plasmoids as primitive life forms

In this section evidence for many-sheeted space-time represented together with development of more concrete ideas about plasmoids as primitive life forms. Recall that might form the basis of new energy technology able to recycle the fuel.

3.1 Evidence for many-sheeted space-time

The dropping of particle to a larger space-time sheet liberates energy which is the difference of the energies of the particle at two space-time sheets. If the interaction energy of the particle with the matter at space-time sheet can be neglected the energy is just the difference of zero point kinetic energies. This energy depends on the details of the geometry of the space-time sheet. Assuming p-adic length scale hypothesis the general formula for the zero point kinetic energy can be written as

$$E(k) = x \times E_0(k) \quad , \quad E_0(k) = \frac{3}{2} \frac{\pi^2}{mL^2(k)} \quad .$$

Here x is a numerical factor taking into account the geometry of the space-time sheet and equals to $x = 1$ for cubic geometry.

The liberated zero point kinetic energy in the case that the particle drops to a space-time sheet labelled by $k_f = k + \Delta k$ with same value of x is

$$\Delta E(k, \Delta k) = x \times E_0(k) \times (1 - 2^{-\Delta k}) \quad .$$

The transitions are seen as discrete lines for some resolution $\Delta k \leq \Delta k_{max}$. At the limit $k \rightarrow \infty$ transitions give rise to a quasicontinuous band. The photon energy for $k \rightarrow \infty$ transition is same as the energy from $k - 1 \rightarrow k$ transition, which brings in additional option to the model building.

For a proton dropping from the atomic space-time sheet $k = 137$ to very large space-time sheet ($\Delta k \rightarrow \infty$) one has $\Delta E(k) = E(k) \sim x \times .5$ eV. Since the ratio of electron and proton masses is $m_p/m_e \simeq .94 \times 2^{11}$, the dropping of electron from space-time sheet $k_e = k_p + 11$ liberates zero point kinetic energy which is by is by a factor .9196 smaller. For $k_p = 137$ one would have $k_e = 148$. This energy corresponds to the metabolic energy currency of living systems and the idea is that the differences of zero point kinetic energies define universal metabolic energy currencies present already in the metabolism of pre-biotic systems. In the following fit electron's zero point kinetic energy will be taken to be $E_0(148) = .5$ eV so that for proton the zero point kinetic energy would be $E_0(137) = .544$ eV.

The hypothesis predicts the existence of anomalous lines in the spectrum of infrared photons. Also fractally scaled up and scaled down variants of these lines obtained by scaling by powers of 2 are predicted. The wavelength corresponding to .5 eV photon would be $\lambda = 2.48$ μm . These lines should be detectable both in laboratory and astrophysical systems and might even serve as a signature for a primitive metabolism. One can also consider dropping of Cooper pairs in which case zero point kinetic energy is scaled down by a factor of 1/2.

Interestingly, the spectrum of diffuse interstellar medium exhibits three poorly understood structures [33]: Unidentified Infrared Bands (UIBs), Diffuse Interstellar Bands (DIBs) [34], and Extended Red Emission (ERE) [35] allowing an interpretation in terms of dropping of protons or electrons (or their Cooper pairs) to larger space-time sheets. The model also suggests the interpretation of bio-photons in terms of generalizes EREs.

3.1.1 Unidentified Infrared Bands

Unidentified infrared bands (UIBs) contain strong bands at $\lambda = 3.3, 6.2, 11.3$ microns [33]. The best fit for the values of k and Δk assuming dropping of either electron or proton are given by the following table. The last row of the table gives the ratio of predicted photon energy to the energy characterizing the band and assuming $x = 1$ and $E_0(148, e) = .5$ eV. Discrepancies are below 8 per cent. Also the dropping of protonic Cooper pair from $k = 137$ space-time sheet could reproduce the line $\Delta E = .2$ eV. The fit is quite satisfactory although there is of course the uncertainty related to the geometric parameter x .

$\lambda/\mu m$	$E/.5eV$	k	Δk	$\Delta E(k, \Delta k)/E$	p/e
330	.7515	137	$\sim \infty$	1.002	e
620	.4000	138	3	1.067	e
1130	.2195	139	3	0.878	e
1130	.2195	139+11=150	3	1.076	p

Table 1. Table gives the best fit for UIBs assuming that they result from dropping of proton or electron to a larger space-time sheet and one has $E_0(148, e) = .5$ eV. The fourth column the table gives the ratio of predicted photon energy to the energy characterizing the band and assuming $x = 1$. e/p tells whether electron or proton is in question.

According to [33], UIBs are detected along a large number of interstellar sight-lines covering a wide range of excitation conditions. Recent laboratory IR spectra of neutral and positively charged poly-cyclic aromatic hydrocarbons (PAHs) has been successfully used by Allamandola [37] to model the observed UIBs. It is believed that PAHs are produced in reactions involving photosynthesis and are regarded as predecessors of biotic life [36]. This would conform with the presence of metabolic energy quanta.

DNA sugar bone, some aminoacids, and various hallucinogens involve 5- and 6-cycles and the proposal is that these cycles involve free electron pairs, which possess Planck constant $\hbar = n\hbar_0$, $n = 5, 6$. These free electron pairs would explain the anomalous conductivity of DNA and would be an essential characteristic of living matter. The emergence of $n = 5, 6$ levels could be seen as the first step in the pre-biotic evolution.

3.1.2 Diffuse Interstellar Bands

There are diffuse interstellar bands (DIBs) at wavelengths 578.0 and 579.7 nanometers and also at 628.4, 661.4 and 443.0 nm. The 443.0 nm DIB is particularly broad at about 1.2 nm across - typical intrinsic stellar absorption features are 0.1 nm [33]. The following table proposes a possible identification of these lines in terms of differences of zero point kinetic energies. Also now the best fit has errors below 7 per cent.

λ/nm	$E/.5eV$	k	Δk	$\Delta E(k, \Delta k)/E$	p/e
628.4	3.947	$135 = 3^3 \times 5$	$\sim \infty$	0.987	e
661.4	3.750	$135 + 11 = 2 \times 73$	3	0.985	p
443.0	5.598	$134 = 2 \times 67$	2	0.933	e
578.0	4.291	$135 + 11 = 2 \times 73$	$\sim \infty$	0.986	p
579.7	4.278	$135 + 11 = 2 \times 73$	$\sim \infty$	0.984	p

Table 2. Table gives the best fit for DIBs assuming that they result from dropping of proton or electron to a larger space-time sheet. Notations are same as in the previous table.

The peak wavelengths in chlorophyll and photosynthesis are around 650 nm and 450 nm and would correspond to second and third row of the table.

3.1.3 The Extended Red Emission

The Extended Red Emission (ERE) [33, 35] is a broad unstructured emission band with width about 80 nm and located between 540 and 900 nm. The large variety of peak wavelength of the band is its characteristic feature. In majority of cases the peak is observed in the range 650-750 nm but also the range 610-750 nm appears. ERE has been observed in a wide variety of dusty astronomical environments. The necessary conditions for its appearance is illumination by UV photons with energies $E \geq 7.25$ eV from source with $T \geq 10^4$ K. The position of the peak depends on the distance from the source [35].

According to [33] the current interpretation attributes ERE to a luminescence originating from some dust component of the ISM, powered by UV/visible photons. Various carbonaceous compounds seem to provide a good fit to the observational constraints. However, the real nature of ERE is still unknown since most candidates seem to be unable to simultaneously match the spectral distribution of ERE and the required photon conversion efficiency.

1. Consider first the band 650-750 nm appearing in the majority of cases. The most natural interpretation is that the lower end of the band corresponds to the zero point kinetic energy of electron at $k = 135 + 11 = 146 = 2 \times 73$ space-time sheet. This would mean that the lines would accumulate near 650 nm and obey the period doubling formula

$$\frac{\lambda(k) - \lambda(\infty)}{\lambda(\infty)} = \frac{2^{-k}}{1 - 2^{-k}} .$$

By the estimate of Table 2 the lower end should correspond to $\lambda = 628.4$ nm with a correction factor $x < 1$ reducing the zero point kinetic energy. The reduction would be smaller than 4 per cent. $\Delta k = 3$ transition would correspond to 744 nm quite near to the upper end of the band. For $\Delta k = 2$ transition one has $\lambda = 867$ nm not to far from the upper end 900 nm. $\Delta k = 1$ corresponds to 1.3 μm .

2. For proton with $k = 135 = 146$ the energy band would shift by the factor $2^{11}m_e/m_p \simeq 1.0874$ giving the range (598,690) nm.
3. The variation for the position of the peak can be understood if the charged particles at the smaller space-time sheet can have excess energy liberated in the dropping to the larger space-time sheet. This excess energy would determine the position of the lower end of the band in the range (540, 650) nm.
4. One should also understand the role of UV photons with energy larger than 7.25 eV. For proton the energy would be 8.76 eV. For photon the energy would be 8.76 eV. UV photon with energy $E \geq 8$ eV could kick electrons from large space-time sheets to $k = 144 = 146 - 4$

space-time sheet where they have zero point kinetic energy of 8 eV plus possible additional energy (for proton the energy would be 8.76 eV). One possibility is that these electrons drop first to $k = 145$ by the emission of ~ 4 eV UV photon and then to $k = 144$ by the emission ~ 2 eV photon corresponding to 650 nm line. The further dropping to larger space-time sheets would produce besides this line also the lines with longer wavelengths in the band.

The energy of UV photons brings in mind the bond energy 7.36 eV of N_2 molecule and the possibility of metabolic mechanism using UV light as metabolic energy and based on the dissociation of N_2 followed by re-association liberating metabolic energy kicking protons or electrons to a smaller space-time sheet. For the $k \rightarrow k + 3$ transition of electron the energy would be 7 eV which suggests that this transition defines important metabolic energy quantum for living interstellar dust using dissociation and its reversal as basic metabolic mechanism.

3.2 Laboratory evidence for plasmoids as life forms

Accepting the notion of magnetic body one is naturally led to the idea about plasmoids as primitive life forms quantum controlled by the dark matter at the magnetic body of the plasma ball. Magnetic body itself would contain Bose-Einstein condensates of ions and electrons and could be seen as a quantum plasmoid. Plasmoids would be very simple systems able to recycled metabolism and therefore highly interesting from the point of new energy technologies. Magnetic body of the plasmoid could also be responsible for a continual feed of charge keeping plasma ball charged (DNA strands are negatively charged in bio-matter).

3.2.1 From dust to dust

The article *From Plasma crystals and helical structures towards inorganic living matter* of Tsytovich *et al* in August issue of New Journal of Physics provides new empirical support for plasmoids as living life forms. The results of the article suggest that interstellar dust could behave like living matter in some respects: it could even have variant of genetic code. This is a really shattering finding and with single blow destroys the standard dogma about life as something purely chemical. It should also give also some headaches for those influential colleagues who have decided that it is necessary to accept the anthropic principle. Here is little popularization of the result.

SCIENTISTS have discovered that inorganic material can take on the characteristics of living organisms in space, a development that could transform views of alien life.

An international panel from the Russian Academy of Sciences, the Max Planck institute in Germany and the University of Sydney found that galactic dust could form spontaneously into helixes and double helixes and that the inorganic creations had memory and the power to reproduce themselves.

A similar rethinking of prospective alien life is being undertaken by the National Research Council, an advisory body to the US government. It says Nasa should start a search for what it describes as weird life" - organisms that lack DNA or other molecules found in life on Earth.

The new research, to be published this week in the New Journal of Physics, found nonorganic dust, when held in the form of plasma in zero gravity, formed the helical structures found in DNA. The particles are held together by electromagnetic forces that the scientists say could contain a code comparable to the genetic information held in organic matter. It appeared that this code could be transferred to the next generation.

Professor Greg Morfill, of the Max Planck institute of extra-terrestrial physics, said: Going by our current narrow definitions of what life is, it qualifies.

The question now is to see if it can evolve to become intelligent. Its a little bit like science fiction at the moment. The potential level of complexity we are looking at is of an amoeba or a plant.

I do not believe that the systems we are talking about are life as we know it. We need to define the criteria for what we think of as life much more clearly.”

It may be that science is starting to study territory already explored by science fiction. The television series The X-Files, for example, has featured life in the form of a silicon-based parasitic spore.

The Max Planck experiments were conducted in zero gravity conditions in Germany and on the International Space Station 200 miles above earth.

The findings have provoked speculation that the helix could be a common structure that underpins all life, organic and nonorganic.

To sum up the essentials, plasma phase is involved and the dust life is able to construct analogs of DNA double helices and this has been achieved also in laboratory. "From dust to dust" seems to have a very deep side meaning!

Here is a more quantitative summary of the results reported in [61].

1. The scale of the dust balls seems to be few micrometers. It is essential that the system is open in the sense that there is both metabolic energy feed and continual feed of plasma to negatively charged dust particles to preserve their charges. Authors speak about effective "gravitational" instability as a mechanism leading to the formation of the helices and identify effective gravitational coupling (the formula contains a trivial typo) as a function of charge and mass of the particle plus dimensionless parameter characterizing the modification of Debye model implied by the fact that dust particles are not electrically closed systems. Authors give a long list of life-like properties possessed by the helical structures.
2. Helical structures are generated spontaneously and possess negative charges. The repulsion of the helical structures transforms to attraction at some critical distance interval due to the fact that the large electrostatic self energy depends on the distance between helices and this makes possible double helices (authors speak about over-screening in the formal model). Similar mechanism might work also in the case of ordinary DNA double helices whose stability is poorly understood since also in this case the large negative charge could be preserved by continual feed of charge.
3. The twist angle of the helix makes bifurcations as a function of radius of helix and the values of twist angle could define the letters of genetic code. Also a mechanism for how the twist angle is communicated to neighboring helix is proposed. Also dust vortices are observed and might be those which one can occasionally observe during hot summer days.
4. Authors do not mention magnetic fields but my guess is that the helical structures reflect directly the geometry of the helical magnetic flux tubes, and that dark electron pairs with large Planck constant at these tubes might be the quantal aspect of the system. These currents might relate closely to the plasma current, which charges the dust particles. Also DNA, which is insulator, is known to be able to act as conductor, and here the free electron pairs associated with aromatic rings having $\hbar = n \times \hbar_0$, $n = 5$ or 6 , could make conduction possible since their Compton size would be n-fold.

3.2.2 Elephant trunks in astrophysics

TGD Universe is fractal and this means that the visible structures are formed around magnetic flux quanta containing dark matter with large \hbar appear in all length scales and have geometric patterns reflecting the exact discrete symmetries of dark matter acting as rotational symmetries of the field body and at the level of visible matter giving rise to broken symmetries typical for molecular structures. The helical structures found from the rings of some planets could be one example of fractal life.

For some time ago I learned about "elephant trunks" found by Hubble (I am grateful for Miika Väisälä telling about the trunks and for giving references to the papers about the finding). They appear in very wide range of length scales: at least from 1000 au to 1 pc. They are found in close connection with molecular clouds and HII regions excite by one or more young hot stars (a "metabolic connection" with the above mentioned unidentified bands and lines and PAHs present only if there is also UV source present does not look like a bad guess). In general the trunks are

Another important finding supporting TGD view about Universe which might be seen as a fractally scaled variant of above helices. pointing like fingers to the hot stars. Here is abstract of the paper by P. Carlquist, G. F. Gahm, and H. Kristen [38].

