What makes the mini Big Bangs energetically possible?

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Abstract

Mini Big Bangs throwing out a magnetic flux tube layer from an object, which could be a star or even a planet, play a central notion of TGD inspired cosmology and astrophysics. These explosions define the local TGD counterpart for the smooth cosmic expansion. A liberation of energy compensating the reduction of the gravitational binding energy is required and must present new physics predicted by TGD.

I have considered several candidates for this energy source and phase transitions reducing the value of the effective Planck constant h_{eff} are the natural candidates. Since monopole flux tubes play a key role in the mini Big Bangs, the identification of this energy asdark gravitational cyclotron energy associated with dark particles, in particular nucleons, should have been a natural first guess. In this article this proposal is applied to several cases where a mini Big Bang could be involved. The applications discussed in this article are the proposed doubling of the radius of Earth in the mini Big Bang associated with the Cambrian expansion; the emergence of the Moon in an explosion throwing out a surface layer of Earth and the emergence of the two moons of Mars in similar explosions occurring for either hemisphere of Mars: this would explain the Martian dichotomy. The scales of the gravitational cyclotron energies turn out to be consistent with the gravitational binding energy scales.

The recent model of the Sun relies on the crazy idea that both solar wind and solar energy are produced at the surface layer of the Sun consisting of nuclei of M_{89} hadron physics with a mass scale 512 times that of the ordinary hadron physics, which would transform to ordinary nuclei by p-adic cooling reducing the p-adic mass scale. Besides solar wind and solar eruptions, this process would produce planets as mini Big Bangs throwing out a layer of matter and also supernovas would be results of similar explosions. Quite surprisingly, the cyclotron magnetic

energy for M_{89} nucleons turns out to be equal to the nuclear binding energy per nucleon for M_{89} nuclei. This suggests that the p-adic cooling of M_{89} hadrons to ordinary hadrons begins with the splitting of M_{89} nuclear bonds producing free M_{89} nucleons. The final state could involve the decay of dark M_{107} nuclei with Compton length of electron and binding energy of order 10 keV to ordinary nuclei liberating essentially all the ordinary nuclear binding energy. Same decay would occur in "cold fusion" as dark fusion.

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1 Introduction

Mini Big Bangs [L6, L7], throwing out a monopole magnetic flux tube layer from an object, which could be a star or even a planet, play a central notion of TGD inspired cosmology and astrophysics. These explosions define the local TGD counterpart for the smooth cosmic expansion. A liberation of energy compensating the reduction of the gravitational binding energy is required and must present new physics predicted by TGD.

I have considered several candidates for this energy source and phase transitions reducing the value of the effective Planck constant h_{eff}, defining a hierarchy of effectively dark phases of ordinary matter, are the natural candidates. Note that the dark matter in this sense does not correspond to the galactic dark matter which would correspond to sum of the Kähler magnetic energy and volume energy parameterized by the analog of cosmological constant assignable to cosmic strings as extremely thin monopole flux tubes [L8].

Since monopole flux tubes play a key role in the mini Big Bangs, the identification of this energy as dark gravitational cyclotron energy associated with dark particles, in particular nucleons, should have been a natural first guess. In this article, this proposal is applied to several cases where a mini Big Bang could be involved. The applications include the proposed doubling of the radius of Earth in the mini Big Bang associated with the Cambrian expansion; the emergence of the Moon in an explosion throwing out a surface layer of Earth explaining the mysterious asymmetry between near and far sides of the Moon; the emergence of the two moons of Mars in similar explosions occurring for the hemispheres of Mars: this would explain the mysterious asymmetry of the northern and southern hemispheres of Mars. What is remarkable is that the scales of the gravitational cyclotron energies turn out to be consistent with the gravitational binding energy scales.

The recent model of the Sun [L10] relies on the crazy idea that both solar wind and solar energy are produced at the surface layer of the Sun consisting of nuclei of M_{89} hadron physics [K2, K3] with a mass scale 512 times that of the ordinary hadron physics, which would transform to ordinary nuclei by p-adic cooling reducing the p-adic mass scale. Besides solar wind and solar eruptions, this process would produce planets as mini Big Bangs throwing out a layer of matter and also supernovas would be results of similar explosions.

