A quantum model of the Sun and planetary system as analogs of atomic nucleus and atom

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In this article a model of the Sun and planetary system as analogs of atomic nucleus and atom are discussed. This proposal has been already in earlier articles but the progress in the model of the Sun leading to rather dramatic predictions. In particular, the layer of M_{89} giant nuclei with mass which is 512 times the mass of the ordinary nucleon located at monopole flux tubes would produce the nuclei of the solar wind and the energy of the solar radiation.

One must give up the standard model of the solar core as a seat of hot fusion and energy producer. What could be the real function of the solar core? In this framework the interior of the Sun could be a quantum coherent system analogous to atomic nucleus with hot fusion replaced with dark fusion explaining "cold fusion" as a quantum critical phenomenon. Solar interior would be also analogous to the cell nucleus, where the genetic code would be realized in terms of dark nuclear strings in the same universal way as in the TGD inspired quantum biology. This would conform with the earlier of the planetary system as an analog of an atom with a gigantic value of the gravitational Planck constant whose form is fixed by the Equivalence Principle.

In this article the model of the Sun as an analog of nucleus is developed in detail. The simplest model with a constant average density motivates the gravitational harmonic oscillator model with the orbitals of nuclei replaced with rigid 2-spheres with radii given by the harmonic oscillator model and containing a surface density of matter consistent with the constant average density. The basic quantization condition would state that the angular momentum is quantized using as a unit the gravitational Planck constant associated with the total mass of the sphere and those below it.

This model can be applied also to planets and also a model for the generation of planets in the explosions induced by the transformation of M_{89} nuclei to M_{107} nuclei throwing out part of the the M_{89} layer with baryon number which correspond to 3 Earth masses.

Contents

1 Introduction

In [L10] I ended up with the proposal that stars and even planets, or at least their cores, could be modelled as systems analogous to atoms consisting of "mass shells", which correspond to the analogs of atomic orbitals containing constant mass density. I have already earlier discussed this kind of model for blackhole-like entities in [L8]. In this article my aim is to develop this model further and also test it. First however a summary of the general vision, which differs rather dramatically from the standard model of the Sun, is in order

1.1 A brief summary of the model for the stars and planets

The article "Is the Sun a Black Hole?" by Nassim Haramein [L10] describes a collection of various anomalies related to the physics of the Sun. I have considered many of these anomalies already earlier but the article inspired the development of a more detailed model explaining these anomalies from the TGD point of view. The model expanded to a model of the Sun and planets.

1.2 Is the layer of M_{89} nucleons at the surface of the Sun responsible for the solar energy production and solar wind?

The most important anomalies are the gamma ray anomalies and the missing nuclear matter of about 1500 Earth masses. There is also evidence that the solar surface contains a solid layer citebcastMoshina: something totally implausible in the standard atomic physics. The idea that the Sun could contain a blackhole led in the TGD framework to a refinement of the earlier model for blackhole-like objects (BHs) as maximally dense flux tube spaghettis predicting also their mass spectrum in terms of Mersenne primes and their Gaussian counterparts. The mass of the Sun and the mass which is 4/3 times the mass of the Earth belong to this spectrum.

It however turned out that the TGD based model for the missing nuclear matter could assign the gamma ray anomalies to the magnetic body of the Sun consisting of monopole flux tubes. A magnetic bubble as a layer would cover the surface of the Sun and consist of closed monopole flux tube loops. One option is the analog of a dipole field containing flux tube portions along the magnetic axis from South to North and returning along the solar surface from North to South. Also the solar nucleus could contain M_{89} nucleons. In the second, more plausible looking option, the closed flux tubes reside at the solar surface.

The flux tubes could carry M_{89} nucleons with a mass, which is 512 times the mass of the ordinary nucleon. They could be characterized by the gravitational Planck constant of the Sun with gravitational Compton length equal to $R_E/2$ for all particles (R_E refers to the Earth radius). Intriguingly, the Sunspot size is of the order of $R_E/2$. This flux tube structure, predicted to have a mass of order $1500M_E$, would correspond to one dark M_{89} nucleon per the Compton volume of the ordinary M_{89} nucleon so that the analog of supra phase with very large overlap between wave functions would be in question.

