Exploration

Comparison of Electric Universe Hypothesis & TGD

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Abstract

Electric Universe scenario in its extreme form postulates that electromagnetic fields are enough to explain gravitation and even nuclear fusion. From TGD viewpoint this vision is unrealistic. Wes Johnson however gave links to two Youtube videos related to Electric Universe telling about extremely interesting physical findings providing applications for TGD if take seriously. The first video was about the anomalies related to the craters of the Moon and second describe the claimed findings of SAFIRE team having a nice interpretation in TGD framework using the notions of monopole flux tubes and dark matter as hierarchy of phases of ordinary matter with non-standard value of Planck constant implying that electromagnetism has deep implications in arbitrarily long scales. The question in TGD is therefore not about whether electromagnetism (of gauge interactions in general) or gravitation is enough to understand cosmology and astrophysics: both are needed and in the sense of TGD.

Keywords: Electric universe, Planck constant, TGD framework.

1 Introduction

I have encountered the notion of Electric Universe (EU) several times during the years. Rational Wiki (see `http://tinyurl.com/y847jn6w`) describes EU as pseudoscience claiming that the formation and evolution can be better explaining by electricity and magnetism than by gravity alone as the standard belief goes. Aether is also reported to be part of the theory and have elements from mythology.

One must be however very cautious with these kind of highly negatively emotional articles pretending to represent balanced and objective scientific statements. The words crank and crackpot appeared quite too often in them, and when the entire article is collection of emotionally negative associations about people behind EU than the contents of EU itself, one knows that this is not science.

I have become during last 42 years very familiar with people calling themselves "skeptics" and therefore I decided to to take a more analytic approach and concentrate on "than in terms of gravitation alone". This tells the reductionistic motivations of the author. Author has decided cosmology and astrophysics can be described in terms of gravitation only: the proposal that electromagnetism could be involved, is pseudoscience. The article is only part of battle between different world vires. It is already now clear that one day "gravitation alone" hypothesis will be regarded comparable to the aether hypothesis.

1.1 Could we learn something from EU and the work of SAFIRE team

What EU (see `http://tinyurl.com/y847jn6w`) really claims. There is of course no unique EU but collection of models. Rather, it claims that electromagnetism, in particular plasmas, are central for the understanding of galaxies and astrophysical objects, in particular nuclear fusion. The Electric Sun model (see `http://tinyurl.com/y2mm8cjg`) assumes that astrophysical objects derive their main sources of their power electrically. That gravitation would not be needed at all is only an extremist claim. To me the claim that nuclear physics is not needed, looks unrealistic.

The lucky instance, is that the experimental work of SAFIRE team (see `http://tinyurl.com/y2ae9tar` and `http://tinyurl.com/y2ae9tar`) to be discussed in the sequel concentrates only on question whether nuclear fusion can be achieve in plasma system and the conclusion is that nuclear transmutations occur. This does not mean that nuclear physics is not needed. What it however implies that the

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recent view about nuclear physics is wrong also also the phenomenon dubbed as "cold fusion" or "low energy nuclear reactions" (LENR) has demonstrated [12, 11, 10]. Nuclear physics of solar core has been also plagued by a very serious anomaly for 10 years now [21].

Could we take a less emotional approach and look whether we could learn something - open-mindedness if not anything else - from the people labelled with "EU"? I had luck: I received two extremely interesting links from Wes Johnson to videos describing purely empirical and experimental physics. Nothing about mythology, aether, or anything like that but two highly inspiring videos allowing to see what science as a process of discovery is. This is something totally different from what I have seen SUSY and superstring theoreticians doing last four decades. It is about what is there in the real world, concrete numbers and correlations, discovery of physical anomalies. Something different from infertile games with braney worlds, multiverses, blackholes, etc. and endless production of hype.

It was clear from beginning that these videos provide further applications for the TGD view about cosmology and formation of galaxies and smaller stellar objects.

1.2 TGD view about classical fields

TGD does not assume aether but neither does it assume that gravitation alone is enough for understanding cosmology and astrophysics. In TGD both gravitation and long range electromagnetic fields are in crucial role. Nuclear physics is part of TGD but TGD view from it differs in some crucial aspects.

TGD leads to a new view about classical fields differing from the views of standard model and General Relativity (GRT).

1. The notion of field is generalized by induction procedure. All classical fields are expressible in terms of 8 coordinates of 8-D imbedding space $H = M^4 \times CP_2$ and their gradients. General coordinate invariance reduces their number to 4 effectively. This means enormous reduction in local field like degrees of freedom. The extreme complexity of many-sheeted space-time compensates for this reduction and space-time is topologically complex in all scales.

   This does not reduce gravitation to electromagnetism as EU claims: rather both gravitation, electromagnetism and actually electroweak and color interactions are reduced to the geometry of space-time surface via the notion of the induced gauge field and metric. The induction of spinor structure does the same for spinor fields.

2. Standard model and GRT emerge at QFT limit when space-time sheets are replaced with single region of M^4 made slightly curved. The replacement of many-sheeted space-time with Einsteinian space-time however means enormous loss of information. In particular, the information about magnetic flux tubes is completely lost. This loss of information makes description of systems like living matter extremely difficult.

3. In primordial cosmology Einsteinian picture does not work even as approximation. At this limit space-time surfaces can be idealized by what I call cosmic strings having 2-D M^4 projection and behaving like strings for most practical purposes. Ironically, string like objects are present in all scales in TGD, not only something in Planck length scale. The tragedy of superstring models is easy to see: people had so enormous hurry to guarantee the call from Stocholm that they did not have time to realize that strings must be generalized to 3-D objects having interpretation as both particles and 3-space - depending on the scale.