Using the 2.6 m Nordic Optical Telescope we have observed a large number of elephant trunks in several regions. Here, we present a small selection of this material consisting of a few large, well-developed trunks, and some smaller ones. We find that: (i) the well-developed trunks are made up of dark filaments and knots which show evidence of twisted structures, (ii) the trunks are connected with essentially two filamentary legs running in V-shape, and (iii) all trunks have the maximum extinction in their heads. We advance a theory of twisted elephant trunks which is based on the presence of magnetic flux ropes in molecular clouds where hot OB stars are formed. If the rope contains a local condensation it may adopt a V-shape as the region around the hot stars expands. If, in addition, the magnetic field in the rope is sufficiently twisted, the rope may form a double helix at the apex of the V. The double helix is identified with the twisted elephant trunks. In order to illustrate the mechanisms behind the double helix we have constructed a mechanical analogy model of the magnetic flux rope in which the rope has been replaced by a bundle of elastic strings loaded by a weight. Experiments with the model clearly show that part of the bundle will transform into a double helix when the twist of the bundle is sufficiently large. We have also worked out a simple theoretical model of a mass-loaded magnetic flux rope. Numerical calculations show that a double helix will indeed form when the twist of the rope exceeds a certain critical limit. Numerical model calculations are applied to both the analogy model experiments and one of the well-developed elephant trunks. On the basis of our model we also suggest a new interpretation of the so called EGGs.

The double helix mechanism is quite general, and should be active also in other suitable environments. One such environment may be the shell of supernova remnants. Another example is the expanding bubble outlined by the North Celestial Pole Loop.

For fractally thinking physicist consisting mostly of dark matter with large Planck constant this does not leave many options: life and even intelligent life is everywhere and in all length scales. This provides also a new view about Fermi paradox: see the article [65], which summarizes also the essentials of TGD, TGD based ontology, and TGD based quantum biology.

3.3 Universal metabolic quanta

The basic prediction following from the p-adic length scales hypothesis is that universal metabolic energy quanta come as octaves of p-adic energy scale. The natural expectation is that the evolution of life has proceeded from high to low energy quanta and that also the high energy quanta might be seen even at the level of organic life.

3.3.1 Could UV photons have some metabolic role?

The correlation between UV photons and ERE brings in mind the vision that high temperature plasmoids are primitive life-forms possibly having universal metabolic energy quanta in UV range. One can imagine that the development of chemical energy storage mechanisms has made it possible to use visible light from Sun as a source of metabolic energy and get rid of UV quanta having disastrous biological effects. Ozone layer shields out most of UV light and also air absorbs the UV light below wavelength 200 nm, which justifies the term vacuum UV (VUV) for this range.

Δk	1	2	≥ 3	∞
$\Delta E(144, \Delta k)/eV$	4	6	≥ 7	8
λ/nm	310(UVB)	207(UVB)	≤ 177 (VUV)	155 (VUV)

Table 3. The lines corresponding to the dropping of electron from $k = 144$ space time sheet defining a candidate for UV light inducing generation of ERE in the interstellar dust.

From Table 3 one finds that $\Delta k > 2$ electronic transitions cascading to 8 eV (155 nm by period doubling) belong to vacuum UV (VUV) absorbed by air. The lines 310 nm and 207 nm corresponding to $\Delta k = 1$ and $\Delta k = 2$ could however define frequency windows since these lines need not correspond to any atomic or molecular electronic transitions.

In the solar photosphere the temperature is about 5800 K, roughly half of the minimum temperature 10^4 K needed to generate the UV radiation inducing ERE in interstellar dust. Solar corona however has temperature of about 10^6 K, which corresponds to a thermal energy of order 100 eV and the UV radiation from corona at above mentioned discrete frequencies resulting in dropping of electrons could serve as a metabolic energy source for pre-biotics in the interstellar space. This raises obvious questions. Should the stellar sources inducing ERE possess also corona? Could 4 eV and 6 eV UV photons from the solar corona serve as a source of metabolic energy for some primitive organisms like blue algae?

3.3.2 A simple model for the metabolism of plasmoids

Extended Red Emissions (EREs) are associated with the interstellar dust in presence of UV light with energies above 7.25 eV and source with temperature not below 10^4 K (maximum of wave length distribution of black body radiation corresponds to the energy 4.97 eV at this temperature). This suggests that plasmoids using UV photons as metabolic energy are involved.

1. Since the bond energies of molecules vary in few eV range and their formation typically liberates photons in UV range, the natural hypothesis is that the metabolic cycle is based on the formation of some molecule liberating UV photon kicking electron/proton to a smaller space-time sheet. UV photons from energy source would in turn induce dissociation of the molecule and thus drive the process. The process as a whole would involve several p-adic length scales and several metabolic currencies.
2. This situation is of course encountered also in the ordinary biology but with highly developed sharing of labor. Biosphere would burn hydrocarbons in animal cells with carbon dioxide as the eventual outcome. Carbon dioxide would in turn be used by plants to regenerate the hydrocarbons. Note that in the recent day technology the loop is open: hydrocarbons are burned but there is no process regenerating them: perhaps photons with large Planck constant might some day used to regenerate the fuel and give rise to "living" and perhaps tidier technology.
3. It is believed that complex organic molecules like amino-acids can form in the interstellar dust and the spontaneous formation of aminoacids is known to be possible in the interstellar ice under UV radiation. Hence at least N_2 and perhaps also CO can be expected to be present. The table below gives dissociation energies of some simple molecules.

Molecule	H ₂	O ₂	N ₂	CO	NO
E_D/eV	4.48	5.08	7.37	11.11	5.2

i) N_2 has bond energy 7.37 eV is slightly above the UV threshold 7.26 eV for ERE, which strongly suggests that N_2 is one of the molecules involved with the metabolism of interstellar plasmoids.

ii) If ice is present then carbon monoxide CO would be an excellent candidate for a metabolic molecule since its bond energy is as high as 11.11 eV. The exceptionally large bond energy would naturally relate to the fact that carbon and oxygen are the key molecules of life.

3.3.3 Anomalous light phenomena as plasmoids

TGD suggests that anomalous light phenomena (ALPs, or light balls, or UFOs depending on one's tastes and assumptions) are identifiable as plasmoids behaving as primitive life forms. In the conference held in Rörös Björn Gitle-Hauge told about the determination of the spectrum of visible light emitted by some light balls observed in Hessdalen [63] ("Hessdalen phenomenon" is the term used).

1. The spectrum is a band in the interval 500-600 nm whereas the typical ERE [35] is concentrated in the interval 650-750 nm. The peak is in the interval 540-900 nm, the width of the band is also now 100 nm, and there are no sharp peaks. Therefore the interpretation as ERE can be considered.
2. Because Hessdalen is an old mining district, authors propose that the light ball could consist of burning dust containing some metals. Author proposes that the burning of Titanium and Scandium (encountered only in Scandinavia) might provide the energy for the light ball. Sc reacts vigorously with acids and air (burning in oxygen gives Sc_2O_3 as end product). Ti burns in oxygen and is the only element that burns in nitrogen. Ti is used in fireworks since it produces spectacular fires.

Author notices that the emission lines of N^+ , Al^{++} , *resp.* Sc^+ at 528.02 nm, 528.2 nm, *resp.* 528.576 nm might contribute to the band. This might be the case but the explanation of the band solely in terms of molecular transitions is not favored by its smoothness.

3. The bond energies of TiO and TiN are 6.9 eV and 5.23 eV so that the radiation resulting in their formation is in UV range and could provide part of the metabolic energy. I do not know about bond energy of Scandium oxide.
4. TiO_2 is known to catalyze photolysis in the presence of UV light [31, 30], which in turn is basic step in photosynthesis [29], the basic step of which in TGD Universe would be the kicking of electrons/protons to smaller space-time sheets. Therefore the UV photons liberated in the formation of molecules containing Ti could catalyze photosynthesis like process.

3.4 Life as a symbiosis of plasmoids and biological life

If evolution has discovered something it usually keeps it so that plasmoids and UV metabolism should be still there. This suggests that plasmoids are still in ionosphere. What could this mean? There also also other questions and I am grateful for Sampo Vesterinen for some of them. The key questions are perhaps the following ones. Do plasmoids and biological life forms live in symbiosis in some sense? If this is the case, what plasmoids can give to us and what we can give to plasmoids?

1. Magnetic bodies as quantum plasmoids and plasmoids in magnetosphere

One must make clear what one means with plasmoid. One can consider a plasma made of ordinary visible matter and also large \hbar quantum plasma at magnetic bodies in a form of Bose-Einstein condensates of charged particles. The symbiosis of plasmoids and biomatter could correspond to the symbiosis of magnetic body and biological body.

One can imagine also the possibility that visible matter plasmoids and bio-matter are in symbiosis via the mediation of magnetic bodies. Note that DNA strands are negatively charged so that there is a resemblance with a plasma like state. One aspect of symbiosis would be that magnetic body would feed charged particles to DNA.

2. Some basic facts about magnetosphere

Magnetosphere would be a natural environment for plasmoid population. If one restricts plasmoids to visible matter, then ionosphere, plasma sphere and plasma sheet are the most interesting objects of interest.

1. The temperature in the highest F layer of the ionosphere (extending from 150 km to 1500 km depending on source) is about 1200-1300 K: the photon energy is about .6-.65 eV at the maximum wavelength of thermal distribution. Hence F layer plasmoids might receive metabolic energy in the form of .5 eV metabolic energy quanta via thermal photons. Self-organization occurs in transition layers and especially interesting is the transition region 85-300 km from mesosphere to ionosphere at which temperature increases 300 K to about 1200 K.
2. Inner magnetosphere is a toruslike structure whose extension varies between $4R_E$ (day side) and $8R_E$ (night side) and shielded from solar wind. In the inner magnetosphere the typical density is about 1 ion per cubic centimeter. Inner magnetosphere is bounded by a transition layer of thickness of $\sim R$ (magneto-pause). In this region the density of the ions drops rapidly.

Inner magnetosphere contains plasma sphere whose radius varies in the range $2R_E - 4R_E$ at day side and $2R_E - 6R_E$ at night side. Plasma has a ionospheric origin. The density of the cold plasma consisting mainly of protons sphere varies in the range $10 - 10^3$ ions/cm³, whereas the temperature is $\sim 5 \times 10^3$ K, which corresponds to metabolic energy quantum of .5 eV. Note however that the energy of photon at maximum of thermal distribution is about 2.5 eV which suggests 2 eV metabolic quantum.

The cold, dense plasma of plasma sphere is frozen around magnetic flux lines which co-rotate with Earth. In TGD framework this means that flux tubes co-rotate and thus change shape. In the equatorial plane the density of the plasma sphere drops sharply down to ~ 1 ion/cm³ at $r = 4R$. This transition region is known as a plasma pause. During magnetic storms the outer radius decreases since the pressure of the solar wind compresses the plasma sphere. The day-night variation of the shape of the plasma sphere is rather small. Within this region the magnetic field has in a reasonable approximation dipole shape with radiation belts forming an exception.

The surface temperature of Sun is 6×10^3 K. This temperature is roughly half of the minimum temperature 10^4 K needed for EREs from interstellar dust [35]. This corresponds to photon energy of 3 eV at the maximum of thermal distribution and cannot induce dissociation of N_2 and other simple diatomic molecules. There is also solar corona but its temperature is about 10^6 K (10^2 eV) so that the flux of thermal photons at UV energies is very low.

Taking seriously the finding that $T \geq 10^4$ K for source is necessary for EREs, one might ask whether the plasmoids at the day side are able to receive enough metabolic energy from UV radiation of Sun. Of course, there is no need to assume that dissociation of N_2 molecules is key element in metabolic mechanism. The temperatures in both F layer and plasma sphere allow kicking of protons and electrons to smaller space-time sheets and this might save the situation. Hence metabolism is not a problem for the plasmoids except perhaps during night-time when the plasma cools down somewhat.

3. The plasma sheet [32, N1] at the night side of Earth dark is the most prominent feature of the outer magnetosphere. It has a thickness about Earth radius R_E and extends beyond Moon's orbit (with radius $10^3 R_E$). The average densities of charged particles are very low and same order of magnitude as in plasma sphere: about .4-2 per cm^3 for both protons and electrons and correlates with solar wind density.

The temperature is very high: the thermal energy of electrons is in keV range and ionic temperatures are even higher. The high temperature is due to the leakage of matter from solar wind. Note that up to the distance $d \sim 10^2 R_E$ equator region of outer magnetosphere at the night side of Earth experiences a continual solar eclipse so that this region does not receive radiation energy from Sun: the high temperature of plasma sheet solves this metabolic problem.

The presence of keV photons would destroy molecules at plasma sheet and induce a high degree of ionization so that plasmoid life must be based on ions and electrons. The energy needed to kick an electron to an atomic space-time sheet is about keV from $m_e/m_p \sim 2^{-11}$: hence the dropping of electrons from atomic space-time sheets would be the natural metabolic mechanism for plasmoid life at plasma sheet.

One of the original motivations for the plasmoid hypothesis was the strange finding that plasma sheet at the equator at the dark side of Earth is highly self-organized structure and the velocity distributions of electrons present patterns like "flowers", "eyes", "butterflies" [N1].

3. *What plasmoids could give to us and what we could give to plasmoids?*

An attractive general motivation for the symbiosis would be that magnetic bodies would give us ability to think and we would give them ability to sense.

1. The model of cognitive representations relies on the intersections of magnetic bodies with corresponding p-adic space-time sheets possessing literally infinite size in the real sense. The larger the magnetic body, the better the representations. Magnetic bodies could thus provide us with cognitive representations and an interesting question is whether and how this relates to the strange self-organization patterns at plasma sheet.
2. We could provide for magnetic bodies sensory input and serve as their motor instruments. These magnetic bodies might be also associated with plasma sheet and the plasmoids of ionosphere and plasma sphere and could also use plasmoids of visible matter as a sensory receptors and perhaps even primitive motor instruments.

One can imagine also more concrete motivations for the symbiosis.

1. Plasmoids in the day-side ionosphere could shield biosphere from UV light by "eating" the incoming UV light. Magnetic bodies could also feed negative electronic charge from the plasmoids of magnetosphere to DNA double strands.
2. Plasmoids are not in a need of metabolic energy unless it happens that the temperature in F layer cools too much during night time from $T \sim 0.12$ eV. One might imagine that plasmoids suck metabolic energy from the biosphere during sleep (say brains which remain active): this would be a possible explanation for why we sleep. One can even imagine that during sleep magnetospheric collective levels of consciousness take command and life forms in the biosphere entangle to form kind of stereo consciousness providing a collective view what is to be human, member of species, or a part of biosphere.

4. *About the interpretation of bio-photons?*

Also the wave lengths of bio-photons are in the range of visible photons. Their spectrum is claimed to be featureless, which would suggest that identification in terms of photons resulting in dropping of electrons and protons to larger space-time sheets might not make sense. The variation of the geometric shape of space-time sheets, the possibility of surplus energy, and the clustering of the transition lines around the lower end of wave length spectrum might however give rise to effectively featureless spectrum.

Suppose that bio-photons correspond to superposition of ERE bands and thus reflect the presence of UV energy feed. Unless biological body is not able to generate the needed UV photons, they must arrive from Sun. Bio-photons or their dark counterparts with much longer wavelengths could indeed live at the flux quanta of the magnetic bodies and observed visible bio-photons could represent some kind of leakage.

5. *Gariaev's experiments*

Gariaev's experiments [25] involved the irradiation of DNA using visible laser light with photon energy 1.9595 eV. The irradiation induced emission of radio waves with same polarization with frequencies above kHz. Radio waves induced growth of potatoes. A possible interpretation is that 2 eV photons kicked electrons to a smaller space-time sheet and thus gave metabolic energy to DNA. The radio waves possibly resulting in the dropping of electrons back to the larger space-time sheets could have consisted of dark photons with same or smaller energy and could have been used as a metabolic energy by the potatoes. That the dropping can occur to several space-time sheets would explain why several radio wave frequencies were observed. The prediction would be sum of period doubling spectra discussed earlier since sequences of droppings are possible. The radio-wave signal would result from the de-coherence of dark radio-wave photons to a bundle of ordinary radio-wave photons.