Quite surprisingly, the cyclotron magnetic energy for M_{89} nucleons turns out to be equal to the nuclear binding energy per nucleon for M_{89} nuclei. This suggests that the p-adic cooling of M_{89} hadrons to ordinary hadrons begins with the splitting of M_{89} nuclear bonds producing free M_{89} nucleons. The final state could involve the decay of dark M_{107} nuclei with Compton length of electron and binding energy of order 10 keV to ordinary nuclei liberating essentially all the ordinary nuclear binding energy. Same decay would occur in "cold fusion" as dark fusion.

This model can be consistent with the standard model only if the transformation of the ordinary nuclei or nucleons produced in the p-adic cooling produces the same spectrum of the ordinary nuclei. This would be the case if the "cold fusion" as dark fusion would produce this spectrum and there are indications that this is the case: this has been interpreted as a demonstration that "cold fusion" is a fraud.

2 Some planetary applications of the cyclotron mechanism

In this section some applications of the proposal that the liberation of dark gravitational cyclotron energy could make mini Big Bangs energetically possible are discussed. Consideration is restricted to planets.

2.1 About the energetics of the planetary mini Big Bangs

The magnetic fields should play an important role so that an estimate for the cyclotron energy in the case of the magnetic fields of the Earth, Mars and Sun magnetic field is in order. Consider first Earth and Mars.

1. For the Earth the cyclotron frequency of proton in the endogenous magnetic field, with a nominal value $B_{end} = .2$ Gauss assigned with the monopole flux tubes, is 300 Hz, and the corresponding energy is $E_c = \hbar_{gr,E} eB/m_p = 4.6$ eV. This energy is higher than the gravitational binding energy of protons of about 1 eV at the surface of Earth (note however that the gravitational binding energy increases below the surface like $1/r$). This could make it possible for transition $\hbar_{gr,E} \to \hbar$ or a transition $1/\beta_0 = n \to n-1$ to provide the energy needed for the explosion throwing a surface layer of the Earth giving rise to Moon.

   The existence of this kind a layer and reduction of $\hbar_{gr}$, say a transition $1/\beta_0 = 2 \to 1$ could make energetically possible also the expansion of the radius of the Earth by a factor 2.

2. What does one obtain in the case of Mars? Could the gravitational binding energy be compensated by the liberation of dark cyclotron energy as the value $\hbar_{gr} = GMm_p/\beta_0$ for Mars is reduced to a smaller value. The ratio of the mass of Mars to that of Earth is $M_{Mars}/M_E \simeq .1$. If the monopole flux tubes carry a magnetic field of strength $B_{end,E} = .2$ Gauss the cyclotron energy of the proton is scaled down to .46 eV. The gravitational binding energy for protons at the surface of the Earth is about 1 eV and at the surface of Mars about .1 eV. Also now the liberation of the dark cyclotron energy for protons in a phase transition increasing the value of β_0 could make the explosion of the surface layer possible.

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2.2 Cambrian Explosion

In the article [L4] have developed a more detailed TGD version of the Expanding Earth hypothesis explaining Cambrian Explosion (CE). A more detailed view of the pre-Cambrian biology, geology, and thermal evolution emerges and one can relate it to the standard view. This involves topics like faint Sun paradox, the mechanism of Great Oxygenation Event, understanding the TGD counterparts of supercontinents Rodinia and Pannotia preceding CE, snowball Earth, and CE that led to a sudden emergence of highly advanced multicellulars.

Also a more detailed view of what happened in the Cambrian explosion induced by the increase of the radius of Earth by factor 2 emerges (in the TGD Universe, a smooth continuous cosmological

expansion is replaced with a sequence of short lasting and fast expansions). One ends up with a detailed model for the phase transition leading to the increase of the Earth radius. This phase transition requires a considerable energy feed provided by the phase transition thickening monopole flux tubes of the magnetic body of Earth and liberating energy. In analogy with the recent Mars, pre-Cambrian Earth had a solid core analogous to the inner core. In the phase transition to a liquid outer core with much larger volume. Part of the newly formed outer core could in turn have transformed to form a part of the mantle increasing its thickness.

