

Quantum Coherent Dark Matter and Bio-Systems as Macroscopic Quantum Systems

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Abstract

In this chapter a general vision about the unexpected relationships between cosmology, hadron physics, and biology is discussed. The vision is based on p-adic fractality implying that physics and consciousness should share same basic elements in all scales, and to quite recent dramatic discoveries in astrophysics and hadron physics suggesting that the value of Planck constant might be dynamical as I have proposed earlier. One implication is that living systems would correspond to a large value of Planck constant. This would mean that elementary quantum units correspond to systems consisting of very many elementary particles and that characteristic time and length scales are scaled up from those predicted by ordinary quantum theory so that macroscopic and macro-temporal quantum coherence become possible.

1. Dark matter as macroscopic quantum phase with a gigantic value of Planck constant

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

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

I have proposed already earlier the possibility that Planck constant is quantized. The spectrum is given in terms of integers n characterizing the quantum phases $q = \exp(i\pi/n)$. The Planck constants associated with M^4 and CP_2 degrees of freedom are predicted to be different in general and arbitrarily large values of Planck constants are possible so that $\hbar_{gr} = GMm/v_0$ can be understood in this framework. The general philosophy would be that when the quantum system would become non-perturbative, a phase transition increasing the value of \hbar occurs to preserve the perturbative character. This would apply to QCD and to atoms with $Z > 137$ as well.

The integers n which correspond to polygons constructible using ruler and compass are number theoretically preferred. This gives very strong constraints on planetary masses, their general mass scale, and also on the value of v_0 . The constraints are satisfied with accuracy better than 10 per cent.

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

The rather amazing coincidences between basic bio-rhythms and the periods associated with the states of orbits in solar system suggest that the frequencies defined by the energy levels of the gravitational Schrödinger equation might entrain with various biological frequencies such as the cyclotron frequencies associated with the magnetic flux tubes. For instance, the period associated with $n = 1$ orbit in the case of Sun is 24 hours within experimental accuracy for v_0 .

2. How the scaling of \hbar affects physics?

It is relatively easy to deduce the basic implications of the scaling of \hbar .

a) If the rate for the process is non-vanishing classically, it is not affected in the lowest order. For instance, scattering cross sections for say electron-electron scattering and e^+e^- annihilation are not affected in the lowest order since the increase of Compton length compensates for the reduction of α_{em} . Photon-photon scattering cross section, which vanishes classically and is proportional to $\alpha_{em}^4 \hbar^2/E^2$, scales down as $1/\hbar^2$.

b) Higher order corrections coming as powers of the gauge coupling strength α are reduced since $\alpha = g^2/4\pi\hbar$ is reduced. Since one has $\hbar_s/\hbar = \alpha Q_1 Q_2/v_0$, $\alpha Q_1 Q_2$ is effectively replaced with a universal coupling strength v_0 . In the case of QCD the paradoxical sounding implication is that α_s would become very small.

c) The binding energy scale $E \propto \alpha_{em}^2 m_e$ of atoms scales as $1/\hbar^2$ so that a partially dark matter for which protons have large value of \hbar does not interact appreciably with the visible light. Scaled down spectrum of binding energies would be the experimental signature of dark matter. The resulting atomic spectrum is universal and binding energy scale $\alpha^2 m_e$ is replaced with $v_0^2 m_e$ which corresponds to $\sim .115$ eV and wavelength of $\simeq 10.78$ μm , a typical size of cell. Bohr radius is 12.2 nm for dark hydrogen atom whereas the thickness of cell membrane is about 10 nm. It would be amazing if living matter would exhibit scaled down atomic spectra with this universal energy scale.

3. Hadronic black holes and new view about dark matter

Important steps in the development of ideas were stimulated by the findings made during period 2002-2005 in Relativist Heavy Ion Collider (RHIC) in Brookhaven compared with the discovery of America and for full reason. In particular, the observed production of black-hole like object in heavy ion collisions support the view that in non-perturbative phase of QCD matter possesses large value of \hbar and becomes thus analogous to dark matter. Even more, the earlier model for macroscopic quantum states as resulting when conformal weights of partons become complex such that net conformal weight is real, leads to a general hypothesis that conformal confinement is what forces the system to behave like single coherent quantum unit with large value of \hbar . Surprisingly precise analogies with black hole formation and evaporation or equivalently with big crush followed by big bang describable as scaled down version of TGD inspired cosmology, emerge.

4. Consciousness and cosmology

Consciousness and cosmology represents a rather weird association from the point of view of materialistically inclined cosmologist. p-Adic physics of cognition however predicts that cognitive consciousness is unavoidably a cosmic phenomenon as far its space-time correlates are considered. Magnetic flux tube hierarchy provides the template for the evolution of conscious, intelligent systems in all length scales in TGD Universe, and bio-systems are predicted to possess magnetic bodies of astrophysical size. Adding to this the enormous spectrum of non-deterministic vacuum extremals (with respect to inertial energy) of field equations allowing interpretation as space-time correlates of intentional action, one has good motivations for a serious consideration of the possibility that intentionality might be realized in astrophysical length scales. There is even some evidence that Sun might act as an intentional system. Fortunately, these speculations are not empty since rather dramatic testable phenomena are predicted.

5. Dark matter and living matter

The notion of magnetic body containing macroscopic quantum phases responsible for bio-control introduced already earlier, and the fact that dark matter would reside at magnetic flux tubes, motivate the hypothesis that living matter is actually dark matter with the large value of Planck constant determining the characteristic time and length scales of a conscious system. Complex conformal weights for single particles states and closely related to the zeros of Riemann Zeta would make the many-particle system living. p-Adic fractality allows to deduce rather striking similarities between biology, cosmology, and hadron physics.

6. Dark matter and classical long range electro-weak and color gauge fields

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

1 Introduction

In this chapter a general vision about the unexpected relationships between cosmology, hadron physics, and biology is discussed. The vision is based on p-adic fractality implying that physics and consciousness should share same basic elements in all scales, and to quite dramatic recent findings from astrophysics and hadron physics suggesting that the value of Planck constant might be dynamical as I have proposed [C5] so that living systems would correspond to a large value of Planck constant. This would mean that elementary quantum units correspond to systems consisting of very many elementary particles and that characteristic time and length scales are scaled up from those predicted by ordinary quantum theory so that macro-temporal quantum coherence become possible.

1.1 Dark matter as macroscopic quantum phase with gigantic Planck constant

D. Da Rocha and Laurent Nottale, the developer of Scale Relativity, have ended up with an highly interesting quantum theory like model for the evolution of astrophysical systems [92] (I am grateful for Victor Christianto for informing me about the article). The model is simply Schrödinger equation with Planck constant \hbar replaced with what might be called gravitational Planck constant

$$\hbar \rightarrow \hbar_{gr} = \frac{GmM}{v_0} . \quad (1)$$

Here I have used units $\hbar = c = 1$. v_0 is a velocity parameter having the value $v_0 = 144.7 \pm .7$ km/s giving $v_0/c = 4.6 \times 10^{-4}$. The peak orbital velocity of stars in galactic halos is 142 ± 2 km/s whereas the average velocity is 156 ± 2 km/s. Also subharmonics and harmonics of v_0 seem to appear.

The model makes fascinating predictions which hold true. For instance, the radii of planetary orbits fit nicely with the prediction of the hydrogen atom like model. The inner solar system (planets up to Mars) corresponds to v_0 and outer solar system to $v_0/5$.

It is important to notice that effectively a multiplication $n \rightarrow 5n$ of the principal quantum number is in question in the case of outer planets. If one accepts the interpretation that visible matter has concentrated around dark matter, which is in macroscopic quantum phase around Bohr orbits, this allows to consider also the possibility that \hbar_{gr} has same value for all planets.

1. Some external gravitational perturbations have kicked dark matter from inner orbits to $n \bmod 5 = 0$ orbits. Gravitational perturbations might have caused the same for visible matter. The fact that the tilt angles of Earth and outer planets other than Pluto are nearly the same suggests that the orbits of these planets might be an outcome of some violent quantum process for dark matter preserving the orbital plane in a good approximation but

kicking dark matter from $n = 5$ orbit of Earth to the orbits $n = 5k$, $k = 2, \dots, 7$. Pluto might in turn have experienced some violent collision changing its orbital plane.

2. There could exist at least small amounts of dark matter at all orbits but visible matter is concentrated only around orbits containing some critical amount of dark matter and these orbits satisfy $n = 5k$, $k = 2, 3, \dots$ for some reason.

The predictions for the distribution of major axis and eccentricities have been tested successfully also for exo-planets. Also the periods of 3 planets around pulsar PSR B1257+12 fit with the predictions with a relative accuracy of few hours/per several months. Also predictions for the distribution of stars in the regions where morphogenesis occurs follow from the Schrödinger equation.

What is important is that there are no free parameters besides v_0 . In [92] a wide variety of astrophysical data is discussed and it seems that the model works and has already now made predictions which have been later verified. A rather detailed model for the formation of solar system making quantitatively correct predictions follows from the study of inclinations and eccentricities predicted by the Bohr rules: the model proposed seems to differ from that of Nottale which makes predictions for the probability distribution of eccentricities and inclinations.

I had proposed already earlier [E10] the possibility that Planck constant is quantized. The inverse of the gravitational Planck constant could correspond to a gravitational perturbation of this as $1/\hbar_{gr} = v_0/GMm$. The general philosophy would be that when the quantum system would become non-perturbative, a phase transition increasing the value of \hbar occurs to preserve the perturbative character.

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

The study of inclinations (tilt angles with respect to the Earth's orbital plane) leads to a concrete model for the quantum evolution of the planetary system. Only a stepwise breaking of the rotational symmetry and angular momentum Bohr rules plus Newton's equation (or geodesic equation) are needed, and gravitational Schrödinger equation holds true only inside flux quanta for the dark matter.

1. During pre-planetary period dark matter formed a quantum coherent state on the (Z^0) magnetic flux quanta (spherical cells or flux tubes). This made the flux quantum effectively a single rigid body with rotational degrees of freedom corresponding to a sphere or circle (full $SO(3)$ or $SO(2)$ symmetry).
2. In the case of spherical shells associated with inner planets the $SO(3) \rightarrow SO(2)$ symmetry breaking led to the generation of a flux tube with the inclination determined by m and j and a further symmetry breaking, kind of an astral traffic jam inside the flux tube, generated a planet moving inside flux tube. The semiclassical interpretation of the angular momentum algebra predicts the inclinations of the inner planets. The predicted (real) inclinations are 6 (7) resp. 2.6 (3.4) degrees for Mercury resp. Venus). The predicted (real) inclination of the Earth's spin axis is 24 (23.5) degrees.
3. The $v_0 \rightarrow v_0/5$ transition allowing to understand the radii of the outer planets in the model of Da Rocha and Nottale can be understood as resulting from the splitting of (Z^0) magnetic flux tube to five flux tubes representing Earth and outer planets except Pluto, whose orbital parameters indeed differ dramatically from those of other planets. The flux tube has a shape of a disk with a hole glued to the Earth's spherical flux shell.

It is important to notice that effectively a multiplication $n \rightarrow 5n$ of the principal quantum number is in question. This allows to consider also alternative explanations. Perhaps external gravitational perturbations have kicked dark matter from the orbit of Earth to $n = 5k$, $k = 2, 3, \dots, 7$ orbits: the fact that the tilt angles for Earth and all outer planets except Pluto are nearly the same, supports this explanation. Or perhaps there exist at least small amounts of dark matter at all orbits but visible matter is concentrated only around orbits containing some critical amount of dark matter and these orbits satisfy $n \bmod 5 = 0$ for some reason.

The most interesting predictions from the point of view of living matter are following.

1. The dark matter is still there and forms quantum coherent structures of astrophysical size. In particular, the (Z^0) magnetic flux tubes associated with the planetary orbits define this kind of structures. The enormous value of h_{gr} makes the characteristic time scales of these quantum coherent states extremely long and implies macro-temporal quantum coherence in human and even longer time scales.
2. The rather amazing coincidences between basic bio-rhythms and the periods associated with the orbits in solar system suggest that the frequencies defined by the energy levels of the gravitational Schrödinger equation might entrain with various biological frequencies such as the cyclotron frequencies associated with the magnetic flux tubes. For instance, the period associated with $n = 1$ orbit in the case of Sun is 24 hours within experimental accuracy for v_0 . Second example is the mysterious 5 second time scale associated with the Comorosan effect [33, 34].

In the following I shall discuss Nottale's model from the point of view of TGD with the emphasis in the model of the planetary system. Only the first rudimentary steps in the understanding of the role of quantum gravitational dark matter in the quantum control and coordination of living matter are made. The results however provide firm experimental and theoretical basis for the earlier vision about magnetosphere as a living system responsible for the control of bio-matter.

1.2 Simulating big bang in laboratory

An important steps in the development of ideas were stimulated by the findings made during period 2002-2005 in Relativist Heavy Ion Collider (RHIC) in Brookhaven compared with the finding of America and for full reason.

1. The first was finding of longitudinal Lorentz invariance at single particle level suggesting a collective behavior. This was around 2002.
2. The collective behavior which was later interpreted in terms of color glass condensate meaning the presence of a blob of liquid like phase decaying later to quark gluon plasma since it was found that the density of what was expected to be quark gluon plasma was about ten times higher than expected.
3. The last finding is that this object seems to absorb partons like black hole and behaves like evaporating black hole.

In my personal Theory Universe the history went as follows.

1. I proposed 2002 a model for Gold-Gold collision as a mini big bang identified as a scaled down variant of TGD inspired cosmology. This makes sense because in TGD based critical cosmology the initial state has vanishing mass per comoving volume instead of being infinite as in radiation dominated cosmology. Any phase transition involving a generation of a new space-time sheet might proceed in this universal manner.

2. Cosmic string soup in the primordial stage is replaced by a tangle of color flux tubes containing the color glass condensate. Flux tubes correspond to flow lines of incompressible liquid flow and non-perturbative phase with a very large \hbar is in question. Gravitational constant is replaced by strong gravitational constant defined by the relevant p-adic length scale squared since color flux tubes are analogs of hadronic strings. Presumably L_p , $p = M_{107} = 2^{107} - 1$, is the p-adic length scale since Mersenne prime M_{107} labels the space-time sheet at which partons feed their color gauge fluxes. Temperature during this phase could correspond to Hagedorn temperature for strings and is determined by string tension. Density would be maximal.
3. Next phase is critical phase in which the notion of space-time in ordinary sense makes sense and 3-space is flat since there is no length scale in critical system (so that curvature vanishes). During this critical phase a transition to quark gluon plasma occurs. The duration of this phase fixes all relevant parameters such as temperature (which is the analog of Hagedorn temperature corresponding since critical density is maximal density of gravitational mass in TGD Universe).
4. The next phase is radiation dominated quark gluon plasma phase and then follows hadronization to matter dominated phase provided cosmological picture still applies.

Since black hole formation and evaporation is very much like formation big crunch followed by big bang, the picture is more or less equivalent with the picture in which black hole like object consisting of string like objects (mass is determined by string length just as it is determined by the radius for black holes) is formed and then evaporates. Black hole temperature corresponds to Hagedorn temperature and to the duration of critical period of the mini cosmology.

1.3 Cosmology of consciousness

Consciousness and cosmology represents a rather weird association from the point of view of materialistically inclined cosmologist. p-Adic physics of cognition however predicts that cognitive consciousness is unavoidably a cosmic phenomenon as far its space-time correlates are considered. Magnetic flux tube hierarchy provides the template for the evolution of conscious, intelligent systems in all length scales in TGD Universe, and bio-systems are predicted to possess magnetic bodies of astrophysical size. Adding to this the enormous spectrum of non-deterministic vacuum extremals (with respect to inertial energy) of field equations allowing interpretation as space-time correlates of intentional action, one has good motivations for a serious consideration of the possibility that intentionality might be realized in astrophysical length scales. There is even some evidence that Sun might act as an intentional system. Fortunately, these speculations are not empty since rather dramatic testable phenomena are predicted.

1.4 Living matter and dark matter

The most important gift of RHIC was that several theoretical notions and ideas emerged during last years, and applying in hugely different length and time scales by p-adic fractality, integrate nicely.

1. Dark matter is identified as a macroscopic quantum phase with large \hbar for which particles have complex conformal weights. Dark matter controls ordinary matter in living matter. Dark matter also explains the weird looking findings about Bohr rules for planetary orbits.
2. Living matter would be also matter with large value of \hbar and with extremely quantal properties, including free will of course! Dark matter would be responsible for the mysterious vital force.

3. Any system for which some interaction becomes so strong that perturbation theory does not work gives rise to this kind of system in a phase transition in which \hbar increases to not lose perturbativity gives rise to this kind of "super-quantal" matter.
4. Physically \hbar means a larger unit for quantum numbers and this requires that single particle states form larger particle like units. This kind of collective states with weak mutual interactions are of course very natural in strongly interacting systems. At the level of quantum jumps quantum jumps integrate effectively to single quantum jump and longer moments of consciousness result. Entire hierarchy of quantal size scales is predicted corresponding to values of Planck constants associated with M^4 and CP_2 degrees of freedom. The value of \hbar determines the characteristic time and length scales associated with the conscious living system. One could say that the claim that quantum mechanics in its recent form is not enough for understanding living matter is correct: dynamical \hbar is needed.
5. The picture might have implications also for the understanding of condensed matter. For instance, liquids might be liquids because they contain dark some matter at magnetic/ Z^0 magnetic flux tubes (darkness follows from the large value of \hbar).

2 Is dark matter in macroscopic quantum phase with a gigantic value of Planck constant?

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$$\hbar \rightarrow \hbar_{gr} = \frac{GmM}{v_0} . \quad (2)$$

Here I have used units $\hbar = c = 1$. v_0 is a velocity parameter having the value $v_0 = 144.7 \pm .7$ km/s giving $v_0/c = 4.6 \times 10^{-4}$. The peak orbital velocity of stars in galactic halos is 142 ± 2 km/s whereas the average velocity is 156 ± 2 km/s. Also sub-harmonics and harmonics of v_0 seem to appear.

The model makes fascinating predictions which hold true. For instance, the radii of planetary orbits fit nicely with the prediction of the hydrogen atom like model. The inner solar system (planets up to Mars) corresponds to v_0 and outer solar system to $v_0/5$.

The predictions for the distribution of major axis and eccentricities have been tested successfully also for exoplanets. Also the periods of 3 planets around pulsar PSR B1257+12 fit with the predictions with a relative accuracy of few hours/per several months. Also predictions for the distribution of stars in the regions where morphogenesis occurs follow from the gravitational Schrödinger equation.

What is important is that there are no free parameters besides v_0 . In [92] a wide variety of astrophysical data is discussed and it seem that the model works and has already now made predictions which have been later verified. In the following I shall discuss Nottale's model from the point of view of TGD.

2.1 TGD prediction for the parameter v_0

One of the basic questions is the origin of the parameter v_0 , which according to a rich amount of experimental data discussed in [92] seems to play a role of a constant of Nature. One of the

first applications of cosmic strings in TGD sense was an explanation of the velocity spectrum of stars in the galactic halo in terms of dark matter which could consist of cosmic strings. Cosmic strings could be orthogonal to the galactic plane going through the nucleus (jets) or they could be in galactic plane in which case the strings and their decay products would explain dark matter assuming that the length of cosmic string inside a sphere of radius R is or has been roughly R [D4]. The predicted value of the string tension is determined by the CP_2 radius whose ratio to Planck length is fixed by electron mass via p-adic mass calculations. The resulting prediction for the v_0 is correct and provides a working model for the constant orbital velocity of stars in the galactic halo.

The parameter $v_0 \simeq 2^{-11}$, which has actually the dimension of velocity unless one puts $c = 1$, and also its harmonics and sub-harmonics appear in the scaling of \hbar . v_0 corresponds to the velocity of distant stars in the model of galactic dark matter. TGD allows to identify this parameter as the parameter

$$\begin{aligned} v_0 &= 2\sqrt{TG} = \sqrt{\frac{1}{2\alpha_K}} \sqrt{\frac{G}{R^2}} , \\ T &= \frac{1}{8\alpha_K} \frac{\hbar_0}{R^2} . \end{aligned} \quad (3)$$

Here T is the string tension of cosmic strings, R denotes the "radius" of CP_2 ($2R$ is the radius of geodesic sphere of CP_2). α_K is Kähler coupling strength, the basic coupling constant strength of TGD, whose evolution as a function of p-adic length scale is fixed by quantum criticality. The condition that G is invariant in the p-adic coupling constant evolution and number theoretical arguments predict

$$\begin{aligned} \alpha_K(p) &= k \frac{1}{\log(p) + \log(K)} , \\ K &= \frac{R^2}{\hbar_0 G} = 2 \times 3 \times 5 \times 7 \times 11 \times 13 \times 17 \times 19 \times 23 , \quad k \simeq \pi/4 . \end{aligned} \quad (4)$$

The predicted value of v_0 depends logarithmically on the p-adic length scale and for $p \simeq 2^{127} - 1$ (electron's p-adic length scale) one has $v_0 \simeq 2^{-11}$.

2.2 Model for planetary orbits without $v_0 \rightarrow v_0/5$ scaling

Also harmonics and sub-harmonics of v_0 appear in the model of Nottale and Da Rocha. For instance, the outer planets (Jupiter, Saturn,...) correspond to $v_0/5$ whereas inner planets correspond to v_0 . Quite generally, it is found that the values seem to come as harmonics and sub-harmonics of v_0 : $v_n = nv_0$ and v_0/n , and the argument [92] is that the different values of n relate to fractality. This scaling is not necessary for the planetary orbits in TGD based model.

Effectively a multiplication $n \rightarrow 5n$ of the principal quantum number is in question in the case of outer planets. If one accepts the interpretation that visible matter has concentrated around dark matter, which is in macroscopic quantum phase around Bohr orbits, this allows to consider also the possibility that \hbar_{gr} has the same value for all planets.

1. Some gravitational perturbation has kicked dark matter from the region of the asteroid belt to $n \simeq 5k$, $k = 2, \dots, 6$, orbits. The best fit is obtained by using values of n deviating somewhat from multiples of 5 which suggests that the scaling of v_0 is not needed. Gravitational perturbations might have caused the same for the visible matter. The fact that the tilt angles of Earth and outer planets other than Pluto are nearly the same suggests that the orbits of these planets might be an outcome of some violent quantum process for dark matter

preserving the orbital plane in a good approximation. Pluto might in turn have experienced some violent collision changing its orbital plane.

2. There could exist at least small amounts of dark matter at all orbits but visible matter is concentrated only around orbits containing some critical amount of dark matter.

	Exp.	Titius-Bode	Bohr ₁	Bohr ₂
Planet	R/R_M	R/R_M	$[n, R/R_M]$	$[n, R/R_M]$
Mercury	1	1	[3, 1]	
Venus	1.89	1.75	[4, 1.8]	
Earth	2.6	2.5	[5, 2.8]	
Mars	3.9	4	[6, 4]	
Asteroid belt	6.1-8.7	7	[(7, 8, 9), (5.4, 7.1, 9)]	
Jupiter	13.7	13	[11, 13.4]	[2 × 5, 11.1]
Saturn	25.0	25	[3 × 5, 25]	[3 × 5, 25]
Uranus	51.5	49	[22, 53.8]	[4 × 5, 44.4]
Neptune	78.9	97	[27, 81]	[5 × 5, 69.4]
Pluto	105.2	97	[31, 106.7]	[6 × 5, 100]

Table 2. The table represents the experimental average orbital radii of planets, the predictions of Titius-Bode law (note the failure for Neptune), and the predictions of Bohr orbit model assuming a) that the principal quantum number n corresponds to best possible fit, b) the scaling $\lambda \rightarrow \lambda/5$ for outer planets. Option 1) gives the best fit with errors being considerably smaller than the maximal error $|\Delta R|/R \simeq 1/n$ except for Uranus.

2.2.1 How to understand the harmonics and sub-harmonics of v_0 in TGD framework?

Also harmonics and sub-harmonics of v_0 appear in the model of Nottale and Da Rocha. In particular, the outer planets (Jupiter, Saturn,...) correspond to $v_0/5$ whereas inner planets correspond to v_0 in this model. As already found, TGD allows also an alternative explanation.

Quite generally, it is found that the values seem to come as harmonics and sub-harmonics of v_0 : $v_n = nv_0$ and v_0/n , and the argument [92] is that the different values of n relate to fractality. This quantization is a challenge for TGD since v_0 certainly defines a fundamental constant in TGD Universe.

1. Consider first the harmonics of v_0 . Besides cosmic strings of type $X^2 \times S^2 \subset M^4 \times CP_2$ one can consider also deformations of these strings defining their multiple coverings so that the deformation is n -valued as a function of S^2 -coordinates (Θ, Φ) and the projection to S^2 is thus an $n \rightarrow 1$ map. The solutions are higher dimensional analogs of originally closed orbits which after perturbation close only after n turns. This kind of surfaces emerge in the TGD inspired model of quantum Hall effect naturally [E9] and $n \rightarrow \infty$ limit has an interpretation as an approach to chaos [G2].

Using the coordinates (x, y, θ, ϕ) of $X^2 \times S^2$ and coordinates m^k for M^4 of the unperturbed solution the space-time surface the deformation can be expressed as

$$\begin{aligned}
 m^k &= m^k(x, y, \theta, \phi) , \\
 (\Theta, \Phi) &= (\theta, n\phi) .
 \end{aligned}
 \tag{5}$$

The value of the string tension would be indeed n^2 -fold in the first approximation since the induced Kähler form defining the Kähler magnetic field would be $J_{\theta\phi} = n \sin(\Theta)$ and one

would have $v_n = nv_0$. At the limit $m^k = m^k(x, y)$ different branches for these solutions collapse together.

2. Consider next how sub-harmonics appear in TGD framework. Cosmic strings are predicted to decay to magnetic flux tube structures by absolute minimization of Kähler action. The Kähler magnetic flux $\Phi = BS$ is conserved in the process but the thickness of the M^4 projection of the cosmic string increases field strength is reduced. This means that string tension, which is proportional to B^2S , is reduced (so that also Kähler action is reduced). The fact that space-time surface is Bohr orbit in generalized sense means that the reduced string tension (magnetic energy per unit length) is quantized.

The task is to guess how the quantization occurs. There are two options.

1. The simplest explanation for the reduction of v_0 is based on the decay of a flux tube resembling a disk with a hole to n identical flux tubes so that $v_0 \rightarrow v_0/n$ results for the resulting flux tubes. It turns out that this mechanism is favored and explains elegantly the value of \hbar_{gr} for outer planetary system. One can also consider small-p p-adicity so that n would be prime.
2. Second explanation is more intricate. Consider a magnetic flux tube. Since magnetic flux is quantized, the magnetic field strengths are quantized in integer multiples of basic strength: $B = nB_0$ and would rather naturally correspond to the multiple coverings of the original magnetic flux tube with magnetic energy quantized in multiples of n^2 . The idea is to require internal consistency in the sense that the allowed reduced field strengths are such that the spectrum associated with B_0 is contained to the spectrum associated with the quantized field strengths $B_1 > B_0$. This would allow only field strengths $B = B_S/n^2$, where B_S denotes the field strength of the fundamental cosmic string and one would have $v_n = v_0/n$. Flux conservation requires that the area of the flux tube scales as n^2 .

Sub-harmonics might appear in the outer planetary system and there are indications for the higher harmonics below the inner planetary system [92]: for instance, solar radius corresponds to $n = 1$ orbital for $v_3 = 3v_0$. This would suggest that Sun and also planets have an onion like structure with highest harmonics of v_0 and strongest string tensions appearing in the solar core and highest sub-harmonics appearing in the outer regions. If the matter results as decay remnants of cosmic strings this means that the mass density inside Sun should correlate strongly with the local value of n characterizing the multiple covering of cosmic strings.