6. *Earth's interior as a living system?*

For years ago I developed in detail the working hypothesis that entire magnetosphere is a living system. Even Earth's interior (and also solar surface) could contain plasmoid life [N4, N1]. The temperature below the mantle of Earth does not differ too much from the surface temperature of Sun and metabolic energy could come from the radioactive decays from the interior of Earth. There would be UV shielding by Earth: UV light has energies above 3.1 eV whereas the temperature at the mantle-core boundary is 4300 K which corresponds to energy 2.2 eV energy at the maximum of thermal distribution. Metabolic energy quantum of 2 eV would be highly suggestive and might be directly used to kick protons and electrons to smaller space-time sheet.

The metabolism would not probably involve energy quantum of .5 eV. Magnetic flux tubes could also mediate metabolic energy from the biosphere and possibly also ionosphere and the plasmoid life in question could be at an evolutionary level not tolerating UV light and involve molecules in essential manner.

4 Podletnov effect and Modanese-Podkletnov effect

The name of Podkletnov is associated with two effects for which the simplest explanation seems to be based on the same idea. The older experiment [70] reports a few per cent reduction of strength of Earth's gravitational field above rotating and levitating super-conductor subjected to 1 MHz AC current generated magnetic field. Schnurer [71] reports a similar effect in rotating super-conductor during a phase transition from super-conducting to non-super-conducting phase.

In Modanese-Podkletnov effect [73] the electric discharges of a capacitor for which the second plate is super-conductor are reported to generate a pulse of unidentified radiation inducing the

oscillation of test penduli. What is strange that the beam of radiation does not seem to be attenuated.

I have considered several alternative explanations for the Podkletnov effect but only after having realized the correct interpretation of predicted long ranged electro-weak and color gauge fields in terms of dark matter hierarchy it became obvious that the common denominator of these experiments is phase transition like phenomenon, either (possibly) repeated transition from super-conducting to super-conducting state or dielectric discharge of the super-conductor. This leads to a unique model implying also a close connection with Searl device.

4.1 Modanese-Podkletnov effect

Recently I learned from Hans-Poul Veldhuyzen van Zanten that E. Podkletnov and G. Modanese have constructed a device [73] in which a super-conducting ceramic cathode and a copper anode cause electrical discharges in low pressure gases, at temperatures between 50 and 70 K. The voltage used is 2000 kV. Peak currents are of order 10^4 A. Cathode and anode have radii of 10 cm and their distance varies between 15 and 40 cm. There is also a magnetic field of .9 Tesla present inside the cylindrical chamber to concentrate the discharge to a smaller area. In discharges at voltage above 500 kV two new phenomena were observed. First, discharge does not look like a spark but like a flat, glowing discharge originating from the whole surface of the super-conductor. Secondly, a radiation pulse is emitted at the discharge which propagates orthogonally to the cathode, towards the anode and beyond it, in a collimated beam, apparently without an attention. Radiation pulse carries away an energy of 10^{-3} J at least. It is concluded that the radiation in question cannot be ordinary electromagnetic radiation.

The anomalous radiation was measured using various penduli at the line connecting the centers of cathode and electrode and hanging from a cotton string inside glass cylinders under vacuum. The radii of spheres were 10-25 mm and located at distances 6 m and 150 m from the installation. Various materials for the spheres were used: metal, glass, ceramics, wood, rubber, plastic. It was found that the impact on pendulum did not depend on the material but only on the mass of the pendulum which was in the range 10-50 g. Pendulum did not show any signs of heating. Measurements of the impulse taken at close distance (3-6 m) and large distance (150 m) gave identical results. The pulses where not absorbed by the media or at least, the losses of energy were negligible. The force beam does not seem to diverge and its borders are clear-cut and the width of the beam is that of the super-conducting emitter. If the pulse propagates in air, some energy should be depleted from it and lead to the weakening of the pulse. The observations of the air in the path of pulse only show that brief forward and backward movement of particles occurs.

The radiation appears to propagate through brick walls and metal plates without a noticeable absorption but this is not due to weak coupling with matter. Ordinary electromagnetic radiation cannot be in question. The assumptions that the radiation satisfies $E = cp$ dispersion relation and that the pulse given to the penduli is due to the absorption of energy and momentum of radiation leads to a contradiction. For a pendulum of 18.5 g, the kinetic energy of the pendulum was of the order of 10^{-4} J whereas the momentum was of the order of 10^{-3} kg m/s. If this momentum had to be imparted from the beam, its total energy should be larger than the total energy available in the discharge, 10^6 J in maximum. The conclusion made in [73] is that the radiation does not obey the dispersion relation of massless particles. On the other hand, if the net energy and momentum of the pendulum correspond to the total energy and momentum for quanta of radiation absorbed by the pendulum, the quanta must be tachyonic since one has $E = 10^{-4} J \ll pc = 3 \times 10^5$ J, which suggests that absorption is not the mechanism. Also the fact that radiation does not weaken with distance with a detectable manner suggests the same.

The force is proportional to the mass of the pendulum sphere but the interpretation as a gravitational force is excluded already because of the strength of the effect. Equivalence Principle

states also that the gravitational force depends only on the gravitational mass of the particle, not its particular state. The force is also repulsive.

Consider now a TGD based explanation for the effect.

1. The radiation could correspond to a massless extremal (ME, 'topological light ray') or TGD counterpart of the longitudinal scalar waves of Tesla. The classical field involved could be either electromagnetic or Z^0 type. MEs represent classical completely collimated radiation propagating with light velocity with pulse shape being arbitrary and preserved. Tesla wave represents longitudinal pulse of electric or Z^0 electric) field propagating with light velocity. At least Z^0 type and perhaps also em MEs and scalar waves do not care about Faraday cages: the classical radiation is simply at another space-time sheet. This fits with the observation that the pulse of radiation goes through various obstacles without absorption.
2. Electromagnetic Tesla's scalar waves are favored because their emission could be interpreted as a decay of the electric field of the capacitor by the emission of scalar waves carrying away pieces of space-time containing a constant electric field with intensity equal to the local intensity of the electric field between the capacitor plates. For the scalar wave pulses the quantization of the electric flux analogous to that of magnetic flux suggests that the condition

$$eVL = eEL^2 = n \times 2\pi \quad ,$$

n integer, is satisfied ($\hbar = c = 1$), so that the length of the scalar wave pulse would be $L = \sqrt{n2\pi/eE}$. For an electric field having a magnitude of order $E \sim 10^4 \text{ kV/m}$ (a voltage of 10^4 kV over a distance of 10 cm) and for $n = 1$ the scalar wave pulse would have a length of about one micrometer.

3. What might cause the repulsive force proportional to the mass of the object? $E = pc$ relationship does not hold for the energy transfer: rather momentum is much larger than this would allow. Thus an absorption of massless quanta is certainly not in question. Rather, the relationship suggests an ordinary non-relativistic dispersion relation between kinetic energy and momentum for a massive particle. The total mass of these particles is from numbers $\Delta E = 10^{-4}$ J and $\Delta p = 10^{-3}$ kgm/s equals to about 50 grams. The actual mass mentioned in the example was 18.5 grams. This makes perfect sense since only order of magnitude estimate is in question.
4. Many-sheeted space-time suggests a different explanation for the effect consistent with $E = cp$ relationship. The effect would be actually a special case of anomalies which are very abundant and explained by the many-sheeted space-time concept.
 - i) The space-time sheet of the pulse would act as a temporary bridge between two space-time sheets, say an atomic space-time sheet of the test object and a super-conducting magnetic flux tube of the Earth's magnetic field or its dark counterpart [M3]. Some particles from the atomic space-time sheets of the test object leak along this bridge to a larger space-time sheet or vice versa. The presence of the leaking particles at the bridge would make it temporarily massive and stop the motion of ME/scalar wave pulse for a moment. Since absorption does not occur considerably this should occur only temporarily. In case of the scalar wave pulse the longitudinal electric field would define a force field and induce ionic currents of opposite sign between the space-time sheets.
 - ii) If the particles leak to the direction of the emitter first, as is natural since the join along boundaries bonds are first formed to this direction, then effective repulsive force results as a recoil effect by conservation of total momentum holding in many-sheeted space-time but not for single space-time sheet anymore. Recoil momentum is indeed non-vanishing since

the zero point kinetic energy of particles at atomic space-time sheets is non-vanishing and is transformed to the kinetic energy of the particles at the larger space-time sheet. An order of magnitude estimate is obtained by assuming that the 'dropping' particles are electrons, and that the zero point kinetic energy is $E = \pi^2/2m_e L^2 \simeq 1$ keV resulting, when the size L of the atomic space-time sheet is one Angstrom. This gives for the fraction ϵ of electrons in the pendulum transferred to the beam space-time sheet the estimate $\epsilon \simeq 1.8 \times 10^{-10}$.

iii) If the probability for leakage is same for all particles independent of the material, the recoil momentum of the object resulting from the leakage of particle to another space-time sheet is proportional to the mass of the object as observed.

A possible test for this effect is following one. The object should lose some mass via the leakage, at least temporarily. The loss of mass is predicted to be small, a fraction of order 10^{-13} about the mass of the pendulum. One could also look whether the pendulum becomes charged in the process. The leakage of the super-conducting ions from the magnetic flux tubes of say Earth to the atomic space-time sheets is a fundamental mechanism of breaking of super-conductivity in TGD universe. The quantum theory of bio-systems relies on this mechanism as well as TGD based explanations for certain free energy phenomena like Brown gas [K6]. The 'miraculous' appearance of ions or atoms to system originally not containing them by supra current leakage from magnetic flux tube space-time sheets (say) is the basic testable prediction.

4.2 Podkletnov effect

Podkletnov discovered his effect while working in Tampere University. The report created quite a furor forcing Podkletnov to leave Finland. The responsible leaders of Tampere University even claimed that they had never heard of Podkletnov. To me this episode was an excellent lesson about the silliness of academic decision making in a small country like Finland lacking academic decision makers possessing genuine competence and was later followed later by much personal lessons. Although the effect has not been replicated, NASA got interested in the effect and has been financing the work.

4.2.1 Observations

The observations of Podkletnov *et al* [70] are summarized nicely in [72].

1. The effect is observed with double layered toroidal disks, which are high T_c super-conductors. The lower layer is in non-super-conducting state whereas the upper layer is in super-conducting state. Super conductivity is essential for the effect. Two-layered structure is known to be essential prerequisite for the effect: for single super-conducting disk the effect is not observed.
2. The disk is levitating in a vertical magnetic field B created by AC currents in solenoids along the rim of the super-conductor with frequencies of order MHz. Disk also rotates with a rotation velocity of 5000 rpm. Rotation velocities correspond to velocities of order 10 m/s at the boundaries of the disk. The effect of the addition of non-rotating radial magnets to the rim of the rotating disk creating a vertical magnetic field B_R rotating with respect to the superconductor is also studied.
3. Effective shielding of the gravitational field of Earth by about one per cent is reported. g is reduced in a cylindrical region above the disk but not below it. The best shielding is achieved with frequencies of order 1 MHz. The effect disappears shortly after the turning off of the AC current but not instantaneously. Periodic time variation seems to be essential for the effect, which seems to be largest when heating of the super-conductor is largest. The weight

loss is reported to be .05 per cent near rim and .3 per cent at center. The presence of the rotating magnetic field B_R enhances the effect to 2.1 per cent in the center.

What Schnurer [71] observed was a slight reduction (or order one per cent) of the weight of the test mass above super-conducting disk levitating in a static magnetic field. High temperature super conductor was used also now but it did not possess two-layered structure. Super-conducting disk was not rotating. The effect was observed only during the super-conducting to non-super-conducting phase transition.

4.2.2 TGD based explanation of Podkletnov effect

The common denominator of these experiments is the occurrence of a phase transition like phenomenon, either repeatedly or just once. Since long range correlations are generated in criticality, one might wonder whether topological a Bose-Einstein condensate of very light dark gauge bosons might be generated and have topological light rays (MEs) or scalar wave pulses as a space-time correlate. MEs/scalar wave pulses should carry long range weak (in particular Z^0) and color gauge fields.

Faraday effect and the model model of rotating magnetic systems provide valuable clues. In Faraday effect rotating magnet develops a radial electric field carrying vacuum charge density (not naturally allowed by Maxwell's theory), which in turn induces a radial ohmic current charging the magnet charging it.

That rotation is needed in Podkletnov experiment suggests that dark magnetic fields (em, weak, or color) induced by the rotation of the dark matter are an essential prerequisite for the effect to occur. Note that the rotation of the AC magnetic field created by the coils generates only radial AC Ohmic current which cannot make the disk charged.

1. If the Z^0 magnetic field created by rotation induces Z^0 magnetization of dark matter, the resulting Z^0 magnetic field can be regarded as rotating, and would induce a continual Z^0 charging of magnet followed by eventual Z^0 dielectric breakdown. The objection is that the range of Z^0 fields is characterized by appropriate p-adic length scale and that the density of Z^0 charges scales by p-adic fractality as $1/L^3(k)$ so that effects become very weak above cell length scale. The option avoiding this objection is based on the magnetization associated with the dark em charge of nuclei assignable to charged color bonds [F8].
2. The two-layered structure of the super-conductor could make the system analogous to capacitor playing same role as the capacitor in Modanese-Podkletnov effect. MEs, or perhaps more plausibly scalar wave pulses (for the detailed TGD based model of scalar wave pulses see [69]), could be generated when an analog of di-electric breakdown occurs in the vertical direction during the transition(s) to non-super-conducting phase. MEs/scalar wave pulses generated in the discharges would generate the apparent antigravity effect by the same mechanism as in the case of Modanese-Podkletnov effect. The reported flow of the air upwards would be also due to this effect and essentially identical with corona wind. The di-electric breakdown is predicted to occur in the vertical direction and the emission only in this direction explains why the effect is not observed below the rotating disk.
3. The enhancement of the effect by the addition of the rotating magnetic field B_R can be also understood. B_R generates an ordinary Ohmic current continually charging the resulting magnet as in the case of Searl device and also now the phase transition could induce di-electric breakdowns accompanied by scalar wave pulses or MEs.

4.3 Biefeld-Brown effect, lifters, corona wind, and Modanese-Podkletnov effect

The so called lifters (see the free energy home page of Jean Louis Naudin [79]) might one day symbolize the deepness of the crisis of recent day reductionistic physics. M-theory cosmologists are studying what possibly happened before big bang (they can say very little about what happened after the big bang). At the same time school boys are doing new experimental physics by building and studying lifters. Perhaps experimental physics is experiencing a new renaissance outside academic Big Science suffering of intellectual paralysis. Of course, this process is made possible only by the internet allowing to circumvent the censorship of the academic bullies. Lifters rely on Biefeld-Brown effect, which is poorly understood in standard physics context. Since high voltages, corona discharges and corona wind are involved, the obvious guess is that Modanese-Podkletnov effect is involved with lifter mechanism. This indeed might be the case although the first guess for the lifter mechanism turned out to be wrong.

4.3.1 Biefeld-Brown effect

Also Biefeld-Brown effect allows explanation as a recoil effect in many-sheeted space-time. For long time ago T. T. Brown observed [74, 75, 76] that when capacitor plates are loaded with opposite charges by coupling the capacitor to a voltage source, it jumps to the direction of the second plate. The magnitude of the effect depends on the voltage and begins to decrease above some critical voltage and eventually changes its sign. What is strange is that neither energy nor momentum conservation do not seem to hold true if one assumes that only electric energy is liberated: momentum and energy simply seem to appear from nowhere.

The physics of Biefeld-Brown effect is not understood. Thus one might think that an equipment which can be build by school boys would have been built by some physicist long ago. Also one might imagine that some theoretical physicist might have written an article or even two about the phenomenon during this half century which led to TOEs (Theories Of Everything, often regarded as the end of physics!). The fact is that there is only a quite recent article by Thomas Bahler and Chris Fazi of US Army Laboratory about the phenomenon [77]. These researchers checked that the phenomenon is real, and by doing a little calculation demonstrated that the standard physics explanation in terms of ionic wind predicts roughly 10^5 times too small an effect.