1.3 Cosmic strings thickening to flux tubes as basic element of TGD based cosmology and astrophysics

Cosmic strings carrying monopole fluxes bring a lot of new elements to cosmology and astrophysics and solve the numerous problems of "gravitation only" approach.

1. These cosmic strings, in particular those carrying monopole flux possible due to the non-trivial topology of CP_2 thicken gradually to flux tubes, which are central element of TGD view about formation of various structures, in particular galaxies, stars, planets, and even smaller objects.

   They are present in all scales: also in quantum biology, biochemistry, chemistry, molecular physics, atomic physics, nuclear physics, hadron physics. In all scales new phenomena are predicted and it has been fascinating to realize that the experimental physics is producing anomalies in all these branches of physics and really stunning to realize that theoretical physicists could not be less interested.

   Also in cosmology and astrophysics they are crucial and without them one cannot understand cosmological constant, the notion of dark matter and energy, the formations mechanisms of galaxies, stellar object, stars, and even smaller objects. "Gravitation alone" is not enough.

2. The twistor lift of TGD predicts that cosmological constant depends on p-adic length scale and become extremely small in cosmological scales but very large in short scales. This solves the basic problem of cosmology due to the gigantic value of cosmological constant also due its wrong sign which eventually killed string models.

   During cosmological evolution phase transitions reducing the value of cosmological constant occur leading to an accelerated expansion since volume energy is reduced. This sequences of jerks replaces smooth cosmological expansion of standard cosmology and solves the mystery due to the fact that astrophysical objects co-expand but do not seem to expand themselves. Smooth cosmic expansion is replaced with a sequence of jerks involving accelerating and slowing down periods.

   The reason is that magnetic contribution to string tension is reduced in thickening but volume energy increases so that one has acceleration followed by slowing down leading to a stationary situation. This expansion transforms the energy of flux tube identifiable as dark energy/dark matter to ordinary matter and is counterpart for inflation but occurring in all scales.

3. The model for galaxies as tangles along long cosmic strings predicts that the thickening of flux tube in the tangle generates ordinary matter. This explains the flat velocity spectrum of stars around galaxies as being due to the gravitational field of long string, and also the galaxies apparently without dark matter as galaxies formed around short circular cosmic strings. The model allows to solve the accumulating anomalies of halo model based on dark matter identified as some exotic particles.

4. The local jerks have counterpart even at the level of Earth and the TGD inspired Expanding Earth model predicting that in Cambrian Explosion the radius of Earth increased very rapidly by a factor of 2 can be regarded as this kind of jerk [15]. This leads also to an explanation of Cambrian Explosion and a model for the evolution of prebiotic life as occurring in underground oceans shielded from cosmic rays and meteoric bombardment and preventing the oxygen from leaking to outer space. The splitting of core of Earth to inner core and rotating outer core generated ordinary magnetic field making possible atmosphere.

5. TGD suggests also that dark matter identifiable as $h_{eff} = n \times h_0$ phases and dark energy identifiable as magnetic and volume energy of flux tubes are by quantum classical correspondence (QCC) one and same thing basically. More formally, QCC implies that the eigenvalues for fermionic representations of Cartan algebra generators as Noether charges - observables - are same as the values for classical Noether charges. In particular, energy, momentum and angular momentum.

From this picture it is clear that in TGD Universe both gravitation and electromagnetism - or more generally the physics of induced electroweak and color fields is crucial for understand the formation of astrophysical objects.

1.3.1 The notion of length scale dependent cosmological constant

TGD predicts that cosmological constant Λ characterizing space-time sheets is length scale dependent and depends on p-adic length scale. Furthermore, expansion would be fractal and occur in jerks. This is the picture that twistor lift of TGD leads to [6].

Quite generally, cosmological constant defines itself a length scale $R = 1/\Lambda^{1/2}$. $r = 8\pi^{1/4}\sqrt{Rl_P}$ - essentially the geometric mean of cosmological and Planck length - defines second much shorter length scale r. The density of dark energy assignable to flux tubes in TGD framework is given as$\rho = 1/r^4$.

In TGD framework these scales corresponds two p-adic length scales coming as half octaves. This predicts a discrete spectrum for the length scale dependent cosmological constant Λ [6] . For instance, one can assign to ..., galaxies, stars, planets, etc... a value of cosmological constant. This makes sense in many-sheeted space-time but not in standard cosmology.

Cosmic expansion is replaced with a sequence of fast jerks reducing the value of cosmological constant by some power of 2 so that the size of the system increases correspondingly. The jerk involves a phase transition reducing Λ by some negative power of 2 inducing an accelerating period during which flux tube thickness increases and magnetic energy transforms to ordinary matter. Thickening however increases volume energy so that the expansion eventually halts. Also the opposite process could occur and could correspond to a "big" state function reduction (BSFR) in which the arrow of time changes.

An interesting question is whether the formation of neutron stars and super-novas could involve BSFR so that these collapse phenomena would be kind of local Big Bangs but in opposite time direction. One can also ask whether blackhole evaporation could have as TGD analog BSFR meaning return to original time direction by a local Big Bang. TGD analogs of blackholes are discussed in [17].

Consider now some representative examples to see whether this picture can be connected to empirical reality.

1. Cosmological constant in the length scale of recent cosmology corresponds to $R \sim 10^{26}$ m (see `http://tinyurl.com/k4bwlzu`). The corresponding shorter scale $r = (8\pi)^{1/4}\sqrt{Rl_P}$ is identified essentially as the geometric mean of R and Planck length l_P and equals to $r \sim 4 \times 10^{-4}$ m: the size scale of large neuron. This is very probably not an accident: this scale would correspond to the thickness of monopole flux tubes.