One can ask whether the very process of the formation of the structures could have excited the higher values of n just like closed orbits in a perturbed system become closed only after n turns. The energy density of the cosmic string is about one Planck mass per $\sim 10^7$ Planck lengths so that $n > 1$ excitation increasing this density by a factor of n^2 is obviously impossible except under the primordial cosmic string dominated period of cosmology during which the net inertial energy density must have vanished. The structure of the future solar system would have been dictated already during the primordial phase of cosmology when negative energy cosmic string suffered a time reflection to positive energy cosmic strings.

2.2.2 Nottale equation is consistent with the TGD based model for dark matter

TGD allows two models of dark matter. The first one is spherically symmetric and the second one cylindrically symmetric. The first thing to do is to check whether these models are consistent with the gravitational Schrödinger equation/Bohr quantization.

1. *Spherically symmetric model for the dark matter*

The following argument based on Bohr orbit quantization demonstrates that this is indeed the case for the spherically symmetric model for dark matter. The argument generalizes in a trivial manner to the cylindrically symmetric case.

1. The gravitational potential energy $V(r)$ for a mass distribution $M(r) = xTr$ (T denotes string tension) is given by

$$V(r) = Gm \int_r^{R_0} \frac{M(r)}{r^2} dr = GmxT \log\left(\frac{r}{R_0}\right) . \quad (6)$$

Here R_0 corresponds to a large radius so that the potential is negative as it should in the region where binding energy is negative.

2. The Newton equation $\frac{mv^2}{r} = \frac{GmxT}{r}$ for circular orbits gives

$$v = xGT . \quad (7)$$

3. Bohr quantization condition for angular momentum by replacing \hbar with \hbar_{gr} reads as $mvr = n\hbar_{gr}$ and gives

$$\begin{aligned} r_n &= \frac{n\hbar_{gr}}{mv} = nr_1 , \\ r_1 &= \frac{GM}{vv_0} . \end{aligned} \quad (8)$$

Here v is rather near to v_0 .

4. Bound state energies are given by

$$E_n = \frac{mv^2}{2} - xT \log\left(\frac{r_1}{R_0}\right) + xT \log(n) . \quad (9)$$

The energies depend only weakly on the radius of the orbit.

5. The centrifugal potential $l(l+1)/r^2$ in the Schrödinger equation is negligible as compared to the potential term at large distances so that one expects that degeneracies of orbits with small values of l do not depend on the radius. This would mean that each orbit is occupied with same probability irrespective of value of its radius. If the mass distribution for the stars does not depend on r , the number of stars rotating around galactic nucleus is simply the number of orbits inside sphere of radius R and thus given by $N(R) \propto R/r_0$ so that one has $M(R) \propto R$. Hence the model is self consistent in the sense that one can regard the orbiting stars as remnants of cosmic strings and thus obeying same mass distribution.

2. Cylindrically symmetric model for the galactic dark matter

TGD allows also a model of the dark matter based on cylindrical symmetry. In this case the dark matter would correspond to the mass of a cosmic string orthogonal to the galactic plane and traversing through the galactic nucleus. The string tension would be the one predicted by TGD. In

the directions orthogonal to the plane of galaxy the motion would be free motion so that the orbits would be helical, and this should make it possible to test the model. The quantization of radii of the orbits would be exactly the same as in the spherically symmetric model. Also the quantization of inclinations predicted by the spherically symmetric model could serve as a sensitive test. In this kind of situation general theory of relativity would predict only an angle deficit giving rise to a lens effect. TGD predicts a Newtonian $1/\rho$ potential in a good approximation.

Spiral galaxies are accompanied by jets orthogonal to the galactic plane and a good guess is that they are associated with the cosmic strings. The two models need not exclude each other. The vision about astrophysical structures as pearls of a fractal necklace would suggest that the visible matter has resulted in the decay of cosmic strings originally linked around the cosmic string going through the galactic plane and creating $M(R) \propto R$ for the density of the visible matter in the galactic bulge. The finding that galaxies are organized along linear structures [83] fits nicely with this picture.

3. MOND and TGD

TGD based model explains also the MOND (Modified Newton Dynamics) model of Milgrom [84] for the dark matter. Instead of dark matter the model assumes a modification of Newton's laws. The model is based on the observation that the transition to a constant velocity spectrum seems in the galactic halos seems to occur at a constant value of the stellar acceleration equal to $a_0 \simeq 10^{-11}g$, where g is the gravitational acceleration at the Earth. MOND theory assumes that Newtonian laws are modified below a_0 .

The explanation relies on Bohr quantization. Since the stellar radii in the halo are quantized in integer multiples of a basic radius and since also rotation velocity v_0 is constant, the values of the acceleration are quantized as $a(n) = v_0^2/r(n)$ and a_0 correspond to the radius $r(n)$ of the smallest Bohr orbit for which the velocity is still constant. For larger orbital radii the acceleration would indeed be below a_0 . a_0 would correspond to the distance above which the density of the visible matter does not appreciably perturb the gravitational potential of the straight string. This of course requires that gravitational potential is that given by Newton's theory and is indeed allowed by TGD.

2.3 The interpretation of \hbar_{gr} and pre-planetary period

\hbar_{gr} could corresponds to a unit of angular momentum for quantum coherent states at magnetic flux tubes or walls containing macroscopic quantum states. Quantitative estimate demonstrates that \hbar_{gr} for astrophysical objects cannot correspond to spin angular momentum. For Sun-Earth system one would have $\hbar_{gr} \simeq 10^{77}\hbar$. This amount of angular momentum realized as a mere spin would require 10^{77} particles! Hence the only possible interpretation is as a unit of orbital angular momentum. The linear dependence of \hbar_{gr} on m is consistent with the additivity of angular momenta in the fusion of magnetic flux tubes to larger units if the angular momentum associated with the tubes is proportional to both m and M .

Just as the gravitational acceleration is a more natural concept than gravitational force, also $\hbar_{gr}/m = GM/v_0$ could be more natural unit than \hbar_{gr} . It would define a universal unit for the circulation $\oint v \cdot dl$, which is apart from $1/m$ -factor equal to the phase integral $\oint p_\phi d\phi$ appearing in Bohr rules for angular momentum. The circulation could be associated with the flow associated with outer boundaries of magnetic flux tubes surrounding the orbit of mass m around the central mass $M \gg m$ and defining light like 3-D CDs analogous to black hole horizons.

The expression of \hbar_{gr} depends on masses M and m and can apply only in space-time regions carrying information about the space-time sheets of M and and the orbit of m . Quantum gravitational holography suggests that the formula applies at 3-D light like causal determinant (CD) X_l^3 defined by the wormhole contacts gluing the space-time sheet X_l^3 of the planet to that of

Sun. More generally, X_l^3 could be the space-time sheet containing the planet, most naturally the magnetic flux tube surrounding the orbit of the planet and possibly containing dark matter in super-conducting state. This would give a precise meaning for \hbar_{gr} and explain why \hbar_{gr} does not depend on the masses of other planets.

The simplest option consistent with the quantization rules and with the explanatory role of magnetic flux structures is perhaps the following one.

1. X_l^3 is a torus like surface around the orbit of the planet containing delocalized dark matter. The key role of magnetic flux quantization in understanding the values of v_0 suggests the interpretation of the torus as a magnetic or Z^0 magnetic flux tube. At pre-planetary period the dark matter formed a torus like quantum object. The conditions defining the radii of Bohr orbits follow from the requirement that the torus-like object is in an eigen state of angular momentum in the center of mass rotational degrees of freedom. The requirement that rotations do not leave the torus-like object invariant is obviously satisfied. Newton's law required by the quantum-classical correspondence stating that the orbit corresponds to a geodesic line in general relativistic framework gives the additional condition implying Bohr quantization.
2. A simple mechanism leading to the localization of the matter would have been the pinching of the torus causing kind of a traffic jam leading to the formation of the planet. This process could quite well have involved a flow of matter to a smaller planet space-time sheet Y_l^3 topologically condensed at X_l^3 . Most of the angular momentum associated with torus like object would have transformed to that of planet and situation would have become effectively classical.
3. The conservation of magnetic flux means that the splitting of the orbital torus would generate a pair of Kähler magnetic charges. It is not clear whether this is possible dynamically and hence the torus could still be there. In fact, TGD explanation for the tritium beta decay anomaly citeTroitsk,Mainz in terms of classical Z^0 force [F8] requires the existence of this kind of torus containing neutrino cloud whose density varies along the torus. This picture suggests that the lacking $n = 1$ and $n = 2$ orbits in the region between Sun and Mercury are still in magnetic flux tube state containing mostly dark matter.
4. The fact that \hbar_{gr} is proportional to m means that it could have varied continuously during the accumulation of the planetary mass without any effect in the planetary motion: this is of course nothing but a manifestation of Equivalence Principle.
5. It is interesting to look for the scaled up versions of Planck mass $m_{Pl} = \sqrt{\hbar_{gr}/\hbar} \times \sqrt{\hbar/G} = \sqrt{M_1 M_2 / v_0}$ and Planck length $L_{Pl} = \sqrt{\hbar_{gr}/\hbar} \times \sqrt{\hbar/G} = G \sqrt{M_1 M_2 / v_0}$. For $M_1 = M_2 = M$ this gives $m_{Pl} = M / \sqrt{v_0} \simeq 45.6 \times M$ and $L_{Pl} = r_S / 2 \sqrt{v_0} \simeq 22.8 \times r_S$, where r_S is Schwartshild radius. For Sun r_S is about 2.9 km so that one has $L_{Pl} \simeq 66$ km. For a few years ago it was found that Sun contains "inner-inner" core of radius about $R = 300$ km [26] which is about $4.5 \times L_{Pl}$.

2.4 Inclinations for the planetary orbits and the quantum evolution of the planetary system

The inclinations of planetary orbits provide a test bed for the theory. The semiclassical quantization of angular momentum gives the directions of angular momentum from the formula

$$\cos(\theta) = \frac{m}{\sqrt{j(j+1)}} \quad , \quad |m| \leq j \quad . \quad (10)$$

where θ is the angle between angular momentum and quantization axis and thus also that between orbital plane and (x,y)-plane. This angle defines the angle of tilt between the orbital plane and (x,y)-plane.

$m = j = n$ gives minimal value of angle of tilt for a given value of n of the principal quantum number as

$$\cos(\theta) = \frac{n}{\sqrt{n(n+1)}} . \quad (11)$$

For $n = 3, 4, 5$ (Mercury, Venus, Earth) this gives $\theta = 30.0, 26.6,$ and 24.0 degrees respectively.

Only the relative tilt angles can be compared with the experimental data. Taking as usual the Earth's orbital plane as the reference the relative tilt angles give what are known as inclinations. The predicted inclinations are 6 degrees for Mercury and 2.6 degrees for Venus. The observed values [29] are 7.0 and 3.4 degrees so that the agreement is satisfactory. If one allows half-odd integer spin the fit is improved. For $j = m = n - 1/2$ the predictions are 7.1 and 2.9 degrees for Mercury and Venus respectively. For Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto the inclinations are 1.9, 1.3, 2.5, 0.8, 1.8, 17.1 degrees. For Mars and outer planets the tilt angles are predicted to have wrong sign for $m = j$. In a good approximation the inclinations vanish for outer planets except Pluto and this would allow to determine m as $m \simeq \sqrt{5n(n+1)}/6$: the fit is not good.

The assumption that matter has condensed from a matter rotating in (x,y)-plane orthogonal to the quantization axis suggests that the directions of the planetary rotation axes are more or less the same and by angular momentum conservation have not changed appreciably. The prediction for the tilt of the rotation axis of the Earth is 24 degrees of freedom in the limit that the Earth's spin can be treated completely classically, that is for $m = j \gg 1$ in the units used for the quantization of the Earth's angular momentum. What is the value of \hbar_{gr} for Earth is not obvious (using the unit $\hbar_{gr} = GM^2/v_0$ the Earth's angular momentum would be much smaller than one). The tilt of the rotation axis of Earth with respect to the orbit plane is 23.5 degrees so that the agreement is again satisfactory. This prediction is essentially quantal: in purely classical theory the most natural guess for the tilt angle for planetary spins is 0 degrees.

The observation that the inner planets Mercury, Venus, and Earth have in a reasonable approximation the predicted inclinations suggest that they originate from a primordial period during which they formed spherical cells of dark matter and had thus full rotational degrees of freedom and were in eigen states of angular momentum corresponding to a full rotational symmetry. The subsequent $SO(3) \rightarrow SO(2)$ symmetry breaking leading to the formation of torus like configurations did not destroy the information about this period since the information about the value of j and m was coded by the inclination of the planetary orbit.

In contrast to this, the dark matter associated with Earth and outer planets up to Neptune formed a flattened magnetic or Z^0 magnetic flux tube resembling a disk with a hole and the subsequent symmetry breaking broke it to separate flux tubes. Earth's spherical disk was joined to the disk formed by the outer planets. The spherical disk could be still present and contain super-conducting dark matter. The presence of this "heavenly sphere" might closely relate to the fact that Earth is a living planet. The time scale $T = 2\pi R/c$ is very nearly equal to 5 minutes and defines a candidate for a bio-rhythm.

If this flux tube carried the same magnetic flux as the flux tubes associated with the inner planets, the decomposition of the disk with a hole to 5 flux tubes corresponding to Earth and to the outer planets Mars, Jupiter, Saturn and Neptune, would explain the value of v_0 correctly and also the small inclinations of outer planets. That Pluto would not originate from this structure, is consistent with its anomalously large values of inclination $i = 17.1$ degrees, small value of eccentricity $e = .248$, and anomalously large value of inclination of equator to orbit about 122 degrees as compared to 23.5 degrees in the case of Earth [29].

2.5 Eccentricities and comets

Bohr-Sommerfeld quantization allows also to deduce the eccentricities of the planetary and comet orbits. One can write the quantization of energy as

$$\frac{p_r^2}{2m_1} + \frac{p_\theta^2}{2m_1 r^2} + \frac{p_\phi^2}{2m_1 r^2 \sin^2(\theta)} - \frac{k}{r} = -\frac{E_1}{n^2} ,$$

$$E_1 = \frac{k^2}{2\hbar_{gr}^2} \times m_1 = \frac{v_0^2}{2} \times m_1 . \quad (12)$$

Here one has $k = GMm_1$. E_1 is the binding energy of $n = 1$ state. In the orbital plane ($\theta = \pi/2, p_\theta = 0$) the conditions are simplified. Bohr quantization gives $p_\phi = m\hbar_{gr}$ implying

$$\frac{p_r^2}{2m_1} + \frac{k^2 \hbar_{gr}^2}{2m_1 r^2} - \frac{k}{r} = -\frac{E_1}{n^2} . \quad (13)$$

For $p_r = 0$ the formula gives maximum and minimum radii r_\pm and eccentricity is given by

$$e^2 = \frac{r_+ - r_-}{r_+} = \frac{2\sqrt{1 - \frac{m^2}{n^2}}}{1 + \sqrt{1 - \frac{m^2}{n^2}}} . \quad (14)$$

For small values of n the eccentricities are very large except for $m = n$. For instance, for $(m = n - 1, n)$ for $n = 3, 4, 5$ gives $e = (.93, .89, .86)$ to be compared with the experimental values $(.206, .007, .0167)$. Thus the planetary eccentricities with Pluto included ($e = .248$) must vanish in the lowest order approximation and must result as a perturbation of the magnetic flux tube.

The large eccentricities of comet orbits might however have an interpretation in terms of $m < n$ states. The prediction is that comets with small eccentricities have very large orbital radius. Oort's cloud is a system weakly bound to a solar system extending up to 3 light years. This gives the upper bound $n \leq 700$ if the comets of the cloud belong to the same family as Mercury, otherwise the bound is smaller. This gives a lower bound to the eccentricity of not nearly circular orbits in the Oort cloud as $e > .32$.

2.6 Why the quantum coherent dark matter is not visible?

The obvious objection against quantal astrophysics is that astrophysical systems look extremely classical. Quantal dark matter in many-sheeted space-time resolves this counter argument. As already explained, the sequence of symmetry breakings of the rotational symmetry would explain nicely why astral Bohr rules work. The prediction is however that delocalized quantal dark matter is probably still present at (the boundaries of) magnetic flux tubes and spherical shells. It is however the entire structure defined by the orbit which behaves like a single extended particle so that the localization in quantum measurement does not mean a localization to a point of the orbit. Planet itself corresponds to a smaller localized space-time sheet condensed at the flux tube.

One should however understand why this dark matter with a gigantic Planck constant is not visible. The simplest explanation is that there cannot be any direct quantum interactions between ordinary and dark matter in the sense that particles with different values of Planck constant could appear in the same particle vertex. This would allow also a fractal hierarchy copies of standard model physics to exist with different p-adic mass scales.

There is also second argument. The inability to observe dark matter could mean inability to perform state function reduction localizing the dark matter. The probability for this should be proportional to the strength of the measurement interaction. For photons the strength of the interaction is characterized by the fine structure constant. In the case of dark matter the fine structure constant is replaced with

$$\alpha_{em,gr} = \alpha_{em} \times \frac{\hbar}{\hbar_{gr}} = \alpha_{em} \times \frac{v_0}{GMm} . \quad (15)$$

For $M = m = m_{Pl} \simeq 10^{-8}$ kg the value of the fine structure constant is smaller than $\alpha_{em}v_0$ and completely negligible for astrophysical masses. However, for processes for which the lowest order classical rates are non-vanishing, rates are not affected in the lowest order since the increase of the Compton length compensates the reduction of α . Higher order corrections become however small. What makes dark matter invisible is not the smallness of α_{em} but the fact that the binding energies of say hydrogen atom proportional to $\alpha^2 m_e$ are scaled as $1/\hbar^2$ so that the spectrum is scaled down.

2.7 Quantum interpretation of gravitational Schrödinger equation

Schrödinger equation in astrophysical length scales with a gigantic value of Planck constant looks sheer madness idea from the standard physics point of view. In TGD Universe situation might be different.

1. In TGD inertial four-momentum (or conserved four-momentum) is not positive definite and the net four-momentum of the Universe vanishes. Already in cosmological length scales the density of inertial mass vanishes. Gravitational masses and inertial masses can be identified only at the limit when one can neglect the interaction between positive and negative energy matter. The masses appearing in the gravitational Schrödinger equation are gravitational masses and one can ask whether inertial and gravitational Planck constants are different.
2. The fractality of the many-sheeted space-time predicts that quantum effects appear in all length and time scales. In particular, dark matter is at larger space-time sheets and hence almost invisible.
3. An even more weirder looks the idea that Planck constant could have a gigantic value in astrophysical length scales being of order of magnitude of product of masses using Planck mass as a unit for $\hbar = c = 1$. This would mean that gravitation at space-time sheets of astrophysical size would have super quantal character! But even the gigantic value of Planck constant might be understood in TGD framework.

2.7.1 Beraha numbers and spectrum of Planck constant

The infinite-dimensional Clifford algebra of the configuration space ("the world of classical worlds") gamma matrices defines so called von Neumann algebra with a hierarchy of type II_1 sub-factors. So called Beraha numbers

$$B_n = 4\cos^2\left(\frac{\pi}{n}\right), \quad n \geq 3 \quad (16)$$

relate very closely to these factors as also to braid groups and quantum groups. Roughly, B_n corresponds to the quantum dimension d of Clifford algebra of 2-component spinors. There is also a continuum of dimensions $D \geq 4$ for the dimensions of sub-factors of type II_1 . Obviously, the

dimensions behave like energy spectrum of a quantum mechanical systems. That $D = 4$ is the limiting value of bound state dimensions suggests strongly a connection with the fact that the infinities of quantum field theory appear for $D \geq 4$.

The first attempts to understand large values of Planck constant led to a formula for the dependence of Planck constant on B_n , which turned out to be badly wrong. The improved understanding of Jones inclusions and their role in TGD however led eventually to an extremely simple formula for the Planck constant, as a matter for separate Planck constants associated with M^4 resp. CP_2 degrees of freedom appearing as scaling factors of CP_2 resp. M^4 metric. This theory is summarized in [C6] and in the introduction and will be briefly summarized below.

2.7.2 Jones inclusions and quantization of Planck constants

Quantum TGD emerges from infinite-dimensional Clifford algebra defined as infinite power of 8-dimensional Clifford algebra $C(8)$ generalized to a local algebra by constructing power series of quantum octonionic variable having the elements of this Clifford algebra as coefficients. The eigenstates for the commuting hermitian coordinates assignable to this octonionic variable have M^8 as spectrum and extremely general arguments imply both classical and quantum TGD. The construction works only for $D = 8$ (by non-associativity of the octonionic units) since for other dimensions the local field defined by algebra could not be distinguished from algebra itself.

Perhaps the most important outcome is a general master formula for S-matrix with interactions described as a deformation of ordinary tensor product to Connes tensor products and new view theory of quantum measurement. Further outcomes are prediction the spectra of the quantized values of M^4 and CP_2 Planck constants as characterizers of Jones inclusions associated with quantum phases $q = exp(i\pi/n)$.

1. Some background

It has been for few years clear that TGD could emerge from the mere infinite-dimensionality of the Clifford algebra of infinite-dimensional "world of classical worlds" and from number theoretical vision in which classical number fields play a key role and determine imbedding space and space-time dimensions. This would fix completely the "world of classical worlds".

Infinite-dimensional Clifford algebra is a standard representation for von Neumann algebra known as a hyper-finite factor of type II_1 . In TGD framework the infinite tensor power of $C(8)$, Clifford algebra of 8-D space would be the natural representation of this algebra.

2. How to localize infinite-dimensional Clifford algebra?

The basic new idea is to make this algebra *local*: local Clifford algebra as a generalization of gamma field of string models.

1. Represent Minkowski coordinate of M^d as linear combination of gamma matrices of D-dimensional space. This is the first guess. One fascinating finding is that this notion can be quantized and classical M^d is genuine quantum M^d with coordinate values eigenvalues of quantal commuting Hermitian operators built from matrix elements. Euclidian space is not obtained in this manner. Minkowski signature is something quantal and the standard quantum group $Gl(2, q)(C)$ with (non-Hermitian matrix elements) gives M^4 .
2. Form power series of the M^d coordinate represented as linear combination of gamma matrices with coefficients in corresponding infinite-D Clifford algebra. You would get tensor product of two algebra.
3. There is however a problem: one cannot distinguish the tensor product from the original infinite-D Clifford algebra. $D = 8$ is however an exception! You can replace gammas in the expansion of M^8 coordinate by hyper-octonionic units which are non-associative (or

octonionic units in quantum complexified-octonionic case). Now you cannot anymore absorb the tensor factor to the Clifford algebra and you get genuine M^8 -localized factor of type II_1 . Everything is determined by infinite-dimensional gamma matrix fields analogous to conformal super fields with z replaced by hyperoctonion.

4. Octonionic non-associativity actually reproduces whole classical and quantum TGD: space-time surface must be associative sub-manifolds hence hyper-quaternionic surfaces of M^8 . Representability as surfaces in $M^4 \times CP_2$ follows naturally, the notion of configuration space of 3-surfaces, etc....

3. Connes tensor product for free fields as a universal definition of interaction quantum field theory

This picture has profound implications. Consider first the construction of S-matrix.

1. A non-perturbative construction of S-matrix emerges. The deep principle is simple. The canonical outer automorphism for von Neumann algebras defines a natural candidate unitary transformation giving rise to propagator. This outer automorphism is trivial for II_1 factors meaning that all lines appearing in Feynman diagrams must be on mass shell states satisfying Super Virasoro conditions. You can allow all possible diagrams: all on mass shell loop corrections vanish by unitarity and what remains are diagrams with single N-vertex.
2. At 2-surface representing N-vertex space-time sheets representing generalized Bohr orbits of incoming and outgoing particles meet. This vertex involves von Neumann trace (finite!) of localized gamma matrices expressible in terms of fermionic oscillator operators and defining free fields satisfying Super Virasoro conditions.
3. For free fields ordinary tensor product would not give interacting theory. What makes S-matrix non-trivial is that *Connes tensor product* is used instead of the ordinary one. This tensor product is a universal description for interactions and we can forget perturbation theory! Interactions result as a deformation of tensor product. Unitarity of resulting S-matrix is unproven but I dare believe that it holds true.
4. The subfactor \mathcal{N} defining the Connes tensor product has interpretation in terms of the interaction between experimenter and measured system and each interaction type defines its own Connes tensor product. Basically \mathcal{N} represents the limitations of the experimenter. For instance, IR and UV cutoffs could be seen as primitive manners to describe what \mathcal{N} describes much more elegantly. At the limit when \mathcal{N} contains only single element, theory would become free field theory but this is ideal situation never achievable.

4. The quantization of Planck constant and ADE hierarchies

The quantization of Planck constant has been the basic them of TGD for more than one and half years and leads also the understanding of ADE correspondences (index $\beta \leq 4$ and $\beta = 4$) from the point of view of Jones inclusions.

1. The new view allows to understand how and why Planck constant is quantized and gives an amazingly simple formula for the separate Planck constants assignable to M^4 and CP_2 and appearing as scaling constants of their metrics. This in terms of a mild generalizations of standard Jones inclusions. The emergence of imbedding space means only that the scaling of these metrics have spectrum: no landscape.

2. In ordinary phase Planck constants $\hbar(M^4)$ and $\hbar(CP_2)$ are same and have their standard values. Large Planck constant phases correspond to situations in which a transition to a phase in which quantum groups occurs. These situations correspond to standard Jones inclusions in which Clifford algebra is replaced with a sub-algebra of its G-invariant elements. G is product $G_a \times G_b$ of subgroups of $SL(2, C)$ and $SU(2)_L \times U(1)$ which also acts as a subgroup of $SU(3)$. Space-time sheets are $n(G_b)$ -fold coverings of M^4 and $n(G_a)$ -fold coverings of CP_2 generalizing the picture which has emerged already. An elementary study of these coverings fixes the values of scaling factors of M^4 and CP_2 Planck constants to orders of the maximal cyclic sub-groups. Mass spectrum is invariant under these scalings. The values of Planck constants are $\hbar(M^4) = n_a \hbar_0$ and $\hbar(CP_2) = n_b \hbar_0$ and scaling factor of M^4 covariant metric is n_b and that of CP_2 metric n_a . In Kähler action only the ratio n_a/n_b occurs and the Planck constant \hbar_{eff} occurring in Schrödinger equation is by quantum classical correspondence $\hbar_{eff}/\hbar_0 = n_a/n_b$.
3. This predicts automatically arbitrarily large and also small values of Planck constant depending in the value of the ratio n_a/n_b and assigns the preferred values of Planck constant to quantum phases $q = \exp(i\pi/n_i)$, $i = a, b$ expressible in terms of iterated square roots of rationals: these correspond to polygons obtainable by compass and ruler construction. In particular, experimentally favored values of \hbar in living matter correspond to these special values of Planck constant. This model reproduces also the other aspects of the general vision. The subgroups of $SL(2, C)$ in turn can give rise to re-scaling of $SU(3)$ Planck constant. The most general situation can be described in terms of Jones inclusions for fixed point subalgebras of number theoretic Clifford algebras defined by $G_a \times G_b \subset SL(2, C) \times SU(2)$.
4. These inclusions (apart from those for which G_a contains infinite number of elements) are represented by ADE or extended ADE diagrams depending on the value of index. The group algebras of these groups give rise to additional degrees of freedom which make possible to construct the multiplets of the corresponding gauge groups. For $\beta \leq 4$ the gauge groups A_n, D_{2n}, E_6, E_8 are possible so that TGD seems to be able to mimic these gauge theories. For $\beta = 4$ all ADE Kac Moody groups are possible and again mimicry becomes possible: TGD would be kind of universal physics emulator but it would be anyonic dark matter which would perform this emulation.

2.7.3 Bohr quantization of planetary orbits and prediction for Planck constant

The predictions of the generalization of the p-adic length scale hypothesis are consistent with the TGD based model for the Bohr quantization of planetary orbits and some new non-trivial predictions follow.