A possible explanation is in terms of a recoil effect in many-sheeted space-time. When the voltage is coupled on, the ions with opposite charges rush to the capacitor plates. By their inertia some of them leak to larger space-time sheets (the mechanism of auroras and breakdown of superconductivity could be essentially the same [J1, J2, J3]). The difference of the binding energies is liberated as additional kinetic energy and momentum of the dropped ion and the recoil momentum is obtained from the elementary text book formulas $E_f = E_i + \Delta E$, $E = p^2/2m$ as

$$\Delta p = -p_i \left(\sqrt{1 + \frac{\Delta E}{E_i}} - 1 \right) ,$$

where ΔE denotes the difference in zero point kinetic energies for a charged particle of mass m and subscripts i and f refer to initial and final states of the charged particle. These recoil momenta are absorbed by the entire system and give rise to a recoil effect if the recoil momenta from the plates do not exactly compensate each other. This is not expected to happen since the positive and negative charge carriers have widely different momenta due to the widely different masses and different velocities.

For definiteness assume that there are only electrons and ions of single type; that they drop to single space-time sheet only; and that capacitor plates have opposite charges during loading

so that ionic and electronic currents are of opposite sign at the capacitor plates during loading. Under these assumptions the ratio of the momenta is

$$\frac{p_i(e)}{p_i(I)} = \frac{m_e n_I}{m_I n_e} ,$$

where $n(e)$ ($n(I)$) refers to the density of the electrons (ions). Combining this with the previous equation, one has

$$\frac{\Delta p(e)}{\Delta p(I)} = - \frac{m_e n_I}{m_I n_e} \frac{\left(\sqrt{1 + \frac{\Delta E(e)}{E_i(e)}} - 1 \right)}{\left(\sqrt{1 + \frac{\Delta E(I)}{E_i(I)}} - 1 \right)} .$$

When several ions are present, one must construct a more elaborate model. Also an effect tending to change the mutual distance of the plates is predicted.

The effect is proportional to the charge of the capacitor plate and thus to the voltage but depends on voltage in nonlinear manner. Since the recoil momenta due to electrons and ions depend on non-linear manner on voltage. The change of the sign of the effect when voltage increases should be due to the fact that the velocities gained by ions and electrons depend on the voltage in different manners. The electronic band structure of the conductor could play an important role in the effect.

This mechanism is obviously ideal mechanism of locomotion in living matter and it would be surprising if bio-systems would not have invented it.

4.3.2 What lifters are?

Lifter (see the free energy home page of Jean Louis Naudin [79]) has an extremely simple structure: asymmetric pair of oppositely charged electrodes. The first electrode could be a planar foil and second electrode just a conducting wire somehow fixed to the larger electrode using some insulating material. When this capacitor is charged to a voltage about 30 kV it lifts to air. The force is in the direction of the smaller electrode. The presence of a small discharge current between the electrodes could be essential for the effect.

The Biefeld-Brown effect [74, 75, 76] might be behind the lifter effect. The proposed model [K6] for the Biefeld-Brown effect is based on the leakage of the ions from the space-time sheets of the capacitor plates to a larger space-time sheet resulting in a recoil effect. This kind of effect can occur during the charging of the capacitor since there are ionic currents running to the plates. The different masses for ions of opposite charge would cause the effect even in the case that capacitor plates are identical. In this case the direction of the force would depend on the sign of the voltage. Brown reported that there is a correlation of the effect with the sign of the charge but that the motion is always in the direction of the smaller electrode.

On the other hand, the lifter experiments have shown that the sign of the voltage does not have a detectable effect. The effect is possible also for a constant voltage. Some of the ions of the leakage current flowing between the plates through the di-electric could leak to a larger space-time sheet as they enter the second electrode but this would predict the dependence of the effect on the sign of voltage.

The obvious question is whether the mechanism explaining the finding of Modanese and Podkletnov [73] described in previous section might also be involved the lifter effect, and thus provide a further support for the view that either MEs or, more probably, the scalar waves of Tesla, discovered for a century ago and completely neglected by the academic physicists, are involved. Also the so called corona wind, which has been used for centuries for entertainment purposes and explained fluently as an amusing curiosity caused by ionic wind could involve MEs or Tesla's scalar waves.

4.3.3 What causes the lifter effect?

Juha Hartikka [78] has constructed a lifter consisting of two equilateral triangles on top of each other. The upper triangle consists of a copper wire with radius $r(\text{small}) = .03$ mm, and the low triangle of straws with an aluminium folio around them, and having radius $r(\text{big}) = 1.5$ mm. The length of the side of the triangle is $L = 2.11$ cm (this not of significance now), and the distance between the electrodes is $D = 2.4$ cm. The total mass of the system is .854 g. The contribution of the copper wire to the mass is $M(\text{small}) = .45$ g in the approximation that the density is one atom per Angstrom³ so that the masses of the electrodes are roughly the same.

The most important general findings are following. There is a considerable power expenditure, up to 8 Watts. According to the standard physics expectation this power would be needed to maintain the airflow and to the motion of the lifter. Corona discharge at the wire electrode accompanies the effect, and when corona flow appears at the larger electrode, the effect gets weaker. This suggests a recoil effect appearing only, when the corona discharge is present. Critical voltage is required and sharp edges help to achieve this. The effect is also accompanied by a generation of sounds. The thin electrode is also oscillating in an irregular manner and is curved outside as if experiencing an upwards directed recoil force. Also radio wave emission has been detected.

What could cause the lifter effect?

1. The scalar waves of Tesla could cause the motion of the air by the Modanese-Podkletnov effect. If they cause also the motion of the lifter, both electrodes must emit scalar waves and the small electrode must experience a stronger force. The correlation with the corona discharge however suggests that there is no emission of the scalar waves from the larger electrode, and that the presence of the emission weakens the effect. This would suggest that only the motion of air can be due to the scalar waves.
2. Could the recoil effect be due to the emission of Tesla's scalar waves, when corona discharge is present? In this case the effect would not depend on the sign of the voltage. If the scalar wave pulses leave the lifter with light velocity, the requirement that the gravitational force mg is compensated by the recoil momentum feed, would give $mg = W/c$. For $m \sim 1$ g this would require a power feed $W \sim 10^6$ W. W is found to be below 8 W in the experiments of Juha Hartikka [78]. Therefore this option is definitely excluded.
3. If one substitutes sound velocity $v \simeq 10^{-6}c$ for c ,

$$mg = \frac{W}{v} ,$$

one obtains $W \sim 3$ Watts for $m = 1$ g for the needed power feed and this is below the total power feed. Sound wave emission has been observed. Could the recoil effect be associated with the sparks responsible for the plasma discharge? The sparks would be lightning like exploding plasma regions generated by the ionizing charge flow and generating spherical shock waves during their travel. These shock waves in turn kick the smaller electrode. Since the number of ions in the plasma discharge is much larger than the net charge, there is no dependence on the sign of the voltage.

Does this option make sense? $W = 1$ Watts corresponds to a power of 120 decibels (the formula $P = 10 \times \log_{10}(W/W_0)$, $W_0 = 10^{-12}$ Watt, gives the power in decibels). The power from Walkman radio to single ear can be as high as 80 decibels. The power to single ear in this case would be a fraction of roughly $S/4\pi r^2$ of total power, where r is the distance from the corona discharge and S is the active receptor area of ear. $S = cm^2$ and $r = 1$ m would give factor of order 10^{-5} so that the power to single ear would be something like 70 decibels which sounds too high.

4. The independence of the effect on the sign of the voltage does not support the idea that the recoil would be due to the ions leaving the wire. One can however consider the possibility that the sparks are small plasmoid like structures analogous to ball lightnings. They would emanate from the plasma cloud surrounding the wire electrode and give rise to the recoil effect. The relatively large mass of the plasmoid helps to maximize the strength of the recoil effect. The numbers of the positive and negative ions in the spark would be much larger than the net charge so that there would be no dependence on the sign of the voltage. This option differs from the option 3) for which sparks are not objects travelling through the air but tracks caused by the ions leaking to the larger electrode.

This alternative is encouraged by the crucial role of the plasmoid like structures in TGD inspired theory of consciousness [M1]. Plasmoid like structures are often accompanied by microwave radiation and Juha Hartikka has indeed detected also the presence of radio wave noise in his experiments [78]. The emission of the scalar wave pulses would accompany the emission of plasmoids. Note that also in the experiments of Modanese and Podkletnov a coherent leakage current from super conductor having perhaps plasmoid interpretation is observed [73].

Plasmoids correspond to many-sheeted structures involving super-conducting magnetic flux tubes and atomic space-time sheets with a transfer of ions between various space-time sheets giving rise to and induced by the electromagnetic radiation. The frequency of photons involved corresponds to the difference of the zero point kinetic energies at the space-time sheets involved. For instance, corona glow and radio waves could result in this manner. A considerable part of the leakage current could flow as a supra current, and the recoil effect would result, when a blob of ions from the plasma layer around the thin electrode drops from the atomic space-time sheets to the magnetic flux tubes. This model would actually modify the original model for the Biefeld-Brown effect by replacing ions with blobs of plasma. The same mechanism could also explain why ball lightnings are so stable, that is why their dissipation rate is so low.

4.3.4 General model for the emission of scalar waves

Consider a situation in which one has a planar electrode and a wire electrode above it, both square-shaped, and such that the wires of the wire electrode are parallel to the sides of the planar electrode. One could allow the electrodes to have different sizes.

1. Modanese and Podkletnov study a full discharge at low temperature from a super-conducting electrode whereas now only a small leakage current appears. One can assume that MEs or the TGD counterparts of the Tesla scalar wave pulses are only above the threshold value E_{cr} of the electric field above which also corona discharge occurs. MEs/scalar wave pulses are expected to have a much smaller transversal size since the leakage current is not coherent in the length scale of entire electrodes. The power spent by the system would go to the emission of the scalar waves and to the energy dissipated by the plasma discharge, and the power needed to maintain the motion of air and electrodes could be much higher than this power. This obviously provides a crucial test for the model.
2. One could interpret the scalar wave pulse as a quantum of constant electric field analogous to magnetic flux quantum and escaping the system with light velocity. The power goes to the re-building of the electric field. This argument favours scalar wave pulses instead of MEs. In the case of scalar wave pulses the quantization of the electric flux analogous to that of magnetic flux suggests that the condition $L = \sqrt{n2\pi/eE}$, n integer, is satisfied ($\hbar = c = 1$). For an electric field having a magnitude of order $E \sim kV/m$ (a voltage of 10 kV over a distance of 10 cm) and for $n = 1$ scalar wave pulse would have a length of 9 micrometers. The emission of this quantum would accompany the generation of the plasmoid like structure

and Modanese effect could be the mechanism giving rise to the leakage of the ions to the magnetic flux tubes of the plasmoid.

3. If the pulses propagate past any object, temporary bridges between the atomic space-time sheet of the object and some larger space-time sheet are formed, and the ions or atoms from the object leak to the latter. This creates a recoil effect giving rise to a repulsive force. In the case of scalar wave pulses the temporary bridge would carry electric field, which could induce ionic currents of opposite sign between the space-time sheets. In this case the effect could depend on the sign of the voltage unless the leaking matter is dominantly neutral. For MEs there would be no such dependence. It would seem that MEs/scalar waves must spend some time in the state in which they act as bridges but must continue their travel after the delay: otherwise absorption would occur. The delay could be due to the fact that the particles moving along the ME/scalar wave bridge make it temporarily a massive particle so that its motion slows down and almost stops for a while.
4. Also the molecules of the air suffer the same effect and this might be the fundamental cause of the corona wind in neutral air. According to the observations of Juha Hartikka [78], the air between the electrodes is indeed set into fan like motion from the wire electrode to planar electrode and the flow is non-vanishing also at the surface of the bigger electrode. This downwards flow could indeed be due to the scalar waves emitted from the corona discharge initiated from the wire electrode and affecting also neutral air molecules. The direction of the airflow and its velocity should not depend strongly on the sign of the voltage. One could test whether the effect obeys the same regularities as the effect found by Modanese and Podkletnov. For instance, air-flow should become stronger, when the strength of the electric field at the small electrode increases, and depend only weakly or at all on the distance between the electrodes. If the effect occurs for large distances between planar and wire electrodes, ionic wind as an explanation of the effect can be excluded. Any sharp edge or corner would generate the air flow effect.
5. Since scalar waves seem to be emitted only from the wire electrode where plasma discharge occurs, one can conclude that Modanese- Podkletnov effect can only reduce the lifter effect by direct force to the larger electrode and by the force caused by the airflow.

The simplest assumption is that scalar wave pulses are emitted in the direction of the field lines at the surface of the electrode when plasma discharges occur. Above the threshold the intensity of the scalar wave pulse beam is most naturally proportional to $E^2 - E_{cr}^2$, where E_{cr} is the field value above which the corona discharge begins and E is the field at the surface of the electrode. For a planar electrode this means that the beam of the scalar wave pulses is in the vertical direction and has a constant intensity. For the wire electrode the intensity is inversely proportional to the radial distance from the wire.

In the vicinity of the wire electrode the radial field is very strong and at the surface has the magnitude $E = \sigma_w(\phi)$, where $\sigma(\phi)$ is surface charge density, which depends on the azimuthal angle ϕ in the plane orthogonal to the wire, ϕ can be chosen to be zero in the direction pointing to the planar electrode. The intensity of the scalar wave pulses created by the small electrode is in the radial direction and given by

$$I(\phi) = k(E^2 - E_{cr}^2)(\phi) \times \frac{r_w}{\rho} .$$

The intensity is stronger in directions pointing to the larger electrode. The force experienced by a small test object of mass m is given by

$$F = mI$$

and is in the direction of the scalar wave beam. A test for the hypothesis is whether the local direction of air flow is determined by the directions of field lines at the surface of the electrode or whether the air flow tends to be in the direction of the local electric field.

5 New hydrogen technologies and new physics

The anomalies related to energy technologies involving the burning of hydrogen to oxygen are known for decades. In fact, the anomaly related to the thermal dissociation of hydrogen was discovered by the Nobel chemist Irving Langmuir for century ago. For some reason these anomalies are not paid any attention in standard chemistry.

5.1 Anomalies related to the dissociation of water and hydrogen molecules

The burning of hydrogen to water liberates energy. Because the process does not seem to produce chemical pollution, hydrogen provides one of the most promising energy sources. The basic problem is that the storage and transport of hydrogen is very expensive. A possible solution to the problem is to produce the hydrogen by the dissociation of water at the location where the energy is used. If this goal is achieved, an outcome is an energy source able to compete with other energy sources most of which will be depleted in any case.

The theoretical problem related to various methods producing hydrogen by dissociation of water is in the nutshell that the dissociation of water requires less energy than one might think knowing the bond energies of O-H bonds [82, 84]. Concerning the basic goal this is of course not a problem. Also the energy needed to dissociate hydrogen thermally is smaller than the binding energy of the hydrogen molecule. This was observed already by Nobel chemist Langmuir for century ago [81]. For some reason this observation has not received the recognition it would have deserved. Energy flows to the system in both situations and one should understand the origin of this energy.

The zero point kinetic energy of vacuum (ZPE) [85] has been proposed as a solution the problem. Unfortunately, ZPE theories are not very well defined and far from practically applicable. My intention in the following is to find whether the new physics predicted by TGD might allow to understand the origin of the above mentioned anomalies.

A good guideline is the observation that very many free energy systems involve sharp pulse sequences. Often bi-filar coils invented by Tesla [69] are involved. The liberation of the zero point kinetic energy when particles drop to a larger space-time sheet is a universal liberation of mechanism of energy justifying the notion of free energy. The time mirror mechanism makes possible the control of this process. Either the system needing the energy or controlling the liberation of energy generates negative energy topological light rays accompanied by negative energy photons (generated by a light like vacuum 4-current possibly associated with the topological light ray). Scalar wave pulses could in turn make possible higher level control by inducing the generation of negative energy topological light rays and photons as time reversed version of brehmstrahlung when charged particles are accelerated in the strong electric field of the scalar wave pulse without dissipation.