What has remained open is the energetics. The reduction of gravitational binding energy by a factor of two takes place and since the gravitational binding energy of a proton is about 1 eV at the surface of the Earth, this would require energy of about .5 eV per every nucleon. Dark cyclotron energy of ions at the dark gravitational magnetic body of the Earth or of the Sun is a natural candidate for the energy provider. The idea that every nucleon of the Earth should receive this energy, looks implausible. Note that also dark electrons would contribute with the same dark energy.

For $1/\beta_0 = n$ the gravitational dark cyclotron energy is n-fold. For $n \simeq 2^{11}$ applying to the magnetic body of Sun-Earth system, the energy would be about 10 keV, which happens to be the energy scale associated with "cold fusion" discussed in [L11]. A connection is highly suggestive: could the formation of dark nuclei as dark protons sequences with this binding energy induce the transfer of electrons to dark electrons at the magnetic body of the Sun. For this option, it is enough that roughly a fraction 2^{-11} of the mass of Earth is gravitationally dark. The dark charged particles could reside at the dark gravitational magnetic body of the Sun and would be could be transferred to the magnetic body of the Earth or transform to ordinary charged particles. A reversal of the Pollack effect occurring in the scale of the Earth would be in question.

2.3 What are the mysterious structures observed in the lower mantle?

I learned of very interesting results related to geology. The Dailymail popular article (see this) tells about massive structures in the Earth's deep mantle below Pacific Ocean near the mantle-core boundary. The article "Full-waveform inversion reveals diverse origins of lower mantle positive wave speed anomalies" of Schouten et al published in Scientific reports [F1] (see this) describes the findings.

There are cold regions deep within the Earth where seismic waves behave in unexpected ways. These regions, located 900 to 1,200 kilometers beneath the Pacific Ocean, defy expectations based on conventional plate tectonics theories. These kinds of structures can result from the subduction of continental plates leading to the sinking of a plate to the mantle. There are however no subduction records in the Ocean regions so that the mechanism must be different.

It seems that the recent view of the dynamics of the Earth's mantles is in a need of a profound updating. It has been proposed that the structures could be the remnants of ancient, silica-rich materials from the early days of the Earth when the mantle was formed billions of years ago. Alternatively, they may be areas where iron-rich rocks have accumulated over time due to the constant movement of the mantle. However, researchers are still unsure about the exact composition of these deep Earth structures.

Here is the abstract of the article of Schouten et al.

> *Determining Earth's structure is paramount to unravel its interior dynamics. Seismic tomography reveals positive wave speed anomalies throughout the mantle that spatially correlate with the expected locations of subducted slabs. This correlation has been widely applied in plate reconstructions and geodynamic modelling. However, global travel-time tomography typically incorporates only a limited number of easily identifiable body wave phases and is therefore strongly dependent on the source-receiver geometry.*
>
> *Here, we show how global full-waveform inversion is less sensitive to source-receiver geometry and reveals numerous previously undetected positive wave speed anomalies in the lower mantle. Many of these previously undetected anomalies are situated below major oceans and continental interiors, with no geologic record of subduction, such as beneath the western Pacific Ocean. Moreover, we find no statistically significant correlation positive anomalies as imaged using full-waveform inversion and past subduction.*

These findings suggest more diverse origins for these anomalies in Earth's lower mantle, unlocking full-waveform inversion as an indispensable tool for mantle exploration.

Here some terminology is perhaps in order. Seismic waves are acoustic waves and their propagation in the mantle is studied. Positive speed anomaly means that sound speed is higher than expected. The lowering of temperature or increase of density such as presence of iron can cause this kind of anomalies. The Pacific ocean and the interior regions of plates do not have any subduction history so that the slabs cannot be pieces ofcontinental plates, which have sunk to the mantle.