1. Generalization of the p-adic length scale hypothesis

The evolution in phase resolution in p-adic degrees of freedom corresponds to emergence of algebraic extensions allowing increasing variety of phases $\exp(i\pi/n)$ expressible p-adically. This evolution can be assigned to the emergence of increasingly complex quantum phases and the increase of Planck constant.

One expects that quantum phases $q = \exp(i\pi/n)$ which are expressible using only square roots of rationals are number theoretically very special since they correspond to algebraic extensions of p-adic numbers involving only square roots which should emerge first and therefore systems involving these values of q should be especially abundant in Nature.

These polygons are obtained by ruler and compass construction and Gauss showed that these polygons, which could be called Fermat polygons, have $n_F = 2^k \prod_s F_{n_s}$ sides/vertices: all Fermat primes F_{n_s} in this expression must be different. The analog of the p-adic length scale hypothesis emerges since larger Fermat primes are near a power of 2. The known Fermat primes $F_n = 2^{2^n} + 1$

correspond to $n = 0, 1, 2, 3, 4$ with $F_0 = 3, F_1 = 5, F_2 = 17, F_3 = 257, F_4 = 65537$. It is not known whether there are higher Fermat primes. $n = 3, 5, 15$ -multiples of p-adic length scales clearly distinguishable from them are also predicted and this prediction is testable in living matter. I have already earlier considered the possibility that Fermat polygons could be of special importance for cognition and for biological information processing [H8].

This condition could be interpreted as a kind of resonance condition guaranteeing that scaled up sizes for space-time sheets have sizes given by p-adic length scales. The numbers n_F could take the same role in the evolution of Planck constants assignable with the phase resolution as Mersenne primes have in the evolution assignable to the p-adic length scale resolution.

2. Do the values of gravitational Planck constant correspond to polygons obtained by ruler and compass construction?

Since the macroscopic quantum phases with minimum dimension of algebraic extension should be especially abundant in the universe, the natural guess is that the values of the gravitational Planck constant correspond to n_F -multiples of ordinary Planck constant.

1. The model can explain the enormous values of gravitational Planck constant $\hbar_{gr}/\hbar_0 \simeq GMm/v_0 = n_a/n_b$. The favored values of this parameter should correspond to n_{F_a}/n_{F_b} so that the mass ratios $m_1/m_2 = n_{F_{a,1}}n_{F_{b,2}}/n_{F_{b,1}}n_{F_{a,2}}$ for planetary masses should be preferred. The general prediction $GMm/v_0 = n_a/n_b$ is of course not testable.
2. Nottale [92] has suggested that also the harmonics and subharmonics of λ are possible and in fact required by the model for planetary Bohr orbits (in TGD framework this is not absolutely necessary). The prediction is that favored values of n should be of form $n_F = 2^k \prod F_i$ such that F_i appears at most once. In Nottale's model for planetary orbits as Bohr orbits in solar system $n = 5$ harmonics appear and are consistent with either $n_{F,a} \rightarrow F_1 n_{F_a}$ or with $n_{F,b} \rightarrow n_{F_b}/F_1$ if possible.

The prediction for the ratios of planetary masses can be tested. In the table below are the experimental mass ratios $r_{exp} = m(pl)/m(E)$, the best choice of $r_R = [n_{F,a}/n_{F,b}] * X$, X common factor for all planets, and the ratios $r_{pred}/r_{exp} = n_{F,a}(planet)n_{F,b}(Earth)/n_{F,a}(Earth)n_{F,b}(planet)$. The deviations are below 10 per cent.

<i>planet</i>	<i>Me</i>	<i>V</i>	<i>E</i>	<i>M</i>	<i>J</i>
<i>y</i>	$(2^9, 5)$	$(2^{11}, 17)$	$(2^9, 5, 17)$	$(2^{16}, 5)/(17)$	$(2^{18}, 3, 17)$
<i>y/x</i>	.98	.98	1.00	1.01	.97
<i>planet</i>	<i>S</i>	<i>U</i>	<i>N</i>	<i>P</i>	
<i>y</i>	$(2^{22}, 3, 5)/(17)$	$(2^{21}, 5)/(17)$	$(2^{17}, 5, 17)/(3, 5)$	$(1, 5, 17)$	
<i>y/x</i>	.98	.98	0.99	.98	

Table 1. The table compares the ratios $x = m(pl)/(m(E))$ of planetary mass to the mass of Earth to prediction for these ratios in terms of integers n_F associated with Fermat polygons. y gives the best fit for the allowed factors of the known part y of the rational $n_{F,a}/n_{F,b} = yX$ characterizing planet, and the ratios y/x . Errors are at most 3 per cent.

A stronger prediction comes from the requirement that GMm/v_0 equals to $n = n_{F_a}/n_{F_b}$ $n_F = 2^k \prod_k F_{n_k}$, where $F_i = 2^{2^i} + 1$, $i = 0, 1, 2, 3, 4$ is Fibonacci prime. The fit using solar mass and Earth mass gives $n_F = 2^{254} \times 5 \times 17$ for $1/v_0 = 2044$, which within the experimental accuracy equals to the value $2^{11} = 2048$ whose powers appear as scaling factors of Planck constant in the

model for living matter [M3]. For $v_0 = 4.6 \times 10^{-4}$ reported by Nottale the prediction is by a factor 16/17.01 too small (6 per cent discrepancy).

A possible solution of the discrepancy is that the empirical estimate for the factor GMm/v_0 is too large since m contains also the the visible mass not actually contributing to the gravitational force between dark matter objects whereas M is known correctly. The assumption that the dark mass is a fraction $1/(1 + \epsilon)$ of the total mass for Earth gives

$$1 + \epsilon = \frac{17}{16} \quad (17)$$

in an excellent approximation. This gives for the fraction of the visible matter the estimate $\epsilon = 1/16 \simeq 6$ per cent. The estimate for the fraction of visible matter in cosmos is about 4 per cent so that estimate is reasonable and would mean that most of planetary and solar mass would be also dark.

That $v_0(eff) = v_0/(1 - \epsilon) \simeq 4.6 \times 10^{-4}$ equals with $v_0(eff) = 1/(2^7 \times F_2) = 4.5956 \times 10^{-4}$ within the experimental accuracy suggests a number theoretical explanation for the visible-to-dark fraction.

3. Can one really identify gravitational and inertial Planck constants?

The original unconsciously performed identification of the gravitational and inertial Planck constants leads to some confusing conclusions but it seems that the new view about the quantization of Planck constants resolves these problems and allows to see \hbar_{gr} as a special case of \hbar_I .

1. \hbar_{gr} is proportional to the product of masses of interacting systems and not a universal constant like \hbar . One can however express the gravitational Bohr conditions as a quantization of circulation $\oint v \cdot dl = n(GM/v_0)\hbar_0$ so that the dependence on the planet mass disappears as required by Equivalence Principle. This suggests that gravitational Bohr rules relate to velocity rather than inertial momentum as is indeed natural. The quantization of circulation is consistent with the basic prediction that space-time surfaces are analogous to Bohr orbits.
2. \hbar_{gr} seems to characterize a relationship between planet and central mass and quite generally between two systems with the property that smaller system is topologically condensed at the space-time sheet of the larger system. Thus it would seem that \hbar_{gr} is not a universal constant and cannot correspond to a special value of ordinary Planck constant. Certainly this would be the case if \hbar_I is quantized as λ^k -multiplet of ordinary Planck constant with $\lambda \simeq 2^{11}$.

The recent view about the quantization of Planck constant in terms of coverings of M^4 seems to resolve these problems.

1. The integer quantization of Planck constants is consistent with the huge values of gravitational Planck constant within experimental resolution and the killer test for $\hbar = \hbar_{gr}$ emerges if one takes seriously the stronger prediction $\hbar_{gr} = n_{F,a}/n_{F,b}$.
2. One can also regard \hbar_{gr} as ordinary Planck constant \hbar_{eff} associated with the space-time sheet along which the masses interact provided each pair (M, m_i) of masses is characterized by its own sheets. These sheets could correspond to flux tube like structures carrying the gravitational flux of dark matter. If these sheets corresponds to n_{F_c} -fold covering of M^4 , one can understand \hbar_{gr} as a particular instance of the \hbar_{eff} .

4. Gravitational Planck constant and CP_2 size

The large size of \hbar_{gr} can be interpreted in terms of larger size of $\hbar(CP_2)$ and with G_a covering of CP_2 by huge number n_a . Its huge value implies that also the von Neumann inclusions associated with M^4 degrees of freedom meaning that dark matter cosmology has quantal lattice like structure with lattice cell given by H_a/G , H_a the $a = \text{constant}$ hyperboloid of M^4_{\pm} and G subgroup of $SL(2, C)$. The quantization of cosmic redshifts provides support for this prediction.

There is however a heavy objection against this identification. $\hbar_{gr} = n_a/n_b$ identification implies the scaling $R \rightarrow (GMm/v_0)R$ of CP_2 radius so that immense values of CP_2 radius are possible in the sectors of the imbedding space corresponding to the dark matter. In the case of Sun-Earth system the radius would be of order 10^{20} ly! This would mean completely new view about the relationship between CP_2 and M^4 and space-time would look essentially like M^8 in large \hbar sector of imbedding space in astrophysical and even cosmological length scales. This of course looks completely non-sensible. Note however that the scaling does not affect elementary particle mass spectrum in any manner. Also the model for planetary system in terms of vacuum extremals can be still be used and Newton's laws hold in good approximation. And most importantly, it is dark matter space-time sheets for which CP_2 size is huge.

2.7.4 Gravitational Schrödinger equation as a means of avoiding gravitational collapse

Schrödinger equation provided a solution to the infrared catastrophe of the classical model of atom: the classical prediction was that electron would radiate its energy as brehmstrahlung and would be captured by the nucleus. The gravitational variant of this process would be the capture of the planet by a black hole, and more generally, a collapse of the star to a black hole. Gravitational Schrödinger equation could obviously prevent the catastrophe.

For $1/r$ gravitation potential the Bohr radius is given by $a_{gr} = GM/v_0^2 = r_S/2v_0^2$, where $r_S = 2GM$ is the Schwartzchild radius of the mass creating the gravitational potential: obviously Bohr radius is much larger than the Schwartzchild radius. That the gravitational Bohr radius does not depend on m conforms with Equivalence Principle, and the proportionality $\hbar_{gr} \propto Mm$ can be deduced from it. Gravitational Bohr radius is by a factor $1/2v_0^2$ larger than black hole radius so that black hole can swallow the piece of matter with a considerable rate only if it is in the ground state and also in this state the rate is proportional to the black hole volume to the volume defined by the black hole radius given by $2^3v_0^6 \sim 10^{-20}$.

The $\hbar_{gr} \rightarrow \infty$ limit for $1/r$ gravitational potential means that the exponential factor $\exp(-r/a_0)$ of the wave function becomes constant: on the other hand, also Schwartzchild and Bohr radii become infinite at this limit. The gravitational Compton length associated with mass m does not depend on m and is given by GM/v_0 and the time $T = E_{gr}/\hbar_{gr}$ defined by the gravitational binding energy is twice the time taken to travel a distance defined by the radius of the orbit with velocity v_0 which suggests that signals travelling with a maximal velocity v_0 are involved with the quantum dynamics.

In the case of planetary system the proportionality $\hbar_{gr} \propto mM$ creates problems of principle since the influence of the other planets is not taken account. One might argue that the generalization of the formula should be such that M is determined by the gravitational field experienced by mass m and thus contains also the effect of other planets. The problem is that this field depends on the position of m which would mean that \hbar_{gr} itself would become kind of field quantity.

2.7.5 Does the transition to non-perturbative phase correspond to a change in the value of \hbar ?

Nature is populated by systems for which perturbative quantum theory does not work. Examples are atoms with $Z_1Z_2e^2/4\pi\hbar > 1$ for which the binding energy becomes larger than rest

mass, non-perturbative QCD resulting for $Q_{s,1}Q_{s,2}g_s^2/4\pi\hbar > 1$, and gravitational systems satisfying $GM_1M_2/4\pi\hbar > 1$. Quite generally, the condition guaranteeing troubles is of the form $Q_1Q_2g^2/4\pi\hbar > 1$. There is no general mathematical approach for solving the quantum physics of these systems but it is believed that a phase transition to a new phase of some kind occurs.

The gravitational Schrödinger equation forces to ask whether Nature herself takes care of the problem so that this phase transition would involve a change of the value of the Planck constant to guarantee that the perturbative approach works. The values of \hbar would vary in a stepwise manner from $\hbar(\infty)$ to $\hbar(3) = \hbar(\infty)/4$. The non-perturbative phase transition would correspond to transition to the value of

$$\frac{\hbar}{\hbar_0} \rightarrow \left[\frac{Q_1Q_2g^2}{v} \right] \quad (18)$$

where $[x]$ is the integer nearest to x , inducing

$$\frac{Q_1Q_2g^2}{4\pi\hbar} \rightarrow \frac{v}{4\pi} . \quad (19)$$

The simplest (and of course ad hoc) assumption making sense in TGD Universe is that v is a harmonic or subharmonic of v_0 appearing in the gravitational Schrödinger equation. For instance, for the Kepler problem the spectrum of binding energies would be universal (independent of the values of charges) and given by $E_n = v^2m/2n^2$ with v playing the role of small coupling. Bohr radius would be g^2Q_2/v^2 for $Q_2 \gg Q_1$.

This provides a new insight to the problems encountered in quantizing gravity. QED started from the model of atom solving the infrared catastrophe. In quantum gravity theories one has started directly from the quantum field theory level and the recent decline of the M-theory shows that we are still practically where we started. If the gravitational Schrödinger equation indeed allows quantum interpretation, one could be more modest and start from the solution of the gravitational IR catastrophe by assuming a dynamical spectrum of \hbar determined by Beraha numbers. The implications would be profound: the whole program of quantum gravity would have been misled as far as the quantization of systems with $GM_1M_2/\hbar > 1$ is considered. In practice, these systems are the most interesting ones and the prejudice that their quantization is a mere academic exercise would have been completely wrong.

An alternative formulation for the occurrence of a transition increasing the value of \hbar could rely on the requirement that classical bound states have reasonable quantum counterparts. In the gravitational case one would have $r_n = n^2\hbar_{gr}^2/GM_1^2M$, for $M_1 \ll M$, which is extremely small distance for $\hbar_{gr} = \hbar$ and reasonable values of n . Hence, either n is so large that the system is classical or \hbar_{gr}/\hbar is very large. Equivalence Principle requires the independence of r_n on M_1 , which gives $\hbar = kGM_1M_2$ giving $r_n = n^2kGM$. The requirement that the radius is above Schwarzschild radius gives $k \geq 2$. In the case of Dirac equation the solutions cease to exist for $Z \geq 137$ and which suggests that \hbar is large for hypothetical atoms having $Z \geq 137$.

2.8 How do the magnetic flux tube structures and quantum gravitational bound states relate?

In the case of stars in galactic halo the appearance of the parameter v_0 characterizing cosmic strings as orbital rotation velocity can be understood classically. That v_0 appears also in the gravitational dynamics of planetary orbits could relate to the dark matter at magnetic flux tubes. The argument explaining the harmonics and sub-harmonics of v_0 in terms of properties of cosmic strings and magnetic flux tubes identifiable as their descendants strengthens this expectation.

2.8.1 The notion of magnetic body

In TGD inspired theory of consciousness the notion of magnetic body plays a key role: magnetic body is the ultimate intentional agent, experiencer, and performer of bio-control and can have astrophysical size: this does not sound so counter-intuitive if one takes seriously the idea that cognition has p-adic space-time sheets as space-time correlates and that rational points are common to real and p-adic number fields. The point is that infinitesimal in p-adic topology corresponds to infinite in real sense so that cognitive and intentional structures would have literally infinite size.

The magnetic flux tubes carrying various supra phases can be interpreted as special instance of dark energy and dark matter. This suggests a correlation between gravitational self-organization and quantum phases at the magnetic flux tubes and that the gravitational Schrödinger equation somehow relates to the ordinary Schrödinger equation satisfied by the macroscopic quantum phases at magnetic flux tubes. Interestingly, the transition to large Planck constant phase should occur when the masses of interacting is above Planck mass since gravitational self-interaction energy is $V \sim GM^2/R$. For the density of water about 10^3 kg/m^3 the volume carrying a Planck mass correspond to a cube with side 2.8×10^{-4} meters. This corresponds to a volume of a large neuron, which suggests that this phase transition might play an important role in neuronal dynamics.

2.8.2 Could gravitational Schrödinger equation relate to a quantum control at magnetic flux tubes?

An infinite self hierarchy is the basic prediction of TGD inspired theory of consciousness ("everything is conscious and consciousness can be only lost"). Topological quantization allows to assign to any material system a field body as the topologically quantized field pattern created by the system [L4, K1]. This field body can have an astrophysical size and would utilize the material body as a sensory receptor and motor instrument.

Magnetic flux tube and flux wall structures are natural candidates for the field bodies. Various empirical inputs have led to the hypothesis that the magnetic flux tube structures define a hierarchy of magnetic bodies, and that even Earth and larger astrophysical systems possess magnetic body which makes them conscious self-organizing living systems. In particular, life at Earth would have developed first as a self-organization of the super-conducting dark matter at magnetic flux tubes [L4].

For instance, EEG frequencies corresponds to wavelengths of order Earth size scale and the strange findings of Libet about time delays of conscious experience [35, 36] find an elegant explanation in terms of time taken for signals propagate from brain to the magnetic body [K1]. Cyclotron frequencies, various cavity frequencies, and the frequencies associated with various p-adic frequency scales are in a key role in the model of bio-control performed by the magnetic body. The cyclotron frequency scale is given by $f = eB/m$ and rather low as are also cavity frequencies such as Schumann frequencies: the lowest Schumann frequency is in a good approximation given by $f = 1/2\pi R$ for Earth and equals to 7.8 Hz.

1. Quantum time scales as "bio-rhythms" in solar system?

To get some idea about the possible connection of the quantum control possibly performed by the dark matter with gravitational Schrödinger equation, it is useful to look for the values of the periods defined by the gravitational binding energies of test particles in the fields of Sun and Earth and look whether they correspond to some natural time scales. For instance, the period $T = 2GM_S n^2/v_0^3$ defined by the energy of n^{th} planetary orbit depends only on the mass of Sun and defines thus an ideal candidate for a universal "bio-rhythm".

For Sun black hole radius is about 2.9 km. The period defined by the binding energy of lowest state in the gravitational field of Sun is given $T_S = 2GM_S/v_0^3$ and equals to 23.979 hours for $v_0/c = 4.8233 \times 10^{-4}$. Within experimental limits for v_0/c the prediction is consistent with 24

hours! The value of v_0 corresponding to exactly 24 hours would be $v_0 = 144.6578$ km/s (as a matter fact, the rotational period of Earth is 23.9345 hours). As if as the frequency defined by the lowest energy state would define a "biological" clock at Earth! Mars is now a strong candidate for a seat of life and the day in Mars lasts 24hr 37m 23s! $n = 1$ and $n = 2$ orbitals are not realized in solar system as planets but there is evidence for the $n = 1$ orbital as being realized as a peak in the density of IR-dust [92]. One can of course consider the possibility that these levels are populated by small dark matter planets with matter at larger space-time sheets. Bet as it may, the result supports the notion of quantum gravitational entrainment in the solar system.

The slower rhythms would become as n^2 sub-harmonics of this time scale. Earth itself corresponds to $n = 5$ state and to a rhythm of .96 hours: perhaps the choice of 1 hour to serve as a fundamental time unit is not merely accidental. The magnetic field with a typical ionic cyclotron frequency around 24 hours would be very weak: for 10 Hz cyclotron frequency in Earth's magnetic field the field strength would about 10^{-11} T. However, $T = 24$ hours corresponds with 6 per cent accuracy to the p-adic time scale $T(k = 280) = 2^{13}T(2, 127)$, where $T(2, 127)$ corresponds to the secondary p-adic time scale of .1 s associated with the Mersenne prime $M_{127} = 2^{127} - 1$ characterizing electron and defining a fundamental bio-rhythm and the duration of memetic codon [11].

Comorosan effect [33, 34, J5] demonstrates rather peculiar looking facts about the interaction of organic molecules with visible laser light at wavelength $\lambda = 546$ nm. As a result of irradiation molecules seem to undergo a transition $S \rightarrow S^*$. S^* state has anomalously long lifetime and stability in solution. $S \rightarrow S^*$ transition has been detected through the interaction of S^* molecules with different biological macromolecules, like enzymes and cellular receptors. Later Comorosan found that the effect occurs also in non-living matter. The basic time scale is $\tau = 5$ seconds. p-Adic length scale hypothesis does not explain τ , and it does not correspond to any obvious astrophysical time scale and has remained a mystery.

The idea about astro-quantal dark matter as a fundamental bio-controller inspires the guess that τ could correspond to some Bohr radius R for a solar system via the correspondence $\tau = R/c$. As observed by Nottale, $n = 1$ orbit for $v_0 \rightarrow 3v_0$ corresponds in a good approximation to the solar radius and to $\tau = 2.18$ seconds. For $v_0 \rightarrow 2v_0$ $n = 1$ orbit corresponds to $\tau = AU/(4 \times 25) = 4.992$ seconds: here $R = AU$ is the astronomical unit equal to the average distance of Earth from Sun. The deviation from τ_C is only one per cent and of the same order of magnitude as the variation of the radius for the orbit due to orbital eccentricity $(a - b)/a = .0167$ [29].

2. Earth-Moon system

For Earth serving as the central mass the Bohr radius is about 18.7 km, much smaller than Earth radius so that Moon would correspond to $n = 147.47$ for v_0 and $n = 1.02$ for the sub-harmonic $v_0/12$ of v_0 . For an aficionado of cosmic jokes or a numerologist the presence of the number of months in this formula might be of some interest. Those knowing that the Mayan calendar had 11 months and that Moon is receding from Earth might rush to check whether a transition from $v/11$ to $v/12$ state has occurred after the Mayan culture ceased to exist: the increase of the orbital radius by about 3 per cent would be required! Returning to a more serious mode, an interesting question is whether light satellites of Earth consisting of dark matter at larger space-time sheets could be present. For instance, in [L4] I have discussed the possibility that the larger space-time sheets of Earth could carry some kind of intelligent life crucial for the bio-control in the Earth's length scale.

The period corresponding to the lowest energy state is from the ratio of the masses of Earth and Sun given by $M_E/M_S = (5.974/1.989) \times 10^{-6}$ given by $T_E = (M_E/M_S) \times T_S = .2595$ s. The corresponding frequency $f_E = 3.8535$ Hz frequency is at the lower end of the theta band in EEG and is by 10 per cent higher than the p-adic frequency $f(251) = 3.5355$ Hz associated with the p-adic prime $p \simeq 2^k$, $k = 251$. The corresponding wavelength is 2.02 times Earth's

circumference. Note that the cyclotron frequencies of Nn, Fe, Co, Ni, and Cu are 5.5, 5.0, 5.2, 4.8 Hz in the magnetic field of $.5 \times 10^{-4}$ Tesla, which is the nominal value of the Earth's magnetic field. In [M4] I have proposed that the cyclotron frequencies of Fe and Co could define biological rhythms important for brain functioning. For $v_0/12$ associated with Moon orbit the period would be 7.47 s: I do not know whether this corresponds to some bio-rhythm.

It is better to leave for the reader to decide whether these findings support the idea that the super conducting cold dark matter at the magnetic flux tubes could perform bio-control and whether the gravitational quantum states and ordinary quantum states associated with the magnetic flux tubes couple to each other and are synchronized.

2.9 p-Adic length scale hypothesis and $v_0 \rightarrow v_0/5$ transition at inner-outer border for planetary system

$v_0 \rightarrow v_0/5$ transition would allow to interpret the orbits of outer planets as $n \geq 1$ orbits. The obvious question is whether inner to outer zone as $v_0 \rightarrow v_0/5$ transition could be interpreted in terms of the p-adic length scale hierarchy.

1. The most important p-adic length scale are given by primary p-adic length scales $L(k) = 2^{(k-151)/2} \times 10$ nm and secondary p-adic length scales $L(2, k) = 2^{k-151} \times 10$ nm, k prime.
2. The p-adic scale $L(2, 139) = 114$ Mkm is slightly above the orbital radius 109.4 Mkm of Venus. The p-adic length scale $L(2, 137) \simeq 28.5$ Mkm is roughly one half of Mercury's orbital radius 57.9 Mkm. Thus strong form of p-adic length scale hypothesis could explain why the transition $v_0 \rightarrow v_0/5$ occurs in the region between Venus and Earth ($n = 5$ orbit for v_0 layer and $n = 1$ orbit for $v_0/5$ layer).
3. Interestingly, the *primary* p-adic length scales $L(137)$ and $L(139)$ correspond to fundamental atomic length scales which suggests that solar system be seen as a fractally scaled up "secondary" version of atomic system.
4. Planetary radii have been fitted also using Titius-Bode law predicting $r(n) = r_0 + r_1 \times 2^n$. Hence one can ask whether planets are in one-one correspondence with primary and secondary p-adic length scales $L(k)$. For the orbital radii 58, 110, 150, 228 Mkm of Mercury, Venus, Earth, and Mars indeed correspond approximately to $k = 276, 278, 279, 281$: note the special position of Earth with respect to its predecessor. For Jupiter, Saturn, Uranus, Neptune, and Pluto the radii are 52, 95, 191, 301, 395 Mkm and would correspond to p-adic length scales $L(280 + 2n)$, $n = 0, \dots, 3$. Obviously the transition $v_0 \rightarrow v_0/5$ could occur in order to make the planet-p-adic length scale one-one correspondence possible.
5. It is interesting to look whether the p-adic length scale hierarchy applies also to the solar structure. In a good approximation solar radius .696 Mkm corresponds to $L(270)$, the lower radius .496 Mkm of the convective zone corresponds to $L(269)$, and the lower radius .174 Mkm of the radiative zone (radius of the solar core) corresponds to $L(266)$. This encourages the hypothesis that solar core has an onion like sub-structure corresponding to various p-adic length scales. In particular, $L(2, 127)$ ($L(127)$ corresponds to electron) would correspond to 28 Mm. The core is believed to contain a structure with radius of about 10 km: this would correspond to $L(231)$. This picture would suggest universality of star structure in the sense that stars would differ basically by the number of the onion like shells having standard sizes.

Quite generally, in TGD Universe the formation of join along boundaries bonds is the space-time correlate for the formation of bound states. This encourages to think that (Z^0) magnetic flux tubes are involved with the formation of gravitational bound states and that for $v_0 \rightarrow v_0/k$

corresponds either to a splitting of a flux tube resembling a disk with a whole to k pieces, or to the scaling down $B \rightarrow B/k^2$ so that the magnetic energy for the flux tube thickened and stretched by the same factor k^2 would not change.

2.10 Further evidence for dark matter

The notion of many-sheeted space-time has been continually receiving qualitative support from various anomalies. In the following two latest anomalies are summarized briefly.

2.10.1 First dark matter galaxy found

The propose model for dark matter suggests an existence of dark matter planets and even dark matter galaxies. Therefore the news about finding of the first dark galaxy in New Scientist [85] came as a pleasant surprise. The galaxy is located at a distance of 10^7 light years. It contains 1 per cent hydrogen gas and and 99 per cent dark matter and is identified by 21 cm hydrogen line: hence the name VIRGOH21. The amount of dark matter counts as 10^8 average stars.