2. If the large scale R is solar radius about 7×10^8 m, the short scale $r \sim 10^{12}$ m is about electron Compton length, which corresponds to p-adic length scale $L(127)$ assignable to Mersenne prime $M_{127} = 2^{127} - 1$. This is also the size of dark proton explaining dark fusion deduced from Holmlid's findings [11, 12]: this requires $h_{eff} \sim 2^{12}$!

   Remark: Dark proton sequences could be neutralized by a sequence of ordinary electrons locally. This could give rise to analogs of atoms with electrons being very densely packed along the flux tube.

   The prediction of the TGD based model explaining the 10 year old puzzle related to the fact that nuclear abundances in solar interior are larger than outside [21] (see `http://tinyurl.com/y38m54ud`) assumes that nuclear reactions in Sun occur through intermediate states which are dark nuclei. Hot fusion in the Sun would thus involve the same mechanism as "cold fusion". The view about cosmological constant and TGD view about nuclear fusion lead to the same prediction.

3. If the short scale is p-adic length $L(113)$ assignable to Gaussian Mersenne $M_{G,113} = (1+i)^{113} - 1$ defining nuclear size scale of $r \sim 10^{-14}$ m, one has $R \sim 10$ km, the radius of a typical neutron star (see `http://tinyurl.com/y5ukv2wt`) having a typical mass of 1.4 solar masses.

   A possible interpretation is as a minimum length of a flux tube containing sequence of nucleons or nuclei and giving rise to a tangle. Neutron would take volume of about nuclear size - size of the magnetic body of neutron? Could supernova explosions be regarded as phase transitions scaling the stellar Λ by a power of 2 by making it larger and reducing dramatically the radius of the star?

4. Short scale $r \sim 10^{-15}$ m corresponding to proton Compton length gives R about 100 m. Could this scale correspond to quark star (see `http://tinyurl.com/y3n78tjs`)? The known candidates for quark stars are smaller than neutron stars but have considerably larger radius measured in few kilometers. Weak length scale would give large radius of about 1 cm. The thickness of flux tube would be electroweak length scale.

1.4 TGD view about craters of Moon and findings of SAFIRE team

This article is a commentary of the mentioned two videos from TGD point of view.

1. The first video told about craters of Moon and I learned that existing theories, about which I found representations in Wikipedia too, are full of anomalies. I could not find anything obviously pseudoscientific in the representations apart. Since I have a habit to concentrate on content than social clues, I realized only later that the killer label EU assigned with these both videos.

   It was immediately clear that TGD based model for "cold fusion", another branch of evolving science labelled as pseudoscience but already now led to a developing technology, can be scaled up to describe the formation of craters.

2. Second video was about experiments done by SAFIRE team. They forget theoretical prejudices and just try to look whether Sun can be created in laboratory. Sun would be spherical electrode with positive charge surrounded by similar electrode with opposite charge and there would be strong electric field between them. The video told about the discoveries made also by "cold fusion" people: transmutations producing elements with higher isotope number are found to occur. Do transmutations occur everywhere and is nuclear fusion in solar core only one part of the story? This is the question that also TGD raises.

It must be emphasized, that these videos represent only two examples of the continual stream of anomalies having immediate explanation in TGD framework. Some time ago I had learned that even the cherished nuclear physics has had a very serious anomaly for a decade [21]: the model of cold fusion [12, 5] based on TGD view about dark matter and the notion of monopole magnetic flux tube generalizes to a model of nuclear reactions and of Sun itself explaining this anomaly too. Only few weeks ago I had learned that the magnetic field of Mars behaves very weirdly: popular article used the word "magnetic madness" [18]. Some days ago I learned about evidence that Earth's surface 600 million years was without details such as rivers and lakes: this fits with the Expanding Earth hypothesis [15]. I learned also fascinating and strange facts about earthquakes and volcanic eruptions providing an applications for zero energy ontology based view about state function reduction in macroscopic length scales [19].

2 What created the craters of Moon and other celestial bodies?

I received from Wes Johnson a link to to a Youtube video of Space News: Electric Universe titled *Our Lightning-Scarred Moon-The Evidence Grows* (see `http://tinyurl.com/y3bsgevu`). Very briefly: the basic message is that in case of Moon the basic theories for the formation of craters assuming impacts and volcanism as mechanisms are challenged by a large number of anomalies. It is also claimed that the theory assuming electric discharges - lightnings- as a cause is consistent with the data.

The video was highly interesting and I listened it through several times and the following is my attempt to summarize what I learned and how the model based on electric lightnings can be formulated in TGD framework. Actually a generalization of a model formulated for what happens in "cold fusion" as dark nuclei transform to ordinary ones, is in question. The formation of craters could involve "cold fusion" and a kind of nuclear explosion.

2.1 Standard view about the formation of craters

Consider first what mainstream science says about the formation of craters. Impacts and volcanism would be the basic mechanisms. Most of craters would be however due to impacts.

1. According to Wikipedia article (see `http://tinyurl.com/7vnrysd`), the cratering records of very old surfaces, such as Mercury, the Moon, and the southern highlands of Mars, record a period of intense early bombardment in the inner Solar System around 3.9 billion years ago. This is actually hypothesis known as late bombardment hypothesis.

2. The Wikipedia article about craters in Moon (see `http://tinyurl.com/y2ja9qjg`) states that most craters in Moon are impact craters. The number of craters in Moon and Mars is many orders of magnitude larger than that of impact craters in Earth. A natural explanation is that geological processes have destroyed the craters and very few from time before 500 million years are known (happens to be the time of Cambrian explosion [15] (see `http://tinyurl.com/yc4rgkco`) about which I have talked a lot).