I have not earlier considered what happened in the lower mantle in the sudden expansion of Earth increasing its radius by factor 2 and giving rise to the Cambrian Explosion. Did these kinds of cracks occur also in the mantle-core boundary and lead to the formation of the recently observed structures also below regions where there is no geologic record for subduction? Could at least some regions which are believed to be caused by the sinking of parts of continental plates have such structure?

Could the Cambrian explosion be a mini Big Bang that happened in the lower mantle and forced the motion of the upper layers leading to the increase of the radius of Earth? The longstanding problem has been the identification of the energy needed to overcome the gravitational force. The order of magnitude of the gravitational binding energy per nucleon is about 1 eV at the surface of the Earth and decreases like $M(R)/M_E)/R \propto R^2$ below it. How did the matter above the monopole flux tube layers get this energy?

1. Since the monopole flux tubes are the key actors, a natural first guess is that there was a layer of dark protons at monopole flux tubes in the lower mantle, say above the core, and that the gravitational energy is compensated by the cyclotron energy of dark proton with gravitational Planck constant $\hbar_{gr}(M(below))$ at monopole flux tube carrying a magnetic field of order of magnitude of endogenous magnetic field. The value of B_{end} need not be the same as its value $B_{end} = .2$ Tesla at the surface of the Earth.

2. If the monopole flux behaves like $1/R^3$, as the dipole character of the Earth's magnetic field suggests, and the mass appearing in the gravitational Planck constant is the mass $M(R) = (R/R_E)^3 M_E$ below the monopole flux tube layer is used, the cyclotron energy is the same as at the surface of the Earth. In the explosion, the value of $\hbar_{gr}$ would be reduced dramatically, perhaps to $\hbar$ and the cyclotron energy would be liberated.

   In the interior of the Earth, the gravitational potential energy for mass m is of form $E_{gr} = GM_E m V_{gr}(R)$, $V_{gr}(R) = R^2/2R_E^3 - (3/2)/R_E$ and approaches in the center of the Earth the value $-(3/2)GM_E m/R_E$ and at the surface of the Earth to the value $-GM_E m/R_E$.

3. All nuclei must receive the cyclotron energy compensating the gravitational binding energy and a larger fraction should therefore be dark before the explosion. The gravitational Planck constant $\hbar_{gr} = GMm/\beta_0$ of a nucleus is proportional to its mass number so that the cyclotron energy $\propto ZeB/m$ does not depend on the mass number A of the ion of mass $m \simeq Am_p$. For $1/\beta_0 = 1$, the extreme option is that the entire Earth's interior contains gravitationally dark nuclei meaning that there is a large negatively charged exclusion zone created in the Pollack effect, perhaps giving rise to the electric body assignable to the Earth. Can this be consistent with what is known about the Earth's history? For $1/\beta_0 = 2^{-11}$ assignable with the magnetic body of the Sun-planet system, the value of cyclotron energy would be about 10 keV, which happens to be the energy scale of "cold fusion" identified as dark fusion in the TGD framework [L11]. Could the formation of dark nuclei with nucleon radius of order electron Compton length and with a dark nuclear binding energy of order 10 keV involve the formation of the monopole flux tubes with this dark cyclotron energy?

2.4 A model for the formation of Moon

The model for the formation of planets can be applied also to the mysteries of the Moon.

1. The origin of the Moon is a mystery although the fact that its composition is the same as that of Earth gives hints. Theia hypothesis proposes that the Moon was formed from the debris of a collision of a planet with mass of order mass of Mars. The TGD proposal is that

the Moon was formed as Earth expanded suddenly, throwing out a spherical shell which then developed a hole and suffered a gravitational collapse to form the Moon.

2. Moon is receding from us. Cosmic recession velocity is 78 percent of this velocity, which suggests that surplus recession velocity is due to the explosion citebtartpreCE. The breaking of the spherical symmetry caused by the development of the hole plus the transformation of the gravitational binding energy to kinetic energy during the collapse would give the Moon a radial recession velocity which would gradually slow down to the cosmic recession velocity.