2.10.2 Anomalous chemical compositions at the surface of Sun as evidence for dark matter

Physics in Action, February 2005 contained the popular article "Chemical Controversy at the Solar Surface" by J. Bahcall in Physics in Action [86]. The article describes the problems created by results reported in the article "The Solar Chemical Decomposition" by M. Asplund, N. Grevesse, J. Sauval [87]. The abundances of C, N, O, Ne, Ar at the solar surface are about 30-40 per cent less than predicted by the standard solar model. If these abundances are feeded into the standard solar model as input the predictions change in the range $.45R - .73R$ of distances from solar interior (R is solar radius). In particular, sound velocity is predicted incorrectly. Interestingly, these abundances are consistent with the abundances in the gaseous medium in the neighborhood of our galaxy.

In TGD framework a possible solution of paradox comes from already old model of solar corona and solar magnetic field. Part of matter resides as dark matter at magnetic and Z^0 magnetic flux tubes of Sun (dark energy) and enters to the solar corona along these. That also gaseous medium in the neighborhood of our galaxy contains same abundances suggests that the formation of Sun has proceeded by a transformation of part of dark matter to a visible matter by leakage to space-time sheets visible to us. This is indeed what TGD inspired model for the formation of solar system based on quantal dark matter suggests.

2.10.3 Does Sun have a solid surface?

$n = 1$ Bohr orbit corresponds in a reasonable approximation to $L(276)/9 \simeq L(270)$ and thus to solar radius. This raises the question whether solar surface could contain spherical shell representing a topological condensate of dense matter around dark matter, kind of spherical preform of planet below the photosphere.

Recently new satellites have begun to provide information about what lurks beneath the photosphere. The pictures produced by Lockheed Martin's Trace Satellite and YOHKOH, TRACE and SOHO satellite programs are publicly available in the web. SERTS program for the spectral analysis suggest a new picture challenging the simple gas sphere picture [53]. The visual inspection of the pictures combined with spectral analysis has led Michael Moshina to suggests that Sun has a solid, conductive spherical surface layer consisting of calcium ferrite. The article of Moshina [53] provides impressive pictures, which in my humble non-specialist opinion support this view. Of course, I have not worked personally with the analysis of these pictures so that I do not have the

competence to decide how compelling the conclusions of Moshina are. In any case, I think that his web article [53] deserves a summary.

Before SERTS people were familiar with hydrogen, helium, and calcium emissions from Sun. The careful analysis of SERTS spectrum however suggest the presence of a layer or layers containing ferrite and other heavy metals. Besides ferrite SERTS found silicon, magnesium, manganese, chromium, aluminum, and neon in solar emissions. Also elevated levels of sulphur and nickel were observed during more active cycles of Sun. In the gas sphere model these elements are expected to be present only in minor amounts. As many as 57 different types of emissions from 10 different kinds of elements had to be considered to construct a picture about the surface of the Sun.

Moshina has visually analyzed the pictures constructed from the surface of Sun using light at wave lengths corresponding to three lines of ferrite ions (171, 195, 284 Angstroms). On basis of his analysis he concludes that the spectrum originates from rigid and fixed surface structures, which can survive for days. A further analysis shows that these rigid structure rotate uniformly.

The existence of a rigid structure idealizable as spherical shell in the first approximation could by previous observation be interpreted as a spherical shell corresponding to $n = 1$ Bohr orbit of a planet not yet formed. This structure would already contain the germs of iron core and of crust containing Silicon, Ca and and other elements.

There is also another similar piece of evidence [88]. A new planet has been discovered orbiting around a star in a triple-star system in the constellation Cygnus. The planet is a so-called hot Jupiter but it orbits the parent star at distance of .05 AU, which much less than allowed by current theories of planetary formation. Indeed, the so called migration theory predicts that the gravitational pull of the two stars should have stripped away the proto-planetary disk from the parent star. If an underlying dark matter structure serves as a condensation template for the visible matter, the planetary orbit is stabilized by Bohr quantization.

There is however a problem: ordinary iron and also ordinary iron topologically condensed at dark space-time sheets, becomes liquid at temperature 1811 K at atmospheric pressure. Using for the photospheric pressure p_{ph} , the ideal gas approximation $p_{ph} = n_{ph}T_{ph}$, the values of photospheric temperature $T_{ph} \sim 5800$ K and density $\rho_{ph} \sim 10^{-2}\rho_{atm}$, and idealizing photosphere as a plasma of hydrogen ions and atmosphere as a gas of O_2 molecules, one obtains $n_{ph} \sim .32n_{atm}$ giving $p_{ph} \sim 6.4p_{atm}$. This suggests that calcium ferrite cannot be solid at temperatures of order 5800 K prevailing in the photosphere (the material with highest known melting temperature is graphite with melting temperature of 3984 K at atmospheric pressure). Thus it would seem that dark calcium ferrite at the surface of the Sun cannot be just ordinary calcium ferrite at dark space-time sheets.

The alternative model of inherently dark atom developed in this chapter and applied also in [L2, N2] provides a possible solution of the problem. The transition energies of dark N -molecules are N -fold as compared to those of the ordinary molecules. Therefore N -molecules can be stable and also exist in solid phase at N times higher temperatures than ordinary molecules. The N -photons emitted by dark N -molecules can decay to N ordinary photons and produce the spectral signatures of the ordinary molecules. Therefore the solid surface of the Sun would consists of dark N -matter. Quite generally, the spectral lines of molecules detected in environments where they are not thermally stable would be the signature of N -molecules and could be used to test the proposed model.

2.10.4 How to create dark matter in laboratory...

The creation of dark matter at laboratory is of course the crucial test. The hints for what to do come already from the findings of Tesla, which did not fit completely with Maxwell's electrodynamics (, which, using M-theory inspired jargon, had become "the only known classical theory of electromagnetism",) and were thus forgotten.

To transform visible matter to dark matter in laboratory one might try to generate conditions in which visible matter leaks to larger space-time sheets. What one could try is to generate pulsed current of electrons. For instance, current could flow to a circuit component acting as a charge reservoir. When the circuit is opened, and current cannot leave the charge reservoir, a situation analogous to a traffic jam occurs and some electrons might leak to larger space-time sheets via join along boundaries bonds generated in the process. Di-electric breakdown along larger space-time sheet would be in question. Recoil effects and zero point kinetic energy liberated as ionizing radiation would serve as a signature of the process. The production of dark matter might occur also in the usual di-electric breakdown and lead to the appearance of electrons in much larger volume after it partially re-enters original space-time sheets. The change of zero point kinetic energy would be liberated as radiation and would cause formation of plasma. Tesla detected dramatic effects of this kind in experiments utilizing sharp pulses.

2.10.5 ..or has it already been done?

In their article "Investigation of high voltage discharges in low pressure gases through large ceramic super-conducting electrodes", Modanese and Podkletnov [95] report a fascinating discovery suggesting that some new form of radiation is generated in the di-electric breakdown of a capacitor at low temperature and having super-conductor as a second electrode. This radiation induces oscillatory motion of test penduli but, and this is very strange, its intensity is not reduced with distance.

The TGD based explanation [G3] would be in terms of either "topological light rays" or what I call in honor of Tesla "scalar wave pulses" (much like a capacitor moving with velocity of light predicted by TGD but not allowed by Maxwell's ED). This radiation would induce the formation of join along boundaries bonds between atomic and larger space-time sheets and part of electrons from penduli would leak to larger space-time sheets and their motion would result as a recoil effect. The radiation would have only the role of control signal and this would explain why its intensity is not weakened.

From the point of view of single sheeted space-time an over-unity device would be in question since the zero point kinetic energy would be transformed to kinetic energy. The transformation of visible matter to dark matter is in TGD Universe the basic mechanism of metabolism predicting universality of metabolic energy currencies and living matter in TGD Universe has developed a refined machinery to recycle the dropped charges back to the atomic space-time sheets to be used again. Combined with time mirror mechanism this makes, not a perpetuum mobile, but an extremely flexible mechanism of metabolism.

3 Consciousness and cosmology

The words consciousness and cosmology at the same line represent a totally insane association unless one has assimilated the conceptual background provided by TGD inspired theory of consciousness, where p-adic physics of cognition means that cognitive consciousness is unavoidably cosmic phenomenon as far its space-time correlates are considered and magnetic flux tube hierarchy provides the template for the evolution of conscious, intelligent systems in all length scales.

There is a further argument supporting the view that conscious intelligence is the basic property of Universe. As found in the chapter "Intentionality, Cognition, and Physics as Number theory or Space-Time Point as Platonian", the need to algebraically continue rational physics to all number fields was shown to lead to a generalization of the notion of space-time point to what might be regarded as realization of the monad concept of Leibniz. Mathematical points are still completely structureless in the real sense but with respect to p-adic topologies situation changes profoundly. One can assign to space-time point a free algebra, kind of "Mother of All Algebraic

Structures” allowing representation of any algebraic structure. This would realize Universe as an algebraic hologram, and give good hopes of understanding of what are the space-time correlates of mathematical cognition.

3.1 Gravitation and consciousness

The purpose of the following arguments is to persuade the reader to consider seriously the possibility that classical gravitational interactions are space-time correlate for the subjective existence defined as sequence of quantum jumps.

3.1.1 p-Adic self hierarchy

Quantum jump as moment of consciousness and self as a system able to not develop bound state entanglement are basic notions of TGD inspired theory of consciousness [10]. The contents of consciousness of self are determined as a statistical average over the ensemble formed by quantum jumps which have occurred after the last ”wake-up”.

Macro-temporal quantum coherence corresponds to generation of bound state entanglement with rational or extended rational entanglement probabilities stable against state function reduction and preparation processes occurring in each quantum jump. The implication is that state function reduction and preparation processes cease in appropriate degrees of freedom and decoherence does not occur. As a consequence, the entropy of quantum jump ensemble does not increase and self stays negentropic. Since mental images correspond to sub-selves, mental images remain sharp during macro-temporal quantum coherence. One can say that moments of consciousness effectively integrate to a single long lasting moment of consciousness during macro-temporal quantum coherence. Quantum jumps represent the elementary particles of consciousness, and bound state entanglement binds both elementary particles and moments of consciousness to larger structural elements. The outcome is a fractal hierarchy of consciousness completely analogous and very intimately related to the corresponding hierarchy of matter.

Self hierarchy is the basic prediction of TGD inspired theory of consciousness differentiating it from many competing theories: everything is conscious and consciousness can be only lost. At the bottom of the self hierarchy are elementary particles and at the top of it is the entire Universe. p-Adic fractality suggests that the self hierarchy looks essentially the same at every level. p-Adic physics as physics of cognition adds additional weight to this vision since real and p-adic space-time sheets have rational points as common points and p-adically infinitesimal distances correspond to infinite real distances. On basis of these arguments one has reasons to believe that even structures of cosmological size should be conscious, intelligent, and capable of intentional action. The non-determinism of the vacuum extremals suggests the same at classical level.

3.1.2 Subjective time-geometric time, gravitational mass-inertial mass

Quite generally, the dynamics of topologically condensed matter is about the evolution of ”gravitational” counterparts of various currents defined as differences of the currents associated with positive and negative energy matter. Interestingly, this is what one could expect on the basis of quantum classical correspondence. Quantum jump is the basic building block of conscious experience and only changes can be experienced consciously. One the other hand, crossing symmetry allows to regard positive and negative energy particles as the initial and final states of particle reaction. In terms of TGD inspired theory of consciousness, ”inertial” corresponds to the ”objective” existence (quantum states) and ”gravitational” to the ”subjective” existence (quantum jumps). Classical fields and quanta of fields (CP_2 type extremals) correspond also to the gravitational-inertial dichotomy.

1. The space-time sheet is an absolute minimum of Kähler action and classical electro-weak and color fields are determined by this dynamics. The energy momentum tensor of Kähler action characterizes the net four-momentum density. The dynamics of the induced spinor fields is the super-symmetric counterpart of Kähler action and thus corresponds to the "inertial sector" of the theory. The fundamental role of the induced spinor fields in quantum theory suggests the same. That induced Kähler field and induced spinor field do not directly correspond to change or difference of any quantum number and are not directly observable conforms with their "inertial" character.
2. The divergences of classical YM fields are non-vanishing in general and define non-conserved vacuum gauge currents. Einstein's equations make sense only if the divergences of the energy momentum tensor of matter and those of classical YM fields cancel each other. The goal is achieved if the YM currents associated with the topologically condensed matter are equal to the vacuum YM currents. Also the net divergences of other contributions to the energy momentum tensor must vanish and this gives to the analogs of hydrodynamical equations.
3. The question is whether the YM currents correspond to the sum or difference of currents associated with positive and negative energy matter. Internal consistency suggests that the dynamics is for the differences of various charges for matter and antimatter so that the currents would correspond to "gravitational" counterparts of gauge charges. This would be also consistent with the facts that only the covariant divergence of these currents is vanishing and that they are not genuinely conserved. Fortunately, the expressions for the currents would be exactly the same as in the standard approach assuming opposite charges for negative energy matter.

With this interpretation even the predicted presence of long range electro-weak and color gauge fields becomes understandable. For instance, the presence of long range W^\pm fields codes for the occurrence of quantum jumps in which electro-weak quantum numbers are changed. Classical gauge fields would be in a well-defined sense "gravitational" counterparts of the quantum fields corresponding to elementary particles. This interpretation applies also in the case of electromagnetic current. Indeed, classical em current corresponds to the covariant divergence of em field and if classical W^\pm fields are present em current fails to be conserved.

3.1.3 Vacuum extremals, gravitation, intentionality, and Universe engineering itself

Kähler action has a gigantic vacuum degeneracy: any four-surface $X^4 \subset M_+^4 \times Y^2$, $Y^2 \subset CP_2$ a Legendre manifold with a vanishing induced Kähler form, is a vacuum extremal with respect to the inertial energy. The physical interpretation of this degeneracy remained open for a long time although it became clear that it is responsible for spin glass degeneracy and quantum criticality of TGD Universe crucial for understanding of living matter. The fact that vacuum extremals are not vacua with respect to gravitational four-momentum provides the sought for interpretation. Vacuum extremals correspond to the space-time correlate for that aspect of the Universe, which is engineered and can be affected by intentional action. Living creatures are certainly natural candidates for a phase of matter modellable in terms vacuum extremals or their small deformations.

p-Adic fractality and the fact that the evolution of cognition as cognitive growth proceeds from long to short length scales (p-adically infinitesimal corresponds to infinite in real context) forces to take very seriously the possibility that Universe is a product of conscious, intentional engineering in all length scales and could be seen as a kind of four-dimensional artwork or a living organism of cosmic size in 4-dimensional homeostatic equilibrium.

The changes of gravitational mass provide direct signature of intentional action. Intentional action leads to a generation of a pair of positive and negative energy space-time sheets with a vanishing net (conserved) inertial energy: $E_+ + E_- = 0$. The gravitational energy of the system

increases by $\Delta E_{gr} = E_+ - E_- = 2E_+$. It would be possible to measure the weight of intention by a gravitational scale! Also the reverse effect is possible. The ceasing of intentional actions at the moment of biological death could relate to the claimed loss of weight at the moment of biological death. Note that the annihilation of pairs of positive energy fermions and negative energy anti-fermions to photons and their phase conjugates provides a possible source of antigravity effects and it might be possible to develop antigravity machines utilizing this effect and possibly already utilized by living matter.

It would seem that Penrose's intuition about the role of quantum gravity is both right and wrong. Penrose proposes that it is possible to reduce the non-determinism of quantum jump to non-computable dynamics of gravitational fields, perhaps even at classical level. In TGD Universe classical gravitation involves genuine classical non-determinism which serves as a symbolic representations for conscious, intentional existence which at fundamental level corresponds to the dynamics of quantum jumps.

3.1.4 Topological thermodynamics and TGD

The dimension of CP_2 projection of space-time surface is an important classifier for the phases of matter in TGD Universe. R. M. Kiehn has developed highly interesting differential-topological view about thermodynamics, which he calls topological thermodynamics [17]. The basic goal is to reduce thermodynamics to differential topology using so called Pfaff systems defined by one-forms A_k identified as various thermodynamical potentials and completely analogous to action 1-forms in symplectic mechanics. The basic classifier for thermodynamical phases is the so called topological dimension associated with the Pfaff system defined by one-form A identified as action in Kiehn's approach. The topological dimension d of Pfaff system is the number of non-vanishing terms in the sequence $\{A, dA, A \wedge dA, dA \wedge dA, ..\}$. Even differential-topological definition of entropy is achieved in this approach.

The construction of solutions of field equations in TGD framework relies on the idea that the absolute minima of Kähler action corresponds asymptotically to self-organization patterns which do not dissipate anymore and that this is reflected as the vanishing of Lorentz-Kähler 4-force. Against this essentially thermodynamical background it is not surprising that there is very close relationship to Kiehn's approach. In TGD context action A is identifiable as the induced Kähler gauge potential A whereas d corresponds to the dimension of CP_2 projection of the space-time sheet.

For vacuum vacuum extremals d is 1 or 2. For instance, Lorentz invariant Robertson-Walker cosmologies have $d = 1$, whereas critical cosmology has $d = 2$. Besides vacuum extremals also Kähler magnetic flux tubes have $d = 2$ and correspond to highly ordered ferromagnetic phase. $d = 4$ corresponds to chaos. The most interesting phase from the point of view of living systems and information processing (perhaps by topological quantum computation) has $d = 3$ and is identifiable as spin glass phase representing the critical transition region between $d = 2$ and $d = 4$ phases. Thus $d = 2$ vacuum extremals seem to provide the hardware, the matter which conscious intelligent systems manipulate and perhaps also create from it $d = 3$ systems by small perturbations.

Kiehn's detailed thermodynamical interpretation of the contact and symplectic structure associated with A allows in principle a rather detailed thermodynamical interpretation of the absolute minima of Kähler action. For instance, vacuum extremals can be interpreted as thermodynamical equilibria for which entropy function associated with various points of space-time sheet is constant. The classical non-determinism of the space-time sheets could thus be also seen as a thermal randomness. This randomness would be however absolutely essential for space-time engineering by first melting the space-time sheet to a vacuum extremal, deforming it to the desired shape, and then allowing to cool it again. $d = 3$ corresponds in Kiehn's approach to thermal non-equilibrium states far from equilibrium and identifiable as topological defects.

3.1.5 Topological quantum computation in cosmic length scales?

Magnetic flux tube structures are the basic building blocks of living matter in TGD inspired quantum biology [M1, M3], and the assumption has been that the creation of pairs of positive and negative energy flux tube structures is one of the basic mechanisms of intentional action. For example, the self-assembly of proteins could be identified as a reversed time evolution for negative energy magnetic flux tube structures serving as templates for the formation of living matter. TGD inspired model of quantum biology leads to model for DNA in which the DNA double strand and also other helical structures corresponds to pairs of positive and negative energy magnetic flux tubes.

Also cosmic strings form tightly coiled pairs and can form complex knotted and linked structures. The scale is different but by p-adic fractality and quantum criticality of TGD Universe these structures should be very similar. Even more, cosmic strings should evolve to magnetic and Z^0 magnetic flux tubes by gradual thickening and by generation of fermion or anti-fermion number.

The TGD inspired model for topological quantum computation (TQC) using linking and braiding of magnetic flux tubes [E9] led to the proposal that also the double strand of DNA and/or RNA might perform TQC. The two strands would correspond to positive and negative energy magnetic flux tubes with linking and knotting of RNA coding for TQC program. The braiding of the two strands would define not only a TQC program but also its geometric time reversal. The possibility of quantum parallel dissipation makes also possible generalization of topological quantum computation to that involving dissipation.

p-Adic fractality and the view about evolution of cognition as a process proceeding from long length and time scales towards shorter ones inspires the question whether the coiled pairs of cosmic strings could be seen as fractally scaled up versions of pairs of RNA strands and define cosmic topological quantum computations such that negative energy string corresponds to communication to and control of the geometric past making possible endless iteration of TQC.

3.2 Is solar system a genuine self-organizing quantum system?

There are two means of determining the positions of planets in the solar system [89, 90, 91, 32]. The first method is based on optical measurements and determines the position of planets with respect to the distant stars. Already thirty years ago [32] came the first indications that the planetary positions determined in this manner drift from their predicted values as if planets were in accelerated motion. The second method determines the relative positions of planets using radar ranging: this method does not reveal any such acceleration.

C. J. Masreliez [90] has proposed that this acceleration could be due to a gradual scaling of the planetary system so that the sizes L of the planetary orbits are reduced by an over-all scale factor $L \rightarrow L/\lambda$, which implies the acceleration $\omega \rightarrow \lambda^{3/2}\omega$ in accordance with the Kepler's law $\omega \propto 1/L^{3/2}$. This scaling would exactly compensate the cosmological scaling $L \rightarrow (R(t)/R_0) \times L$ of the solar system size L , where $R(t)$ the curvature parameter of Robertson-Walker cosmology having the line element

$$ds^2 = dt^2 - R^2(t) \left(\frac{dr^2}{1+r^2} + r^2 d\Omega^2 \right) . \quad (20)$$

According to Masreliez, the model explains also some other anomalies in the solar system, such as angular momentum discrepancy between the lunar motion and the spin-down of the Earth [90]. The model also changes the rate for the estimated drift of the Moon away from the Earth so that the Moon could have very well formed together with Earth some five billion years ago.

In the TGD framework planetary acceleration could reflect non-trivial dynamics of quantum jumps so that quantum effects would be directly observable in the scale of solar system. Two

times would be involved: subjective time defined by sequence of quantum jumps and geometric time. The dynamics with respect to the geometric time would be determined by the equations of motion for planetary dynamics in expanding background for the space-time sheet representing solar system: the radar measurements would probe this dynamics.

The dynamics with respect to subjective time would make itself visible since the space-time sheet would be replaced by a new one in each quantum jump and characterized by slightly different parameters after each quantum jump. The optical measurements measuring positions of stars with respect to distant stars would probe this dynamics. The basic parameter would be the size of the solar system as measured with respect to M_+^4 metric. The scaling compensating the cosmic expansion would guarantee that the observed size remains constant. For each geometric history the size would increase in the geometric future. The solar system would utilize quantum non-determinism in order to avoid decay by cosmic expansion.

3.2.1 The basic coordinate systems

Consider now the previous argument in more detail. The first task is to identify the coordinates appearing in the equations of motion of the planetary system. Denote the standard spherical Minkowski coordinates by (m^0, r_M, θ, ϕ) . The line element reads as

$$ds^2 = d(m^0)^2 - dr_M^2 - r_M^2 d\Omega^2 . \quad (21)$$

Light cone coordinates are related to these coordinates by the relationship

$$a = \sqrt{m_0^2 - r_M^2} , \quad r = r_M/a . \quad (22)$$

Here a is the light cone proper time along radii from the dip of the light cone $a = \text{constant}$ surfaces are hyperboloids. The line element is given

$$ds^2 = da^2 - a^2 \left(\frac{dr^2}{1+r^2} + r^2 d\Omega^2 \right) \quad (23)$$

and is nothing but the empty space Minkowski metric.

The Robertson-Walker metric for the space-time sheet reads as

$$ds^2 = g_{aa} da^2 - a^2 \left(\frac{dr^2}{1+r^2} + r^2 d\Omega^2 \right) . \quad (24)$$

The space-time sheet possessing this metric as induced metric is obtained as a map $M_+^4 \rightarrow CP_2$ having the form $s^k = s^k(a)$, where s^k denote CP_2 coordinates satisfying the constraint

$$g_{aa} = 1 - s_{kl} \partial_a s^k \partial_a s^l , \quad (25)$$

where s_{kl} denotes the metric tensor of CP_2 .

One can introduce cosmic time as proper time coordinate t , or Hubble time as it is called, by the equation

$$\frac{dt}{da} = \sqrt{g_{aa}} . \quad (26)$$

For the matter-dominated cosmology one as

$$\frac{t}{t_0} = \left(\frac{a}{a_0}\right)^{3/2} . \quad (27)$$

$t \simeq 1.5 \times 10^{10}$ ly is the value which explains the planetary acceleration in the model of Masreliez.

The basic question concerns the connection between cosmic coordinates and the radial and time coordinates (r_{PN}, t_{PN}) used in Post-Newtonian approximation. The correspondence $(t = t_{PN}, r = r_{PN})$ is the natural first approximation.

The cosmic time dilation would slow down the time scale of the planetary dynamics and cosmic expansion would lead to adiabatic expansion of the size of the solar system. This would predict the scaling $L(a)/L(a_0) = a/a_0$ for the sizes of the planetary orbits as measured using the r_M coordinate of M_+^4 metric whereas angular velocities of planets would remain constant $\omega(a)/\omega(a_0) = constant$. The solar system would gradually decay.

3.2.2 Quantum compensation of the cosmic expansion

In order to compensate the cosmic expansion solar system should perform quantum jumps compensating the scaling caused by the cosmic expansion so that the observed size of the solar system would remain unchanged. This requires $L(a)/L(a_0) = constant$ and the scalings

$$\frac{\omega(a)}{\omega(a_0)} = \left(\frac{a}{a_0}\right)^{3/2} = \frac{t}{t_0} , \quad \frac{v(a)}{v(a_0)} = \left(\frac{a}{a_0}\right)^{1/2} = \left(\frac{t}{t_0}\right)^{1/2} \quad (28)$$

for the angular velocity ω and and tangential velocity v along the orbit. The equation for the angular acceleration is $d\omega/dt = \omega/t$. This result differs by a factor of 3 from the equation $d\omega/dt = 3\omega/t$ of Masreliez [90]. On basis of work of Masreliez one can conclude this kind of scaling indeed explains the observed drift quite satisfactorily for $t \simeq 5$ billion years (instead of $t = 15$ billion years of [90]). Thus the effect would allow to see the effects of the cosmic expansion in human time scale and would make possible to determine the value of cosmic time t from the planetary dynamics.

The obvious question is why this kind of scaling would occur and a possible answer suggested by TGD inspired theory of consciousness is that the solar system is conscious self-organizing system which purposefully tends to avoid the decay caused by cosmic expansion. There must be some mechanism making the scaling possible. One can imagine at least the following mechanisms.

1. A gradual generation of Z^0 charges, which are opposite sign for Sun and planets would provide a possible mechanism of this kind. The weakness of the model is that it requires constant Z^0 charge/mass ratio.
2. Also the creation of pairs of positive and negative energy magnetic flux tubes from vacuum could generate gravitational mass. The strong magnetic and Z^0 magnetic field of solar magnetic field zone could consist pairs of flux tubes with positive and negative inertial energies. If the gravitational mass M_{gr} of Sun relates to its radius R by $M_{gr}R^3 = constant$ law holding true for non-rotating non-relativistic astrophysical objects [16], the growth of mass and solar radius would obey the law $d\log(M)/d\log(a) = 3/4$ and $d\log(R)/d\log(a) = -1/4$. In the context provided by general philosophy of TGD inspired theory of consciousness the extremely complex self-organizing magnetic flux tube structure of convective zone brings unavoidably in mind cortical layers of brain. The new view about dark matter as a super-quantal system gives additional impetus to the otherwise weird sounding idea about the solar system as intelligent and conscious system.

3.2.3 Explanation of the anomalous acceleration of space-crafts

The model for solar system as a self-organizing system provides also an explanation for the anomalous acceleration $a_F = (8.744 \pm 1.33) \times 10^{-8} \text{ cm/s}^2$ of space crafts discussed in the earlier section. The value of the anomalous acceleration has been found to be given by Hubble constant: $a_F = cH$. $H = 82 \text{ km/s/Mpc}$ gives $a_F = 8 \times 10^{-8} \text{ cm/s}^2$. It is very difficult to believe that this could be an accident. Indeed, if the planets suffer an anomalous inward acceleration compensating for the cosmic expansion, then also the space-crafts in the radial motion experience the same acceleration. Unless it is assumed that Z^0 charge to mass ratio is same for objects in the size scale ranging from space-crafts to planets, the anomalous acceleration favors the model for the compensation of the cosmic expansion based on the increase of the gravitational mass of Sun or Sun and the inner planetary system.