2.2 Anomalies of the standard model

The video argues that the properties of craters of Moon are not consistent with either hypothesis.

1. The sizes of craters can be enormous. Moon has a gigantic crater which has radius of 25000 km and is 390 km deep. It is one of the largest craters in solar system. Impact theory predicts that there should be material bursted from the mantle to the surface. The material is shocked and melded and there is no material from mantle as volcanic hypothesis would require (data are from Apollo mission).

2. Why Moon should be so heavily cratered? The hypothesis that so called late heavy bombardment (see `http://tinyurl.com/y6hx2q3b`) period 4.5-3.8 Gy ago lasting for 20 -200 million years gave rise to the impacts producing the craters. Asteroids have been assumed to have caused the impacts. The video mentions an article claiming that asteroids are not probable cause. The modified hypothesis is that remnants from the formation of planetary system caused the impacts.

3. The craters are highly circular and can form sequences. There are also smaller craters at the rims of the craters bringing in mind fractal structure: vortices containing vortices containing....

4. Also very long rilles very different from lava tubes at Earth are found and often start from the circular craters. Rilles have sequences of craters within them. The rilles can be very long, much longer than at Earth: the longest rille is 185 km long. Just the opposite should be the case, since the heat loss in very thin atmosphere should be faster than at Earth with insulating atmosphere so that the rilles should be shorter. There is no rubble at the bottom of rilles as at Earth. The rilles can be directed uphill rather than downhill as in hydrodynamic and lava flows. Rilles also disappear instantaneously. The rilles dwindle suddenly, which does not support the idea that lava flow caused their formation by "eating" the surface material. Rather this, suggest a sheet like structure entering the surface as giving rise to the rille. In the case of the highly circular craters a tube like structure meeting the surface orthogonally suggests itself.

5. Also glass spheres and chondrules and minerals formed at very high temperatures are found in craters. Amusingly, crop circles [3, 4] (see `http://tinyurl.com/y32n3qwc` and `http://tinyurl.com/y4mawmqh`) involve also glass spheres and the model that propose for their formation decades ago would be the same as the model to be discussed for the formation of craters.

6. The near side of Moon less cratered than far side. There are even hexagonal craters. At Mars there is hemisphere dichotomy with southern hemisphere containing more craters.

2.3 Electric discharge model

Consider the model based on electric discharges argued to be consistent with all data.

1. Immanuel Velikovsky proposed that cosmic lightnings between planets and Moons created the craters of Moon Mainstream has labelled Velikovski as pseudoscientist. Carl Sagan has written a rather civilized critic (see `http://tinyurl.com/yxfzae93`) of Velikovski's ideas concentrating on content rather than direct personal insults. On basis of his vision Velikovski predicted remanent magnetism in lunar rocks. Nowadays the magnetic field is very weak. This remanent magnetism has been observed.

2. The crucial discovery by Brian J. Ford was that the electric discharges in lab applied also in industrial processes produce structures very similar to those observed in Moon. The ratio of sizes of largest to smallest craters is the same in Moon and in Mars. In particular, the craters produced in electric discharges are extremely circular. The document claims the electric discharge hypothesis is consistent with all findings about craters in Moon.

3. R. Juergens studied the rilles appearing in many scales and starting typically from the craters. They were originally called cracks and proposed to be formed by a flow of water or lava across surfaces or beneath the ground. Juergens found however that high energy electric discharge is favoured as a model. Lava and water cannot explain the features of rilles already listed like craters along rilles whereas electric discharges reproduce these features.

2.4 TGD based model

If the arguments of the document are true, the proposal must be taken very seriously. It seems incredible that mainstream could neglect so serious anomalies but I have seen this to happen in particle physics for decades. So: suppose that one take the claims seriously. What could be TGD explanation?

1. Monopole magnetic flux tubes carrying dark matter - perhaps dark nuclei as dark proton sequences is of course what comes first in mind. The flux tubes carrying the dark nuclei as dark cosmic rays could be associated with solar wind and are proposed to form a part of a bigger network allowing cosmic rays to propagate between galaxies, stars and smaller astrophysical objects. This would be a cosmic analog of blood circulation [21, 19] (see `http://tinyurl.com/yyjy5e2r` and `http://tinyurl.com/y23qczau`).

   Flux tubes have flux tubes within flux tubes that mathematical connection between incompressible liquid flow and magnetic field would allow to understanding the various structures as analogs of hydrodynamic tubules having vortices within vortices fractal structure.

2. In the collision with ground the dark nucleus formed by dark nucleon sequence nucleons would transform to ordinary nucleons and liberate practically all nuclear binding energy [5, 12] (see `http://tinyurl.com/y7u5v7j4` and `http://tinyurl.com/y2v3qn6a`) . The event would be like a nuclear explosion and this could explain why the effect is so large. This would be "cold fusion" event in macro scale. "Cold fusion" is known to involve formation of craters in micro scale and it would interesting to see whether the situation are scaled versions of each other.

   Also flux sheets are possible and the long rilles could correspond to these. Flux tubes inside flux tubes and inside flux sheets are possible and could give rise to fractal craters. This explanation would mean that also electric discharges in laboratory give rise to nuclear transmutations producing heavier elements as happens also in "cold fusion". This predictions could be tested in lab.

3. From Wikipedia article (see `http://tinyurl.com/7vnrysd`) one learns that ores often accompany craters and an interesting question is whether the craters formed in this manner give rise to ores.