3. It seems that the Moon has effectively turned inside out [E1]. The natural explanation is that the far face of the Moon corresponds to the surface of the ancient Earth which remained solid in the explosion and formed an outwards directed bulge, since compression was not possible. The first guess is that the near face corresponds to the lower boundary of the expanding shell, which partially transformed to magma in the explosion, which liberated a lot of heat. It turns out that part of a large fraction of the spherical disk must have transformed to magma form in the final stages of the gravitational collapse. This conforms with the empirical facts.

4. The faces of the Moon are very different [E2]. The mechanism of the formation explains this.

5. The latest mystery that I learned of, are the magnetic anomalies of the Moon. The TGD based view of the origin of the Moon combined with the TGD view of magnetic fields generalizing the Maxwellian view explains all these findings. Monopole flux tubes have a closed cross section and there is no need for the currents to maintain the. This would also explain the stability of the Earth's magnetic field [L2] and the preservation of the magnetic fields in cosmic scales.

This leads to a proposal that the Moon was formed in an explosion throwing out a surface layer of the Earth with the mass of the Moon. This would explain various anomalies listed above. If the magnetic body of the Earth, or possibly of the Sun, provides the energy needed to overcome the gravitational force, also the energetic might be understood. As already explained, the gravitational binding energy for a proton at the surface of the Earth is of the order of 1 eV. Note that for Fe ion the energy is A=56 times larger however. The dark gravitational cyclotron energy of a charged ion at the gravitational magnetic body of the Earth is about 5 eV. For the Sun the energy is about 10 keV, the energy scale assignable to "cold fusion". This could make possible the formation of the Moon in a mini Big Bang.

The basic prediction of the model is that the compositions of the Earth and Moon are the same. The model of formation based on the collision of a Mars sized object with the Earth does not predict this. Quite recently, Taylor Reed Ramsey informed me that this seems to be the case. The article titled "Composition, structure, and origin of the Moon" by Sossia et al [E3] (see this and this) provides the details.

2.5 Martian dichotomy from the TGD point of view

Mars has a very strange property called Martian dichotomy (see this). The Northern and Southern hemispheres of Mars are very different. The crust is significantly thicker in southern highlands than in northern lowlands. The mountains at southern highlands rise even 6 kilometers higher than in northern lowlands. Southern rocks are magnetized suggesting that Mars has had a large scale magnetic field. Mars still has short scale magnetic fields as the appearance of Martian auroras tells. Southern highlands appear to be older than the northern lowlands: the age is estimated from the density of impact craters. It is also believed that there has been a vast water ocean in northern lowlands.

Several explanations have been proposed. A mega-impact or several impacts could have produced the depression in the crust in the northern lowlands area. Second explanation is in terms of plate tectonics which would be asymmetric.

Also Mars has analogues of earthquakes. They could be called marsquakes. According to the popular article (see this), it is claimed that the study of the marsquakes has led to the understanding of the Martian dichotomy [E4]. Its origin would relate to the dynamics deep inside the planet. The new finding is that the seismic waves associated with the marsquakes lose energy quicker in

southern highlands. This would mean that the temperature in highlands is higher. These findings suggest that the asymmetry is caused by the internal dynamics of Mars rather than impacts.

What could one say about the Martian dichotomy in the TGD framework? TGD adds two new pieces to the puzzle.

1. Moon has an analogous asymmetry but now the hemispheres correspond to the hemisphere that we see always and the hemisphere we never see. This is due to the phase locking of the spinning rotation of the Moon with its orbital rotation around Earth. The TGD based model [L9] assumes that Earth has lost its upper layer in a mini big bang [L6, L7], which then formed the Moon. The inner and outer surfaces of the Moon would correspond to the lower and upper boundary of the layer respectively and this would explain their difference.