3.3 The independence of the age distribution of stars in galaxies on the age of galaxy as evidence for quantum coherent dark matter

Big bang cosmology is in a middle of deep crisis. Various aspects of the situation were discussed in the first Crisis in Cosmology conference held 23-25 June 2005 in Portugal. One of the most serious arguments against Big Bang cosmology is the evidence that the age distribution of stars in galaxies does not depend on the age of the galaxy. As if the cosmology were steady state cosmology in a sharp contrast to the voluminous experimental evidence suggesting an expanding cosmology [31]. The defenders of the standard cosmology have claimed that the measurement inaccuracies are so high that one cannot draw definite conclusions about the situation.

In TGD framework, the independence of the age distribution of stars on the age of the galaxy would add a further item to the long list of paradoxes due to the erratic identification of the notions of geometric time and experienced time. The TGD based explanation of the anomaly generalizes the earlier model for the shrinking of planetary radii for which there is also evidence [89, 90, 91]. Rather unexpectedly, the finding lends support for the basic predictions of TGD inspired theory of consciousness including the existence of the infinite hierarchy of conscious entities, and allows to considerably sharpen the earlier view about the relationship between geometric and experienced time.

3.3.1 The connection between the notions of geometric and experienced time

Consider first the TGD based view about the connection between geometric and experienced time.

1. *Time flow as a drift of the space-time sheet of observer relative to environment*

1. The space-time sheet X_o^4 associated with the conscious observer drifts towards geometric future with respect to the space-time sheet X_e^4 defined by the environment. From the perceived change of the environment the conscious observer concludes that time flows. The motion towards geometric future corresponds to some average increment τ of geometric time per quantum jump: τ can be identified as a drift velocity $v = \tau$ with respect to subjective time measured using single quantum jump as a unit. Its inverse $1/v$ gives the number of quantum jumps per geometric time defining a measure for the temporal resolution of the conscious experience. This connection explains the origin of the natural but erratic identification of the geometric time with the experienced time.
2. Drift velocity τ characterizes system-subsystem pair and can in principle vary. Geometric considerations suggests that there is a minimal drift velocity (maximal temporal resolution) corresponding to an average increment of geometric time per quantum jump or order CP_2

time $\tau_{CP_2} = R/c$. Quantum classical correspondence allows to consider the possibility that relativity principle for geometric time might have an analog at the level of subjective time.

3. The experience of the flow of subjective time is associated with the number $1/v$ of quantum jumps per unit of geometric time measuring the rate of dissipation. The dissipated power P could be identified as the time component of four-force causing a drift towards geometric future. Dimensional considerations and p-adic fractality suggests that the inverse of the drift velocity (number $1/\tau$ of quantum jumps per geometric time) would be proportional to P/M , where M is the rest mass of the sub-system:

$$\frac{1}{\tau} \frac{dt}{ds} = \frac{P}{M} . \quad (29)$$

Here t denotes the geometric time coordinate, most naturally M_+^4 proper time, and s the curve length along the orbit of the space-time sheet regarded as a point-like object. This predicts that for light systems such as elementary particles the number of quantum jumps per geometric time is high and small for larger systems. For $P = 0$ there would be no experience of time flow since single quantum jump would have an infinite geometric duration and the system would be in a state of Eternal Now.

2. p-Adic time scale hierarchy for time resolutions of conscious experience

The hierarchy of p-adic length and time scales would relate naturally to the hierarchy of drift velocities and dissipation rates P . The first guess is

$$P \propto \frac{kM}{T_p} , \quad (30)$$

where M is the rest mass of particles condensed at space-time sheet characterized by the p-adic prime p . This gives

$$\tau_p = \frac{T_p}{k} , \quad (31)$$

which is also what p-adic fractality would suggest. The time resolution of conscious experience with respect to the geometric time would weaken as p grows in accordance with the idea that p-adic hierarchy defines a hierarchy of length and time resolutions. The higher the dissipation rate, the shorter then geometric duration of quantum jump and the slower the system drifts towards geometric future.

3. Hierarchy of quantum jumps and dark matter

TGD inspired theory of consciousness predicts a hierarchy of quantum jumps such that single quantum jump at given level would correspond to a sequence of quantum jumps at the level below it. The self at the higher level of hierarchy experiences its sub-selves as mental images, and the sub-sub-...selves at lower levels give rise to a kind of diffuse background experience giving rise to an experience of time flow during single quantum jump.

This hierarchy of moments of consciousness of increasing subjective and geometric durations defines a direct counterpart for the hierarchy formed by elementary particles, hadrons, atoms, molecules, etc.... Indeed, the formation of bound states with rational entanglement probabilities characterized by positive entanglement negentropy identified as a p-adic variant of Shannon entropy

is identified as be the physical correlate for the hierarchy or moments of consciousness [H2]. The generalization of this picture to the case of hyper-finite type II_1 factors is also discussed in [H2].

This hierarchy of consciousness should relate closely to the hierarchy of Planck constants defined by Beraha numbers $B_n = 4\sin^2(\pi/n)$ and their generalizations B_r with r rational. For large values of \hbar and dark matter the average increment of geometric time per quantum jump would be longer than for small values of \hbar and to ordinary matter and each quantum jump would be experienced as longer and longer lasting "Eternal Now".

4. Life as an attempt to climb as far as possible to the geometric future

That human beings and presumably all living systems experience time flow would be due to the dissipation by the component of the living system consisting of ordinary matter. The basic goal of the life cycle would be to run faster than the environment to future get as far as possible to the geometric future to be able to experience what the environment at more advanced levels of evolution looks like. Climbing up hill would be a good metaphor for life.

This would serve a good quantum physical definition for the notion of progress. One can imagine several means for achieving this goal: the increase of the p-adic prime p (size of the system), the minimization of the dissipation rate, and the transition to a higher level in the hierarchy of dark matter. The price paid would be a poorer time resolution of direct conscious experience. The diffuse background due to sub-sub...-selves however provides the experience about time flow. Somewhat paradoxically, in quantum jumps of long geometric duration the highest level contribution to the experience would be that of Eternal Now experienced in pure form during experiences like NDEs when the contributions from the biological body are minimal.

The p-adic length scale hierarchy associated with the biological body would define a hierarchy of these goals. At a given level of hierarchy of moments of consciousness (the hierarchy of Planck constants) the geometric time would run the faster, the longer the p-adic length scale characterizing partially the level in the evolutionary hierarchy is. If the number of quantum jumps is roughly the same at various levels of p-adic hierarchy, the subjectively experienced life span defined as number of quantum jumps would be also more or less the same.

5. Life cycle as single moment of consciousness?

There is a group of questions relating to the identification of "me" in the hierarchy of conscious entities. What is the geometric duration of moment of consciousness for "me" as the highest level intentional agent affecting my life ("silent witness")? Does it correspond to some neurophysiological time scale, say some EEG period, to single day in life, or does biological life cycle correspond to a single moment of consciousness of "silent witness" so that all its experiences in shorter time scales would correspond to mental images defined by sub-sub...-selves with a smaller value of τ (in particular, moments of sensory consciousness with a geometric time duration of order .1 seconds). Meditative practices indeed claim that we are conscious also during deep sleep but do not usually remember anything about this period.

If "I" would cease to exist as a conscious entity during deep sleep my directly experienced life history could not be longer than single day in life unless the communications with other conscious entities generate a mental image about longer life history as a cognitive construct.

This supports the view that "me" as an intentional agent responsible for the grand design of the life cycle corresponds to the "silent witness". Lower level intentional "me's" are present but their effects of lower level selves to the geometric future have a shorter time span by statistical determinism, and characterized by the corresponding p-adic time scales.

6. Time mirror mechanism for intentional action and time localization of the sensory experience and intentional inertness of the geometric past

The proposed picture does not yet resolve all imaginable paradoxes.

1. My sensory experience is more or less from single moment of geometric time rather than from the entire 4-dimensional body as would be suggested by life span a single moment of consciousness picture. It would seem that the state of the sensory space-time sheets of the geometric past is such that they do not contribute to the everyday conscious experience. Sensory memories and perhaps also cognitive memories (clearly distinguishable from sensory reality) define exceptions to this rule. If the basic character of the sensory experience is such that it takes the sensory receptor into a state in which further sensory perception is not possible for a sufficiently long period of time, this would be the case.
2. In TGD based model for sensory receptors sensory receptors are analogous to population inverted lasers which return to the ground state during sensory perception (in the capacitor model of sensory receptors sensory input generates a discharge of the capacitor [K3]). By classical non-determinism it is possible to have a situation in which the return to the ground state in a given quantum jump occurs only in a finite time interval defined naturally by an appropriate space-time sheet. Since the return to the initial state requires energy feed, there is some recovery time, perhaps even of order life span, for the sensory receptors. Quantum classical correspondence and the fact subjective past does not change in quantum jumps would suggest that no recovery occurs. The quantum jump sequence should induce the falling down of the domino pieces ordered along the time axis and the pieces should not get up too soon.

Unless the geometric past is inert with respect to intentional action, one can imagine a situation in which the intentional action on the geometric past can affect the fate of the entire biological body of geometric future in time scales of life span. Rather paradoxical situations can result. For instance, a musician could wake up as physicist when a young "me" in the geometric past or the highest level intentional agent makes a different choice. Paradoxes are avoided if geometric past becomes inert with respect to intentional action.

The view about how intentional action is realized allows to understand both the time localization of the contents of sensory experience and the inertness of the geometric past with respect to intentional action.

1. According to the TGD based model, intentional action is realized as a negative energy signal sent to the geometric past representing a desire about action inducing positive energy signals realizing the action. The intentional action has a fractal structure: the desire about action at highest level and longest length and time scale induces desires at lower levels proceeding down to the bio-molecular level. The temporal distances at which the signals propagate into geometric past is expected to be proportional to T_p so that lower dimensional intentional agents would have a shorter span of intentional action.
2. A negative energy signal from the geometric future induces the return of the population inverted many-sheeted laser defining a sensory receptor to the ground state inducing the positive energy signal responsible for the action. Because of the finite recovery time the subsequent intentional actions of the lower level intentional agents induce a drift of the front of sensory experience towards geometric future. One can of course imagine the possibility that the recovery time is shorter than life span in which the revived youth begins to contribute to the conscious experience: this might relate to the fact that old people can relive the youth.
3. Intentional and sensory life could be seen as an analog of p-adic length scale evolution in which shorter and shorter p-adic time scales are excited with downwards scaling mapped to the time evolution. Life cycle would be like carving a statue by starting from a rough sketch and adding details. This conforms also with the basic anatomy of quantum jump.

7. *The drift velocities towards geometric future must be same for communicating intentional agents in biosphere*

The assumption that the drift velocities towards geometric future are different for conscious entities able to communicate also leads to a paradoxical situations. For instance, if my drift velocity is lower than that of my friend, I soon find that my friend looks more or less like a dead statue if the hypothesis about intentional inertness is true. If my drift velocity is higher, I would learn that my friend is in a macroscopic quantum superposition of different variants of my friend: one would be musician, one would be physicist, etc... This suggests that the drift velocity is same for conscious entities able to communicate. The findings about planetary system and age distribution of stars are consistent with this assumption. The assumption becomes natural if the intentional agents correspond to dark matter in general.

3.3.2 Quantum explanation for the shrinking planetary radii and apparent steady state cosmology

The independence of the age distribution of stars on the age of galaxy suggests that cosmology looks like a steady state cosmology with respect to the subjective time and expanding cosmology with respect to the geometric time. The explanation for why this is the case would be same as for the shrinking of the orbital radii of planets [89, 90].

1. *The model*

Consider next the explanation for the shrinking of the orbital radii of planets and for the independence of the age distribution of stars on the age of galaxy.

1. Assume that the Newtonian radii correspond to the radial coordinate r of the Robertson-Walker coordinate system with origin at the Sun. Assume that quantum jumps have physical effects even in astrophysical length scales, and are such that they compensate completely the increase of the distance s of the planet from Sun caused by the cosmic expansion so that $s = a \int_0^r dr / (1 + r^2) \simeq ar$ stays constant apart from the oscillatory variation caused by the non-circular motion.
2. This situation is achieved if the space-time sheet X_o^4 associated with the observer drifts with respect to the space-time sheet X_p^4 associated with the planetary system, which in turn drifts with the same velocity at the space-time sheet X_g^4 of galaxy. This implies that the change of perceived 3-D environment at X_p^4 due to the drift of X_o^4 at X_p^4 is compensated by the drift of X_p^4 at X_g^4 .
3. In the same manner, the independence of the age distribution of stars on the age of galaxy can be understood if X_o^4 drifts at X_g^4 with the same velocity as X_g^4 sheets drift at the cosmological space-time sheet X_c^4 . The equality of the drift velocities is consistent with the hypothesis that field/magnetic bodies of even galactic size contribute to our conscious experience.
4. Also p-adic fractality implying cosmologies with cosmologies picture suggests that the age distribution of stars does not depend on the age of galaxy.

2. *The interpretation of the astrophysical and cosmic anomalies as a support for the quantum coherence of dark matter*

The assumption that dark matter is in a quantum coherent state in astrophysical and even cosmic length and time scales means that the systems consisting of dark matter do not dissipate much and thus do not drift much with respect to each other.

Since Universe consists mostly of dark matter, the shrinking of planetary radii and the constancy of the age distributions of stars in galaxies can be seen as an evidence for the quantum coherence of dark matter and for the assumption that dark matter at our magnetic bodies is what makes us intentional agents. The findings support also the view that universe is conscious even in the length and time scales of galaxies and even enjoy what meditative practices call enlightened states or cosmic consciousness and that these length scales contribute also to our consciousness.

4 Living matter and dark matter

The most precious gift of RHIC to TGD was that several theoretical notions and ideas, which have emerged during last years, and applying in hugely disparate length and time scales by p-adic fractality, integrate nicely. Especially interesting are the implications for the understanding of what differentiates between living and ordinary matter and what gives living systems its macroscopic and macro-temporal quantum coherence.

I have already mentioned the black hole like objects identified in Relativistic Heavy Ion Collider in Brookhaven. Because of the exceptional importance of the finding I summarize briefly the main findings and theoretical concepts and ideas again from a more holistic point of view. The discovery of black hole like objects was third in a series of discoveries.

4.1 Living matter as ordinary matter quantum controlled by dark matter

Also living matter could be ordinary matter controlled by dark matter with a large value of \hbar and thus possessing extremely quantal properties, including free will and intentional action in time scales familiar to us! Dark matter would be responsible for the mysterious vital force.

Any system for which some interaction becomes so strong that perturbation theory does not work, could give rise to this kind of system in a phase transition in which \hbar increases to not lose perturbativity gives rise to this kind of "super-quantal" matter. In this sense emergence corresponds to strong coupling. One must however remember that emergence is actually much more and involves the notion of quantum jump. Dark matter made possible by dynamical \hbar is necessary for macroscopic and macro-temporal quantum coherence and is thus prerequisite for emergence.

Physically large \hbar means a larger unit for quantum numbers and this requires that single particle states form larger particle like units. This kind of collective states with weak mutual interactions are of course very natural in strongly interacting systems. At the level of quantum jumps quantum jumps integrate effectively to single quantum jump and longer moments of consciousness result. Entire hierarchy of quantal size scales is predicted corresponding to values of \hbar . The larger the value of \hbar the longer the characteristic time scale of consciousness and of a typical life cycle.

In RHIC color glass condensate resembles incompressible liquid. Liquids might be liquids because they contain some dark matter at magnetic/ Z^0 magnetic flux tubes (darkness follows from the large value of \hbar). Incompressibility of liquid could correspond to maximal density of flux tubes and to the fact that magnetic fields have no sources. In accordance with the previous ideas already water would be living and conscious system in some primitive sense.

The notion of field body in turn means that dark matter at the magnetic flux tubes would serve as an intentional agent using biological body as a motor instrument and sensory receptor. Dark matter would be the miraculous substance that living systems are fighting for, and perhaps the most important substance in metabolic cycle.

4.2 Could biology, cosmology, and hadron physics have something in common?

p-Adic fractality suggests that scaled versions of cosmological evolution appear in all length and time scales and that biological life cycle and cosmological life cycle from big bang to big crunch might have much common as far as mathematical description is considered.

There are very important differences between biology and cosmology as we usually understand the latter. Usually cosmology is thought to be something occurring just once, not engineered, and not receiving an energy flow forcing self-organization. Intentional action is not believed to play any role.

In TGD situation looks however different. The new notions of energy and geometric time imply that all matter is in principle creatable from vacuum by intentional action. Fractal hierarchy of cosmologies within cosmologies means that cosmologies are interacting and can receive self-organizing energy feed. Our inability to detect life forms unless they sufficiently resemble us might be a cause of an enormous distortion in our world view. Be it as may, if a proposed kind of universality prevails, it becomes in principle possible to test whether system characterized by much longer or shorter time and length scales has some features possessed by living systems.

If this vision is taken seriously, many-sheeted cosmology might even provide some concrete help in attempts to understand the growth of biological organism and its eventual decay. At least the very fact that we are born and eventually die could be understood as the unavoidable fate of any space-time sheet and analogous to process leading from big bang to big crunch. For instance, the models for the early periods in the development of organism might profit something from fractal thinking and critical cosmology suggests universal dynamics in the roughest description of these processes.

Just for fun and taking the liberty of being very naive one could look whether something useful might result from kind of analogy. The early phase consisting of flux tubes and small amount of visible matter (DNA) on them might correspond to the dominance of magnetic body.

Chromosomes containing DNA indeed correspond to multiply coiled very dense many-sheeted structure filling the cell nucleus and would be a natural candidate for the primordial magnetic flux tube dominated phase carrying quantum controlling dark matter. Also proteins would naturally correspond to flux tube like structures. These structures would fractally organize to larger scaled up versions also having similar flux tube like structure and living matter is filled with this kind of structures in various scales.

Quantum critical period during which the space-time in ordinary sense emerges could correspond to the generation of cellular structures larger than basic bio-molecules. Radiation dominated phase could correspond to the period during which cells replicate but visible structures have not yet emerged. Matter dominated period during which organelles are formed around existing magnetic flux tube structures containing quantum controlling dark matter might correspond to the generation of structures from pre-existing micro-structures defined by the magnetic flux tube structures.

One can of course argue that hadrons differ from living matter in the sense each cell of living matter contains these magnetic flux tube structures but hadrons do not. This need not be the case. As I have proposed valence quarks could form a structure connected by color magnetic flux tubes containing gluon condensate, and define the hadronic analog of DNA contained by every hadron. In RHIC experiments a very long structure of this kind analogous to chromosomes would formed when the energy of colliding nuclei is materialized as they slow down.

I have also proposed in cosmological context the idea about linked and knotted cosmic strings as counterparts of DNA double strands [D4]. Here the time orientations for cosmic strings could be different. Even the flux tubes associated with DNA strand and its conjugate might have opposite time orientations and could be created from vacuum. If one takes completely seriously fractality and the hierarchy of Planck constants implying consciousness in all scales, one must conclude that linked and knotted structures might be responsible for topological quantum computation in all

length and time scales [E9].

4.3 Overall view

Dark matter is identified as a macroscopic quantum phase with large \hbar for which particles have complex conformal weights.

The sum of the imaginary parts of conformal weights assumed for number theoretical reasons to be expressible as sums of imaginary parts for the zeros of Riemann Zeta would define a new conserved quantum number, "scaling momentum" [C1]. The conjugation of the complex conformal weight would distinguish between quantum states and their phase conjugates. This point is important since phase conjugate photons represent negative energy signals propagating into geometric past, assumed to be distinguishable from positive energy signals propagating into geometric future, play a key role in TGD based biology: this distinction cannot be made in QFT context.

Living matter could be matter with a large value of \hbar and hence dark, and form conformally confined blobs behaving like single units with extremely quantal properties, including free will and intentional action in time scales familiar to us. Dark matter would be responsible for the mysterious vital force.

Any system for which some interaction becomes so strong that perturbation theory does not work, could give rise to this kind of system in a phase transition in which \hbar increases to not lose perturbativity gives rise to this kind of "super-quantal" matter. In this sense emergence would correspond to strong coupling. The interpretation would be that strong fluctuations at strong coupling give rise to a large number of orbifold points so that the S-matrix elements to a phase with larger Planck constant become large. Dark matter made possible by dynamical \hbar is necessary for macroscopic and macro-temporal quantum coherence and is thus prerequisite for emergence.

Physically large \hbar means a larger unit for quantum numbers and this requires that single particle states form larger particle like units. This kind of collective states with weak mutual interactions are of course very natural in strongly interacting systems. The N sheets of M_{\pm}^4 , where N is the order of group G_b involved with the Jones inclusion in question. Each partonic 2-surface appears as N geometrically identical copies which can however carry different fermionic quantum numbers. Hence the N -fold space-time sheet carry up to N G_b invariant partons with identical quantum numbers so that an effective breaking of Fermi statistics becomes possible.

One implication would be the notion of N-atom, which at the level of quantum jumps quantum jumps integrate effectively to single quantum jump and longer moments of consciousness result. Entire hierarchy of size scales for matter blobs is predicted corresponding to values of \hbar . The larger the value of \hbar the longer the characteristic time scale of consciousness and of a typical life cycle.

In RHIC color glass condensate resembles incompressible liquid. Liquids might be liquids because they contain some dark matter at magnetic/ Z^0 magnetic flux tubes (darkness follows from the large value of \hbar). Incompressibility of liquid could correspond to maximal density of flux tubes and to the fact that magnetic fields have no sources. In accordance with the previous ideas already water could be living and conscious system in some primitive sense.

The notion of field body in turn means that dark matter at the magnetic flux tubes would serve as an intentional agent using biological body as a motor instrument and sensory receptor. Dark matter would be the miraculous substance that living systems are fighting for, and perhaps the most important substance in metabolic cycle.

4.3.1 Hierarchy of dark matters and hierarchy of minds

The notion of dark matter is only relative concept in the sense that dark matter is invisible from the point of view of the ordinary matter. One can imagine an entire hierarchy of dark matter structures corresponding to the hierarchy of space-time sheets for which p-adic length scales differ by a factor $1/v_0 \sim 2^{11}$. The BE condensates of N_{cr} ordinary matter particles would serve as dynamical units

for "doubly dark matter" invisible to the dark matter. The above discussed criticality criterion can be applied at all levels of the hierarchy to determine the value of the dynamical interaction strength for which BE condensates of BE condensates are formed.

This hierarchy would give rise to a hierarchy of the values of \hbar_n/\hbar coming as powers of v_0^{-n} as well as a hierarchy of wavelengths with same energy coming as powers of v_0^n . For zero point kinetic energies proportional to \hbar^2 this hierarchy would come in powers of v_0^{-2n} , for magnetic interaction energies proportional to \hbar the hierarchy would come in powers v_0^{-n} whereas for atomic energy levels the hierarchy would come in powers of v_0^{2n} (assuming that this hierarchy makes sense).

The most interesting new physics would emerge from the interaction between length scales differing by powers of v_0 made possible by the decay of BE condensates of dark photons to ordinary photons having wavelength shorter by a factor $\sim v_0$. This interaction could provide the royal road to the quantitative understanding how living matter manages to build up extremely complex coherent interactions between different length and time scales.

In the time domain dark matter hierarchy could allow to understand how moments of consciousness organize to a hierarchy with respect to the time scales of moment of consciousness coming as 2^{11k} multiples of CP_2 time scale. Even human life span could be seen as single moment of consciousness at $k = 14^{th}$ level of the dark matter hierarchy whereas single day in human life would correspond to $k = 12$.

4.3.2 Realization of intentional action and hierarchy of dark matters

How long length scales are able to control the dynamics in short length scales so that the extremely complex process extending down to atomic length scales realizing my intention to write this word is possible. This question has remained without a convincing answer in the recent day biology and there strong objections against the idea that this process is planned and initiated at neuronal level.

I have proposed a concrete mechanism for the realization of intentional action in terms of time mirror mechanism involving the emission of negative energy photons and proceeding as a cascade in a reversed direction of geometric time from long to short length scales [K1]. This cascade would induce as a reaction analogous processes proceeding in the normal direction of geometric time as a response and would correspond to the neural correlates of intentional action in very general sense of the word.

The counterparts for the negative energy signals propagating to the geometric past would be phase conjugate (negative energy) laser beams identifiable as Bose-Einstein condensates of dark photons. In the time reflection these beams would transform to positive energy dark matter photons eventually decaying to ordinary photons. The space-time correlate would be MEs decaying into MEs and eventually to CP_2 type extremals representing ordinary photons.

The realization of intentional action as desires of boss expressed to lower level boss would naturally represented the decay of the phase conjugate dark laser beam to lower level laser beams decaying to lower level laser beams decaying to... . This would represent the desire for action whereas the time reflection at some level would represent the realization desire as stepwise decay to lower level laser beams and eventually to ordinary photons. The strong quantitative prediction would be that these levels correspond to a length and time scale hierarchies coming in powers of $1/v_0 \sim 2^{11}$.

4.3.3 Wave-length hierarchy, coherent metabolism, and proton-electron mass ratio

The fact that a given wavelength length corresponds to energies related to each other by a scaling with powers of v_0 provides a mechanism allowing to transfer energy from long to short long scales by a de-coherence occurring either in the standard or reversed direction of geometric time.

De-coherence in the reversed direction of time would be associated with mysterious looking processes like self-assembly allowing thus an interpretation as a normal decay process in reversed time direction.

It is perhaps not an accident that the value of $v_0 \simeq 4.6 \times 10^{-4}$ is not too far from the ratio of $m_e/m_p \simeq 5.3 \times 10^{-4}$ giving the ratio of zero point kinetic energies of proton and electron for a given space-time sheet. Proton mass ratio $m_p/m_e = 1836.15267261$ corresponds in good approximation to $n = 2^2 \times 3^3 \times 17 = 1836$. This integer is of form $n = 9 \times n_F$. This co-incidence could in principle make possible a metabolic mechanism in which dark protons and ordinary electrons co-operate in the sense that dark protons generate dark photon BE condensates with wave length λ transforming to ordinary photons with wavelength $v_0\lambda$ absorbed by ordinary electrons.

Some examples are in order to illustrate these ideas.

1. As already found, in the case of dark atoms the scaling of binding energies as $1/\hbar^2$ allows the coupling of ~ 9 cm scale of brain hemisphere with the length scale $\sim 50 \mu\text{m}$ of large neuron. $N_{cr} \leq 137$ ordinary IR photons would be emitted in single burst and interacting with neuron.
2. For a non-relativistic particle in a box of size L the energy scale is given by $E_1 = \hbar^2\pi^2/2mL^2$ so that the visible photons emitted would have energy scaled up by a factor $(\hbar_s/\hbar)^2 \simeq 4 \times 10^6$. The collective dropping of N_{cr} dark protons to larger space-time sheet would liberate a laser beam of dark photons with energy equal to the liberated zero point kinetic energy. For instance, for the p-adic length scale $L(k = 159 = 3 \times 53) \simeq .63 \mu\text{m}$ this process would generate laser beam of IR dark photons with energy $\sim .5$ eV also generated by the dropping of ordinary protons from $k = 137$ atomic space-time sheet. There would thus be an interaction between dark protons in cell length scale and ordinary protons in atomic length scale. For instance, the dropping of dark protons in cell length scale could induce driving of protons back to the atomic space-time sheet essential for the metabolism [K6]. Similar argument applies to electrons with the scale of the zero point kinetic energy about 1 keV.
3. If the energy spectrum associated with the conformational degrees of freedom of proteins, which corresponds roughly to a frequency scale of 10 GHz remains also invariant in the phase transition to dark protein state, coherent emissions of dark photons with microwave wave lengths would generate ordinary infrared photons. For instance, metabolic energy quanta of $\sim .5$ eV could result from macroscopic Bose-Einstein condensates of 58 GHz dark photons resulting from the oscillations in the conformational degrees of freedom of dark proteins. A second option is that the conformal energies are scaled by \hbar_s/\hbar (ω would remain invariant). In this case these coherent excitations would generate ordinary photons with energy of about 1 keV able to drive electrons back to the atomic $k = 137$ space-time sheet.
4. Since magnetic flux tubes have a profound role in TGD inspired theory of consciousness, it is interesting to look also for the behavior of effective magnetic transition energies in the phase transition to the dark matter phase. This transition increases the scale of the magnetic interaction energy so that anomalously large magnetic spin splitting $\hbar_s eB/m$ in the external magnetic field could serve as a signature of dark atoms. The dark transition energies relate by a factor \hbar_s/\hbar to the ordinary magnetic transition energies.