4. What one can say about these monopole flux tubes carrying the dark nuclei to Moon. Most naturally they would be dark flux tubes associated with solar wind bringing cosmic rays. Earth does not have this kind of craters and the number of impact craters is small. The simplest explanation is that geological and atmospheric processes have caused the erosion of these structures. This is proposed as an explanation for the very small number of impact craters in Earth (190), whereas their number in Moon, some planets and their moons is much larger due to the absence of atmosphere.

   It is also possible that reconnections of solar flux tubes with the flux tubes of dark magnetic field associated with the Moon (planet or its moon) is involved and leads to the event! Also the flux tubes of dark magnetic fields of planets and Moon (moons of planets) could take place.

One can test the hypothesis is consistent with the TGD inspired version of Expanding Earth model [15] (see `http://tinyurl.com/yc4rgkco`).

1. The model assumes that Earth had radius, which is half of the recent value before Cambrian explosion and same as the recent radius of Mars. Then came geologically fast expansion (jerk in sequence of fast expansions reducing the value of length scale dependent cosmological constant replacing smooth cosmic expansion in TGD Universe) and the life that had evolved in underground oceans below Earth's surface bursted to the surface and oceans were formed.

2. The assumption that the situation at Earth was the same as in Mars before the expansion [18] (see `http://tinyurl.com/yxzye6xu`), would explain the finding that the surface of Earth seems to have lost various details like rivers and lakes about 600 million years ago preceding Cambrian explosion about 512 million years ago.

   If the surface of Earth was like the surface of Mars now it would have been full of craters formed by electrical discharges due to the solar wind. This does not kill the model. The presence of erosion due to the emergence of atmosphere and biosphere would explain the absence of these craters at the surface of recent Earth. At the bottom of oceans formed in the expansions they would be automatically absent. Inside tectonic plates signatures of their presence might be found.

3. The recent Earth is shielded by van Allen belts. If the van Allen belts consisted of dark flux tubes, they should have been present also before expansion and shielded Earth from cosmic rays and solar wind by guiding it to the Earth's interior. This would have brought ions and dark photons into the underground oceans and made possible the evolution of multicellular life capable of photosynthesis.

3 The findings of SAFIRE team as support for dark nucleosynthesis

I got from West Johnson a highly interesting link to a video providing a representation about the experimental work done in SAFIRE project (see `http://tinyurl.com/y548t9qk` . The motivation is so called Electric Universe model, which I see as unrealistic but the work itself was purely experimental. The mainstream claim, which can be found in Wikipedia is that these scientists are crackpots. To my best understanding this claim is simply an intentional lie. This conclusion is not difficult to make on basis of what I have been experienced during these four decades of TGD. The world view is changing: the old memes defending themselves against new memes desperately and the end justifies the means.

One must of course be extremely cautious. Nuclear transmutations are in air, so to say. This is because mainstream nuclear physics has had for a decade profound anomaly associated with solar nuclear synthesis: the abundances deduced in solar interior differ from those deduce from spectroscopy and meteorites [21] (see `http://tinyurl.com/yyjy5e2r`). It is difficult to believe that TGD would be totally unknown in physics community although there is politically motivated total silence about TGD leading to even comic manifestations. When it begins to look plausible that certain theory might provide a

breakthrough at the level of entire world view, it might lead to over-reactions. However, Electric Universe seems to be the theoretical background of SAFIRE project and it is very different vision as compared to TGD.

3.1 What SAFIRE team is studying?

What SAFIRE group is doing?

1. SAFIRE team is studying plasma. They are not doing it in garage, a big laboratory is in question, and the researchers have academic credentials.

2. One has two electrodes - positively charge inner spherical electrode and outer negatively charged spherical anode. This gives rise to a strong electric field. Various gases are in the atmosphere, in particular hydrogen: (see `http://tinyurl.com/y4cxohp3` for the Youtube video). Electric discharge is created and electric currents run in the voltage. The situation is like in electrolysis. The temperatures is rather low: around 100 degrees Celsius.

   Note that in cold fusion experiments one has a situation in which hydrogen atoms are absorbed in the cathode. Plasma is created in this kind of situation and one looks what happens by measuring all kinds of observables. One can study what happens at the surface of the anode, one can study the plasma atmosphere say by measuring the voltage and doing optic spectroscopy.

3.2 What SAFIRE team observed?

SAFIRE team observed several phenomena challenging the existing views about plasmas.

3.2.1 Occurrence of nuclear transmutations

For me the most interesting topic of the talk (see `http://tinyurl.com/y4cxohp3` for the Youtube video) were nuclear transmutations. "Cold fusion" model based on magnetic flux tubes containing dark matter as $h_{eff} = n/timesh_0$ phases predicts just what has been observed. It was really amazing to see direct experimental verification of the most radical predictions of TGD: things are going really fast now.

1. One of the basic predictions of TGD are nuclear transmutations. They observe nuclear transmutations at low temperatures than believed and production of energy. Essentially this is observed also by "cold fusion" experimentalists [12, 5] (see `http://tinyurl.com/y7u5v7j4`) and `http://tinyurl.com/y2v3qn6a`).

2. Energy production was claimed. The ratio of the output power to input power seemed to me incredible. Dark nuclear fusion predicts in optimal situation very large COP but in the "cold fusion" experiments the COP is of order 2-3 typically. If I understood correctly, it was now something like 10 or even more. Maybe I misunderstood.

3. The experimentalists do not know the mechanism involved and there is no such mechanism in standard model Universe. In TGD Universe it would be the formation of dark proton sequences - dark nuclei - transforming to ordinary nuclei and liberating essentially nuclear binding energy. In fact, also ordinary nuclear reactions would also proceed by the formation of dark nuclei as intermediate states: this replaces tunnelling phenomenon as mechanism in TGD Universe [21] (see `http://tinyurl.com/yyjy5e2r`). A long list of elements produced in transmutations was claimed: C, O in the second row; Na, Mg, (Al,Si), P, S, Cl in the third row; K, Ca, Ti, Zn in the fourth row; Sn in the fifth row; Ba in sixth row; and La in the eighth row of the periodic table. Al and Si are not certain since they could have contamined.