2. The crazy idea is that the northern and southern hemispheres of Mars could have lost different masses in an asymmetric mini big bang leading to the birth of Phobos and Deimos, the two Moons of Mars (this). The asymmetry should reflect itself in the properties of these moons. The moons have an irregular shape. Phobos has a diameter of 22.2 km, mass 1.1×10^{16} kg, and semimajor axis 13.5 km. Deimos has a diameter of 12.6 km, mass 1.5×10^{15} kg, and semimajor axis 23.5 km.

3. This suggests the associations **northern hemisphere-more massive Deimos-thicker crust-earlier-farther from Mars** and **southern hemisphere-lighter Phobos-thinner crust-later-nearer to Mars**.

   The more massive Deimos would have originated in a mini big bang throwing out a considerably thicker layer from the northern Martian hemisphere. This would explain the thinner northern crust. Large fraction of the magnetic field associated with the surface layer would have blown out. The TGD view of magnetic fields of the Earth and Sun the monopole flux tube part of the magnetic fields would have a part concentrated in a surface layer. Deimos would have originated later than Phobos. One could understand why the southern hemisphere has thicker crust, why it has more impact craters and therefore looks older, and why it still has a magnetic field consisting of monopole flux tubs. The orbital parameters do not depend on the mass of the Moon (Equivalence Principle). Deimos would have however originated earlier and received a recoil momentum and would be now farther from Mars and Phobos.

The key question concerns the energetics of the transition. Where does the energy compensating the reduction of the gravitational binding energy come from? An analogous question is encountered in the model for the formation of the Moon as a mini Big Bangs throwing a spherical layer from the surface of Earth. It is also encountered in the TGD version of the Expanding Earth model [K1] [L4] assuming that the radius of Earth grew by a factor 2 in a relatively short time scale and induced Cambrian Explosion as life from underground oceans bursted to the surface. Mini Big Bangs would also cause the formation of planets as a surface layer of a star explodes [L6, L7]. Also Super Novas would be explosions of this kind. Micro Big Bangs could give rise to solar wind and solar eruptions [L10].

3 Is the model of the Sun consistent with the standard model?

The key question is whether the proposed model is consistent with the standard model of the Sun. Can the predicted nuclear abundances be consistent with the abundances predicted by the standard model? Is there a counterpart for the notion of stellar generations with a new generation formed from the remnants of supernova explosions. I have also proposed that dark fusion as the TGD counterpart of "cold fusion" could replace ordinary hot fusion even in the case of the Sun. How does the model based on $M_{89} \to M_{107}$ transition relate to this model and can the two views be consistent?

Mini Big Bangs [L6, L7] would cause the formation of planets as a surface layer of a star explodes [L10]. This predicts a new kind of mechanism for the creation of rogue planets (see) or, more formally, isolated planetary mass objects (iPMO). Also supernovas would be explosions

of this kind. Micro Big Bangs at the surface of the Sun could cause solar wind and coronal mass ejections (see this).

In the case of solar wind and related phenomena magnetic fields are involved and must be an essential aspect of the phenomena. The mechanism for the acceleration of trace amounts of heavy ions and atomic nuclei of elements such as carbon, nitrogen, oxygen, neon, magnesium, silicon, sulfur, and iron encountered also in solar plasma is believed to involve magnetic fields but the mechanism is not understood.

The key ideas are as follows.

1. The mini and micro Big Bangs could be seen as the TGD counterpart for the cosmic expansion replacing it with a sequence of rapid bursts.

2. A phase transition changing the effective Planck constant and relevant p-adic length scale could take place. This phase transition would liberate large cyclotron energy making it possible to overcome the gravitational force.

3. The notion of magnetic bubble [L6, L5] identified as a layer formed by a network of monopole flux tubes and forming the basic structural element of the magnetic body together with radial U-shaped gravitational monopole flux tubes could be crucial. For instance, this leads to a model for the solar wind based on the reconnection of flux tubes of a surface layer of the Sun formed by magnetic monopole flux tubes.