For instance, in the magnetic field $B_{end} = 2B_E/5 = .2$ Gauss, where $B_E = .5$ Gauss is the nominal value of the Earth's magnetic field, explaining the effects of ELF em fields on vertebrate brain, dark electron cyclotron frequency is 6×10^5 Hz and corresponds to ordinary microwave photon with frequency ~ 1.2 GHz and wavelength $\lambda \simeq 25$ cm. For proton the cyclotron frequency of 300 Hz would correspond to energy of ordinary photon with frequency of 6×10^5 Hz and could

induce electronic cyclotron transitions and spin flips in turn generating for instance magneto-static waves.

It is easy to imagine a few step dark matter hierarchy connecting EEG frequencies of dark matter with frequencies of visible light for ordinary photons. This kind of hierarchy would give considerable concreteness for the notion of magnetic body having size scale of Earth.

4.3.4 A connection with bio-photons

The biologically active radiation at UV energies was first discovered by Russian researcher Gurwitz using a very elegant experimental arrangement [56]. Gurwitz christened this radiation mitogenetic radiation since it was especially intense during the division of cell.

A direct proof for the biological activity of mitogenetic radiation consisted of a simple experiment in which either quartz or glass plate was put between two samples. The first sample contained already growing onion roots whereas the second sample contained roots which did not yet grow. In the case of quartz plate no stimulation of growth occurred unlike for glass plate. Since quartz is not transparent to UV light whereas the ordinary glass is, the conclusion was that the stimulation of growth is due to UV light.

The phenomenon was condemned by skeptics as a pseudo science and only the modern detection technologies demonstrated its existence [80], and mitogenetic radiation became also known as bio-photons (the TGD based model for bio-photons is discussed in [K6]). Bio-photons form a relatively featureless continuum at visible wavelengths continuing also to UV energies, and are believed to be generated by DNA or at least to couple with DNA. The emission of bio-photons is most intense from biologically active organisms and the irradiation by UV light induces an emission of mitogenetic radiation by a some kind of amplification mechanism. It has been suggested that bio-photons represent some kind of leakage of a coherent light emitted by living matter.

According to Russian researcher V. M. Injushin [57], mitochondrios emit red light at wavelengths 620 nm and 680 nm corresponding to energies 2 eV and 1.82 eV. According to the same source, the nucleus of cell sends UV light at wavelengths 190, 280 and 330 nm corresponding to the energies 6.5, 4.4 and 3.8 eV. The interpretation as a kind of leakage of coherent light would conform with the identification in terms of BE condensates of dark photons with $\hbar_s/\hbar \simeq 2^{11}$ emitted at wavelengths varying in the range .3 – 1.25 mm and decaying to photons with energies visible and UV range. For instance, 1.82 eV radiation corresponds to a dark photon wave length of 1.4 mm for $v_0(eff) = 2^{-11}$. A bio-control of ordinary bio-matter at sub-cellular level performed by dark matter from the millimeter length scale could be in question. This proposal conforms with the fact that 1 mm defines the scale of the blobs of neurons serving as structural units in cortex.

The analysis of Kirlian photographs has shown that the pattern of visible light emitted by various body parts, for instance ear, code information about other body parts [81]. These bio-holograms for which a general model is discussed in [K4] could be realized as dark photon laser beams.

In phantom DNA effect [82] a chamber containing DNA is irradiated with a visible laser light and the DNA generates as a response coherent visible radiation at same wavelength. Strangely enough, the chamber continues to emit weak laser light even after the removal of DNA. This effect could be due to the decay of a dark photon BE condensate remaining in the chamber. Also the findings of Peter Gariaev [58] about the effects of visible laser light on DNA, in particular the stimulated emission of radio waves in kHz-MHz frequency range might also relate to dark photons somehow.

4.3.5 A connection with the scaling law of homeopathy

The value of the parameter $1/v_0 \simeq 2083$ is essentially the ratio of CP_2 radius and Planck length scale (as also the ratio of Compton lengths of electron and proton) and rather near to $2^{11} = 2048$.

Interestingly, much larger number $2 \times 10^{11} \simeq 3 \times 2^{36}$ appears in the simplest form for what I have christened the scaling law of homeopathy [K5]. This rule has been proposed on basis of experimental findings [54] but has no convincing theoretical justification. The scaling law of homeopathy states that high frequency em radiation transforms to a low frequency radiation and vice versa preferably with the frequency ratio $f_{high}/f_{low} \simeq 2 \times 10^{11}$.

The proposed hierarchy of dark matter and ensuing hierarchy of dark laser beams decaying into lower level beams might provide a deeper explanation for the scaling law of homeopathy. The factor 2×10^{11} is with 3 per cent accuracy equal to the integer $n_F = 3 \times 2^{36} \simeq 2.06 \times 10^{11}$ characterizing ruler and compass quantum phase. Hence the interpretation in terms of a phase transition leading from a phase with a large value of Planck constant $\hbar = n_F \hbar_0$ to ordinary phase is possible.

In [K5] I have discussed some mechanisms for the transformation of high energy photons to low energy photons consistent with the rule and proposed a generalization of the rule based on p-adic length scale hypothesis. For instance, high energy visible photons of frequency f could induce an excitation of the receiving system having same frequency, propagating with velocity $\beta = v/c \simeq 10^{-11}/2$, and having wave length equal $\lambda_0 = f/v = \lambda/\beta$. This excitation would in turn couple to photons of wavelength λ_0 and frequency $f_0 = \beta f$.

5 Plasmoids as life forms and dark matter

The idea that plasmoids defined as magnetic flux tube structures containing plasma could define primitive life forms emerged several years ago [M1, N1, N2, L4]. For about a year ago I experienced pleasant surprise while reading the news that plasmoids sharing basic signatures assigned to living systems appear in simple electric circuits [59].

The work with the model for the strange experimental findings about the behavior of rotating magnetic system involving a static magnet at center and smaller cylindrical magnets rolling along it (Searl machine) carried out by Russian researchers Godin and Roschin [61] led to a realization that this system might have in common with living systems very important basic function, namely remote metabolism based on time mirror mechanism [K1].

The first key element of the model was the rotating magnetic field generating radial vacuum electric field with a non-vanishing density of vacuum electric charge not possible in Maxwell's electrodynamics. This generates radial ohmic current charging the system and means that the fundamental prerequisite of self-organization is satisfied: there is feed of charge and energy forcing the system to self-organize with dissipation taking the role of Darwinian selector.

One of the strange features of this system is the appearance of cylindrical magnetic walls spaced at even intervals during the period when the rotational motion of the rollers accelerates spontaneously. The realization was that these magnetic walls provide energy and angular momentum via remote metabolism to the roller magnets. They could be also seen as a concrete example of magnetic body central in the TGD based model of living systems [M1, N1].

At that time I had not realized that the formation of the radial ohmic current is the quintessential property of the system as a self-organizing system, nor that the simple magnetic flux tube structure defining an elementary plasmoid, say topologically quantized magnetic dipole field, must rotate along its symmetry axis to generate radial ohmic current charging the core region containing the ordinary matter.

Neither had I discovered the possibility that Planck constant might be dynamical and quantized, and that dark matter and living matter would involve in an essential manner a macroscopic quantum phase with a large value of \hbar very naturally located at the magnetic flux tubes or walls emanating from the core region.

5.1 Charged plasmoids as primitive life forms

The simplest primitive life form could consist of a topologically quantized magnetic dipole field for which magnetic flux tubes are replaced by rotating magnetic walls emanating from an extended dipole region. One can consider also separate flux tubes emanating from the extended dipole spinning synchronously around their axes but synchronous spinning might be not represent as stable a situation as magnetic walls.

The region containing the physical counterpart of the extended dipole would be analogous to the stator magnet in Searl's device and carry ordinary matter. If magnetized, this matter can amplify further the magnetic field created by the dark matter. Flux tubes/magnetic walls would contain magnetized dark matter in a spinning/rotational motion creating a rotating magnetic flux along the dipole lines flowing to the central dipole core visualizable as bar magnet. If matter creates magnetic field, it is forced to co-rotate and amplifies the rotating magnetic field in the matter region. The rotation/spinning in turn generates the over-all important radial Ohmic current forcing self-organization in the matter system ("bar magnet") and leading to bio-molecular evolution with Darwinian selection performed by dissipation.

5.1.1 Plasmoids and universal metabolism

As far as metabolism is considered, this configuration is ideal in many respects.

1. Dark matter behaves quantum coherently and makes spin flip transitions and cyclotron transitions coherently. As a consequence, the resulting magnetic field is highly stable and individual contributions add up coherently rather than tending to cancel each other.
2. The dark matter part of the system can apply remote metabolism using time mirror mechanism, that is send negative energy (phase conjugate) dark photon laser beams to a power source generating radiation at spin flip frequency or more general magnetic transition frequency. Of course, there must be mechanism kicking the particles back to the original space-time sheets: otherwise over unity mode cannot last for long.
3. Since \hbar is large, the cyclotron energy is also higher than usually by a factor \hbar_s/\hbar . Because of their small mass electrons are obviously ideal in this respect. Ordinary matter would in turn receive metabolic energy by receiving positive energy dark laser pulses from the dark matter. An especially interesting option is dropping of electrons, protons or other ions to larger space-time sheets from the space-time sheets associated with the core region of dipole containing ordinary matter. This means a spectrum of universal metabolic energy currencies. Dark matter would act essentially as a negentropy source forcing coherence to the behavior of the material system. Second law need not be broken since it applies with respect to subjective time defined by the quantum jump sequence (geometric time reversal makes decay process to look like self assembly).

5.1.2 Formation of small \hbar versions of atoms as a source of energy

The experiments of Mills [51] suggest fractionization of hydrogen atom energies in plasma state. The simplest explanation is as a phase transition changing the value of Planck constant to $\hbar = (n_a/n_b)\hbar_0$ with $n_a/n_b < 1$ leading to the increase of binding energy scale by a factor $(n_b/n_a)^2$. For $n_b/n_a = k$ one obtains the states reported by Mills. As suggested in [F9], this phase transition could proceed via a formation of q-hydrogen atoms allowing fractional energy states with $n = 1/2$ and $n \simeq 1/k$, $k = 3, 4, \dots$. The transformation of ordinary matter to small \hbar matter would provide an ideal mechanism for generating energy and plasmoids could apply also this mechanism. The general systematics seems to be that formation of large \hbar phases requires metabolic energy

whereas formation of small \hbar phases provides ordered energy. This conforms with the general thermodynamical picture.

5.1.3 Plasmoids, bio-molecules, and living cells

The basic properties of plasmoids make obvious the basic properties of bio-molecules and of living cell difficult to understand in the framework of the standard chemistry.

1. The rotation of the magnetic field generates a radial electric field with a non-vanishing divergence (vacuum charge density whose sign depends on the direction of rotation), which in turns induces an Ohmic current, which forces self-organization with dissipation acting as a Darwinian selector. The Ohmic current also gradually generates charge in the material system. For some critical charge di-electric breakdown occurs in which electrons, protons and possibly other ions drop from the space-time sheets associated with the system and liberate zero point kinetic energy which can be utilized by the dark matter part of the system applying time mirror mechanism. The metabolic energy quanta are universal and the usual $\sim .5$ eV quantum liberated in the dropping of proton from the atomic space-time sheet represents only one instance in the hierarchy of metabolic energy quanta.
2. Parity breaking is an automatic consequence since the sign of the charge of the system depends on the direction of rotation. In fact, the presence of classical Z^0 magnetic fields prefers second direction of rotation and induces parity breaking. The ordinary chiral selection in living system would be induced by this fundamental chiral selection. Linear bio-molecules are indeed excellent candidates counterparts for the stator of the Searl machine with the magnetic flux at magnetic walls carrying the dark matter and defining the magnetic body of the bio-molecule. Chiral selection implies that bio-molecules are charged and the sign of charge is always the same. Bio-molecules like DNA and proteins are always negatively charged.
3. The model predicts the basic properties of cells. The space-time containing plasmoids carries negative charge by parity breaking. Living cells are indeed negatively charged and this property is necessary for the presence of the resting potential. Nerve pulses could have developed from di-electric breakdowns occurring in the system under continual generation of charge. The spherical capacitor like system defined by a membrane like outer boundary allows a simple realization for a sensory receptor in which di-electric breakdown produces sensory qualia identified as quantum number increments of interior of the cell like structure in the process [M5].
4. During the cell division (for an animation see [60]) cell exhibits a structure which brings in mind a dipolar magnetic field replicating itself by a process in which the dipole lines containing the dark matter are pinched in the middle plane of the center dipole. Essentially the analog for the splitting of bar magnet to two bar magnets would take place: hard to imagine anything simpler. This process occurring also in molecular length scales would be accompanied by a complex molecular replication developed during the chemical evolution.

5.1.4 Could microwave induced ionization distinguish between the chemistries of living and dead matter?

TGD inspired explanation for microwave induced ionization is following.

1. A rotating approximately dipole magnetic field is generated and the induced radial Ohmic current generates a negative charge at the space-time sheet carrying the magnetic field inside

the region corresponding to the magnet. This space-time sheet corresponds to a space-time sheet larger than $k = 137$ space-time sheet associated with the electrons of the atoms of air.

2. The microscopic mechanism generating the radial Ohmic current involves the dropping of electrons of surrounding air from $k = 137$ atomic space-time sheet to the space-time sheet of the magnet and drifting to the region of magnet. The electron in question must have a small kinetic energy so that the large zero point kinetic of electron at $k = 137$ atomic space-time sheet must be emitted as a virtual X ray and be absorbed by a second atom or molecule of air: two-particle process is required by the momentum conservation.
3. The zero point kinetic energy of electron is $\sim .94$ keV for $k = 137$ atomic space-time sheet and is enough to induce the ionization of C, O and N molecules (for N the ionization energy of $n = 1$ electron is .87 keV according to Bohr model). The energetic electrons from the ionized atoms in turn excite and ionize further atoms and molecules. That the zero point kinetic energy of $k = 137$ electron is enough to ionize $n = 1$ inner non-valence electrons of C, O and N atoms but not those of heavier atoms, might distinguish them from the chemically similar atoms Si, P and S in the next period of the periodic system and relate to their role as basic building blocks of bio-molecules. A kind of primitive metabolic symbiosis between C, O and N atoms and plasmoids leading to the evolution of more complex bio-molecules would look like a natural outcome of the self-organization process induced by the radial Ohmic current.
4. Molecules containing P ions ($Z = 15$) have exceptional role in the ADP-ATP cycle, and the ionization energy of $n = 2$ electron of P differs by a factor $(15/16)^2$ from that for $n = 1$ electron for O . Hence one can wonder whether for the P^+ ions of living matter might lack the inner $n = 2$ electrons of P and possess all valence electrons and whether same might apply to Na^+ and Mg^+ with $Z = 11$ and 12 . K^+, Ca^{++}, Mn^+ and Fe^{++} with $Z = 19, 20, 25$ and 26 important for the functioning of living matter might be produced by the same ionization mechanism. The ionization energies of $n = 3$ electron of Mn and Fe are nearly equal to that of O . The proposed ionization mechanism is not able to ionize atoms with $Z \geq 40$.

To sum up, the question raised by these consideration is whether the microwave induced ionization of the inner atomic electrons could distinguish between the chemistries of living and dead matter.

5.1.5 Generalizations

Topological quantized dipole magnetic field represents a candidate for the simplest life-form that one can imagine. TGD however predicts several closely related dynamical hierarchies. There is a hierarchy p-adic length scales quantifying the hierarchy of space-time sheets: to each level it is possible to assign a "magnetic body" generalizing the notion of rotating magnetic walls and inducing radial Ohmic current forcing self organization at corresponding space-time sheet. There is a hierarchy of dark matter in which dark matter systems of given level form Bose Einstein condensates at the new level. There is also a hierarchy of cognitive representations for which TGD predicts even S-matrix from the general structure of von Neumann algebras and inclusions [C6].

All these hierarchies have space-time correlates and the key features of the model of plasmoid as life form in principle generalize to more complex cases. In particular, the notion of magnetic body with size defined by the wavelength of EEG waves, and even hierarchy of larger magnetic bodies, makes perfect sense in this framework. The mysterious dark matter would solve the riddle of life.

5.1.6 How to detect the magnetic body of the plasmoid?

Plasmoid should possess a magnetic body consisting of flux quanta which could be flux tubes and/or flux sheets. Rotating magnetic systems studied by Godin and Roschin [93] are reported to involve cylindrical magnetic walls with thickness of about 5 cm and distance between walls about 5. m. Also a formation of plasma phase and cooling of the the air near the rotating systems is reported. Hence the interpretation in terms of a formation of plasmoid might make sense.

If plasmoid is moving the flux quanta of the magnetic body should pass through a stationary magnetometer and induce magnetic pulses whose duration is inversely proportional to the velocity of the motion of plasmoid. Dave Akers has studied the anomalous luminous phenomena (ALPs) in Yakama Indian Reservation at Toppenish, Washington [94], and has detected sequences of magnetic pulses with a wide range of durations possible assignable to ALPs. The intensity of the magnetic pulse is typically in the range 15-25 mGauss but also intensities of .3 Gauss have been detected. Recall that the intensity of magnetic fields associated with effects of ELF em fields on vertebrate brain is .2 Gauss.

Magnetic pulses could be quite generally a signature of the magnetic body, and it would be interesting to find whether a magnetometer moving with respect to a living organism might record sequence of magnetic pulses.

5.2 Plasmoids, tornadoes, lightnings, and ball lightnings

The notion of plasmoid provides also a model for tornadoes, generation huge voltages in thunder storms, lightnings, and ball lightnings.

5.2.1 Development of thunder clouds and plasmoids

With the advent of advanced measurement techniques lightnings are beginning to look increasingly mysterious [64]. For instance, in the framework of standard physics it is very difficult to understand the huge voltages generated in thunder clouds, and how the electrons flowing to ground during lightning can gain the observed immense energies as indicated by the detected emission of X rays [65]. Even more, intensive gamma ray bursts are associated with lightnings and precede them by about 1 microsecond [66].

The arguments which led to a more precise formulation of the notion of plasmoid were actually stimulated by the idea that the generation of the polarization of thunder cloud might involve the formation of pairs of positively and negatively charged plasmoids. The rotating magnetic field would induce the radial Ohmic current in the core of a dipolar magnetic field configuration of plasmoid and induce large plasmoid charge. If only the negatively charged plasmoids are stable, the base of the thunder cloud would contain plasmoids and top positive charge as ordinary ions.

If the water is partially dark matter in the sense that protons of nuclei can be in a phase with a large value of \hbar , one could understand why the presence of water (generation of clouds) is an essential prerequisite for the formation of plasmoids.

Consider now the explanation for the gamma rays. An acceleration of electrons or dark electrons could occur in the strong electric field of thunder cloud either to the direction of positively charged ground or of positively charged top of the cloud and generate brehmstrahlung. This mechanism should explain the X ray bursts observed on ground and gamma ray bursts observed in upper atmosphere.

The problem from the point of view of standard physics is that the acceleration of ordinary electrons in the atmosphere involves dissipation and cannot yield gamma rays. Situation would be different for a macroscopic quantum phase of electrons at larger space-time sheets. In a(n idealized) static situation the potential difference between two points at which two space-time sheets are in contact is the same irrespective of along which space-time sheet it is taken so that the strong

electric field is indeed present also at larger space-time sheets. A coherent acceleration of block of N_{cr} dark electrons would lead to an emission of BE condensates of dark gamma rays decaying to N_{cr} ordinary gamma rays. The charge-over-mass ratio is same as for an ordinary electron so that the acceleration is same and the overall energy scale of emitted gamma rays is predicted to be same as for ordinary electrons.

5.2.2 Ball lightnings and plasmoids

Plasmoids from the base of the thunder cloud could drift to the surface of Earth in the radial electric field of Earth. Space-time sheets containing negatively charged plasmoids could correspond to ball lightnings. The negatively charged ball lightnings would be attracted by the Earth's electric field so that the usual counter argument that light plasma balls should raise up in the air unlike ball lightnings which fall down, can be circumvented. The spectrum of sizes of ball lightnings would range from molecular length scales to macroscopic length scales, and an interesting experimental challenge is to find whether micro plasmoids are produced copiously during thunder storms.

Thunder storms occurred continually in the primordial atmosphere and could have created abundantly negatively charged ball lightnings. This picture raises obvious questions. Did biological life develop from molecular and cell sized ball lightnings by some stabilization mechanism? Or could small ball lightnings be inherently more stable than large ones? Did large ball lightnings decay to smaller ones? Did the plasmoids find a safe seat where the continual feed of metabolic energy needed to kick electrons and other charged particles back to smaller space-time sheets was guaranteed?

5.2.3 Tornadoes as plasmoids

Also tornadoes might be regarded as primitive life forms involving the rotating core, which would correspond to a spiral helix containing ordinary matter in rotational motion and return flux walls containing the dark matter. Both ordinary and Z^0 magnetic fields would be involved. The dropping of charges to larger space-time sheets would serve also now as a source of metabolic energy. Tornadoes are indeed known to develop charge and intense emission of light, in particular blue light suggesting collisions of molecules of the atmosphere with highly energetic electrons, is often reported.

The rotation of convective eddies makes them natural candidates for seeds of tornadoes defining natural candidates for primitive life forms serving as templates for the formation of more complex life forms. Interestingly, tornadoes are now known to appear abundantly in Mars [67]. They are about 10 km tall, one kilometer across, and throw up clouds of dust and spray lightning bolts. These "red devils" could make the Martian atmosphere not only a dangerous place for humans, but also a laboratory for the study of the simple predecessors of more complex life forms.

5.2.4 Ball lightnings created in microwave oven

As I proposed for years ago that microwaves, typically associated with magnetic transitions in external magnetic field, could serve as "food" of plasmoids just as ordinary light serves as "food" of plants, some pragmatic soul wondered whether these plasmoids could be created in microwave ovens. It did not occur to me to type to search engine something like "plasma" and "microwave oven". When I realized the connection with between plasmoids and rotating magnetic systems needing a feed of microwave radiation to rotate the magnetic field, I did this and Google told me that any one can generate ball lightnings in his own microwave oven [63]!

The simplest procedure is to put a vertically oriented burning match into oven. More generally, it seems that a source of carbon polymers, in this case cellulose, must be used. The resulting plasma balls last for seconds and raise upwards unlike ordinary ball lightnings. Either the air heated by

the burning and rising upwards yields a lift winning the attraction of Earth's electric field or the plasma ball has a positive charge.

By adding various elements to the system it has been found that their emission lines appear in the spectrum of light emitted so that either a high temperature plasma is involved or the highly energetic electrons dropping to a larger space-time sheet excite the atoms and molecules of the air without necessary heating it.

Consider now a model for the situation based on the formation of light ball containing plasmoids.

1. Plasmoids would be most naturally associated with the macromolecules of the cellulose. Heating would lead to their evaporation from the burning match.
2. Microwaves provide the metabolic energy guaranteeing the rotation of the magnetic field. The mechanism would be the emission of negative energy dark photon maser beams from dark matter at the rotating magnetic walls associated with the molecules: microwave radiation would to some extent bring the organic molecules back to life. This is absolutely essential in order to put the magnetic field in rotation. In living matter bio-molecules themselves are expected to generate the microwave radiation: for instance, the conformational dynamics of proteins and dark matter super-molecules and condensed dark matter generate microwave radiation. Also the dropping of ions from suitable space-time sheets can do the same trick.
3. The material evaporated from the burning match should define the conductive medium carrying the crucial radial Ohmic current. Electrically charged organic macro-molecules, such as DNA, are known to act as conductors [62] and also cellulose molecules could do so. The dropping of electric charges from core region liberates metabolic energy and produces the plasma phase.
4. Microwave ovens utilize microwave frequency 2.54 GHz, which corresponds to 11.4 cm wavelength belonging the wavelength interval .3 mm-30 cm coupling strongly to bio-molecules. This frequency corresponds to an electronic spin flip frequency in a field of .2 Tesla, which corresponds to magnetic length (roughly the radius of magnetic flux tube carrying single flux quantum) of order 100 nm, a sub-cellular length scale and possibly assignable to the linear macromolecules evaporated from the match during burning.

For dark electrons the field needed would correspond to $B \sim 10^{-4}$ Tesla, that is $B \sim 2B_e/X$, where B_e denotes the Earth's magnetic field. That Earth's magnetic field could be in question, conforms with the view that dark matter self-organizes around the flux tubes of the Earth's magnetic field and controls ordinary matter associated with organic molecules carrying much stronger magnetic field. The fact that the magnetic field has disappeared from Mars might relate to the recent absence of higher life forms.

5.2.5 Jean Naudin's glow discharge plasma panel power tests

The measurements performed by Jean Naudin [68, 69, 70] are related to the work of Industrial Plasma Engineering Group of the UTK Plasma Sciences Laboratory, which has been supported by NASA Grant NCC 1-223 since October 1, 1995 to develop the applications of a One Atmosphere Uniform Glow Discharge Plasma (OAUGDP) to aerodynamic boundary layer and flow control. These and related applications are described in U. S. Patent 5,669,583, "Method and Apparatus for Covering Bodies with a Uniform Glow Discharge Plasma and Applications Thereof". Wind tunnel measurements for this research were taken in the 7 X 11 inch Low Speed Wind Tunnel of the NASA Langley Research Center's Fluid Modeling and Control Branch, Hampton, VA. More references to the phenomenon can found on Naudin's web pages.

The basic observation behind the experiments is that microwave radiation induces ionization of the air in front of the wing and this in turn reduces the drag. The mechanism of the microwave

induced ionization of air by the mechanism generating the radial Ohmic current carrying electrons from the surrounding air to the space-time sheet of the magnet has been already discussed, and was found to allow the ionization of atoms with nuclear charge not higher than $Z = 8$ so that C , O and N atoms are indeed ionized.

The electrons at the magnetic walls are an essential element of the system taking care of the preservation and rotation of the dark matter magnetic field. The energy needed for this is sucked from microwave power source by time mirror mechanism by sending phase conjugate laser beams of negative energy dark photons decaying into ordinary negative energy photons absorbed by the power source.

Jean Naudin has studied a system that he calls glow discharge plasma panel (GDP panel) [68] in an attempt to understand what happens in the generation of plasma by microwaves (see Figs 5.2.5 and 5.2.5). The system studied consists of a primary system generating pulses at frequency of ~ 6 kHz coupled via an ignition coil to a GDP coil containing no magnetic core. The GDP panel starts to glow and generates a plasma discharge in the surrounding air. The system is interesting since it could provide information allowing to develop a more detailed model for rotating magnetic systems and plasmoids.

The findings of J. Naudin relate to the behavior of currents breaking the basic rules of circuit theory, in particular the conservation of current. The resolution of the strange findings is based on the presence of the radial ohmic current in the GDP coil implying an exchange of charge with the surrounding air and also with the secondary ignition coil along the flux tubes of mutual induction magnetic field connecting these systems.

1. How the rapid oscillating part of the current through the secondary ignition coil is generated

The measurements [69, 70] show that in a closed circuit containing the secondary coil of ignition coil and GDP (glow discharge plasma) panel the voltage V measured through the panel oscillates smoothly with a period of ~ 6 kHz (see Figs 5.2.5 and 5.2.5). On the other hand, the current I through a resistor below the secondary coil of ignition coil oscillates rapidly and the amplitude of oscillation fluctuates wildly when the magnitude of V is in certain critical interval. Also the correlation between V and I disappears during oscillations as the Lissajous figures demonstrate (see Figs 5.2.5 and 5.2.5).