These ingredients lead to a concrete model for how the origin of the energy liberated in the dissociation of water and to a proposal how this method could be made more effective. If the proposed explanation is correct, the dissociation of water molecules could be induced also by the irradiation of water by phase conjugate laser light, whose frequencies could be fine tuned to correspond to the needed frequencies. This could mean considerable energy savings.

In the following the model explaining the anomalies related to the dissociation of water and hydrogen is discussed. Also a TGD based justification for the notion of hydrino-atom introduced by Randell Mills [86] is proposed.

5.2 The anomalies associated with the dissociation of water molecules

In the sequel the general ideas about time mirror mechanism and many-sheeted lasers is applied to the anomalies observed in the dissociation of water.

5.2.1 Constraints on the model of anomalies found in the electrolysis and plasma electrolysis of water

The general theory leaves a lot of freedom for the building of a detailed model. There are however several facts, which provide constraints on the imagination.

1. In plasma electrolysis a pulsed electronic current is an essential part of the process. The natural guess is that the dropping of electrons to larger space-time sheets could excite O-H bonds or O and H atoms to higher energy states. This could happen during the dissociation of the water molecule or already before it. Prof. Kanarev has proposed that the O-H bonds of water molecule are indeed excited before the process. Kanarev has also suggested a separate mechanism in which two electrons join to the water molecule during the dissociation. This mechanism is not needed if the sole role of the electronic current is excitation of the O-H bonds.
2. In very many free energy phenomena a pulsed voltage/current seem to induce the generation of negative energy topological light rays (photons). They in turn would serve as a control signal inducing the generation of positive energy topological light rays (photons) as population inverted many-sheeted laser returns to the ground state. The mechanism generating the phase transition is the same as in the induced emission. This would support the model of Prof. Kanarev: the positive energy photons (analogous to laser beam) would excite the O-H bonds or O and H atoms of the water molecules. Electrons have both thermal and ordered kinetic energy. This means that the energy liberated in the dropping process varies and that the liberated energy can be larger than the zero point kinetic energy. An energy continuum results and makes it possible to excite O and H atoms having a sharply defined transition energies. One can also imagine that so called seesaw mechanism is at work. Negative energy topological light rays would be created in a transition which is the reversal for that producing positive energy topological light rays. Fine tuning would be automatic now. This mechanism might be a central part of bio-control.
3. If the amplification of negative energy signal is based on the mechanism of induced emission, the particles involved must be bosons. Only the Cooper pairs of electrons come into consideration now. In the case of fermions one might think that the dropping of fermions from a given space-time sheet creates free vacancies and makes possible the dropping of fermions to this space-time sheet from smaller space-time sheets. This could induce kind of a chain reaction proceeding from long to short p-adic length scales.
4. The second option is that water molecule emits negative energy photons when it dissociates so that the oxygen and hydrogen atoms of O-H bonds are excited to a higher energy state. This option does not allow to understand the role of the pulse current serving as external controller of the process.

5.2.2 Zero point kinetic energies

If the kinetic energy of the dropping electrons can be neglected, the spectrum for the energy quanta liberated in the dropping process is universal since zero point kinetic energies are fixed by p-adic length scale hypothesis apart from a numerical factor near unity characterizing the shape of the

space-time sheet. The formula for the zero point kinetic energy in the non-relativistic case reads as

$$\begin{aligned} E_0(k) &= n \times \frac{\pi^2}{2mL(k)^2} , \\ L(k) &= 2^{(k-151)/2} \times L(151) , \quad L(151) \simeq 10 \text{ nm} . \end{aligned} \quad (1)$$

Here m denotes the mass of the particle and n is a numerical constant near one.

Atomic space-time sheet $k = 137$ corresponds in the case of proton to an energy of about .4 eV, which is the basic energy currency of metabolism. This inspires the idea that the basic function of the ADP-ATP system is to drive protons from larger space-time sheets to the atomic space-time sheets by utilizing the chemically stored energy. From this space-time sheet they drop back to the larger space-time sheets liberating the zero point kinetic energy $E_p(137) \simeq .4 \text{ eV}$. An entire hierarchy of metabolic currencies is actually predicted [K6, K1].

Also electrons and their Cooper pairs can drop to larger space-time sheets and in this case the liberated zero point kinetic energy is larger by a factor $m_p/m_e \simeq 2^{11}$. The zero point kinetic energy at $k = 137$ space-time sheet $\sim .4 - .5 \text{ eV}$ is a convenient unit, in terms of which one can express the zero point kinetic energies of proton, electron, electronic and protonic Cooper pair.

$$\begin{aligned} E_p(k) &= 2^{137-k} \times .5 \text{ eV} , \\ E_{2p}(k) &= 2^{137-k-1} \times .5 \text{ eV} , \\ E_e(k) &= 2^{148-k} \times .5 \text{ eV} , \\ E_{2e}(k) &= 2^{147-k} \times .5 \text{ eV} . \end{aligned} \quad (2)$$

Here the nominal value of .5 eV for $E_p(137)$ is used.

5.2.3 Consistency conditions

A natural consistency condition is that the thermal de Broglie wave length $\lambda_{dB} = \pi/\sqrt{2MT}$, where M denotes the mass of the heaviest particle at particular space-time sheet, is of the same order of magnitude as the p-adic length scale characterizing the size scale for the space-time sheet from which the particle drops.

$$\lambda_{dB} = \frac{\pi}{\sqrt{2MT}} \sim L(k) . \quad (3)$$

On the other hand, super conductivity requires that thermal energy is smaller than the zero point kinetic energy defining the basic energy unit. This gives the condition

$$\lambda_{dB} > L(k) . \quad (4)$$

Here one must however require that there is no allowed p-adic length scale between λ_{dB} and $L(k)$. What "allowed" means is quite not obvious. The first extreme corresponds to the situation in which all values of the integer k are possible so that p-adic length scales come in half octaves and that all n-ary p-adic length scales are possible. The second extreme corresponds to the situation in which k is prime. At least secondary p-adic length scales (k is two times prime) are allowed, and the model of EEG suggests that all values of k are possible but that those values which correspond to highest cognitive level are the most important ones (every prime factor k_i in the decomposition of k to a product of primes defines a k_i -bit cognitive code[M4]).

5.2.4 Experimental data

The experimental values for the reduction of the binding energy of water allow to estimate the integer k characterizing the space-time sheets from which electrons or their Cooper pairs drop.

1. In the ordinary electrolysis the energy needed to dissociate O-H bond has been found to be only 1/3 of the binding energy $E_w \sim 10$ eV of the water molecule. The reduction of the binding energy is $\Delta E_w \simeq 6.66$ eV.
2. In the plasma electrolysis of Prof. Kanarev the energy needed to dissociate water molecule is only $\sim .5$ eV and the effective reduction of the binding energy is as high as $\Delta E_B \sim 9.5$ eV.

A rough approximation for the energy needed would be 8 eV in both cases. This energy is $2^4 = 16$ higher than the zero point kinetic energy of proton at $k = 137$ space-time sheet. In plasma electrolysis the temperature is in the interval $.5 \times 10^4$ - 10^4 C and around 10^3 C in the ordinary electrolysis.

5.2.5 The four options

One can distinguish between four different models depending on what the reaction mechanism is and whether the energy is donated by electron or electronic Cooper pair.

1. The energy is donated to O-H bond. The ratio r is predicted to be $r = 3.33$ and $r = 4.75$ corresponding to ordinary and plasma electrolysis. The rough estimate is $r = 4$.
2. The energy is donated to the entire water molecule. In this case the ratio of the donated energy to the zero point kinetic energy is $r = 6.66$ in the usual electrolysis and $r = 9.5$ in plasma electrolysis. The rough estimate is $r = 8$.

Furthermore, one can distinguish between two cases according to whether the energy is donated by i) electronic Cooper pairs or ii) electrons. The first option is supported by quantum coherence implying that reaction rate would be proportional to the square of the number of the dropped electronic Cooper pairs. Also the mechanism of the induced emission works for Cooper pairs unlike in the electronic case. It is however better to keep mind open for both options at this stage.

5.2.6 Analysis and conclusions

The following represents the analysis of the four options.

a) Energy is used to excite only single O-H bond.

i) For electronic Cooper pairs the condition $r = 4$ gives $k = 142 = 2 \times 71$ corresponding to the secondary p-adic length scale $L(2, 71) = .56$ nm. The estimate for the thermal de-Broglie wave length in plasma electrolysis is $.7 - 1$ nm. In the ordinary electrolysis de-Broglie wavelength is roughly 2 times longer. In both cases the thermal de Broglie wavelength is longer than the p-adic length scale so that the necessary condition for super-conductivity is satisfied.

ii) In the electronic case the condition $r = 4$ gives for the p-adic length scale the estimate $k = 143 = 11 \times 13 \simeq .8$ nm. This length scale corresponds to the prime $p \simeq 2^{13}$ and would represent a very low information content unlike $k = 142$, which corresponds to rather large prime $p \simeq 2^{71}$. The ratio $\lambda_{dB}/L(k)$ is same as in the first case.

b) The energy is used to excite the entire water molecule.

i) In the case of electronic Cooper pairs the condition $r = 8$ gives $k = 141 = 3 \times 47$ corresponding to the tertiary p-adic length scale $L(3, 47) \simeq .4$ nm.

ii) In the case of electrons one has $k = 142 = 2 \times 71$.

In both cases the ratio $\lambda_{dB}/L(k)$ grows by a factor $\sqrt{2}$ from the value in the preceding case so that the resulting model is poorer.

As a summary one can state the following.

1. The ratio of the thermal de-Broglie wave length to the p-adic length scale is same for both electron and Cooper pair options since the p-adic length scales are $L(k)$ for electron and $L(k - 1)$ for the Cooper pair and differ by a factor of $\sqrt{2}$ from each other.
2. For all options de Broglie wavelength in the case of ordinary electrolysis is at least by a factor of two too large and this forces to question the de Broglie wave length criterion. Of course, one can think that the production of positive energy photons generates temporary hot spots so that de Broglie conditions holds true after all.
3. The dropping of two electronic Cooper pairs per water molecule from $k = 2 \times 71$ space-time sheet is the most promising option, since in this case the mechanism of induced emission is possible and a satisfactory consistency with de Broglie criterion is achieved. The secondary p-adic length scale is also very natural.

5.2.7 Could phase transition to dark matter reduce the energy of OH bonds

An alternative explanation for the findings of Kanarev is that the *energy scale* of some OH bonds is reduced by some new physics mechanism. No excitation would thus be involved. Dark matter hierarchy [A9] provides a candidate for this kind of mechanism.

There is evidence for the occurrence of cold nuclear reactions in Kanarev's plasma electrolysis using KOH and NaOH in water environment [83]. The TGD based model [F9] assuming the presence of dark analogs of Li nuclei modelled as nuclear strings and also longer nuclei obtained by fusing Li nuclear strings can explain the presence of the observed nuclei in the Fe cathode as resulting in cold nuclear reactions. The model is consistent with the TGD based description of cold fusion observed in deuterium systems [F9], and provides also a possible solution to the so called lithium problem of cosmology [52] and $H_{1.5}O$ anomaly of water [53, 54, 55, 56].

$H_{1.5}O$ anomaly suggests that 1/4 of protons of water are dark in atto-second time scale [F10] and one can imagine that both protons of water molecule can become dark under conditions defined by plasma electrolysis. Also the atomic space-time sheets and electron associated with OH bonds could become dark. The model of cold fusion assumes that the nuclear space-time sheets of Li nuclei become dark in plasma electrolysis so that also their size is scaled up. The phase transition of Li to its dark variant (there would be some kinetic equilibrium) could explain why the abundance of Li predicted by standard Big Bang cosmology is by a factor of 2.5 higher than the measured abundance.

Atomic binding energies transform as $1/\hbar^2$ and are scaled down. If the energy of hydrogen bond transforms like Coulombic interaction energy as given by the perturbative calculation, it is scaled down as $1/\hbar$ since the length of the bond scales up like \hbar . Effectively $\alpha_{em} \propto 1/\hbar$ is replaced by its scaled down value. For $\hbar \rightarrow 2^4 \hbar_0$ the energy would scale from 8 eV to .5 eV and the standard metabolic energy quantum could induce the splitting of the dark OH bond. If 2^4 is the scale factor of \hbar for dark nuclear space-time sheets, their size would be of order 10^{-3} meters. A scaling up to the size of even atomic size is considered in [F9].

The fact that the energy of hydrogen bonds [58] is typically around .5 eV forces to ask what distinguishes hydrogen bond from dark OH bond. Could it be that the two bonds are one and the same thing so that dark OH bonds would form standard part of the standard chemistry and molecular biology? In hydrogen bond same hydrogen would be shared by the oxygen atoms of the neighboring atoms. For the first O the bond would be ordinary OH bond and for the second O its dark variant with scaled down Coulomb energy. In plasma electrolysis both bonds would become dark. The variation of the hydrogen bond energy could reflect the variation of the scaling factor of \hbar . The concentration of the spectrum of bond energies on integer multiples of fundamental energy scale - or even better, on powers of 2 - would provide support for the identification. There is evidence for two kinds of hydrogen bonds with bond energies in ratio 1:2 [60, 59]: the TGD

based model is discussed in [F10]. The energy needed to transform the bond to dark bond could come from remote metabolism from the dropping of dark protons from a dark variant of some sub-atomic space-time sheet with size not smaller than the size of the atomic space-time sheet to a larger space-time sheet.

5.3 The anomaly related to the thermal dissociation of molecular hydrogen

Already the Nobel-chemist Langmuir found, that thermal dissociation in a temperature range extending up to the temperature of $T = 2200$ K, led to a much higher dissociation rate than one might expect on basis of thermodynamical considerations. The binding energy of the hydrogen molecule is 4.52 eV. If one requires that the ratio of the dissociated molecules to that of non-dissociated molecules is given as by the Boltzmann exponent $\exp(-E_b/kT)$, a discrepancy of order 10^8 results. If one assumes that the effective binding energy is $\simeq .44$ eV, a correct result is obtained.

This suggests that also now the dissociating hydrogen molecule receives energy from some source and that the energy is ~ 4 eV. Dissociation mechanism could be based either on the self-excitation of the hydrogen molecule by the emission of negative energy photons. Also some other system could emit negative energy photons and induce a cascade of positive energy photons. One has two options.

1. The dropping of an electronic Cooper pair from $k = 142 = 2 \times 71$ space-time sheet is involved as in the case of the optimal mechanism for the dissociation of water.
2. The dropping of an electron from $k = 143$ space-time sheet is an alternative option.

5.4 Hydrino atoms, anyons, and fractional quantization in many-sheeted space-time

The so called hydrino atom concept of Randell Mills [86] represents one of the notions related to free energy research not taken seriously by the community of university physicists. What is claimed that hydrogen atom can exist as scaled down variants for which binding energies are much higher than usually due to the large Coulombic energy. The claim is that the quantum number n having integer values $n = 0, 1, 2, 3..$ and characterizing partially the energy levels of the hydrogen atom can have also inverse integer values $n = 1/2, 1/3,$. The claim of Mills is that the laboratory BlackLight Inc. led by him can produce a plasma state in which transitions to these exotic bound states can occur and liberate as a by-product usable energy.

The National Aeronautic and Space Administration has dispatched mechanical engineering professor Anthony Marchese from Rowan University to BlackLight's labs in Cranbury, NJ, to investigate whether energy plasmas-hot, charged gases- produced by Mills might be harnessed for a new generation of rockets. Marchese reported back to his sponsor, the NASA Institute for Advanced Concepts, that indeed the plasma was so far unexplainably energetic. An article about the findings of Mills and collaborators have been accepted for publication in Journal of Applied Physics so that there are reasons to take seriously the experimental findings of Mills and collaborators even if one does not take seriously the theoretical explanations.