4. A natural guess is that nuclear fusion is involved in the case of the Sun. I have considered several options for what the fusion-like process could be in the TGD Universe. The standard option is ordinary nuclear fusion in the core but is plagued by several conflicts with empirical facts.

The first TGD inspired proposal is based on "cold fusion" [L3, L1] identified as dark fusion giving rise to dark proton sequences with dark Compton length of order electron Compton length. The dark nucleon sequences would spontaneously decay to ordinary nuclei. This could ignite ordinary fusion but one can also consider the option that ordinary fusion is not needed at all.

1. The elegance of the "no hot fusion" option inspires the question whether dark fusion at a surface layer of the Sun could produce the radiation energy of the Sun and the solar wind. The energy scale for the gamma rays from the transition of the dark nuclei is about 10 keV and considerably lower than the MeV scale for the ordinary nuclei.

2. This option should be consistent with the ordinary model of nuclear fusion. The first objection is that this seems to realize the stellar evolution so that it occurs at the level of a single star. This view conforms with the fact that nuclei up to nuclear masses of Fe are present in the solar wind. It has been also found that the distribution of stars in various stages of evolution does not seem to depend on the cosmic time.

3. Can this view be consistent with the assumption that the evolution of stars is by supernova explosions providing material for the subsequent generation of stars? Zero energy ontology allows us to consider the possibility that the supernova explosions are quantum tunnelling events involving two "big" state function reductions (BSFRs) changing the arrow of time. This view might allow us to understand why the fraction of the heavier nuclei in the surface layer increases in the supernova explosions.

There is also a second proposal. In [L10] I have considered a rather radical, one might call it totally crazy, proposal that the Sun contains a surface layer in which the monopole flux tubes carry nuclei of M_{89} hadrons physics with mass scale which is 512 times higher than for the ordinary hadron physics.

1. The transformation of M_{89} nuclei to ordinary nucleons in p-adic cooling would be responsible for the solar wind and also for the energy production of the Sun. The interior of the Sun could be totally different from what has been believed. This layer would be gravitationally dark and have thickness of order of gravitational Compton length of the Sun which is $R_E/2$.

2. This model should reproduce the predictions of the standard model of solar energy production assuming nuclear fusion in the solar core. Suppose that the dark fusion at the surface layer produces the same distribution of nuclei as the ordinary fusion. Suppose that the end product of $M_{89} \to M_{107}$ transition consists of dark nuclei of M_{107} hadron physics, which spontaneously transform to the ordinary nuclei. If the composition of the solar wind codes for the outcome of the ordinary fusion, the model could be consistent with the standard model.

3. Ordinary nuclear reactions (, which could take place as dark fusion by tunnelling by two BSFRs) are possible between the ordinary nuclei produced in the phase transition and affect the distribution of the nuclei. There are some indications that the "cold fusion" produces the same distribution of nuclei and these indications have been used as a justification for the claims about fraud.

Consider now the role of gravitational magnetic monopole flux tubes in the case of the Sun. Did their dark cyclotron energy make possible the energy production by the Sun?

1. Somewhat surprisingly, the magnetic field at the surface of the Sun is the same order of magnitude as the magnetic field of Earth. One can estimate the value of solar gravitational Planck constant $\hbar_{gr} = GM_S m_p/\beta_0$ in the case of protons with mass $m = m_p$ and corresponding dark cyclotron energy. The Nottale's model for the planetary orbits as Bohr orbits implies $\beta_0 \simeq 2^{-11}$ for the Sun and suggests $\beta_0 \simeq 1$ for the Earth. The ratio of the solar mass to the mass of the Earth is $M_S/M_E \simeq 3 \times 10^5$.

   For the Sun with $\beta_0 = 2^{-11}$ E_c is scaled up by the factor $(M_S/M_E/\beta_0$ to $E_c = 2.76$ GeV, almost 3 proton masses, which looks nonsensical! In the radical model for solar energy production involving M_{89} hadrons this scale would be natural. A possible interpretation is as nuclear binding energy for M_{89} nuclei: one has 512×5 MeV$= 2.56$ GeV.