4. It was also claimed that SAFIRE produces by transmutations just those non-organic atoms that are observed in interstellar space. If true, this would support the TGD based proposal that part of elements is formed in interstellar space besides solar cores. If both are involved, the abundances from both should be very similar. If nuclear transmutations involve only the production of dark proton sequences transforming to ordinary nuclei whereas ordinary nucleosynthesis in Sun would involve also the fusions of ordinary nuclei by generating dark nuclei as intermediate states, it is is not clear whether this is the case.

5. The flux tubes carry also electric fields parallel to them in average sense and charges along them can accelerate to high energies. Second point is that dissipation is very slow due to the large value of h_{eff}: this brings a completely new element into the picture. The dark protons and ions at flux tubes can accelerate to very high energies. This would explain for instance the production of very high energy electrons in lightnings: would they accelerate to unexpectedly high energies in the electric field of Earth prevailing also inside flux tubes. By the way, I am still not sure whether gravitational flux tubes can be regarded as monopole flux tubes.

3.2.2 The phenomena at the surface

Consider first the phenomena observed at the surface of anode. Highly interesting were the pictures about the microscopic structures involved. They brought in mind the craters on the surface of Moon (see `http://tinyurl.com/y6yqtdj7`). The mechanism would be the same - TGD Universe is fractal.

The balls of size in micron scale formed by elements were one very interesting detail that should be understood. Some kind of micro-crystallization happening in cooling of liquid or vapour phase of elements formed by dark fusion mechanism could be in question. In the talk this is suggested to be very much analogous to gravitational phenomenon. The proposal relies on the EU hypothesis that gravitation reduces to electromagnetism and the belief that plasma phenomena are purely electromagnetic. Note that micron scale corresponds to biological length scale.

Was the transformation to ordinary nuclei quantum coherent process as I have proposed on basis of large h_{eff} and occurred for a bundle of flux tubes simultaneously? - these bundles are actually part of the h_{eff} hypothesis. The motivation was the observation of Holmlid [11] that even kaons with masses in 500 MeV range were produced! The production of so large energy quanta is not possible without large scale quantum coherence since nuclear binding energies are in MeV range. h_{eff} is proportional the number of flux tubes in bundle [16] (see `http://tinyurl.com/yy88v35d`) .

3.2.3 The formation of double plasma layers

The formation of self-organized double plasma layers in the atmosphere around anode formed from double layers was also reported. The layers have opposite charges at their boundaries. Double layers represent a standard phenomenon in plasma physics (see `http://tinyurl.com/y52s3a32`.

1. The thickness of the double layer is of order 10 Debye lengths $\lambda_D = 1/k_D$,

$$k_D^2 = (4\pi)^2 \alpha q^2 n \lambda_{th} \qquad \lambda_{th} = \frac{n\hbar}{T} \quad . \tag{3.1}$$

   n is the density of screening ions, q their charge using e a unit, and $\alpha = 4\pi e^2/\hbar \simeq 1/137$ is fine structure constant (I have used units with $((c = 1, k_B = 1))$. λ_{th} is thermal Compton length telling the distance below which macroscopic quantum phenomena are possible.

2. Debye length is the distance over which charge is screened in plasma in the units used. λ_D is few centimeters in the ionosphere, few tens of meters in the interplanetary medium, and tens of kilometers in the intergalactic medium. Note that the formula is purely classical in the sense that $\hbar$ disappears from it.

3. In the layer the electric field is strong that outside it because of the polarization. The temperature T inside double layer is higher than outside it because of acceleration and dissipation of charges in the electric field. These double layers bring in mind cell membranes and polarization over cell membrane. Also a negatively charged layer very near to the positively charged anode has been observed.

4. So called dark mode was mentioned and the behaviour of electric voltage as function of distance for dark mode and glow mode with visible atmosphere were compared. If I understood correctly, the plasma becomes invisible in dark mode. What could this mean in TGD Universe? Could a phase transition transforming ordinary photons to dark photons be in question? Or is the rate for the transformation of dark photons to ordinary photons for some reason much slower in the dark mode? Could this rate be proportional to h_{eff} and could dark mode have larger h_{eff}.

3.3 TGD based model for the findings

In the following the basic building bricks of TGD based model are described and a model for the formation of the spherical crystals is considered.

3.3.1 Some applications of the TGD view about dark matter as starting point

It is good to start with the basic building bricks provided by existing applications of the vision about dark matter as phases of ordinary matter labelled by the hierarchy of Planck constants

1. Nottale [1] was the first to propose the expression $h_{eff} = nh_0 = \hbar_{gr} = GM_Dm/v_0$ for the gravitational Planck constant assignable to gravitational flux tubes. Here M_D is some large dark mass. v_0 is a parameter with dimensions of velocity: for the inner planets of Sun $\beta_0 = v_0/c \simeq 2^{-11}$ gives a satisfactory estimate for their radii as radii of Bohr orbits.

   $\hbar_{gr}$ must be used when its value is larger than $\hbar$: one motivation is that Nature itself guarantees the convergence of the perturbation series by making a phase transition increasing the effective value of Planck constant. This transition can be interpreted as a change of the space-time topology: one can say that it becomes n-sheeted structure. A more detailed view is that one has $n = n_1n_2$, where n_1 is the number of sheets over CP_2 and n_2 over M^4. Sheets over CP_2 would correspond to parallel flux tubes.