The magnetic body carrying long strings of M_{89} nucleons could be seen as a 2-D surface variant of the TGD counterpart of blackhole, which is dark. This model conforms with the earlier model of the sunspot activity related to the reversal of the solar magnetic field.

A possible explanation for the gamma ray anomalies would be in terms of M_{89} and $M_{G,79}$ mesons generated in the TGD counterpart for the formation of quark gluon plasma in a process analogous to high energy nuclear collision creating very high nuclear densities. The decay of M_{89} nucleons to ordinary nucleons of solar wind in a stepwise process that I call p-adic cooling would generate anomalous gamma rays. In proposed this process to explain Centauro and Gemini events which anomalies of particle physics [K2, K3].

p-Adic cooling produces also M_{89} mesons. There is evidence for the formation of M_{89} mesons already from LHC assigned to what in the QCD framework is interpreted as the formation of quark gluon plasma [K2, K3]. $M_{G,79}$ mesons could be also generated in the touching of two M_{89} flux tubes, whose distance would be larger than 2 Compton lengths of M_{89} (M_{107}) nucleons.

1.3 Also dark nuclei are needed?

In the p-adic cooling, the splitting of the long M_{89} flux tubes to short flux tubes by reconnections involving the decay of the M_{89} nucleons to the ordinary M_{107} nucleons would generate solar wind and the radiation from the Sun. If the M_{89} layer at the surface of the Sun produces solar wind and solar energy, the standard model for the Sun becomes obsolete. What really happens in the solar interior? Does it even exist as a super dense system at extremely high temperatures? Could it actually be a quantum system?

A possible answer to this question is provided by the model for dark nucleons applied in the models of "cold fusion" [L1] and pre-stellar evolution [L2].

1. The first possibility is that the heating by the dark fusion ignites the ordinary nuclear reactions giving rise to the stellar core. The convection zone could consist of dark nuclei and the core to (possibly dark, or even gravitational dark) ordinary nuclei so that ordinary nuclear fusion is a part of the model.

   Only after the supernova explosion, would the outcome of the nuclear fusion believed to take place in the interior of the core, emerge into daylight. The solar neutrino problem however challenges this picture! Mikheyev-Smirnov-Wolfenstein (MSW) effect (see `https://en.wikipedia.org/wiki/MikheyevSmirnovWolfenstein_effect`this), proposed as an explanation for the anomalously large mixing of high energy neutrinos, involves a resonance effect caused by the presence of a density of electrons with a value dictated by neutrino mass difference considered. The MSW effect might not be needed in the TGD based model since the M_{89} contribution could be decisive.

   This is not the only problem: the neutrino flux correlates with the solar wind and anticorrelates with the sunspot activity! Also the anomalously low convective heat transfer from the core challenges this view: is there any flux of nuclei from the core?

2. The second, more radical possibility, suggested by the proposal that the Sun is analogous to an atomic nucleus, is that the dark nuclear fusion also applies in the core and its temperature is of order 10 keV guaranteeing quantum criticality needed for the optimal dark fusion explaining the "cold fusion".

1.4 Reconnection and polarization reversal

There reversal of the solar magnetic field occurring with an 11 year period is one of the poorly understood aspects of the Sun and I have proposed a model for this process [L6].

Reconnection makes possible the orientation reversal of the solar magnetic field. The portions of the monopole flux with opposite directions must be very near to each other and touch so that the splitting to closed monopole flux tubes becomes possible. These flux tubes can change their orientation and after that fuse back to the flux tubes with opposite direction of the magnetic flux. The polarization reversal could involve to subsequent time reversals ("big" state function reductions).

In the TGD inspired quantum biology, biocatalysis involves a reduction of h_{eff} for U-shaped flux look connecting the reactants. This reduces the length of the flux tube and brings reactants together and liberates energy kicking the reactants over the energy wall preventing the reaction otherwise.

Now something analogous could take place. The closed flux tube having a distance of about $R_E/2$ between parallel strands with opposite polarities could suffer a phase transition reducing the value of $\hbar_{gr}$ so that their distance would become very small and the reconnection splitting the long and narrow flux tube pair to pieces which then reconnect to form a narrow structure with opposite polarization. After that h_{eff} would increase to $\hbar_{gr}$.