2. Could one think that the p-adic cooling of M_{89} nuclei to ordinary nuclei begins with their decay to M_{89} nucleons such that the gravitational cyclotron energy for M_{89} nucleons (, which does not dependence on the mass) at the monopole flux tubes with magnetic field strength of about $B_{end} = .2$ Gauss provides the energy needed to split the M_{89} nuclear bonds so that the outcome is free M_{89} nuclei unstable against the p-adic cooling to M_{107} nuclei?

3. For $1/\beta_0 = 1$, the solar cyclotron energy would be $E_c = 1.38$ MeV, which corresponds to the energy scale of weak nuclear interactions. They would make possible weak transitions transforming neutrons to protons and vice versa even if the final state would consist of dark nucleon sequence. The nuclear binding energy per nucleon for light nuclei is around 7 MeV and looks somewhat too large: note however that $1/\beta_0 = n > 1$ is possible for the horizontal monopole flux tubes and is consistent with quantum criticality.

What could these results mean? Solar wind contains nuclei up to Fe, the heaviest nucleus produced in ordinary fusion and there is also a mysterious finding that the solar surface contains solid iron. One can consider several options.

1. Quantum criticality suggests that several values for $\hbar_{gr}$ corresponding to different values of β_0 are possible. Just for fun, suppose that the horizontal flux tubes at the solar surface have $\beta_0 \sim 1$ whereas the gravitational U-shaped flux tubes with $\beta_0 \simeq 2^{-11}$ are radial.

   For $\beta_0 \geq 1$ horizontal flux tubes with cyclotron energy about 1.38 MeV, ordinary nuclear reactions and even fusion might take place near the surface of the Sun. Could dark cyclotron photons from monopole flux tubes with $1 \leq 1/\beta_0 \leq 7$ transforming to ordinary gamma radiation ignite the ordinary nuclear fusion in the surface layer and in this way explain why the standard model works so well?

2. The second, more radical, option is that the dark nuclei as products of dark fusion and having a binding energy scale of 2.6 GeV, possibly produced as the outcome of the $M_{89} \to M_{107}$ transition, first ordinary nucleons as the dark cyclotron photons with energy about 2.6 GeV split the M_{89} nuclear bonds. These nucleons could form dark nucleons with nuclear binding energy about 10 keV, which in turn transform to ordinary nucleons as in dark fusion. Note

that also the ordinary nuclear fusion could be reduced to dark fusion involving tunnelling by two BSFRs. If so, the attempts to realize nuclear fusion in nuclear reactors would be based on wrong assumptions about the underlying physics.

3. The density of the Sun at the photosphere is $\sim 10^{-4}$ kg/m^3 whereas the average density of the Sun is 1.41×10^3 kg/m^3 (the average density of Earth is 5.51×10^3 kg/m^3). The density is extremely low so that surface fusion at photosphere cannot explain the energy production of the Sun. The surface fusion layer should exist at some depth where the density is not far from the average density of the Sun. One candidate is a layer above the surface of the solar core. As found its thickness should be of the order of Earth radius.

4. The solar core, usually believed to be the seat of hot fusion, has radius about $.2R_S$ and its mass is roughly .8 percent of the mass of the Sun. This brings in mind the strange finding that .5 percent of the mass needed to explain the fusion energy power produced in the solar core seems to be missing. Could this missing mass be associated with a layer near the surface layer of the Sun and could it be responsible for the solar wind?

   The radius of Earth is 1/109 times the radius of the Sun and the gravitational Compton length $L_{gr,S}$ of the Sun equals to $L_{gr,S} = R_E/2$ and is therefore .5 percent of R_S! What could these coincidences mean? If the Sun has a layer of thickness ΔR with the average density of the Sun, one has $\Delta M/M = 3(\rho_S/\rho_E)\Delta R/R \sim .75\Delta R/R$. For $\Delta R = R_E$ one obtains $\Delta M/M \simeq .75$ per cent, not far from .5 per cent. Could the Sun have a layer of thickness about R_E with density $.75\rho_S$.

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