   For gravitation the parameter $GMm/\hbar_{gr} = \beta_0$ appearing in perturbation series is smaller than 1. The integer n has concrete topological interpretation in terms of space-time topology [16] (see `http://tinyurl.com/yy88v35d`) . This formula has rather obvious generalization to the electromagnetic case.

   How to identify the large dark mass M_D? $M_D = M_E$ is the naive first guess. On the other hand, the application to the fountain phenomenon in super-fluid in turn suggests $M_D \sim 10^{-4}M_E$.

2. In accordance with Equivalence Principle the gravitational Compton length $\lambda_{gr} = GM_D/v_0 = 2r_s/\beta_0$ does not depend on m at all and also cyclotron energy $E_c = \hbar_{gr}ZeB/m$ is independent of m. In TGD inspired quantum biology this would guarantee that the cyclotron energies of all charged particle generate same molecular transitions in UV and visible range.

   $\lambda_{gr} = 2r_S(M)/v_0$ looks like a natural parameter for the size scale (radius) of the layers and corresponds to the same scales as the system itself (say anode). For $M_D = M_E$ one would have $r_s(M_E) \sim 1$ mm. $v_0 = 2^{-11}$ (true for Sun and inner planet flux tubes) would give $\lambda_{gr} \sim 4$ m. For $M_D \sim 10^{-4}M_E$ suggested by the model of fountain effect of super-fluidity one would have $\lambda_{gr} \sim r_S$. Could the value of M_D be determined by the condition $\lambda_{gr} = r_S(M)$? This is however not the case for Sun.

If this picture makes sense, quantum gravitation could be central element of plasma phenomena regarded usually purely electromagnetic in contrast to EU hypothesis stating just the opposite. Later it will be found that quantum gravitation could be essentials also for phenomena like crystallization.

3. The model for the quantal effects of ELF radiation on vertebrate brain involves the assumption about the presence of "endogenous" magnetic field $B_{end} \sim 2B_E/5$, $B_E = .5 \times 10^{-4}$ Gauss is the nominal value of the Earth's magnetic field strength. Is B_{end} is associated with the gravitational flux tubes or with monopole flux tubes and can gravitational flux tubes be monopole flux tubes. I cannot answer this question definitively. In any case, since the magnetic field should consist of monopole flux tubes and those assignable to the ordinary magnetic field, B_{end} can correspond to the monopole fluxes.

   Dark ions are not only an essential element of the effects of ELF em fields on vertebrate brain but of entire TGD inspired quantum biology [7, 8]. What makes ion dark and how do they relate to the dark variants of atoms/ions explaining Pollack effect and "cold fusion"? The vision has been that dark atoms/ions differ from ordinary atoms/ions in that their magnetic body has dark part with non-standard value of h_{eff}. The value of Planck constant should be large: perhaps the gravitational part of the magnetic body is dark having Planck constant $h_{eff} = h_{gr}$.

4. Also the thermal Compton length $\lambda_{th} = \hbar_{gr}/T$ is expected to be relevant and is very large for large values of h_{gr}. For instance, at room temperature one has $T \sim 10^{-2}$ eV and $\lambda_{th} \simeq 10^{-4}$ m. Bio-applications suggest that EEG frequencies - say $f = 10$ Hz - correspond to energies $E = h_{gr}f$ above thermal energy of 10^{-2} eV and having $\lambda \sim 10^{12}$ Hz giving $\hbar_{gr}/h \geq 10^{11}$. This would correspond to $\lambda_{th} \sim 10^7$ m which is of the order of the Earth's radius. This length scales could correspond to the size scale of gravitonic Bose-Einstein condensate. Note that the effective value of fine structure constant is scaled down to keep so that the Debye length is unaffected.

"Cold fusion" and Pollack effect represent situations in which the value of h_{eff} is not so large and might be assignable to flux tubes mediating electromagnetic interactions.

1. The dark protons in "cold fusion" have essentially the same Compton length as electrons from the findings of Holmlid [11, 12], which would suggest that analogs of hydrogen atoms are formed as neutral bound states of dark protons and ordinary electrons. This generalizes: further scaling of h_{eff} for protons can be accompanied by similar scaling for electrons to guarantee local charge neutrality. Similar local neutralization mechanism applies to dark DNA identified as dark protons sequences and ordinary DNA [14].

   For "cold fusion" h_{eff} would be about $m_p/m_e \sim 2^{11}$ and much smaller than h_{gr}. Therefore the flux tubes assignable to the dark atom cannot be gravitational flux tubes although dark atom flux tube can reside inside gravitational flux tube. One would have two kinds of flux tubes: do they correspond to the monopole flux tubes and non-monopole flux tubes predicted by TGD and which is which?

   The binding energy of dark nuclei is scaled down by $1/h_{eff}$. The proposal is that this is due to the lengthening of the flux tubes of the magnetic body of nucleons mediating nuclear interactions. Nuclei would look like plants: the nucleus would be like the seed or root and magnetic body would correspond to the visible part of the plant. Parts of magnetic body could become dark by the change of h_{eff} from the standard value.

2. Dark nuclei formed in Pollack effect [2, 9] would be dark proton sequences but with a value of h_{eff} differing from that in cold fusion. If also weak interactions become dark, their rate is comparable to that for em interactions below the scaled up weak length scale h_{eff}/M_W and one can say that electroweak symmetry breaking is absent. Could the dark proton sequences transform to dark nuclei by dark weak decays $p \to n + e^+ + \nu_e$. Could the resulting stable dark nuclei correspond to stable ordinary nuclei?