The question to be addressed in the following is whether the many-sheeted space-time concept could allow to understand the claimed $n \rightarrow 1/n$ generalization of the Bohr's quantization rules claimed by Mills or a generalization of this rule consistent with the experimental findings of Mills. In the following I discuss three arguments allowing to understand the scaled up energy spectra claimed by Mills. These arguments are not independent and do not exclude each other.

5.4.1 p-Adic quantization and fractional spectrum

p-Adic integers $n = \sum n_k p^k$, $k \geq 0$, can have infinite values as real integers. If one requires that p-adic integer has a p-ary expansion which is periodic, only p-adic integers, which correspond to rationals are possible: $n \rightarrow q = r/s$, where s is not divisible by p . The expansion of $1/s$ in powers of p indeed gives rise to an infinite (in real sense) p-adic integer.

One might argue that all rational values of the principal quantum number n of hydrogen atom are actually possible, which would mean that the spectrum is effectively continuous as in classical physics. What quantum physics would bring in would be the selection of integers from other rational numbers so that effectively one would have integer spectrum under the usual experimental conditions.

5.4.2 Fractional valued quantum numbers and controlled transition to chaos

Bohr's quantization rules apply to completely integrable systems for which complete separation of variables occurs so that one effectively has a set of one-dimensional systems performing motion on circle or line. One can quantize the motion separately in each dynamical degree of freedom characterized by a cyclic coordinate q_i and the corresponding canonical momentum p_i . If q_i is a circle coordinate, one can use the basic quantization rule

$$\oint p_i dq_i = n_i \hbar ,$$

Here the integral is over a full cycle of the periodic motion. If q_i corresponds to a motion on line, no quantization rule is applied.

Primes are known to appear, when one attempts to quantize chaotic systems and effectively p-adic physics might be closely related to the approach to the chaos implied by the classical non-determinism of the Kähler action. This suggests that fractional quantization might emerge in a system for which the interactions with the environment destroy the simple periodic motion, which is the prerequisite for the application of Bohr's quantization rules.

So, an interesting question is what occurs when the motion is slightly perturbed. Do orbits become non-closed or do they close after N cycles so that the transition to the chaos corresponds to the sequence $N = 1 \rightarrow 2 \rightarrow 3 \rightarrow \dots$. Period doubling leading to chaos represents just this kind of series of perturbations with $N = 2^k$, $k = 1, 2, \dots$. In TGD universe, where orbits could correspond to space-time sheets themselves, this kind of ordered transition to chaos could be realized in contrast to what one might expect in standard physics.

The natural guess would be that one must replace the quantization condition with

$$\oint p_i dq_i = \frac{n_i}{N} \hbar ,$$

where the integration is over the previous cycle, which has become $1/N$:th cycle. In the case of hydrogen atom this would give rise to a fractional angular momenta m and fractional principal quantum number n , and the spectrum would contain the spectrum claimed by Mills.

One could argue that all rational numbers, for which the denominator is not divisible by the prime p characterizing the atomic space-time sheet, represent possible values of the principal quantum number n . The most natural estimate for p is $p \simeq 2^{137}$ (that fine structure constant is in a good approximation $\alpha = 1/137$ might express cosmic sense of humor). The requirement that the rest energy of the electron stays positive, gives the condition $N < 1/\alpha \simeq 137$. Quantum physics favors finite integers because of their finite p-ary expansion and in the usual experimental situation only integer spectrum would be possible. As the system grows more complex, also the values $1/n$ and m/n of the principal quantum number would become possible.

5.4.3 Fractional quantization and controlled transition to chaos at space-time level

In TGD all quantum level concepts should have space-time correlates. In particular, Bohr's quantization rules have exact counterparts in TGD and are implied by the absolute minimization of Kähler action. Also the proposed transition to chaos by the generation of orbits which close only after N cycles should have a natural space-time correlate.

I have already earlier proposed that the orbits of electrons in atoms could be more than a fictive concept and have concrete 3-surfaces as their representatives. One might say that electrons would move along quantum tracks. This is consistent with the general vision that space-time surface provides symbolic representation for all quantum physics concepts. This means that the electronic space-time sheet having size of order electron Compton length would be topologically condensed at representing the classical orbit of electron. In TGD universe all quantum phenomena should have classical space-time correlates and also the quantum resolution of the well known infrared catastrophe (electron slows down by emitting brehmstrahlung and falls into the nucleus) should have a space-time correlate. Closing the electron inside a closed tubular structure representing its path would clearly prevent the infrared catastrophe.

In the first approximation the ordinary orbit of electron would be replaced by a torus like tube along the classical orbit within which the electron wave function is concentrated. For $N > 1$ the torus would run around N times before closing. The transformation of closed orbital 3-space sheets to orbital 3-space sheets closing after N cycles occurs very naturally at the level of space-time sheets. The closure must occur for some value of N since otherwise the resulting orbital 3-surface would be extremely irregular, have infinite volume, and could carry infinite classical field energy. It is natural to expect that the transition occurs by the sequence $N = 1 \rightarrow 2 \rightarrow 3 \dots$ or some sub-sequence of it. One can image that in high temperature plasma the interactions with the external world might indeed replace the simple periodic Bohr orbitals with orbitals which would close only after N cycles.

1. Fractional Bohr quantization

In fractional Bohr quantization the angular momentum component would be quantized in units of \hbar/N rather than \hbar .

$$\oint p_\phi d\phi = \frac{m}{N} \hbar ,$$

This phenomenon could also provide the space-time correlate for anyons having fractional angular momentum and giving rise to fractional quantum Hall effect. The quantization condition for the radial variable would be also replaced by a more general quantization condition

$$\oint p_r dr = \frac{n}{N} \hbar .$$

This would give as a special case the quantization rule proposed by Mills. Quite generally, the spectrum of hydrogen atom would be scaled up by N^2 , $N = 2, 3, 4, \dots$ or some subsequence of this sequence.

2. Constraints on the orbital 3-surface

The picture based on formal Bohr rules is too simplistic and might be even wrong. In particular, one can ask is the value of N same for both radial and angular degrees of freedom. A more detailed consideration indeed shows that naive fractional Bohr quantization need not be correct approach.

A more concrete space-time picture results, when one takes into account the requirement that the Coulomb force experienced by electron corresponds to intuitive expectations.

1. The electric gauge flux must flow to the orbital surface somehow, either through wormhole contacts or through join along bonds connecting the orbital surface to the boundaries of holes

in atomic space-time sheet. The latter option looks more natural. If only part of the flux flows to the orbital surface, also orbital surface suffers Coulomb force. The failure for the imbeddability of the electric field is expected to cause the generation of holes in the 3-space.

2. The average Coulombic force at various sheets of the multiple-sheeted orbital surface must be same.

By applying these constraints one ends up to two simple prototype realizations for the multiply-sheeted orbital surface, which could be called neo-classical and non-classical. Also the hybrid of these options is possible.

3. The neo-classical option allows fractional quantization of magnetic quantum number m .

For neo-classical option the $1/N$ -periods of the orbit corresponds to slightly different radii. The Compton length of electron, about 10^{-12} meters determines the thickness of the orbital sheet. Since the natural scale of the atomic resolution is Bohr radius $a_0 \simeq 10^{-10}$ meters, it is possible to have roughly $N = 100$ without too strong effects on the force experienced by electron. $N = 137$ would follow from the requirement that the rest mass of electron stays positive and is natural because $p \simeq 2^k$, $k = 137$ defines the p-adic length scale of the atomic space-time sheet.

The electric gauge flux would flow to the orbital 3-surface and back from it. This option is nearest to the one suggested by classical physics intuition and one can indeed imagine that the perturbations caused by the interaction with environment have this kind of effect.

Bohr quantization argument would suggest fractional quantization of both m and n . One can however argue that the radial and angular degrees of freedom separate in a good approximation at the level of Schrödinger equation, and that one obtains fractional quantization for the magnetic quantum number m but not for the principal quantum number n . Thus this option would not produce the desired N^2 -scaling of the energy spectrum but would allow to understand anyon physics at space-time level.

4. The non-classical option allows fractional quantization of the radial quantum number n .

The multiply-sheeted orbit could be also analogous to a Riemann surface associated with a multiple valued complex function $z^{1/N}$. That is the various sheets are at the top of each other: this option does not have any classical mechanics counterpart so that the attribute "non-classical" is well-motivated. This requires that there are $N - 1$ folds in the radial direction so that the structure is like a carpet folded back for some length, then continuing in the initial direction, folded back ... There is no obvious upper bound for the value of N .

In those parts of the multiple fold rug, where the electric field is oriented inwards, electron suffers a repulsive force and cannot form stable states at these sheets. Situation is clearly same as in catastrophe theory, where these parts of the cusp catastrophe represent maxima of potential as a function of the external parameters. How the interaction with the environment folds the rug might be understood in terms of catastrophe theory.

If the orbital 3-surface is rotationally symmetric, Schrödinger equation allows a complete decoupling between radial and rotational degrees of freedom. In this case one would have fractional quantization for the principal quantum number n only but not for the magnetic quantum number m . The cautious conclusion is that the experimental arrangement of Mills indeed demonstrates a new physics effect which does not have any classical mechanics counterpart.

One can combine radial and angular fractional quantizations in various manners.

1. Radially N_r -fold orbital surface closes after N_ϕ rotations. In this case these degrees of freedom separate completely.
2. A given radial fold is glued after each rotation to a different radial fold. In the general case the fractional quantizations of the radial and angular degrees of freedom can still correspond

to different integers N_r and $N_\phi < N_r$ such that $N_\phi > 1$ divides N_r . If one has $N_r = p$, p prime, only $N_\phi = N_r = p$ is possible.

5.5 An explanation of findings of Mills in terms of quantized Planck constant

The recent view about quantization of Planck constants allows to understand the findings of Mills elegantly.

5.5.1 Quantization of Planck constants and the generalization of the notion of imbedding space

The recent geometric interpretation for the quantization of Planck constants is based on Jones inclusions of hyper-finite factors of type II_1 [A9].

1. Different values of Planck constant correspond to imbedding space metrics involving scalings of M^4 *resp.* CP_2 parts of the metric deduced from the requirement that distances scale as $\hbar(M^4)$ *resp.* $\hbar(CP_2)$. Denoting the Planck constants by $\hbar(M^4) = n_a \hbar_0$ and $\hbar(CP_2) = n_b \hbar_0$, one has that covariant metric of M^4 is proportional to n_b^2 and covariant metric of CP_2 to n_a^2 . In Kähler action only the effective Planck constant $\hbar_{eff}/\hbar_0 = \hbar(M^4)/\hbar(CP_2)$ appears and by quantum classical correspondence same is true for Schrödinger equation. Elementary particle mass spectrum is also invariant. Same applies to gravitational constant. The alternative assumption that M^4 Planck constant is proportional to n_b would imply invariance of Schrödinger equation but would not allow to explain Bohr quantization of planetary orbits and would to certain degree trivialize the theory (to be honest I believed to this option for some time and it produced a lot of confusion).
2. M^4 and CP_2 Planck constants do not fully characterize a given sector $M^4_\pm \times CP_2$. Rather, the scaling factors of Planck constant given by the integer n characterizing the quantum phase $q = \exp(i\pi/n)$ corresponds to the order of the maximal cyclic subgroup for the group $G \subset SU(2)$ characterizing the Jones inclusion $\mathcal{N} \subset \mathcal{M}$ of hyper-finite factors realized as subalgebras of the Clifford algebra of the "world of the classical worlds". This means that subfactor \mathcal{N} gives rise to G -invariant configuration space spinors having interpretation as G -invariant fermionic states.
3. $G_b \subset SU(2) \subset SU(3)$ defines a covering of M^4_\pm by CP_2 points and $G_a \subset SU(2) \subset SL(2, C)$ covering of CP_2 by M^4_\pm points with fixed points defining orbifold singularities. Different sectors are glued together along CP_2 if G_b is same for them and along M^4_\pm if G_a is same for them. The degrees of freedom lost by G -invariance in fermionic degrees of freedom are gained back since the discrete degrees of freedom provided by covering allow many-particle states formed from single particle states realized in G group algebra. Among other things these many-particle states make possible the notion of N-atom.
4. Phases with different values of scalings of M^4 and CP_2 Planck constants behave like dark matter with respect to each other in the sense that they do not have direct interactions except at criticality corresponding to a leakage between different sectors of imbedding space glued together along M^4 or CP_2 factors. In large $\hbar(M^4)$ phases various quantum time and length scales are scaled up which means macroscopic and macro-temporal quantum coherence. In particular, quantum energies associated with classical frequencies are scaled up by a factor n_a/n_b which is of special relevance for cyclotron energies and phonon energies (superconductivity). For large $\hbar(CP_2)$ the value of \hbar_{eff} is small: this leads to interesting physics: in particular the binding energy scale of hydrogen atom increases by the factor n_b/n_a^2 .

5.5.2 Explanation for the findings of Mills

Also the small values of $\hbar_{eff} = n_a/n_b$ are interesting since in this case hydrogen atom binding energy scale increases by factor $(n_b/n_a)^2$ as Planck constant decreases (this conforms with the interpretation about approach to chaos in systems like plasmas). The assumption $n_b/n_a = k = 2, 3, \dots$ predicts exactly the binding energies reported of Mills. Also the fact that for $n_b/n_a > 137$ the binding energy becomes larger than electron rest mass remaining invariant in the phase transition implies trivially the upper bound $k \leq 137$.

More generally, this picture leads to the notion of N-atom. The space-time sheets can be regarded as $N(G_b)$ -fold coverings of M^4 by CP_2 points related by subgroup $G_b \subset SU(2) \subset SU(3)$ (color group) and this means that one can put one hydrogen atom to each sheet of the covering (analogous to multi-sheeted Riemann surface). The signature for N-atom would be scaled up binding energy spectrum whereas vibrational energies would be scaled downwards.

Another kind of N-atom results for $n_a/n_b > 1$. This N-atom would be like N-molecule having discrete spatial symmetry characterized by $G_a \subset SO(3)$: for large values of n_a the symmetry would consist of planar rotations and reflections with number-theoretically preferred values of n_a corresponding to Fermat polygons constructible using only ruler and compass. The only genuinely 3-D symmetry groups would correspond to tetrahedral and icosahedral symmetries which are encountered in the structure of water. Icosahedral and dual dodecahedral structures are very abundant in living matter.

In this case energies $E = hf$ associated with classical frequencies are scaled up by factor $n_a/n_b > 1$ so that the vibrational modes need not be masked by the thermal noise. Note that also the quantum energies associated with cyclotron and plasma frequency are scaled up. For $n_a/n_b = n$ integer, one can ask whether the vibrational dark photons emitted by dark atoms could decay to n ordinary photons having ordinary vibrational energy. The signature would be the appearance of a compound such as water in places where it is not thermally stable.

5.6 Could q-Laguerre equation relate to the claimed fractionation of the principal quantum number for hydrogen atom?

In [F10] a semiclassical model based on dark matter and hierarchy of Planck constants is developed for the fractionized principal quantum number n claimed by Mills [86] to have at least the values $n = 1/k$, $k = 2, 3, 4, 5, 6, 7, 10$. This model can explain the claimed fractionization of the principal quantum number n for hydrogen atom [86] in terms of single electron transitions for all cases. The original model could not cope with $n = 1/2$: the basic reason is that Jones inclusions are characterized by quantum phases $q = \exp(i\pi/n)$, $n > 2$. Since quantum deformation of the standard quantum mechanism is involved, this motivated an attempt to understand the claimed fractionization in terms of q-analog of hydrogen atom. The safest interpretation for them would be as states which can exist in ordinary imbedding space (and also in other branches). The natural guess would be that they can occur as intermediate states in the phase transition changing $n_b/n_a = 1$ to $k = 2, 3, \dots$

The Laguerre polynomials appearing in the solution of Schrödinger equation for hydrogen atom possess quantum variant, so called q-Laguerre polynomials [17], and one might hope that they would allow to realize this semiclassical picture at the level of solutions of appropriately modified Schrödinger equation and perhaps also resolve the difficulty associated with $n = 1/2$. Unfortunately, the polynomials discussed in [17] correspond to $0 < q \leq 1$ rather than complex values of $q = \exp(i\pi/m)$ on circle and the extrapolation of the formulas for energy eigenvalues gives complex energies.