Charge conservation requires that the secondary coil of the ignition coil must exchange charge with some system. What comes in mind is that there is oscillatory exchange of charge with the GDP coil.

Since the current through the resistor flows to the GDP coil and the voltage V through it is smooth, there must be some compensation mechanism which takes care of this. The only thing that one can imagine is that following one. The oscillating current to GDP coil generates an oscillating part to the magnetic field through the GDP coil. This in turn induces an oscillating part to the radial ohmic current. If all of this oscillating current runs to the secondary of ignition coil it is in principle possible to have a situation in which the oscillating radial current compensates the effects of the oscillating ohmic current so that V remains smooth.

2. Why the magnitude of the output current from GDP coil is than the magnitude of the input current?

The magnitude of the output $I_{GDP,out}$ current from the GDP coil is by a factor ~ 3 larger than the input current $I_{GDP,in}$ to the GDP coil. One can understand also this in terms of the current non-conservation caused by the radial Ohmic current.

The parity breaking implied by the classical long range Z^0 force is expected to favor second direction of rotation for the magnetic field and thus either positive or negative net charge for the GDP foil. Bio-molecules and cells, which provide basic examples of plasmoids, are negatively charged. If this holds also now, the radial Ohmic current tends to reduce the electron current

running from output of GDP to its input associated with the rotating magnetic field since the current wire can provide electrons to the interior of the GDP coil.

There is however a problem. When the electron current flows from GDP input to output, input current should be larger than output current: this does not occur. Obviously, the direction of the rotation of the magnetic field should change during the second half of the oscillation period of ~ 6 kHz. The magneto-static frequency is given by $\omega_{GDP} = \pm eH_{GDP}/m_e$, where H_{GDP} corresponds to the magnitude of the magnetic field created by the current I_{GDP} . The change of sign is indeed possible if H_{GDP} is proportional to I_{GDP} so that it varies in an oscillatory manner during ~ 6 kHz period of oscillation. If ω changes sign when H_{GDP} changes its direction, the behavior of the radial current is oscillatory. H_{GDP} is proportional to $\int V_{GDP} dt$ in the approximation that the charge leakage due to the radial ohmic current is neglected.

3. The rapidly oscillating current through secondary ignition coil as a resonant coupling with GDP coil

The wildly oscillating part to the current and the loss of $V - I$ correlation appears in certain critical range of absolute values of the voltage V (see Figs 5.2.5 and 5.2.5). This conforms with the assumption that a magneto-static wave is generated in the ignition coil. The frequency of this wave is given by

$$\omega_I = \sqrt{\omega_{H_I} \times \omega_{H_I+M}} ,$$

where M corresponds to the contribution to magnetic field from permanent magnetization of the ignition coil and H_I from the current. Also this frequency changes its sign during ~ 6 kHz period. The resonance is achieved for

$$\omega_I = \omega_{GDP}$$

so that the resonant current flow between the two systems occurs only in some range of voltages V for which the resonance condition is approximately satisfied.

The simplest assumption is that the charge flow between secondary ignition coil and GDP coil results from the dropping of electrons to the magnetic flux tubes of the mutual magnetic induction connecting the secondary ignition coil and GDP coil. At these coils the rotation of the magnetic field corresponds to spinning.

Naudin assumes that the rapid periodic oscillation corresponds to the onset of a plasma generation. Due to the shortness of the period of oscillation this assumption cannot be justified on basis of visual observations. In TGD framework this period corresponds to the onset of a rapidly oscillating component in the radial Ohmic current, whereas the slowly varying component is present all the time.

4. The output current from GDP coil is reduced when the resistance in the output is increased

A further anomalous feature from the point of view of ordinary circuit theory relates to the output current from GDP. Several independent measurements give the value ~ 80 mA for the GDP output current using 10 Ohm resistor and thus a power consumption of .8 Watt. On the other hand, the temperature of 100 Ohm resistor raises only by 2 Kelvins during 2 minutes. This means that the current through the 100 Ohm resistor must be much smaller than 80 mA through 10 Ohm resistor. This is not possible in standard circuit theory.

The resolution of the paradox is based on the presence of the radial Ohmic current. Current flow tends to favor the route of minimal resistance. If the value of the resistance is increased by a factor of 10, the portion of the radial Ohmic current going along the GDP wire is reduced and a larger portion of the current leaks to the surrounding air (its space-time sheet).

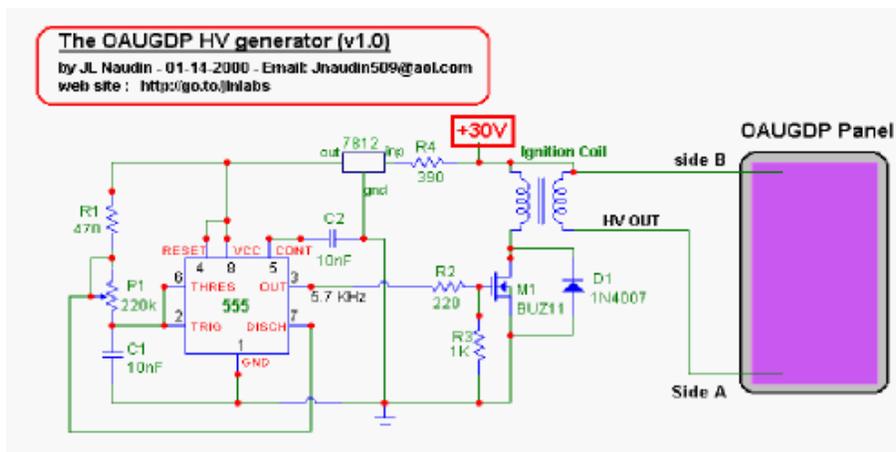


Figure 1: The figure illustrates the circuit used in Naudin's experiments. GDP coil does not have a magnetic core.

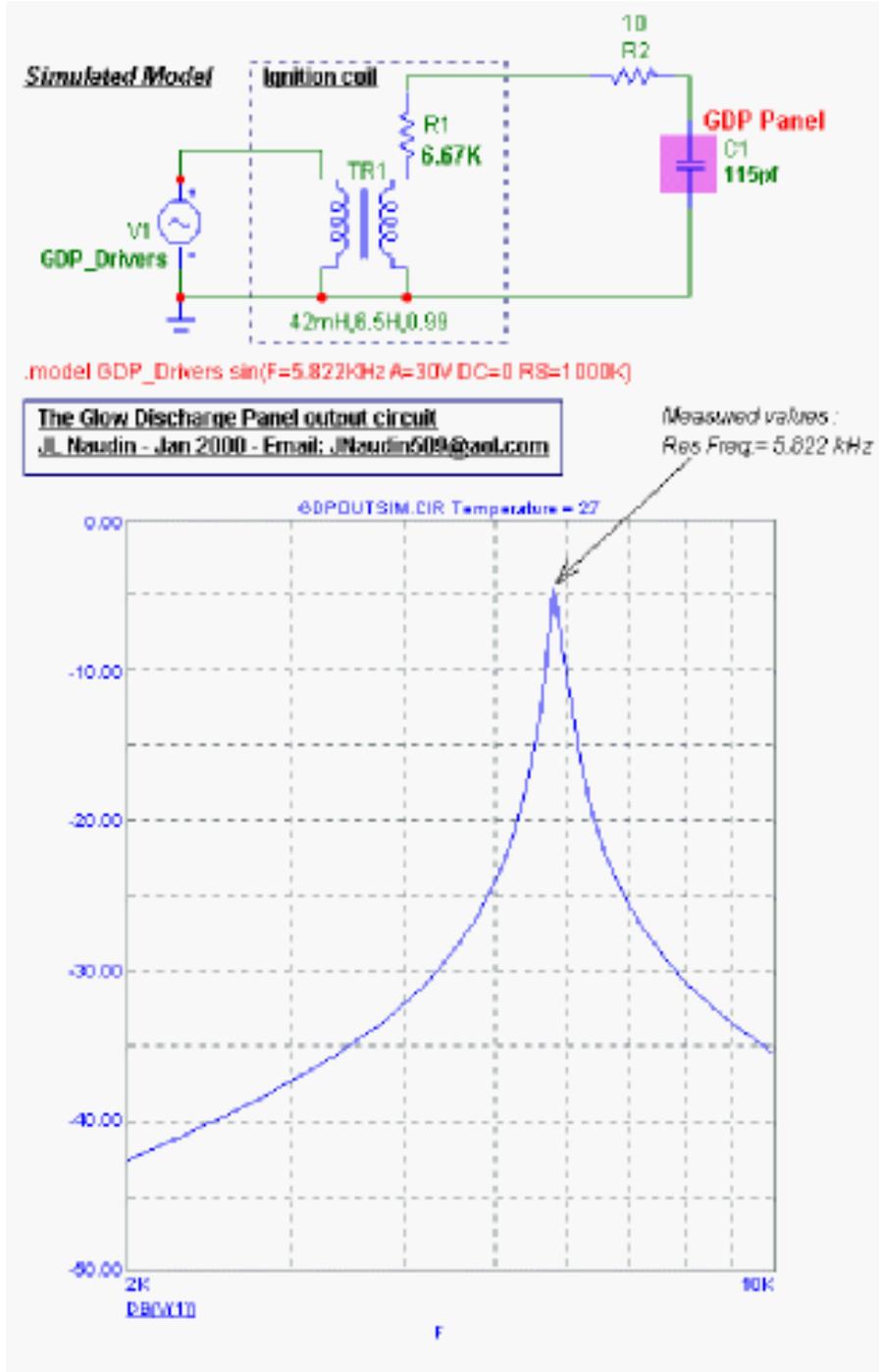


Figure 2: A schematic description of the experimental arrangement used by Naudin and the frequency distribution of current peaking around 5.822 kHz.

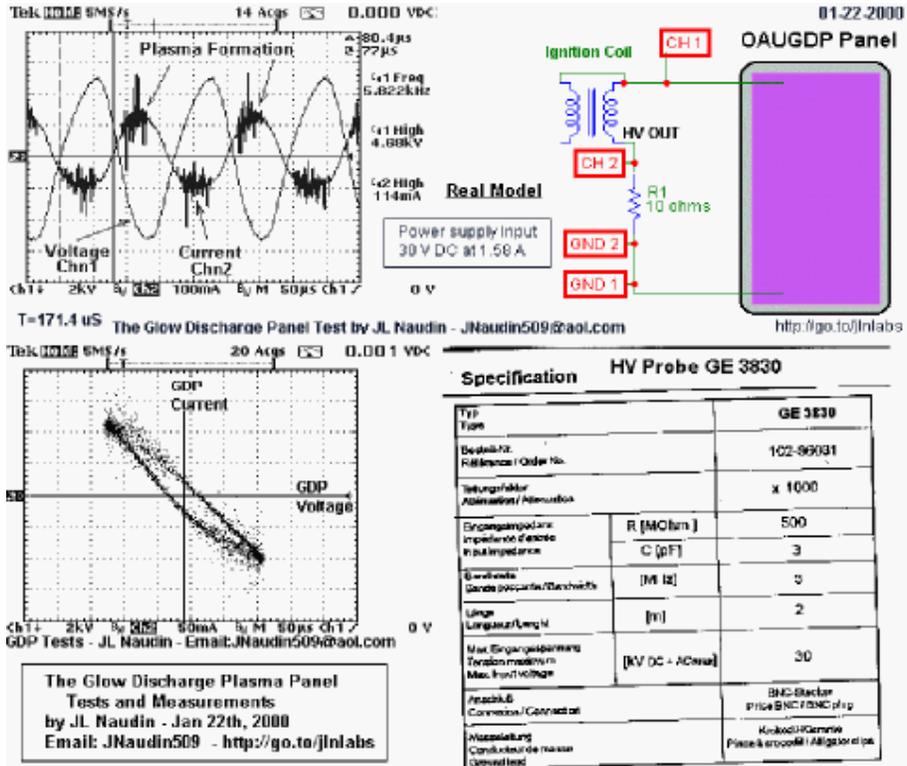


Figure 3: The figure illustrates the voltage V over the GDP coil and the current I through the 10 Ohm resistor as well as the Lissajous figure for expressing the correlation and phase relation between V and I . Note that V does not exhibit the rapid oscillation and that $I - V$ correlation disappears as the rapid oscillation appears in the current. V and I have same sign in the region where $I - V$ correlation is lost to high degree.

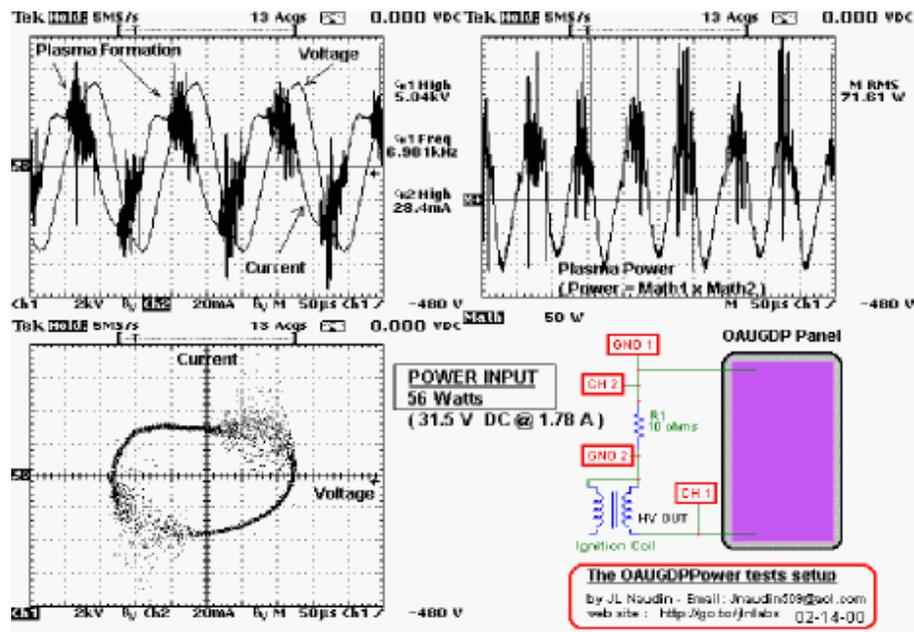


Figure 4: Second example of a similar measurement based with slightly different values of input DC voltage and current. Note that I and V have *opposite* sign over almost entire Lissajous figure, in particular in the region where $I - V$ correlation is lost to high degree.

5.2.6 Crop circles and plasmoids

During its development the idea about microwaves serving as a "food" of plasmoids found support from various sources. Intelligently behaving light balls are standard stuff of UFO reports. Plasma balls are also often reported to be associated with crop circles [71] (for a TGD based model of crop circle formations see [N2]).

Crop circles tend to appear in regions where the soil has a high concentration of calcium carbonate (lime stone) and is therefore electron rich meaning that the generation of negatively charged plasmoids is easier. Magnetic material is found in two thirds of the cases studied confined in regions of radius about .5 m.

Microwaves generated by plasmoids provide also the mechanism leading to the downing of crops. In regions where crops are flattened, there are clear alterations in growth nodes in the crop formation areas [72]. In particular, an expansion of growth nodes relative to normal is observed: this expansion is about 115 per cent for regular and 200 per cent for the irregular crop formations. Also tufts of standing plants within formation have node expansions equal to or exceeding the expansion level in flattened plants. Expanded nodes contain expulsion cavities which can be understood as resulting from a rapid and intense heating by micro-waves causing pressure buildup [72]: cellular components have literally blown out through epidermal cell walls. Node expansion is also accompanied by a bending. This suggests that the node expansion makes possible the downing of the crops.

5.3 Earth's magnetosphere as a gigantic plasmoid: did life evolve in the womb of Mother Gaia?

For a couple of years ago I studied a highly speculative scenario for a pre-biotic evolution involving plasmoids in an essential manner [L4]. The scenario led also to a model for the evolution of genetic code and DNA. The vision was inspired both by the problems of existing scenarios for pre-biotic evolution as well as by the ideas inspired by the work with crop circles [N2].

The crazy sounding idea, which I still find impossible to represent without some tongue in cheek, is that in many-sheeted space-time (and only here!) the interior of Earth could serve as a seat for plasmoid like life forms. Boundaries between two phases are always the regions where strong gradients appear and thus also intense self-organization occurs, and the boundary between solid mantle and liquid core is especially interesting as far as the evolution of plasmoid life forms is considered. The metabolic energy would be provided in this kind of environment continually by the dropping of particles from the hot space-time sheet carrying the molten iron.

The question is whether the creation of plasmoids in thunder storms is consistent with the idea that life evolved in the interior of Earth. To get some perspective one can pose first pose the question about whether Sun could provide X ray energy kicking electrons to atomic space-time sheets in some regions of atmosphere.

X rays are indeed emitted by Sun, by planets including Earth, and even by comets [73]. The formation of solar Corona and emission of X rays from it has remained more or less a mystery. The dropping of electrons to larger space-time sheets is a natural explanation for both the formation of corona consisting of highly ionized plasma in high temperature and for the emission of X rays from Corona [D6].

Plasmoids in the corona could provide a mechanism producing these X rays which supports the earlier suggestion that primitive plasmoid like life could flourish even under the extreme conditions of solar corona. X rays would be emitted by excited neutral and partially ionized molecules. The ionization and excitations would be produced in the collisions of highly energetic electrons dropped from $k = 131$ and $k = 137$ space-time sheets to larger space-time sheets (zero point kinetic energies are around 64 keV *resp.* 1 keV in these two cases). The dropping can also liberate highly energetic photons that can kick electrons back to the atomic space-time sheets of plasmoids.

X ray radiation from Sun reaches only the upper atmosphere down to height of about 40 km and ionizes it (the outcome is so called E layer) whereas the height at which thunder clouds develop is about 10-20 km. E layer could contain plasmoids but it is not clear whether solar X rays could supply metabolic energy for plasmoids in thunderstorms by kicking electrons back to the atomic space-time sheets. It might be that the lifetime of the primitive life forms in upper atmosphere and thunder storms is not longer than single day. If this the case the plasmoids would have excellent reason to penetrate to the interior of Earth.

The hypothesis that life in the biosphere has matured in the womb of Mother Gaia would solve several difficult problems of the standard scenarios of chemical evolution. The very notion of plasmoid alone could solve several basic problems since it replaces the dissipative energy feed with a precisely defined radial Ohmic current tailored for the individual anatomy of matter carrying space-time sheet, defines a hierarchy of universal metabolic energy currencies, and predicts pre-existing complex topological information carrying patterns defined by the magnetic bodies.

The problem is how to guarantee continual metabolism and sufficiently long life-time for plasmoids. The minimal requirement is radiation feeding energy to the dark matter magnetic transitions and highly energetic photons kicking ions back to the atomic space-time sheets. The space-time sheets in the interior of Earth could define a warm and safe womb for the life to evolve through the first crucial stages of chemical evolution when the chemical metabolic machinery including the ability to store photonic energy as chemical energy does not yet exist. In the many-sheeted space-time Earth's surface need not define an in-penetrable wall for plasmoids generated during thunder storms, and they could leak into the interior of Earth without difficulty (a metaphoric counterpart for fertilization).

This vision must sound absolutely bizarre in the mind set of simple standard physicist producing publications in single sheeted space-time but is perfectly natural in the fractal view in which also Earth's rotating magnetic field would naturally give rise to radial Ohmic currents and self organization in the interior of Earth. Magnetosphere would contain dark matter and be responsible for the higher levels of consciousness and serve as a seat of intentional action in accordance with the general vision [M1, N1]. EEG could be seen as a tool of commutations between brain and magnetosphere, and the strange delays of conscious experience [74] very difficult to understand in the framework of standard neuroscience have an elegant explanation in terms of finite signal velocity [K1].

5.4 Is the transformation of ordinary matter to dark matter possible in macroscopic length scales?

Even the possibility to transform ordinary matter to dark matter molecular length scales would have dramatic implications. For instance, it would give substantial support for the vision that the magnetic body of the Earth's magnetic field or its dark counterpart carrying the field $B_{end} = 2B_E/5$ serves as a circuitry allowing the transfer of bio-molecules in the length scale of magnetosphere [L4]. Note that the endogenous magnetic field $B_{end} = .2$ Gauss rather than B_E with nominal value of .5 Gauss (as was the original erratic belief) explains the effects of ELF em fields in vertebrate brain in terms of cyclotron transitions. The model for these effects inspires the hypothesis that flux quanta of B_E is accompanied by those of B_{end} carrying dark matter with scaled up value of Planck constant $\hbar = n\hbar_0$ [M3]. For B_{end} one would have $n = 5$.

The finding that rotating magnetic systems generate magnetic walls [61] and the hypothesis that these walls carry dark matter provide good clues about how to achieve this kind of phase transition. The model for plasmoids as primitive life-forms involving rotating magnetic fields relies on this finding. Plasmoids themselves might be able to transform to dark matter. Shoulders discovered the existence of micron sized negatively charged clusters containing about 10^{11} electrons and about 10^6 ions which he reports to be able to transform to a invisible form [76, 77].

The possibility to perform this transformation for macroscopic objects would have even more dramatic implications since the objects in dark matter phase would pass through ordinary solids without any difficulty. The first implications that come in mind relate to technology (manipulation of properties of condensed matter from interior), to medicine (many-sheeted surgical operations), and research of large condensed matter systems (say the study of Earth's interior).

5.4.1 Are macroscopic visible-to-dark phase transitions possible?

One can wonder whether visible-to-dark phase transition could occur also spontaneously in macroscopic length scales. There is indeed quite a lot of documented evidence.

1. Hutchison effect [78] involves a catastrophic fracture of metal samples when posed to a radiation. Also physical objects of different composition were reported to become inexplicably embedded in each other once these objects were radiated. For a couple of years I discussed a model for this effect in [G1]. The phase transition involved with this model was not identified as ordinary-to-dark matter transformation but the basic many-sheeted mechanism inducing the temporary transparency is essentially the same.
2. The appearance of human made artifacts in places where they should not occur is this kind of effect. There are a lot of reports for this kind of artifacts [99, 100, 79]. These reports can of course be claimed to be just folklore. On the other hand, many of these artifacts are in museums and precise reports about where they were found exist. There are also reports about this kind of objects in journals like Scientific American [96] and Nature [97]. Hence one must consider seriously the possibility that the stories about artifacts in wrong place are real. Creationists have used these artifacts as an objection against Darwinian view about evolution and as a support that the actual age of universe is not more than what Bible tells. This kind of explanation is very difficult to take seriously by anyone with basic knowledge about science. T. Twietmeyer [79] has proposed that a transformation of the ordinary matter to a form in which it can pass ordinary matter is involved with these phenomena.

Man-made objects are reported to appear in so old archeological layers that even our species did not yet exist. The ages of the artifacts discussed in [99, 100, 79], if really the same as that of environment, vary from 50.000 years up to 300 million years.

Artifacts have been found inside rock, inside geods which are small spherical stones with hollow interiors lined with crystals, and inside coal. Examples of artifacts found are an object which seems to be a candlestick holder [96], "coin", nails, screw, an object which resembles spark plug [101], a strange cube like object made of iron [97], metal nodules, gold chain, iron pot, brass bell, etc...

Tornadoes are reported to induce transfer of human made artifacts to places where they should not exist [79]. A piece of field straw penetrating through a window pane without breaking it has been reported. According to second report, a rubber tire which was not cut appeared after tornado surrounding a telephone pole that had a wooden crossbar and power lines on top. This kind of topological impossibilities would be a clear-cut signature of the ordinary-to-dark phase transition. Tornadoes are indeed basic examples of primitive living systems involving rotating magnetic and Z^0 magnetic fields and thus generating magnetic walls or more general rotating flux quanta containing dark matter.

5.4.2 TGD based explanation for artifacts in wrong places

The TGD based mechanism explaining the findings would be the transformation of the artifact to dark matter phase (its mass would not be changed appreciably) and subsequent free fall in the gravitational field of Earth in the case that the object still feeds its gravitational flux to the space-time sheet carrying Earth's gravitational field. The object would quite literally be swallowed

by Earth. For a vanishing initial velocity the time t spent in the dark matter phase would relate the depth h at which the object falls freely as $t = \sqrt{2h/g}$, $g \simeq 10 \text{ m/s}^2$. From the typical depths at which the objects are found, one can conclude that the time spent in dark matter phase is measured in seconds. A possible explanation is that the rotation period of magnetic field creating the dark matter phase is usually not longer than this.

Macroscopic quantities of dark matter could result in catastrophic events like fractures. The potential wall hindering the formation of the fracture might be overcome by the formation of dark matter phase in the immediate vicinity of the fracture. Nuclear transmutations should occur routinely in dark matter phase and there is indeed evidence for the transmutations in living matter [44], in cold fusion, and in fracto-fusion [43]. The long lasting emission of light from fractures (earth lights observed in the lines of seismic activity) might be identifiable as coherent beams of dark photons decaying to ordinary photons. Also UFOs might have interpretation as plasmoids.

The observed difficult-to-understand properties of lightnings might find explanation if lightning track is in dark matter phase so that charged particles are in effectively super-conducting phase so that electrons can accelerate to relativistic velocities. This suggests that electric discharges in high voltage could produce dark matter (perhaps this is one function of nerve pulse). Ball lightnings might induce generation of dark matter.

To sum up, it is very easy to get scientific respect by claiming that all these reports are cooked up by swindlers and taken seriously by crackpots. I however dare hope that some ingenious experimentalist would see the trouble of finding whether TGD explanation is correct by trying to develop a method of inducing the phase transition to dark matter along the lines proposed.

5.4.3 Dark matter and supersolids

It might be that the strange ability of solid matter objects corresponding to different space-time sheets to move through each other has been already observed [30]. The existence of so called supersolids was predicted long time ago by Russian theoreticians Andreev and Lifschitz, who proposed that ^4He , which is a bosonic solid at low temperatures and as a noble element has weak bonds between atoms, could make under a high enough pressure a phase transition to a supersolid state which is the analog of super-fluid state. Supersolid can be regarded as a Bose-Einstein condensate behaving like single particle and having vanishing friction with respect to other solids.

What the loss of friction with respect to other solid means is not quite clear. The conservative view is that supersolid can glide along another solid without friction. A more radical view is that supersolid can flow through other solids, even ordinary, without any friction.

There is empirical support for the latter option. The experimental procedure used by M. Chan and his student E. Kim [30] is roughly the following.

1. Compress ^4He gas into a small glass disk made of fused silica containing atomic-sized pores.
2. Construct a torsional oscillator by hanging this disk to a string spinning with kHz frequency back and forth. Increase the pressure gradually from the solidification pressure 40 atm to 62 atm and monitor the oscillation frequency as the pressure is increased.

What is observed is a sudden increase of oscillation frequency at .2 K as if some of ^4He had leaked out and the system would have lost some of its inertia. The experimenters have however excluded the leakage. Their explanation is in terms of the emergence of ^4He supersolid phase which remains at rest since it has no friction: glass simply flows through it. The effect is absent for ^3He , which is a fermionic solid, and this supports the conclusion of the experimentalists.

The ability to flow through another solid makes the notion of supersolid highly counterintuitive in ordinary single-sheeted space-time. Intuitively one tends to assign the friction with the boundary of the supersolid and solid rather than interior and this would mean that supersolid would only glide without friction along but not flow through another solid.

Quantum classical correspondence is the basic interpretational guideline of TGD and forces to ask what the space-time correlate for the formation of supersolid, or whatever is in question in the experiment, might be. The ability of the two solids to flow through each other can be understood if the formation of the supersolid involves the separation of supersolid phase to its own space-time sheet. This separation becomes possible if the friction between ordinary solid and supersolid vanishes. Obviously this interpretation is consistent with the conservative view and implies the radical view in many-sheeted space-time.