1.5 How M_{89} nuclei could be regenerated?

The generation of M_{89} nucleons is necessary.

1. The birth of a new star requires the emergence of a M_{89} layer. This layer must be also regenerated after its decay. There might be also M_{89} nucleus deep in the interior of the Sun playing the role of the dipole of a dipole magnetic field. How could it emerge? M_{89} regions should be deep in the interior of the Sun and define the analog of a dipole field. The M_{89} nuclei must be generated in the solar nucleus or feeded to the nucleus of to the M_{89} layer.

2. p-Adic cooling occurring in a stepwise manner by reducing the p-adic scales by octaves would provide a model for the decay of M_{89} nuclei to M_{107} nuclei [K2, K3]. Can one consider a p-adic heating of M_{107} nuclei to M_{89} nuclei?

   There is evidence from LHC for the creation of M_{89} mesons and the solar gamma ray anomalies suggest that M_{89} and even $M_{G,79}$ mesons are produced. From this there is however a long way to the p-adic heating of nuclei increasing their mass by factor 512 but one can ask whether the p-adic heating leads in a stepwise way also to a formation of M_{89} nuclei.

3. In zero energy ontology (ZEO) [K5] it is natural to ask whether the p-adic heating could be a time reversal of the p-adic cooling identifiable as a quantum tunnelling involving a pair of "big" state function reductions (BSFRs). Huge energies are needed but the rise of the temperature could take place by steps proceeding hadron physics by hadronic physics with decreasing p-adic length scale $L(107) \to L(105) = 2L107.... \to L(89)$.

4. Time reversal and macroscopic quantum coherence are general aspects of TGD and one can wonder whether heating quite generally involves a time reversal. In the TGD based model of self-organization the energy feed could correspond to extraction of energy from the environment by using reversal of the arrow of time.

5. Could the solar core involve a hierarchy of layers for which the p-adic temperature increases in powers of 2, at least up to the QCD $\Lambda \sim 100 - 200$ MeV assignable to the the temperature at which the transition to quark gluon plasma is believed to occur in QCD?

   This option is a diametric opposite of the suggestion that solar core is at a relatively low temperature and dark fusion implies the analog of genetic evolution.

This allows us to consider two identifications for the energy feed needed to regenerate M_{89} nuclei.

1. Time reversal could make it possible to extract energy from the environment of the solar nucleus to transform M_{107} nuclei to M_{89}. The needed energies are huge and it is far from clear whether these energies can be provided by ordinary nuclear reactions with a much smaller energy scale and even by the reactions transforming nuclei at different p-adic temperatures to each other which also involve huge energy scales. If this were the case, the energy would come from the solar core and generate a heat current towards the surface.

2. The energy arrives at the Sun from the outside. TGD predicts that the stars of the galaxies form a network connected by monopole flux tubes. Could this network acting like blood circulation feed M_{89} nuclei from, say galactic nuclei, to the Sun to be used as a fuel. M_{89} nuclei would be burned to M_{107} nuclei and in induce a p-adic heating of the environment around the region at which they enter. This region could be either the M_{89} layer or the solar nucleus as analog of magnetic dipole. The simplest option that it is the M_{89} layer.

1.6 Analogies with the TGD inspired quantum biology

There are strong analogies with the TGD inspired quantum biology.

1. In the TGD inspired quantum biology the dark variants of ordinary nuclei provide a fundamental realization of the genetic code in terms of dark nuclei. This might be possible also in the M_{89} case. Note that in TGD, the genetic code has a universal realization as a completely exceptional icosa tetrahedral tessellation of the hyperbolic 3-space H^3 [L3] allowing tetrahedra, octahedra, and icosahedra as building bricks allowing realization in all scales rather than only a single Platonic solid.

2. Could the cosmic network of monopole flux tubes connected to a galactic blackhole-like object be analogous to a living organism? The filamentary structure observed in the cosmic scales strongly brings in mind the connective structure of the brain and could be associated with the monopole flux tube network.