5.6.1 q-Laquerre equation for $q = \exp(i\pi/m)$

The most obvious modification of the Laguerre equation for S -wave states (which are the most interesting by semiclassical argument) in the complex case is based on the replacement

$$\begin{aligned}\partial_x &\rightarrow \frac{1}{2}(\partial_x^q + \partial_x^{\bar{q}}) \\ \partial_x^q f &= \frac{f(qx) - f(x)}{(q-1)x} , \\ q &= \exp(i\pi/m)\end{aligned}\tag{5}$$

to guarantee hermiticity. When applied to the Laguerre equation

$$x \frac{d^2 L_n}{dx^2} + (1-x) \frac{dL_n}{dx} = nL_n ,\tag{6}$$

and expanding L_n into Taylor series

$$L_n(x) = \sum_{n \geq 0} l_n x^n ,\tag{7}$$

one obtains difference equation

$$\begin{aligned}a_{n+1} l_{n+1} + b_n l_n &= 0 , \\ a_{n+1} &= \frac{1}{4R_1^2} [R_{2n+1} - R_{2n} + 2R_{n+1}R_1 + 3R_1] + \frac{1}{2R_1} [R_{n+1} + R_1] \\ b_n &= \frac{R_n}{2R_1} - n^q + \frac{1}{2} , \\ R_n &= 2\cos[(n-1)\pi/m] - 2\cos[n\pi/m] .\end{aligned}\tag{8}$$

Here n^q is the fractionized principal quantum number determining the energy of the q -hydrogen atom. One cannot pose the difference equation on l_0 since this together with the absence of negative powers of x would imply the vanishing of the entire solution. This is natural since for first order difference equations lowest term in the series should be chosen freely.

5.6.2 Polynomial solutions of q-Laquerre equation

The condition that the solution reduces to a polynomial reads as

$$b_n = 0\tag{9}$$

and gives

$$n^q = \frac{1}{2} + \frac{R_n}{2R_1} ,\tag{10}$$

For $n = 1$ one has $n^q = 1$ so that the ground state energy is not affected. At the limit $N \rightarrow \infty$ one obtains $n^q \rightarrow n$ so that spectrum reduces to that for hydrogen atom. The periodicity $R_{n+2Nk} =$

R_n reflects the corresponding periodicity of the difference equation which suggests that only the values $n \leq 2m - 1$ belong to the spectrum. Spectrum is actually symmetric with respect to the middle point $[N/2]$ which suggests that only $n < [m/2]$ corresponds to the physical spectrum. An analogous phenomenon occurs for representations of quantum groups. When m increases the spectrum approaches integer valued spectrum and one has $n > 1$ so that no fractionization in the desired sense occurs for polynomial solutions.

5.6.3 Non-polynomial solutions of q-Laquerre equation

One might hope that non-polynomial solutions associated with some fractional values of n^q near to those claimed by Mills might be possible. Since the coefficients a_n and b_n are periodic, one can express the solution ansatz as

$$\begin{aligned} L_n(x) &= P_a^{2m}(x) \sum_k a^k x^{2mk} = P_a^{2m}(x) \frac{1}{1 - ax^{2m}} , \\ P_a^{2m}(x) &= \sum_{k=0}^{2m-1} l_k x^k , \\ a &= \frac{l_{2m}}{l_0} , \end{aligned} \tag{11}$$

This solution behaves as $1/x$ asymptotically but has pole at $x_\infty = (1/a)^{1/2m}$ for $a > 0$.

The expression for $l_{2m}/l_0 = a$ is

$$a = \prod_{k=1}^{2m} \frac{b_{2m-k}}{a_{2m-k+1}} . \tag{12}$$

This can be written more explicitly as

$$\begin{aligned} a &= (2R_1)^{2m} \prod_{k=1}^{2m} X_k , \\ X_k &= \frac{R_{2m-k} + (-2n^q + 1)R_1}{R_{4m-2k+1} - R_{4m-2k} + 4R_{2m-k+1}R_1 + 2R_1^2 + 3R_1} , \\ R_n &= 2\cos[(n-1)\pi/m] - 2\cos[n\pi/m] . \end{aligned} \tag{13}$$

This formula is a specialization of a more general formula for $n = 2m$ and resulting ratios l_n/l_0 can be used to construct P_a^{2m} with normalization $P_a^{2m}(0) = 1$.

5.6.4 Results of numerical calculations

Numerical calculations demonstrate following.

1. For odd values of m one has $a < 0$ so that a a continuous spectrum of energies seems to result without any further conditions.
2. For even values of m a has a positive sign so that a pole results.

For even value of m it could happen that the polynomial $P_a^{2m}(x)$ has a compensating zero at x_∞ so that the solution would become square integrable. The condition for reads explicitly

$$P_a^{2m}\left(\left(\frac{1}{a}\right)^{\frac{1}{2m}}\right) = 0 . \quad (14)$$

If $P_a^{2m}(x)$ has zeros there are hopes of finding energy eigen values satisfying the required conditions. Laguerre polynomials and also q-Laguerre polynomials must possess maximal number of real zeros by their orthogonality implied by the hermiticity of the difference equation defining them. This suggests that also $P_a^{2m}(x)$ possesses them if a does not deviate too much from zero. Numerical calculations demonstrate that this is the case for $n^q < 1$.

For ordinary Laguerre polynomials the naive estimate for the position of the most distant zero in the units used is larger than n but not too much so. The naive expectation is that L_{2m} has largest zero somewhat above $x = 2m$ and that same holds true a small deformation of L_{2m} considered now since the value of the parameter a is indeed very small for $n^q < 1$. The ratio $x_\infty/2m$ is below .2 for $m \leq 10$ so that this argument gives good hopes about zeros of desired kind.

One can check directly whether x_∞ is near to zero for the experimentally suggested candidates for n^q . The table below summarizes the results of numerical calculations.

1. The table gives the exact eigenvalues $1/n_q$ with a 4-decimal accuracy and corresponding approximations $1/n_{\simeq}^q = k$ for $k = 3, \dots, 10$. For a given value of m only single eigenvalue $n^q < 1$ exists. If the observed anomalous spectral lines correspond to single electron transitions, the values of m for them must be different. The value of m for which $n^q \simeq 1/k$ approximation is optimal is given with boldface. The value of k increases as m increases. The lowest value of m allowing the desired kind of zero of P^{2m} is $m = 18$ and for $k \in \{3, 10\}$ the allowed values are in range $18, \dots, 38$.
2. $n^q = 1/2$ does not appear as an approximate eigenvalue so that for even values of m quantum calculation produces same disappointing result as the classical argument. Below it will be however found that $n^q = 1/2$ is a universal eigenvalue for odd values of m .

m	$1/n_{\simeq}^q$	$1/n^q$	m	$1/n_{\simeq}^q$	$1/n^q$
18	3	2.7568	30	8	7.5762
20	4	3.6748	32	8	8.3086
22	5	4.5103	34	9	9.0342
24	5	5.3062	36	10	9.7529
26	6	6.0781	38	10	10.4668
28	7	6.8330			

Table 1. The table gives the approximations $1/n_{\simeq}^q = 1/k$ and corresponding exact values $1/n^q$ in the range $k = 3, \dots, 10$ for which $P_a^{2m}(x_\infty)$ is nearest to zero. The corresponding values of $m = 2k$ vary in the range, $k = 18, \dots, 38$. For odd values of m the value of the parameter a is negative so that there is no pole. Boldface marks for the best approximation by $1/n_{\simeq}^q = k$.

5.6.5 How to obtain $n^q = 1/2$ state?

For odd values of m the quantization recipe fails and physical intuition tells that there must be some manner to carry out quantization also now. The following observations give a hunch about be the desired condition.

1. For the representations of quantum groups only the first m spins are realized. This suggests that there should exist a symmetry relating the coefficients l_n and l_{n+m} and implying $n^q = 1/2$ for odd values of m . This symmetry would remove also the double degeneracy associated with the almost integer eigenvalues of n^q . Also other fractional states are expected on basis of physical intuition.
2. For $n^q = 1/2$ the recursion formula for the coefficients l_n involves only the coefficients R_m .
3. The coefficients R_k have symmetries $R_k = R_{k+2m}$ and $R_{k+m} = -R_m$.

There is indeed this kind of symmetry. From the formula

$$\begin{aligned} \frac{l_n}{l_0} &= (2R_1)^n \prod_{k=1}^n X_k , \\ X_k &= \frac{R_{n-k} + (-2n^q + 1)R_1}{[R_{2n-2k+1} - R_{n-2k} + 4R_{n-k+1}R_1 + 2R_1^2 + 3R_1]} \end{aligned} \quad (15)$$

one finds that for $n^q = 1/2$ the formula giving l_{n+m} in terms of l_n changes sign when n increases by one unit

$$\begin{aligned} A_{n+1} &= (-1)^m A_n , \\ A_n &= \prod_{k=1}^m \frac{b_{n+m-k}}{a_{n+m-k+1}} = \prod_{k=1}^m (2R_1)^m \prod_{k=1}^m X_{k+n} . \end{aligned} \quad (16)$$

The change of sign is essentially due to the symmetries $a_{n+m} = -a_n$ and $b_{n+m} = b_n$. This means that the action of translations on A_n in the space of indices n are represented by group Z_2 .

This symmetry implies $a = l_{2m}/l_0 = -(l_m)(l_0)^2$ so that for $n^q = 1/2$ the polynomial in question has a special form

$$\begin{aligned} P_a^{(2m)} &= P_a^{(m)}(1 - Ax^m) , \\ A &= A_0 . \end{aligned} \quad (17)$$

The relationship $a = -A^2$ implies that the solution reduces to a form containing the product of m^{th} (rather than $(2m)^{th}$) order polynomial with a geometric series in x^m (rather than x^{2m}):

$$L_{1/2}(x) = \frac{P_a^{(m)}(x)}{1 + Ax^m} . \quad (18)$$

Hence the n first terms indeed determine the solution completely. For even values of m one obtains similar result for $n^q = 1/2$ but now A is negative so that the solution is excluded. This result also motivates the hypothesis that for the counterparts of ordinary solutions of Laguerre equation sum (even m) or difference (odd m) of solutions corresponding to n and $2m - n$ must be formed to remove the non-physical degeneracy.

This argument does not exclude the possibility that there are also other fractional values of n allowing this kind of symmetry. The condition for symmetry would read as

$$\prod_{k=1}^m (R_k + \epsilon R_1) = \prod_{k=1}^m (R_k - \epsilon R_1) ,$$

$$\epsilon = (2n^q) - 1 . \quad (19)$$

The condition states that the odd part of the polynomial in question vanishes. Both ϵ and $-\epsilon$ solutions so that n^q and $1 - n^q$ are solutions. If one requires that the condition holds true for all values of m then the comparison of constant terms in these polynomials allows to conclude that $\epsilon = 0$ is the only universal solution. Since ϵ is free parameter, it is clear that the m :th order polynomial in question has at most m solutions which could correspond to other fractionized eigenvalues expected to be present on basis of physical intuition.

This picture generalizes also to the case of even n so that also now solutions of the form of Eq. 18 are possible. In this case the condition is

$$\prod_{k=1}^m (R_k + \epsilon R_1) = - \prod_{k=1}^m (R_k - \epsilon R_1) . \quad (20)$$

Obviously $\epsilon = 0$ and thus $n = 1/2$ fails to be a solution to the eigenvalue equation in this case. Also now one has the spectral symmetry $n_{\pm} = 1/2 \pm \epsilon$.

The symmetry $R_n = (-1)^m R_{n+m-1} = (-1)^m R_{n-m-1} = (-1)^m R_{m-n+1}$ can be applied to show that the polynomials associated with ϵ and $-\epsilon$ contain both the terms $R_n - \epsilon$ and $R_n + \epsilon$ as factors except for odd m for $n = (m+1)/2$. Hence the values of n can be written for even values of m as

$$n^q(n) = \frac{1}{2} \pm \frac{R_n}{2R_1} , \quad n = 1, \dots, \frac{m}{2} , \quad (21)$$

and for odd values of m as

$$n_{\pm}^q(n) = \frac{1}{2} \pm \frac{R_n}{2R_1} , \quad n = 1, \dots, \frac{m+1}{2} - 1 ,$$

$$n^q = 1/2 . \quad (22)$$

Plus sign obviously corresponds to the solutions which reduce to polynomials and to $n^q \simeq n$ for large m . The explicit expression for n^q reads as

$$n_{\pm}^q(n) = \frac{1}{2} \pm \frac{(\sin^2(\pi(n-1)/2m) - \sin^2(\pi n/2m))}{2\sin^2(\pi/2m)} . \quad (23)$$

At the limit of large m one has

$$n_{+}^q(n) \simeq n , \quad n_{-}^q(n) \simeq 1 - n . \quad (24)$$

so that the fractionization $n \simeq 1/k$ claimed by Mills is not obtained at this limit. The minimum for $|n^q|$ satisfies $|n^q| < 1$ and its smallest value $|n^q| = .7071$ corresponds to $m = 4$. Thus these zeros cannot correspond to $n^q \simeq 1/k$ yielded by the numerical computation for even values of m based on the requirement that the zero of P^{2m} cancels the pole of the geometric series.

5.6.6 Some comments

Some closing comments are in order.

1. An open question is whether there are also zeros $|n^q| > 1$ satisfying $P_a^{2m}((1/a)^{1/2m}) = 0$ for even values of m .
2. The treatment above is not completely general since only s-waves are discussed. The generalization is however a rather trivial replacement $(1-x)d/dx \rightarrow (l+1-x)d/dx$ in the Laguerre equation to get associated Laguerre equation. This modifies only the formula for a_{n+1} in the recursion for l_n so that expression for n^q , which depends on b_n 's only, is not affected. Also the product of numerators in the formula for the parameter $a = l_{2m}/l_0$ remains invariant so that the general spectrum has the spectral symmetry $n^q \rightarrow 1 - n^q$. The only change to the spectrum occurs for even values of m and is due to the dependence of $x_\infty = (1/a)^{1/2m}$ on l and can be understood in the semiclassical picture. It might happen that the value of l is modified to its q counterpart corresponding to q-Legendre functions.
3. The model could partially explain the findings of Mills and $n^q \simeq 1/k$ for $k > 2$ also fixes the value of corresponding m to a very high degree so that one would have direct experimental contact with generalized imbedding space, spectrum of Planck constants, and dark matter. The fact that the fractionization is only approximately correct suggests that the states in question could be possible for all sectors of imbedding space appear as intermediate states into sectors in which the spectrum of hydrogen atom is scaled by $n_b/n_a = k = 2, 3, \dots$
4. The obvious question is whether q-counterparts of angular momentum eigenstates ($idf_m/d\phi = mf_m$) are needed and whether they make sense. The basic idea of construction is that the phase transition changing \hbar does not involve any other modifications except fractionization of angular momentum eigenvalues and momentum eigenvalues having purely geometric origin. One can however ask whether it is possible to identify q-plane waves as ordinary plane waves. Using the definition $L_z = 1/2(\partial_u^q + \partial_{\bar{u}}^q)$, $u = exp(i\phi)$, one obtains $f_n = exp(in\phi)$ and eigenvalues as $n^q = R_n/R_1 \rightarrow n$ for $m \rightarrow \infty$. Similar construction applies in the case of momentum components.

5.7 Free energy from atomic hydrogen

The anomalies reported by free energy researchers such as over unity energy production in devices involving repeated formation and dissociation of H_2 molecules based on the original discovery of Nobelist Irwing Langmuir [81] (see for instance [80]) suggest that part of H atoms might end up to dark matter phase liberating energy.