Large \hbar supersolids could exist even at room temperature so that technological implications would be quite dramatic. Also the artifacts in wrong places could result by a temporary phase transition to large \hbar supersolid phase. The low temperature of the phase transition suggests that ${}^4\text{He}$ is not large \hbar phase.

References

Online books about TGD

- [1] M. Pitkänen (2006), *Topological Geometrodynamics: Overview*.
<http://www.helsinki.fi/~matpitka/tgdview/tgdview.html>.
- [2] M. Pitkänen (2006), *Quantum Physics as Infinite-Dimensional Geometry*.
<http://www.helsinki.fi/~matpitka/tgdgeom/tgdgeom.html>.
- [3] M. Pitkänen (2006), *Physics in Many-Sheeted Space-Time*.
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html>.
- [4] M. Pitkänen (2006), *Quantum TGD*.
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html>.
- [5] M. Pitkänen (2006), *TGD as a Generalized Number Theory*.
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html>.
- [6] M. Pitkänen (2006), *p-Adic length Scale Hypothesis and Dark Matter Hierarchy*.
<http://www.helsinki.fi/~matpitka/paddark/paddark.html>.
- [7] M. Pitkänen (2006), *TGD and Fringe Physics*.
<http://www.helsinki.fi/~matpitka/freenergy/freenergy.html>.

Online books about TGD inspired theory of consciousness and quantum biology

- [8] M. Pitkänen (2006), *Bio-Systems as Self-Organizing Quantum Systems*.
<http://www.helsinki.fi/~matpitka/bioselforg/bioselforg.html>.
- [9] M. Pitkänen (2006), *Quantum Hardware of Living Matter*.
<http://www.helsinki.fi/~matpitka/bioware/bioware.html>.
- [10] M. Pitkänen (2006), *TGD Inspired Theory of Consciousness*.
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html>.
- [11] M. Pitkänen (2006), *Mathematical Aspects of Consciousness Theory*.
<http://www.helsinki.fi/~matpitka/genememe/genememe.html>.

- [12] M. Pitkänen (2006), *TGD and EEG*.
<http://www.helsinki.fi/~matpitka/tgdeeg/tgdeeg/tgdeeg.html>.
- [13] M. Pitkänen (2006), *Bio-Systems as Conscious Holograms*.
<http://www.helsinki.fi/~matpitka/hologram/hologram.html>.
- [14] M. Pitkänen (2006), *Magnetospheric Consciousness*.
<http://www.helsinki.fi/~matpitka/magnconsc/magnconsc.html>.
- [15] M. Pitkänen (2006), *Mathematical Aspects of Consciousness Theory*.
<http://www.helsinki.fi/~matpitka/magnconsc/mathconsc.html>.

References to the chapters of books

- [A1] The chapter *An Overview about the Evolution of Quantum TGD* of [1].
<http://www.helsinki.fi/~matpitka/tgdview/tgdview.html#tgdevo>.
- [A9] The chapter *Does TGD Predict the Spectrum of Planck Constants?* of [1].
<http://www.helsinki.fi/~matpitka/tgdview/tgdview.html#Planck>.
- [C1] The chapter *Construction of Quantum Theory: Symmetries* of [4].
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html#quthe>.
- [C2] The chapter *Construction of S-matrix* of [4].
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html#smatrix>.
- [C3] The chapter *Is it Possible to Understand Coupling Constant Evolution at Space-Time Level?* of [4].
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html#rgflow>.
- [C5] The chapter *Equivalence of Loop Diagrams with Tree Diagrams and Cancellation of Infinities in Quantum TGD* of [4].
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html#bialgebra>.
- [C6] The chapter *Was von Neumann Right After All* of [4].
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html#vNeumann>.
- [D1] The chapter *Basic Extremals of Kähler Action* of [3].
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#class>.
- [D3] The chapter *The Relationship Between TGD and GRT* of [3].
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#tgdgrt>.
- [D4] The chapter *Cosmic Strings* of [3].
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#cstrings>.
- [D5] The chapter *TGD and Cosmology* of [3].
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#cosmo>.
- [D6] The chapter *TGD and Astrophysics* of [3].
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#astro>.
- [E10] The chapter *Intentionality, Cognition, and Physics as Number theory or Space-Time Point as Platonica* of [5].
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html#intcognc>.

- [E2] The chapter *TGD as a Generalized Number Theory: Quaternions, Octonions, and their Hyper Counterparts* of [5].
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html#visionb>.
- [E3] The chapter *TGD as a Generalized Number Theory: Infinite Primes* of [5].
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html#visionc>.
- [E5] The chapter *p-Adic Physics: Physical Ideas* of [5].
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html#phblocks>.
- [E9] The chapter *Topological Quantum Computation in TGD Universe* of [5].
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html#tqc>.
- [F2] The chapter *Massless States and Particle Massivation* of [6].
<http://www.helsinki.fi/~matpitka/paddark/paddark.html#mless>.
- [F3] The chapter *p-Adic Particle Massivation: Hadron Masses* of [6].
<http://www.helsinki.fi/~matpitka/paddark/paddark.html#padmass2>.
- [F4] The chapter *p-Adic Particle Massivation: Hadron Masses* of [6].
<http://www.helsinki.fi/~matpitka/paddark/paddark.html#padmass3>.
- [F5] The chapter *p-Adic Particle Massivation: New Physics* of [6].
<http://www.helsinki.fi/~matpitka/paddark/paddark.html#padmass4>.
- [F7] The chapter *The Recent Status of Leptohadron Hypothesis* of [6].
<http://www.helsinki.fi/~matpitka/paddark/paddark.html#leptc>.
- [F8] The chapter *TGD and Nuclear Physics* of [6].
<http://www.helsinki.fi/~matpitka/paddark/paddark.html#padnucl>.
- [F9] The chapter *Dark Nuclear Physics and Living Matter* of [6].
<http://www.helsinki.fi/~matpitka/paddark/paddark.html#exonuclear>.
- [G1] The chapter *Anomalies Related to the Classical Z^0 Force and Gravitation* of [7].
<http://www.helsinki.fi/~matpitka/freenergy/freenergy.html#Zanom>.
- [G2] The chapter *The Notion of Free Energy and Many-Sheeted Space-Time Concept* of [7].
<http://www.helsinki.fi/~matpitka/freenergy/freenergy.html#freenergy>.
- [G3] The chapter *Did Tesla Discover the Mechanism Changing the Arrow of Time?* of [7].
<http://www.helsinki.fi/~matpitka/freenergy/freenergy.html#tesla>.
- [G4] The chapter *Ufos, Aliens, and the New Physics* of [7].
<http://www.helsinki.fi/~matpitka/freenergy/freenergy.html#mantleufo>.
- [H2] The chapter *Negentropy Maximization Principle* of [10].
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#nmpc>.
- [H8] The chapter *p-Adic Physics as Physics of Cognition and Intention* of [10].
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#cognic>.
- [J5] The chapter *Wormhole Magnetic Fields* of [9].
<http://www.helsinki.fi/~matpitka/bioware/bioware.html#wormc>.
- [K1] The chapter *Time, Spacetime and Consciousness* of [13].
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#time>.

- [K2] The chapter *Macro-Temporal Quantum Coherence and Spin Glass Degeneracy* of [13].
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#macro>.
- [K3] The chapter *General Theory of Qualia* of [13].
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#qualia>.
- [K4] The chapter *Bio-Systems as Conscious Holograms* of [13].
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#hologram>.
- [K5] The chapter *Homeopathy in Many-Sheeted Space-Time* of [13].
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#homeoc>.
- [K6] The chapter *Macroscopic Quantum Coherence and Quantum Metabolism as Different Sides of the Same Coin* of [13].
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#metab>.
- [L1] The chapter *Genes and Memes* of [11].
<http://www.helsinki.fi/~matpitka/genememe/genememe.html#genememec>.
- [L2] The chapter *Many-Sheeted DNA* of [11].
<http://www.helsinki.fi/~matpitka/genememe/genememe.html#genecodec>.
- [L4] The chapter *Pre-Biotic Evolution in Many-Sheeted Space-Time* of [11].
<http://www.helsinki.fi/~matpitka/genememe/genememe.html#prebio>.
- [M1] The chapter *Magnetic Sensory Canvas Hypothesis* of [12].
<http://www.helsinki.fi/~matpitka/tgdeeg/tgdeeg/tgdeeg.html#mec>.
- [M3] The chapter *Dark Matter Hierarchy and Hierarchy of EEGs* of [12].
<http://www.helsinki.fi/~matpitka/tgdeeg/tgdeeg/tgdeeg.html#eegdark>.
- [M4] The chapter *Quantum Model for EEG: Part I* of [12].
<http://www.helsinki.fi/~matpitka/tgdeeg/tgdeeg/tgdeeg.html#eegI>.
- [M5] The chapter *Quantum Model of EEG: Part II* of [12].
<http://www.helsinki.fi/~matpitka/tgdeeg/tgdeeg/tgdeeg.html#eegII>.
- [N1] The chapter *Magnetospheric Sensory Representations* of [14].
<http://www.helsinki.fi/~matpitka/magnconsc/magnconsc.html#srepres>.
- [N2] The chapter *Crop Circles and Life at Parallel Space-Time Sheets* of [14].
<http://www.helsinki.fi/~matpitka/magnconsc/magnconsc.html#crop1>.

Theoretical physics

- [16] L. D. Landau and E. M. Lifshitz (1970), *Statistical Physics*, Pergamon Press.
- [17] R. M. Kiehn (2004), *Non-Equilibrium and Irreversible Thermodynamics-from a Perspective of Topological Evolution*.
<http://www22.pair.com/cscd/download/topthermo.pdf> .

Physics related references

- [18] V. M. Lobashev *et al*(1996), in *Neutrino 96* (Ed. K. Enqvist, K. Huitu, J. Maalampi). World Scientific, Singapore.
- [19] Ch. Weinheimer *et al* (1993), *Phys. Lett.* 300B, 210.
- [20] B. B. Back *et al*(2002), *Nucl. Phys.* A698, 416 (2002).
- [21] B. B. Back *et al*(2002), *Phys. Rev. Lett.* Vol. 89, No 22, 25 November. See also <http://www.scienceblog.com/community/modules.php?name=News&file=article&sid=357>.
- [22] A. Gefter (2004), *Liquid Universe*, a popular article about the unexpected properties of recently discovered quark gluon plasma. *New Scientist*, Vol 184, No 2469 (16 October).
- [23] E. S. Reich (2005), *Black hole like phenomenon created by collider*, *New Scientist* 19, issue 2491.
- [24] T. Ludham and L. McLerran (2003), *What Have We Learned From the Relativistic Heavy Ion Collider?*, *Physics Today*, October issue. <http://www.physicstoday.org/vol-56/iss-10/p48.html>.
- [25] H. Nastase (2005), *The RHIC fireball as a dual black hole*, hep-th/0501068.
- [26] BBC NEWS Science/Nature (2002), *Quakes reveal 'core within a core'*, Wednesday, 2 October, <http://news.bbc.co.uk/1/hi/sci/tech/2290551.stm> .
- [27] T. Ericson and J. Rafelski (2002), *The tale of the Hagedorn temperature*, *Cern Courier*, vol 43, No 7, <http://www.cerncourier.com/main/toc/43/7>.
- [28] W. Broniowski (2002), *Two Hagedorn temperatures*, hep-ph/0006020.
- [29] <http://hyperphysics.phy-astr.gsu.edu/hbase/solar/soldata2.html>.
- [30] E. Kim and M. H. W. Chan (2004), *Nature* 427, 225.
See also the popular article
B. K. Kennedy (2004), *Probable Discovery of a New, Supersolid, Phase of Matter*, *Science Journal*, Vol. 21.
<http://www.science.psu.edu/journal/Summer2004/SupersolidSum04.htm>.
- [31] M. Chown (2005) , *End of the Beginning*, *New Scientist* 2. July 2005, vol 187, No 2506. <http://www.newscientist.com/article.ns?id=mg18625061.800>.
- [32] C. Oesterwinter and C. J. Cohen (1972), *Cel. Mech.* 5, 317.

Life science related references

- [33] S. Comorosan(1975), *On a possible biological spectroscopy*, *Bull. of Math. Biol.*, Vol 37, p. 419.
- [34] S. Comorosan, M.Hristea, P. Murogoki (1980), *On a new symmetry in biological systems*, *Bull. of Math. Biol.*, Vol 42, p. 107

- [35] S. Klein (2002), *Libet's Research on Timing of Conscious Intention to Act: A Commentary* of Stanley Klein, *Consciousness and Cognition* 11, 273-279.
http://cornea.berkeley.edu/pubs/ccog_2002_0580-Klein-Commentary.pdf.
- [36] B. Libet, E. W. Wright Jr., B. Feinstein, and D. K. Pearl (1979), *Subjective referral of the timing for a conscious sensory experience* *Brain*, 102, 193-224.
- [37] S. L. Glashow (1999), *Can Science Save the World?*,
http://www.hypothesis.it/nobel/nobel99/eng/pro/pro_2_1_1.htm.
- [38] M. Jibu, S. Hagan, K. Pribram, S. R. Hameroff, K. Yasue (1994), *Quantum optical coherence in cytoskeletal microtubules: implications for brain function*. *BioSystems*, 32:195-209.
- [39] S. R. Hameroff (1996), *Cytoplasmic Gel States and Ordered Water: Possible Roles in Biological Quantum Coherence*. Proceedings of the 2nd Annual Advanced Water Sciences Symposium, Dallas, TX.
- [40] M. Tegmark (1999), *The importance of quantum de-coherence in brain processes*, quant-ph/9907009.
- [41] Jed Rothwell(1996).
Some recent developments in cold fusion,
<http://ourworld.compuserve.com/homepages/JedRothwell/brieftec.htm>.
Report on The Second International Low Energy Nuclear Reactions Conference Holiday Inn, College Station, Texas, September 13-14, 1996.
<http://ourworld.compuserve.com/homepages/JedRothwell/ilenrc2s.htm>,
Review of the Sixth International Conference on Cold Fusion (ICCF6),
<http://ourworld.compuserve.com/homepages/JedRothwell/iccf6rev.htm>.
- [42] E. Storms (1996), *Review of cold fusion effect*.
<http://www.jse.com/storms/1.html>.
- [43] E. Storms (2001), *Cold fusion, an objective assessment*,
<http://home.netcom.com/storms2/review8.html>.
- [44] C. L. Kervran (1972), *Biological Transmutations*. Swan House Publishing Co.
- [45] T. Mizuno(1998), *Nuclear Transmutation: The Reality of Cold Fusion*, Infinite Energy Press.
- [46] B. R. Barber *et al* (1994), *Phys. Rev. Lett.* , Vol 72 , No 9, p, 1380.
- [47] R. T. Lahey Jr., R. P. Taleyarkhan, R. I. Nigmatulin (2005), *Sonofusion-Fact or Fiction*,
http://www.rpi.edu/%7elahey/Sonofusion%20Paper-pdf_Lahey_NURETH-11.pdf
 For material about sonofusion see <http://members.nuvox.net/on.jwclymer/snf/>.
- [48] P. Ball (2005), *A new kind of alchemy*, *New Scientist*, 16 April issue.
<http://www.newscientist.com/channel/fundamentals/mg18624951.800>.
- [49] W. D. Knight *et al* (1984), *Phys.Rev. Lett.* 52, 2141.
- [50] A. W. Castleman *et al* (2005), *Al Cluster Superatoms as Halogens in Polyhalides and as Alkaline Earths in Iodide Salts*, *Science*, 307, 231-235.
- [51] R. Mills *et al*(2003), *Spectroscopic and NMR identification of novel hybrid ions in fractional quantum energy states formed by an exothermic reaction of atomic hydrogen with certain catalysts*.
<http://www.blacklightpower.com/techpapers.html> .

- [52] *Some sunspot facts*,
<http://www.sunblock99.org.uk/sb99/people/KMacpher/properties.html>.
- [53] M. Moshina (2005), *The surface ferrite layer of Sun*,
<http://www.thesurfaceofthesun.com/TheSurfaceOfTheSun.pdf>.
- [54] C. Smith (2001), *Learning From Water, A Possible Quantum Computing Medium*, talk in CASYS'2001, 5th international conference on Computing Anticipating Systems held in Liege, Belgium, August 13-18. Abstract book published by Chaos.
- [55] M. Chaplin (2000), *Molecular Vibration and Absorption*,
 Online book. Selected Science Educators, London Southbank University,
<http://www.lsbu.ac.uk/water/vibrat.html>.
- [56] A. Gurwitsch(1923), *Die Natur des Specifischen Erregurs der Zelteilung*, Roux, Archiv: 100; 11.
 D. Downing (2001), *Daylight Robber - The importance of sunlight to health*, chapter 8. Online book at
<http://www.bio-immuno-development.com/books/daylight/924.htm>.
- [57] V.M. Inyushin and P.R. Chekorov (1975), *Biostimulation through laser radiation and bio-plasma*, Alma-Ata, Kazakh SSR. Translated into english in 1976.
- [58] P. P. Gariaev *et al*(2002), *The spectroscopy of bio-photons in non-local genetic regulation*, Journal of Non-Locality and Remote Mental Interactions, Vol 1, Nr 3.
<http://www.emergentmind.org/gariaevI3.htm> .
- [59] E. Lozneau and M. Sanduloviciu (2003) *Minimal-cell system created in laboratory by self-organization*, Chaos, Solitons & Fractals, Volume 18, Issue 2, October, p. 335.
 See also *Plasma blobs hint at new form of life*, New Scientist vol. 179 issue 2413 - 20 September 2003, page 16.
- [60] *Animal Cell Mitosis*, video animation of mitosis.
<http://www.cellsalive.com/mitosis.htm>.
- [61] V. V. Roshchin and S.M. Godin (2001), *An Experimental Investigation of the Physical Effects in a Dynamic Magnetic System*, New Energy Technologies Issue #1 July-August 2001.
 V. V. Roschin and S. M. Godin (2001), *Generator with Energy Conversion and Anti-Gravity Effects*, Neue Wasserstofftechnologien un Raumantriebe, Vortäge der Kongresses vom 23.-24. Juni, Weinfelden. Jupiter Verlag.
- [62] A Kasumov *et al* (2001), *Proximity-induced superconductivity in DNA*, Science 291, 280.
 See also *Electronic properties of DNA*, Physicsweb,
<http://physicsweb.org/articles/world/14/8/8>
- [63] S. Barros (1998), *Generating Hot Plasmas Using a Microwave Oven*,
<http://apache.airnet.com.au/fastinfo/microwave/ball.html>.
 J. Naudin (2003), *Plasmoid (ball lightning) generation with a microwave resonator*,
<http://jlnlabs.online.fr/plasma/4wres/>.
- [64] A. Gosline (2005), *Lightning: Thunderbolts from space*. New Scientist, 10 May, issue 2498.
<http://www.newscientist.com/article.ns?id=mg18624981.200>.
- [65] N. Jones (2003), *Lightning strikes release powerful X-ray bursts*, New Scientist, February 2003, issue 2381.
<http://www.newscientist.com/article.ns?id=mg17723811.500>.

- [66] M. McKee (2005), *Earth creates powerful gamma-ray flashes* NewScientist.com news service, 17 February, <http://www.newscientist.com/channel/space/dn7025>.
- [67] B. Daviss (2004), *Red Devils*, New Scientist, issue 2346, <http://www.newscientist.com/article.ns?id=mg17423463.800>.
- [68] J. Naudin (2000), *How to build yourself a Glow Discharge Plasma panel*, Advanced Reduced Drag Aircraft project By Jean-Louis Naudin created on January 16th, 2000. http://jlnlabs.online.fr/plasma/html/s_gdp1.htm.
- [69] J. Naudin (2000), *The glow discharge power tests*, http://jlnlabs.online.fr/plasma/html/s_gdp4.htm.
- [70] J. Naudin (2000), *The glow discharge power tests*, http://jlnlabs.online.fr/plasma/html/s_gdp5.htm.
- [71] BLT Research Team, Inc., <http://www.bltresearch.com/>.
W. C. Levengood and J. A. Burke (1995), *Semi-Molten meteoric Iron Associated with a Crop Formation*, Journal of Scientific Exploration, Vol 9, No. 2, pp. 191-199. <http://www.bltresearch.com/published.html>.
J. A. Burke (1998), *The physics of crop formations*, MUFON Journal, October, 1998, pp. 3-7. <http://www.bltresearch.com/published.html>.
Other facts, BLT Research Team, Inc., <http://www.bltresearch.com/otherfacts.html>.
- [72] W. C. Levengood and N. P. Talbott (1999), *Dispersion of Energies in Worldwide Crop Formations*, Physiological Plantarum 105: 615624. <http://www.bltresearch.com/published.html>.
- [73] *The Sun's Corona* http://imagine.gsfc.nasa.gov/docs/science/mysteries_l1/corona.html.
X Ray emission from Comets and Planets, http://www.mpe.mpg.de/xray/research/comets/comets_planets_v01.html.
- [74] B. Libet(1982), E. W. Wright , C. A. Gleason (1982), *Readiness potentials preceding unrestricted spontaneous and preplanned voluntary acts*, Electroencephalography and Clinical Psychology 54, 322-325.
S. Klein (2002), *Libet's Research on Timing of Conscious Intention to Act: A Commentary* of Stanley Klein, Consciousness and Cognition 11, 273-279. http://cornea.berkeley.edu/pubs/ccog_2002_0580-Klein-Commentary.pdf.
B. Libet, E. W. Wright Jr., B. Feinstein, and D. K. Pearl (1979), *Subjective referral of the timing for a conscious sensory experience* Brain, 102, 193-224.
- [75] D. B. Kaplan, A. E. Nelson and N. Weiner (2004), *Neutrino Oscillations as a Probe of Dark Energy*, hep-ph/0401099.
- [76] M. B. King (2001), *Quest For Zero Point Energy*, Adventures Unlimited Press. Electronic clusters are discussed in the chapter *Dual Vortex Forms: the Key to a Large Zero Point Energy Coherence*
- [77] K. R. Shoulders (1991), *Energy Conversion Using High Charge Density*, Oatent No. 5,018,180.
- [78] J. Hutchison (1994), *The Hutchison Effect Apparatus*, Proc. of the first Symposium on New Energy, Denber, May 1994, p. 199.

- [79] T. Twietmeyer (2005), *How Solid Matter Can Pass Through Rock*, <http://www.rense.com/general66/solid.htm>.
- [80] F. A. Popp, B.Ruth, W.Bahr, J.Bhm, P.Grass (1981), G.Grolig, M.Rattemeyer, H.G.Schmidt and P.Wulle: *Emission of Visible and Ultraviolet Radiation by Active Biological Systems*. Collective Phenomena(Gordon and Breach), 3, 187-214.
 F. A. Popp, K. H. Li, and Q. Gu (eds.) (1992): *Recent Advances in Bio-photon Research and its Applications*. World Scientific, Singapore-New Jersey.
 F.- A. Popp: *Photon-storage in biological systems*, in: *Electromagnetic Bio-Information*, pp.123-149. Eds. F.A.Popp, G.Becker, W.L.Knig, and W.Peschka. Urban & Schwarzenberg, Mnchen-Baltimore.
 F.-A. Popp (2001), *About the Coherence of Bio-photons*, http://www.datadiwan.de/iib/ib0201e_.htm .
 F.-A. Popp and J.-J. Chang (2001), *Photon Sucking and the Basis of Biological Organization*, <http://www.datadiwan.de/iib/ib0201e3.htm> .
 F.-A. Popp and Y. Yan (2001), *Delayed Luminescence of Biological Systems in Terms of States*, <http://www.datadiwan.de/iib/pub2001-07.htm> .
- [81] M. Shaduri. & G.Tshitshinadze (1999), *On the problem of application of Bioenergography in medicine*. Georgian Engineering News 2, 109-112.
 See also <http://www.bioholography.org/> .
- [82] P. Gariaev *et al* (2000), *The DNA-wave-biocomputer*, CASYS'2000, Fourth International Conference on Computing Anticipatory Systems, Liege, 2000. Abstract Book, Ed. M. Dubois.

Astrophysics and cosmology

- [83] Zeldovich, Ya., B., Einasto, J. and Shandarin, S., F. (1982): *Giant Voids in the Universe*. Nature, Vol. 300, 2.
- [84] Milgrom, M. (1983), *A modification of the Newtonian dynamics as a possible alternative to the hidden mass hypothesis*, ApJ, 270, 365. See also <http://www.astro.umd.edu/~ssm/mond/astronow.html>.
- [85] S. Clark, *First Dark Galaxy Found*, New Scientist 26 February 2005, vol 185, No 2488.
- [86] J. Bahcall (2005), *Chemical Controversy at the Solar Surface*, Physics in Action, February 2005, vol 18, No 2.
- [87] M. Asplund, N. Grevesse, J. Sauval (1004) *The Solar Chemical Decomposition*, astro-ph/0410214.
- [88] N. Dume (2005), *New Exoplanet Defies Theory*, Physics Web, <http://physicsweb.org/articles/news/9/7/6/1>.

References related to physics anomalies

- [89] C. J. Masreliez (2001), *Do the planets accelerate*. <http://www.estfound.org>.
- [90] C. J. Masreliez (2001), *Expanding Space-Time Theory*, <http://www.estfound.org>.

- [91] Y. B. Kolesnik (2000), *Applied Historical Astronomy, 24th meeting of the IAU*, Joint Discussion 6, Manchester, England.
Ibid (2001a), *Journées 2000 Systemes de reference spatio-temporels, J2000*, a fundamental epoch for origins of reference systems and astronomical models, Paris.
- [92] D. Da Roacha and L. Nottale (2003), *Gravitational Structure Formation in Scale Relativity*, astro-ph/0310036.
- [93] V. V. Roschin and S. M. Godin (2001), *Generator with Energy Conversion and Anti-Gravity Effects*, Neue Wasserstofftechnologien un Raumantriebe, Vortäge der Kongresses vom 23.-24. Juni, Weinfelden. Jupiter Verlag.
- [94] E. Strand (editor) (2007), *Proceedings of the 7th European SSE Meeting August 17-19, 2007, Røros, Norway*. Society of Scientific Exploration: <http://www.scientificexploration.org/>.
- [95] E. Podkletnov and G. Modanese (2002), *Investigation of high voltage discharges in low pressure gases through large ceramic super-conducting electrodes*, <http://xxx.lanl.gov/abs/physics/0209051>.
- [96] Scientific American, Volume 7, Issue 38, pp. 298-299, June 5, 1852.
<http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&cite=&coll=moa&view=50&root=%2Fmoa%2Fscia%2Fscia0007%2F&tif=00385.TIF&pagenum=298>.
- [97] Nature, London, November 11, 1886, p. 36.
- [98] W. Corliss (1978), *Ancient Man: A Handbook of Puzzling Artifacts*, The Sourcebook Project, Glen Arm (Maryland).
 See also <http://www.miqel.com/text/tcookie.html> about mysterious transfers of large chunks of Earth transferred from one place to another.
- [99] J. R. Jochmans (1979), *Strange Relics from the Depths of the Earth*, Litt.D., 1979 - pub. Forgotten Ages Research Society, Lincoln, Nebraska, USA. See also the article at http://www.delusionresistance.org/creation/antedeluvian_finds.html.
- [100] The article *Out-of-place metal objects* at http://farshores.org/tp_relic.htm uses Jochmans's book as a source.
- [101] P. Strombert and P. V. Heinrich (2000), *The Coso Artifact Mystery from the Depths of Time*. Copyright 2000-2005
<http://www.talkorigins.org/faqs/coso.html>
- [102] For the descriptions of Hudson's findings see *Mono-atomic elements*, <http://www.halexandria.org/dward479.htm>, and *David Hudson at IFNS*, <http://www.halexandria.org/dward467.htm>.