3. M_{89} layer is responsible for the solar wind and radiation from the Sun. What unavoidably comes to mind is the cell membrane, which acts as a sensory organ and excretes the outcome of the M_{89} catabolism as solar wind and surplus energy as solar radiation to stabilize the system thermally.

4. What about the convective zone and solar core? If the abundances of the matter outside the stars are determined to a high degree by M_{89} physics at the surface layer, the standard view of the solar core becomes a mere narrative challenged by the anomalously low convective heat transfer and the anomalously low neutrino flux from the nucleus.

The solar core could be practically isolated from the external. Could the heat flow be from the surface layer to the interior and serve as a metabolic energy feed?!

1. Could the decay of M_{89} nuclei provide metabolic energy for some processes in the convective zone and solar core possibly consisting of dark nuclei? If so, the energy transfer could be from the surface to the interior rather than vice versa as in the standard model!

2. If the core as a quantum system is analogous to an atomic nucleus, with the counterparts of spherical mass shells characterized by a huge gravitational Planck constant, as proposed in the gravitational harmonic oscillator model to be discussed, one can ask whether the ordinary nuclear fusion occurs at all in the core and whether the temperature of the solar core what it is believed to be. Could the hot nuclear fusion be replaced with dark fusion for a quantum critical nuclear matter explaining the scorned "cold fusion"? Could the temperature correspond to a critical temperature for dark fusion measured using keV as a natural unit?

3. Could the solar core be analogous to the cell nucleus carrying the genome? This couldn't be farther away from the standard picture which is however a purely theoretical narrative. Could the process inside the core be reinterpreted as a reorganization of the nuclei to heavier ones representing the counterparts of genes in the TGD inspired quantum biology. Could the isolated solar core or inner core be analogous to a cell nucleus carrying the genome as an M_{107} realization of the genetic code realized also in living matter where water plays the key role? Could neutron stars and blackhole-like objects represent the outcome of a genetic evolution?

1.7 How do the incoming M_{89} flux tubes interact with the M_{89} layer of the Sun?

The quantum biological analogy allows us to imagine how the M_{89} monopole flux tubes arriving at the Sun look like and interact with the M_{89} layer of the Sun.

1. In the TGD inspired quantum biology, monopole flux tubes act as U-shaped tentacles and their reconnections for two systems builds bridges along which communications and matter transfer can take place. These tentacles are an essential element of biocatalysis and of functioning of the immune system [K1]. Microtubules are highly dynamical systems and could be associated with U-shaped flux tubes whose lengths vary.

2. The dark variants of the ordinary nuclei provide a fundamental realization of the genetic code in terms of dark nuclei and this might be possible also for the case. Recall that the genetic code has a universal realization as a completely exceptional icosa tetrahedral tessellation of the hyperbolic 3-space [L3] allowing tetrahedra, octahedra, and icosahedra as building bricks allowing realization in all scales rather than only a single Platonic solid.

Consider now a model for the interaction of the incoming tubes with those at the surface of the Sun.

1. Imagine that there is a bundle of M_{89} monopole flux tubes arriving at the Sun from a blackhole-like entity in the center of the galaxy. The topology of the microtubule bundle gives some idea of what might be involved. Suppose that the arriving bundle forms a cylindrical bundle, which meets the surface of the Sun in a region near its magnetic North pole.

2. The structure could be highly dynamic in this region. Horizontal topological sum connections between the homologically non-trivial spheres could give rise to larger quantum coherent units from the flux tubes. In the extreme situation all the spheres could form a ring and one can say that flux effectively arrives along a cylindrical flux sheet. The degree of the locality of the interactions with the M_{89} layer depends on the longitudinal coherence.

3. Consider a situation where the arriving flux tube turns back near the South Pole of the Sun to form a U-shaped flux tube (in a more complex option the flux tube can also pass the Sun). A reconnection of the U-shaped flux tube in the region near the North pole would split from it to a single closed flux tube of the M_{89} layer. This splitting would occur for the most arriving flux tubes.

4. The M^{89} matter lost in the p-adic cooling to M_{107} matter could be regenerated by reconnecting the closed flux tubes of the layer to arriving flux tubes.

What could be the quantum thickness of the M_{89} flux tube layer?

1. A natural looking assumption is that the flux tubes are dark, at least inside the Sun and perhaps also before arriving and leaving the Sun. The values of the effective Planck constants need not be the same however.