An especially interesting device tested and described in detail by Naudin [80] is MAHG (Möller's Atomic Hydrogen Generator). The system behaves as an over-unity device producing energy from atomic hydrogen by a repeated dissociation and recombination of hydrogen atoms. MAHG tube contains a vacuum tube filled with hydrogen at 0.1 atm and cooled by water. The main part of the MAHG is a tungsten filament (0.25 mm diameter) placed in the center. Dissociation requires a heating of the tungsten filament to a temperature of about 2000 K.

A possible explanation of over-unity effect is inspired by the model of water as a partially dark matter in which one fourth of hydrogen atoms are in a dark phase forming linear super-nuclei with the distance between protons connected by color bonds being few Angstroms [F10]. The over-unity energy production could be due to a gradual transformation of hydrogen to dark hydrogen in the same state as in water. This transformation would compete with recombination and be responsible for the over unity energy production even if the liberated energy is smaller than in recombination since the resulting dark hydrogen would not dissociate anymore. The process could not continue indefinitely since the amount of ordinary hydrogen would be gradually reduced.

Also the dropping of some hydrogen atoms to larger space-time sheets accompanied by liberation of zero point kinetic energy of order .5 eV could be involved and have similar implications since the heating (thermal energy is about .2 eV) is not quite enough to kick all dropped protons back to the atomic space-time sheets.

6 Appendix: A generalization of the notion of imbedding space inspired by hierarchy of Planck constants

The hypothesis that Planck constant is quantized having in principle all possible rational values but with some preferred values implying algebraically simple quantum phases has been one of the main ideas of TGD during last years. The mathematical realization of this idea leads to a profound generalization of the notion of imbedding space obtained by gluing together infinite number of copies of imbedding space along common 4-dimensional intersection. The hope was that this generalization could explain charge fractionization but this does not seem to be the case. This problem led to a further generalization of the imbedding space and this is what I want to discuss below.

6.1 The original view about generalized imbedding space

The original generalization of imbedding space was basically following. Take imbedding space $H = M^4 \times CP_2$. Choose submanifold $M^2 \times S^2$, where S^2 is homologically non-trivial geodesic sub-manifold of CP_2 . The motivation is that for a given choice of Cartan algebra of Poincare algebra (translations in time direction and spin quantization axis plus rotations in plane orthogonal to this plane plus color hypercharge and isospin) this sub-manifold remains invariant under the transformations leaving the quantization axes invariant.

Form spaces $\hat{M}^4 = M^4 \setminus M^2$ and $\hat{CP}_2 = CP_2 \setminus S^2$ and their Cartesian product. Both spaces have a hole of co-dimension 2 so that the first homotopy group is Z . From these spaces one can construct an infinite hierarchy of factor spaces \hat{M}^4/G_a and \hat{CP}_2/G_b , where G_a is a discrete group of $SU(2)$ leaving quantization axis invariant. In case of Minkowski factor this means that the group in question acts essentially as a combination reflection and to rotations around quantization axes of angular momentum. The generalized imbedding space is obtained by gluing all these spaces together along $M^2 \times S^2$.

The hypothesis is that Planck constant is given by the ratio $\hbar/hbar_0 = (n/n_b)$, where n_i is the order of maximal cyclic subgroups of G_i . The hypothesis states also that the covariant metric of the Minkowski factor is scaled by the factor $(n_a/n_b)^2$. One must take care of this in the gluing procedure. One can assign to the field bodies describing both self interactions and interactions between physical systems definite sector of generalized imbedding space characterized partially by the Planck constant. The phase transitions changing Planck constant correspond to tunnelling between different sectors of the imbedding space.

6.2 Fractionization of quantum numbers is not possible if only factor spaces are allowed

The original idea was that the proposed modification of the imbedding space could explain naturally phenomena like quantum Hall effect involving fractionization of quantum numbers like spin and charge. This does not however seem to be the case. $G_a \times G_b$ implies just the opposite if these quantum numbers are assigned with the symmetries of the imbedding space. For instance, quantization unit for orbital angular momentum becomes n_a where Z_{n_a} is the maximal cyclic subgroup of G_a .

One can however imagine of obtaining fractionization at the level of imbedding space for space-time sheets, which are analogous to multi-sheeted Riemann surfaces (say Riemann surfaces associated with $z^{1/n}$ since the rotation by 2π understood as a homotopy of M^4 lifted to the space-time sheet is a non-closed curve. Continuity requirement indeed allows fractionization of the orbital quantum numbers and color in this kind of situation.

6.3 Both covering spaces and factor spaces are possible

The observation above stimulates the question whether it might be possible in some sense to replace H or its factors by their multiple coverings.

1. This is certainly not possible for M^4 , CP_2 , or H since their fundamental groups are trivial. On the other hand, the fixing of quantization axes implies a selection of the sub-space $H_4 = M^2 \times S^2 \subset M^4 \times CP_2$, where S^2 is a geodesic sphere of CP_2 . $\hat{M}^4 = M^4 \setminus M^2$ and $\hat{CP}_2 = CP_2 \setminus S^2$ have fundamental group Z since the codimension of the excluded sub-manifold is equal to two and homotopically the situation is like that for a punctured plane. The exclusion of these sub-manifolds defined by the choice of quantization axes could naturally give rise to the desired situation.
2. H_4 represents a straight cosmic string. Quantum field theory phase corresponds to Jones inclusions with Jones index $\mathcal{M} : \mathcal{N} < 4$. Stringy phase would by previous arguments correspond to $\mathcal{M} : \mathcal{N} = 4$. Also these Jones inclusions are labelled by finite subgroups of $SO(3)$ and thus by Z_n identified as a maximal Abelian subgroup.

One can argue that cosmic strings are not allowed in QFT phase. This would encourage the replacement $\hat{M}^4 \times \hat{CP}_2$ implying that surfaces in $M^4 \times S^2$ and $M^2 \times CP_2$ are not allowed. In particular, cosmic strings and CP_2 type extremals with M^4 projection in M^2 and thus light-like geodesic without zitterbewegung essential for massivation are forbidden. This brings in mind instability of Higgs=0 phase.

3. The covering spaces in question would correspond to the Cartesian products $\hat{M}^4_{n_a} \times \hat{CP}_{2n_b}$ of the covering spaces of \hat{M}^4 and \hat{CP}_2 by Z_{n_a} and Z_{n_b} with fundamental group is $Z_{n_a} \times Z_{n_b}$. One can also consider extension by replacing M^2 and S^2 with its orbit under G_a (say tetrahedral, octahedral, or icosahedral group). The resulting space will be denoted by $\hat{M}^4 \hat{\times} G_a$ resp. $\hat{CP}_2 \hat{\times} G_b$.
4. One expects the discrete subgroups of $SU(2)$ emerge naturally in this framework if one allows the action of these groups on the singular sub-manifolds M^2 or S^2 . This would replace the singular manifold with a set of its rotated copies in the case that the subgroups have genuinely 3-dimensional action (the subgroups which corresponds to exceptional groups in the ADE correspondence). For instance, in the case of M^2 the quantization axes for angular momentum would be replaced by the set of quantization axes going through the vertices of tetrahedron, octahedron, or icosahedron. This would bring non-commutative homotopy groups into the picture in a natural manner.

Also the orbifolds $\hat{M}^4/G_a \times \hat{CP}_2/G_b$ can be allowed as also the spaces $\hat{M}^4/G_a \times (\hat{CP}_2 \hat{\times} G_b)$ and $(\hat{M}^4 \hat{\times} G_a) \times \hat{CP}_2/G_b$. Hence the previous framework would generalize considerably by the allowance of both coset spaces and covering spaces.

6.4 Do factor spaces and coverings correspond to the two kinds of Jones inclusions?

What could be the interpretation of these two kinds of spaces?

1. Jones inclusions appear in two varieties corresponding to $\mathcal{M} : \mathcal{N} < 4$ and $\mathcal{M} : \mathcal{N} = 4$ and one can assign a hierarchy of subgroups of $SU(2)$ with both of them. In particular, their maximal Abelian subgroups Z_n label these inclusions. The interpretation of Z_n as invariance group is natural for $\mathcal{M} : \mathcal{N} < 4$ and it naturally corresponds to the coset spaces. For $\mathcal{M} : \mathcal{N} = 4$ the interpretation of Z_n has remained open. Obviously the interpretation of Z_n as the homology group defining covering would be natural.
2. $\mathcal{M} : \mathcal{N} = 4$ should correspond to the allowance of cosmic strings and other analogous objects. Does the introduction of the covering spaces bring in cosmic strings in some controlled manner? Formally the subgroup of $SU(2)$ defining the inclusion is $SU(2)$ would mean that states are $SU(2)$ singlets which is something non-physical. For covering spaces one would however obtain the degrees of freedom associated with the discrete fiber and the degrees of freedom in question would not disappear completely and would be characterized by the discrete subgroup of $SU(2)$.

For anyons the non-trivial homotopy of plane brings in non-trivial connection with a flat curvature and the non-trivial dynamics of topological QFTs. Also now one might expect similar non-trivial contribution to appear in the spinor connection of $\hat{M}^2 \hat{\times} G_a$ and $\hat{C}P_2 \hat{\times} G_b$. In conformal field theory models non-trivial monodromy would correspond to the presence of punctures in plane.

3. For factor spaces the unit for quantum numbers like orbital angular momentum is multiplied by n_a *resp.* n_b and for coverings it is divided by this number. These two kind of spaces are in a well defined sense obtained by multiplying and dividing the factors of \hat{H} by G_a *resp.* G_b and multiplication and division are expected to relate to Jones inclusions with $\mathcal{M} : \mathcal{N} < 4$ and $\mathcal{M} : \mathcal{N} = 4$, which both are labelled by a subset of discrete subgroups of $SU(2)$.
4. The discrete subgroups of $SU(2)$ with fixed quantization axes possess a well defined multiplication with product defined as the group generated by forming all possible products of group elements as elements of $SU(2)$. This product is commutative and all elements are idempotent and thus analogous to projectors. Trivial group G_1 , two-element group G_2 consisting of reflection and identity, the cyclic groups Z_p , p prime, and tetrahedral, octahedral, and icosahedral groups are the generators of this algebra.

By commutativity one can regard this algebra as an 11-dimensional module having natural numbers as coefficients ("rig"). The trivial group G_1 , two-element group G_2 generated by reflection, and tetrahedral, octahedral, and icosahedral groups define 5 generating elements for this algebra. The products of groups other than trivial group define 10 units for this algebra so that there are 11 units altogether. The groups Z_p generate a structure analogous to natural numbers acting as analog of coefficients of this structure. Clearly, one has effectively 11-dimensional commutative algebra in 1-1 correspondence with the 11-dimensional "half-lattice" N^{11} (N denotes natural numbers). Leaving away reflections, one obtains N^7 . The projector representation suggests a connection with Jones inclusions. An interesting question concerns the possible Jones inclusions assignable to the subgroups containing infinitely manner elements. Reader has of course already asked whether dimensions 11, 7 and their difference 4 might relate somehow to the mathematical structures of M-theory with 7 compactified dimensions.

5. How do the Planck constants associated with factors and coverings relate? One might argue that Planck constant defines a homomorphism respecting the multiplication and division (when possible) by G_i . If so, then Planck constant in units of \hbar_0 would be equal to n_a/n_b for $\hat{H}/G_a \times G_b$ option and n_b/n_a for $\hat{H} \hat{\times} (G_a \times G_b)$ with obvious formulas for hybrid cases. This option would put M^4 and CP_2 in a very symmetric role and allow much more flexibility in the identification of symmetries associated with large Planck constant phases.

6.5 Fractional Quantum Hall effect

The generalization of the imbedding space allows to understand fractional quantum Hall effect [49]. The formula for the quantized Hall conductance is given by

$$\begin{aligned}\sigma &= \nu \times \frac{e^2}{h} , \\ \nu &= \frac{n}{m} .\end{aligned}\tag{25}$$

Series of fractions in $\nu = 1/3, 2/5, 3/7, 4/9, 5/11, 6/13, 7/15, \dots, 2/3, 3/5, 4/7, 5/9, 6/11, 7/13, \dots, 5/3, 8/5, 11/7, 14/9, \dots, 4/1/5, 2/9, 3/13, \dots, 2/7, 3/11, \dots, 1/7, \dots$ with odd denominator have been observed as are also $\nu = 1/2$ and $\nu = 5/2$ states with even denominator [49].

The model of Laughlin [47, 48] cannot explain all aspects of FQHE. The best existing model proposed originally by Jain is based on composite fermions resulting as bound states of electron and even number of magnetic flux quanta [50]. Electrons remain integer charged but due to the effective magnetic field electrons appear to have fractional charges. Composite fermion picture predicts all the observed fractions and also their relative intensities and the order in which they appear as the quality of sample improves.

In [O3] I have proposed a possible TGD based model of FQHE not involving hierarchy of Planck constants. The generalization of the notion of imbedding space suggests also the possibility to interpret these states in terms of fractionized charge and electron number.

1. The easiest manner to understand the observed fractions is by assuming that both M^4 and CP_2 correspond to covering spaces so that both spin and electric charge and fermion number are quantized. With this assumption the expression for the Planck constant becomes $\hbar/\hbar_0 = n_b/n_a$ and charge and spin units are equal to $1/n_b$ and $1/n_a$ respectively. This gives $\nu = nn_a/n_b^2$. The values $m = 2, 3, 5, 7, \dots$ are observed. Planck constant can have arbitrarily large values. There are general arguments stating that also spin is fractionized in FQHE and for $n_a = kn_b$ required by the observed values of ν charge fractionization occurs in units of k/n_b and forces also spin fractionization. For factor space option in M^4 degrees of freedom one would have $\nu = n/n_a n_b^2$.
2. The appearance of $n_b = 2$ would suggest that also Z_2 appears as the homotopy group of the covering space: filling fraction $1/2$ corresponds in the composite fermion model and also experimentally to the limit of zero magnetic field [50]. Also $\nu = 5/2$ has been observed [51].
3. A possible problematic aspect of the TGD based model is the experimental absence of even values of n_b except $n_b = 2$. A possible explanation is that by some symmetry condition possibly related to fermionic statistics kn/n_b must reduce to a rational with an odd denominator for $n_b > 2$. In other words, one has $k \propto 2^r$, where 2^r the largest power of 2 divisor of n_b smaller than n_b .
4. Large values of n_b emerge as B increases. This can be understood from flux quantization. One has $eBS = n\hbar = n(n_b/n_a)\hbar_0$. The interpretation is that each of the n_b sheets contributes n/n_a units to the flux. As B increases also the flux increases for a fixed value of n_a and area S . Note that the value of magnetic field in given sheet is not affected so that the build-up of multiple covering seems to keep magnetic field strength below critical value. For $n_a = kn_b$ one obtains $eBS/\hbar_0 = n/k$ so that a fractionization of magnetic flux results and each sheet contributes $1/kn_b$ units to the flux. $\nu = 1/2$ corresponds to $k = 1, n_b = 2$ and to non-vanishing magnetic flux unlike in the case of composite fermion model.

5. The understanding of the thermal stability is not trivial. The original FQHE was observed in 80 mK temperature corresponding roughly to a thermal energy of $T \sim 10^{-5}$ eV. For graphene the effect is observed at room temperature. Cyclotron energy for electron is (from $f_e = 6 \times 10^5$ Hz at $B = .2$ Gauss) of order thermal energy at room temperature in a magnetic field varying in the range 1-10 Tesla. This raises the question why the original FQHE requires so low temperature. The magnetic energy of a flux tube of length L is by flux quantization roughly $e^2 B^2 S \sim E_c(e)m_e L$ ($\hbar_0 = c = 1$) and exceeds cyclotron roughly by a factor L/L_e , L_e electron Compton length so that thermal stability of magnetic flux quanta is not the explanation. A possible explanation is that since FQHE involves several values of Planck constant, it is quantum critical phenomenon and is characterized by a critical temperature. The differences of the energies associated with the phase with ordinary Planck constant and phases with different Planck constant would characterize the transition temperature.

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