Thermodynamical anomalies as apparent breaking of second law and causal anomalies due to the change of the arrow of thermodynamical time are predicted by ZEO based view about macroscopic quantum jumps requiring also large value of h_{eff}, and might be observable in the system studied.

3.3.2 A model for the formation of spherical micro-crystals

TGD encourages to consider the possibility that all self-organization process are basically quantal [20] and even more, involve the increase of the effective Planck constant $h_{eff} = n \times h_0$ requiring energy feed. If the interpretation of transmutations in terms dark nuclear fusion is correct, the energy needed would come from this. Self-organization would be associated with the long range quantum coherence at dark magnetic flux tubes in turn forcing non-quantal long range coherence of the ordinary matter realized now as a double layer.

Concerning the values of h_{eff} the situation is far from understood. The values of h_{eff} label the flux tubes mediating various interactions and one can talk about gravitational Planck constant h_{gr} and electromagnetic Planck constant h_{em}. The TGD based model for "cold fusion" leads to a concrete identification of Planck constant involved, and one might call it nuclear Planck constant or assign it with dark color interactions. Flux tubes can be also classified according to whether they carry monopole flux or not. Therefore the applications involve guesswork.

1. The formulas for the Debye length and thermal Compton length give some idea about the self-organization process involved. Debye length is purely classical notion having no dependence on Planck constant and characterizes ordinary matter: this scale defines naturally the thickness of the layers. If dark matter and ordinary matter are in thermal equilibrium, the value of thermal Compton length is scaled up by $\hbar_{eff}/\hbar$ for which the estimate is $\hbar_{eff}/\hbar = n/6$ [13]. Dark thermal Compton length $\lambda_T = \hbar_{eff}/T$ would define one quantum scale.

2. EU theory assumes that electromagnetism is enough to understand the situation. In TGD however quantum gravitation plays key role in living matter and perhaps also in self-organization in long length scales. This motivates the notion of gravitational Planck constant $h_{eff} = h_{gr}$ assignable to the flux tubes mediating gravitational interactions (it is not clear whether they are monopole flux tubes carrying net magnetic flux or not) - to be distinguished from the flux tubes mediating em interaction and having much smaller value of h_{eff}. One can also talk about h_{em}, h_{weak} and h_{strong}.

3. TGD predicts also scaled up Compton lengths of dark variants of particles proportional to h_{eff}. In particular, dark gravitational Compton length associated with gravitational Planck constant $h_{gr} = h_{eff}$ having no dependence on particle mass is predicted.

The talk claims that the formation of balls with radius about few microns - biological scale - looks like a gravitational phenomenon: the idea would be that gravitation reduces to plasma physics. In TGD framework the claim is that gravitation is involved with plasma physics thought to be a purely electromagnetic phenomenon.

Spherical micro-crystals are quite general phenomenon and the natural guess is that the balls are micro-crystals. This would suggests that crystallization in general could involve quantum gravitation in an essential manner.

1. The thermal Compton length λ_{th} for the ordinary value of Planck constant is of order 10^{-5} m at room temperature: not far from the size scale of the balls. This is a possible clue but will not be followed in the sequel. The thickness of the flux tubes for B_{end} is few microns. This inspires some guesses concerning the formation of the balls having also radius of this order of magnitude.

2. Suppose that the balls are formed from dark atoms as they transform to ordinary atoms. What dark atoms could be? Pollack effect suggests that dark protons rather than dark hydrogen atoms

reside at flux tubes. Dark proton sequence could be accompanied by a neutralizing sequence of ordinary electrons. If this is the case, one can talk about dark atoms.

Could the dark atoms in this sense with $h_{eff} \leq\leq h_{gr}$ reside at the gravitational flux tubes with $B = B_{end}$ having $h_{eff} = h_{gr}$ and make a phase transition to ordinary atoms condensing to form spherical micro-crystals with size scale of the thickness of the gravitational flux tube? h_{gr} is proportional to the mass of the atom so that given ball characterized by h_{gr} would consist of single type of atom and one would indeed obtain mono-crystals.

3. Quasicrystals cannot be formed by crystal growth as realized by Penrose, who suggested that the formation takes place by macroscopic quantum transition. This kind of transitions are a general TGD based prediction and one of the latest applications is to earthquakes and volcanic eruptions [19] involving in an essential manner zero energy ontology predicting the observed causal anomaly.

   Could the formation of all crystals quite generally involve quantum gravitation and identifiable as a macroscopic quantum jump and involve the proposed selection mechanism putting atoms with different mass numbers to different flux tubes like books with different topics in library as I have suggested earlier? Note this would make living matter a well-organized library instead of random soup of biomolecules.

3.4 How stars and planets could have formed?

In the second part of a talk a proposal for how stars and planets are formed was discussed.

1. It was essentially TGD view except that they did not talk about monopole flux tubes and tangles along them: the natural possibility is that tangles have structure analogous to that of flux lines of dipole magnetic field.

2. One of the basic conjectures of TGD is that stellar interiors are not the only places, where elements are produced. They could be produced by "cold fusion" everywhere and the craters would provide direct evidence for this. The dark currents going along flux tubes to the interior of planets and smaller objects coming from Sun along flux tube network could be in crucial role and give rise to dark nuclear fusion.

3. Electromagnetic fields in long length scales are essential for the formation of the planets and their chemistry. But I do not see purely electric universe as a realistic option. Gravitational fields are also central and the role of gravitational Planck constant assignable to gravitational flux tubes having huge values is in key role in TGD. But also "gravitation alone" approach has failed. What makes electromagnetic fields equally important is the existence of monopole magnetic flux tubes and the hierarchy of Planck constants.

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