2. The Compton length of the M_{89} nucleon is a fraction 1/512 of the Compton length of the ordinary nucleon and ridiculously short. On the other hand, if one assumes that the density of dark M_{89} nuclei corresponds to roughly one per ordinary M_{89} Compton volume, one can understand the missing nuclear mass of $1500M_E$.

   Could gravitational Compton length, which does not depend on the mass of the particle, determine the thickness of the M_{89} layer? For the Sun with $\beta_0 = 2^{-11}$ it would be $\Lambda_{gr} = R_E/2$, where $R_E = R_{Sun}/109$ is the Earth radius defining also the size scale of the Sunspots. For $\beta_0 = 1$ it would be by a factor 1/2000 shorter. It turns out that the gravitational oscillator model predicts $\Lambda_{gr} = R_E/2$ as the basic length scale of the gravitational harmonic oscillator!

Is it possible to speak of genome and its evolution?

1. The decay of M_{89} flux tubes to closed flux tubes by reconnection and further decay to ordinary nucleons determines the abundances of the solar wind. The arriving M_{89} flux tube defines a huge super-nucleus. One can however ask whether this super nucleus decomposes to shorter M_{89} nuclei which would be analogous to the dark variants of genes and proteins of the TGD inspired quantum biology. If this decomposition determines the abundances of the solar wind, which in turn determines the spectrum of the star, would the spectrum reflect the M_{89} "genome"? Note also that the M_{89} atoms at the surface of the Sun have the same spectrum as M_{107} atoms.

2. Is the decomposition to M_{89} nuclei dynamical and subject to evolution in the same way as the ordinary genome? What inspired this question was the anomalous abundance of Lithium for a red dwarf with size 30 times the size of the Sun located in the Milky Way halo. The star is very metal poor and has Li abundance 10^5 times higher than expected [E1] (see this.

1.8 Could the thermodynamical model of the Sun and planets be replaced with a geometric description?

A basic objection against the quantum model of stars and planets is that thermodynamic notions like pressure are absolutely essential for the understanding of the physics of the solar and planetary interiors.

1. In the thermal models pressure prevents gravitational collapse. In the geometric model, the tension of the monopole flux tubes in vertical and horizontal directions would prevent gravitational collapse. I have developed a model of nuclei and atoms based on spherical structures carrying Platonic solids [L4]. If this applies also to the Sun and planets, they would resemble outcomes of engineering.

2. When nuclear fusion does not anymore produce enough energy, the flux tubes decay and the analog of the pressure disappears and the core collapses. The counterpart of this description in the geometric model would be as follows. The monopole flux tubes and the dark matter at them require energy feed and nuclear reactions. The p-adic cooling of M_{89} nuclei could provide it. In the absence of the energy feed h_{eff} is reduced and the flux tubes collapse and gravitational collapse is the outcome.

3. In standard physics, blackholes or neutron stars emerge in the death of the star due to the loss of the pressure created by nuclear reactions. Ordinary BHs correspond to volume filling flux tube spaghettis consisting of M_{107} nucleons. TGD however suggests an entire hierarchy of BHs labelled by Mersenne primes and their Gaussian counterparts. Note that the p-adic cooling in the absence of nuclear reactions transforms M_{89} nuclei to ordinary nuclei and would lead to M_{107} BH. M_{89} blackholes could in turn emerge from $M_{G,79}$ blackholes.

In this article the goal is to study in more detail the proposal that Sun could in long length scales be regarded as an analog of nucleus or atom. This vision generalizes the model of planetary system as atom introduced originally by Nottale.

2 Further questions

The development of a completely new idea is not a rational process. Only when the smoke clears, one realizes what questions one should have posed first in order to avoid side tracks. Here is the list of these kinds of questions at this time.

I started from the idea that the surface of the Sun involves a monopole flux tube layer carrying M_{89} nucleons having mass 512 times that of ordinary nucleons. This would explain the missing nuclear matter of the Sun, the evidence for solid structures at the surface of the Sun, and gamma ray anomalies. The decay of M_{89} nuclei would give rise to ordinary nucleons of the solar wind and generate the radiation from the Sun. If the original goal had been to construct a model of the Sun, I would have started with the following questions.

1. Can one really give up standard nuclear physics and reduce the nuclear physics of the Sun to what happens in the M_{89} flux tube layer? If this were the case, one should start from scratch and the entire known nuclear physics of the Sun should be rediscovered.

   The natural possibility is that the M_{89} surface layer determines what is seen by the observer during the life cycle of the star. Only after the supernova explosion or a formation of BH, the evolution inside the core of the Sun becomes in daylight via the abundances of the elements created. The anomalously low convection currents in the convection zone support this view. Also the puzzle caused by elements heavier than Fe finds a solution: they would be produced in the decay of M_{89} nuclei at the surface.

   It seems that the TGD counterpart for ordinary nuclear physics must be present in the core of the Sun. Could the monopole flux tubes containing only M_{89} nucleons take care of the transfer of the nuclei and energy from the Sun to the environment? This process would involve the decay of M_{89} nuclei to the ordinary nuclei. The M_{89} layer would be an addition to the nuclear physics of the Sun rather than its replacement.

2. How to achieve consistency with the model based on dark fusion? I have developed rather nice models of the "cold fusion" and pre-stellar evolution igniting the ordinary fusion. This suggests that the convective zone corresponds to the region where the dark fusion prevails and the temperature gradually rises as one approaches the core, where the ordinary fusion is ignited. Note that the decay of the M_{89} layer to ordinary nucleons would also provide energy by helping to maintain the temperature in the convective zone.

3. What could be the thickness of the M_{89} layer? The Compton length of the M_{89} nucleon is a fraction 1/512 of the Compton length of the ordinary nucleon and ridiculously short. On the other hand, if one assumes that the density of dark M_{89} nuclei corresponds to roughly one per ordinary M_{89} Compton volume, one can understand the missing nuclear mass of $1500M_E$. Could gravitational Compton length, which does not depend on the mass of the particle, determine the thickness of the M_{89} layer? For the Sun with $\beta_0 = 2^{-11}$ it would be $\Lambda_{gr} = R_E/2$, where $R_E = R_{Sun}/109$ is the Earth radius defining also the size scale of the Sunspots. For $\beta_0 = 1$ it would be by a factor 1/2000 shorter. It turns out that the gravitational oscillator model predicts $\Lambda_{gr} = R_E/2$ as the basic length scale of the gravitational harmonic oscillator!

2.1 Could the solar core consist of dark nuclei?

An additional input is provided by the model for dark nucleons applied in the models of "cold fusion" [L1] and pre-stellar evolution [L2].

1. The earlier proposal [L2] was that the heating by the dark fusion would ignite the ordinary nuclear reactions giving rise to the stellar core. The convective zone could consist of dark nuclei and the core of ordinary nuclei so that the ordinary nuclear fusion would be a part of the model. Only after the supernova explosion, would the outcome of the nuclear fusion emerge into daylight.

   If the p-adic cooling generates solar wind and the radiation from the Sun, the ordinary fusion is not needed to explain them. Is there any need for the hot fusion in the solar core?

2. Also the solar neutrino problem challenges this picture! Mikheyev-Smirnov-Wolfenstein (MSW) effect (see `https://en.wikipedia.org/wiki/MikheyevSmirnovWolfenstein_effect`this), proposed as an explanation for the anomalously large mixing of high energy neutrinos, involves a resonance effect caused by the presence of a density of electrons with a value dictated by neutrino mass difference considered. The MSW effect might not be needed in the TGD based model since the M_{89} contribution could be decisive. A further anomaly is that the neutrino flux correlates with the solar wind and anticorrelates with the sunspot activity!

3. A much more radical possibility, suggested by the proposal that the Sun is analogous to atomic nucleus, is that dark nuclear fusion also applies in the core and the temperature of the core is of order 10 keV guaranteeing quantum criticality needed for the optimal dark fusion explaining the "cold fusion".

2.2 How M_{89} nuclei could be regenerated?

The birth of a new star requires the emergence of a M_{89} layer. This layer must be also regenerated after its decay. There might be also M_{89} nucleus deep in the interior of the Sun playing the role of the dipole of a dipole magnetic field. How could it emerge? The M_{89} nuclei must be generated in the solar nucleus or feeded from outside to the M_{89} layer. This allows us to consider two alternative identifications for the energy feed needed to regenerate M_{89} nuclei.

1. Time reversal could make it possible to extract energy from the environment of the solar nucleus to transform M_{107} nuclei to M_{89}. The needed energies are huge and it is far from clear whether these energies can be provided by ordinary nuclear reactions with a much smaller energy scale. If this were the case, the energy would come from the solar core and generate a heat current towards the boundary.

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One can consider the first option in more detail although it seems that the second option is more plausible.

1. p-Adic cooling, occurring in a stepwise manner by reducing the p-adic scales by octaves, provided a model for the decay of M_{89} nuclei to M_{107} nuclei. Can one consider p-adic heating of M_{107} nuclei to M_{89} nuclei? There is evidence from LHC for the creation of M_{89} mesons and the solar gamma ray anomalies suggest that M_{89} and even $M_{G,79}$ mesons are produced. From this there is however a long way to the p-adic heating of nuclei increasing their mass by factor 512 but one can ask whether the p-adic heating leads in a stepwise way also to a formation of M_{89} nuclei.

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1. Could the decay of M_{89} nuclei provide metabolic energy for some processes in the convective zone possibly consisting of dark nuclei and in the solar core? If so, the energy transfer could be from the surface to the interior rather than vice versa as in the standard model!

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   Could the hot nuclear fusion be replaced with dark fusion for a quantum critical nuclear matter explaining the scorned "cold fusion"? Could the temperature correspond to a critical temperature for dark fusion measured using 10 keV as a natural unit?

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The quantum biological analogy allows us to imagine how the M_{89} monopole flux tubes arriving at the Sun look like and interact with the M_{89} layer of the Sun.

1. In TGD inspired quantum biology flux tubes act as U-shaped tentacles and their reconnections for two systems builds bridges along which communications and matter transfer can take place. In the TGD inspired biology, these tentacles are an essential element of biocatalysis and of functioning of the immune system [K1]. Microtubules are highly dynamical systems and could be associated with U-shaped flux tubes whose lengths vary.

2. The dark variants of the ordinary nuclei provide a fundamental realization of the genetic code in terms of dark nuclei and icosa tetrahedral tessellation also for M_{89} nucleons.

Consider now a model for the interaction of the incoming M_{89} flux tubes with those at the surface of the Sun.

1. Imagine that a bundle of M_{89} monopole flux tubes arrives at the Sun from a blackhole-like entity in the center of the galaxy. The topology of the microtubule bundle gives some idea of what might be involved. Suppose that the arriving bundle forms a cylindrical bundle, which meets the surface of the Sun in a region near its magnetic North pole.

2. The structure could be highly dynamic in this region. Horizontal topological sum connections between the homologically non-trivial spheres could give rise to larger quantum coherent units from the flux tubes. In the extreme situation all the spheres could form a ring and one can say that flux effectively arrives along a cylindrical flux sheet. The degree of the locality of the interactions with the M_{89} layer depends on the longitudinal coherence.

3. Consider a situation in which the arriving flux tube turns back near the South Pole of the Sun to form a U-shaped flux tube (in a more complex option the flux tube can also pass the Sun). A reconnection of the U-shaped flux tube in the region near the North pole would split from it to a single closed flux tube of the M_{89} layer. This splitting would occur for the most arriving flux tubes.

   The M^{89} matter lost in the p-adic cooling to M_{107} matter could be regenerated by reconnecting the closed flux tubes of the layer to the arriving flux tubes feeding M^{89} matter.

What could be the quantum thickness of the M_{89} flux tube layer?

1. A natural looking assumption is that the flux tubes are dark, at least inside the Sun and perhaps also before arriving and leaving the Sun. The values of the effective Planck constants need not be the same however.

2. The Compton length of the M_{89} nucleon is a fraction 1/512 of the Compton length of the ordinary nucleon and ridiculously short. On the other hand, if one assumes that the density of dark M_{89} nuclei corresponds to roughly one per ordinary M_{89} Compton area (!), one can understand the missing nuclear mass of $1500M_E$.

   Could the gravitational Compton length, which does not depend on the mass of the particle, determine the thickness of the M_{89} layer. For the Sun, assuming $\beta_0 = 2^{-11}$, it would be $\Lambda_{gr} = R_E/2$, where $R_E = R_{Sun}/109$ is the Earth radius defining also the size scale of the Sunspots. For $\beta_0 = 1$ it would be by a factor 1/2000 shorter. It turns out that the gravitational oscillator model predicts $\Lambda_{gr} = R_E/2$ as the basic length scale of the gravitational harmonic oscillator!

Is it possible to speak of M_{89} genome and its evolution?

1. The decay of M_{89} flux tubes to short closed flux tubes by reconnection and further decay to ordinary nucleons determines the abundances of the solar wind. The arriving M_{89} flux tube defines a huge super-nucleus. Could this super nucleus decomposes to shorter M_{89} nuclei, analogous to the dark variants of genes and proteins of the TGD inspired quantum biology. If this decomposition determines the abundances of the solar wind, which in turn determines the spectrum of the star, the spectrum would reflect the M_{89} genome? Note also that the M_{89} atoms at the surface of the Sun have the same spectrum as M_{107} atoms.

2. Is the decomposition to M_{89} nuclei dynamical and subject to evolution in the same way as the ordinary genome? What inspired this question was the anomalous abundance of Lithium for a red dwarf with size 30 times the size of the Sun located in the Milky Way halo. The star is very metal poor and has Li abundance 10^5 times higher than expected [E1] (see this.

2.5 Could the thermodynamic model of the Sun and planets be replaced with a geometric description?

A basic objection against the quantum model of stars and planets is that thermodynamic notions like pressure are absolutely essential for the understanding of the physics of the solar and planetary interiors.

1. In the thermal models pressure prevents gravitational collapse. In the geometric model, the tension of the monopole flux tubes in vertical and horizontal directions would prevent gravitational collapse. I have developed a model of nuclei *resp.* atoms based on spherical structures carrying Platonic solids [L4] having nucleons *resp.* electrons at their vertices. If this applies also to the Sun and planets, they would resemble outcomes of engineering.

2. In the standard model, when nuclear fusion does not anymore produce enough energy, the pressure disappears and the core collapses. The counterpart of this description in the geometric model would be as follows. The monopole flux tubes and the dark matter at them require energy feed and nuclear reactions: otherwise the value of h_{eff} is reduced and the flux tubes shorten. The p-adic cooling of M_{89} nuclei could provide it. In the absence of the energy feed the flux tubes collapse and gravitational collapse is the outcome.

3. In standard physics, blackholes or neutron stars emerge in the death of the star due to the loss of the pressure created by nuclear reactions. In the absence of supporting flux tubes, the ordinary BHs correspond to volume filling M_{107} flux tube spaghettis. TGD suggests an entire hierarchy of BHs labelled by Mersenne primes and their Gaussian counterparts. Note that the p-adic cooling in the absence of nuclear reactions transforms M_{89} nuclei to ordinary nuclei and would lead to M_{107} BH. M_{89} blackholes could in turn emerge from $M_{G,79}$ blackholes.

3 A proposal for a model of the Sun as as analog of atomic nucleus

In what follows a detailed proposal for the model of the Sun as an analog of atomic nucleus is discussed.

3.1 Basic objections against the model of the Sun as an analog of atomic nucleus

Consider first the basic objections against the idea that Sun could be described as an analog of atomic nucleus.

1. We have been used to thinking that stars and planets are thermomechanical equilibrium systems in which pressure gradient, gravitational force and perhaps also electromagnetic forces are in equilibrium. Dissipation is in a central role in this kind of description and suggests that quantum description cannot work.

   One must be cautious however. The TGD based space-time concept differs dramatically from that of TGD and predicts a length scale hierarchy and therefore also a hierarchy of descriptions in various scales. A long length scale quantal description might exist and the usual description is a description applying in short scales. Number theoretical vision indeed predicts quantum coherence in arbitrarily long length scales and gravitational and electric Planck constants characterize this kind of quantum coherence.

2. The first task is to check whether a naive quantal description based on independent particles might work. For stars and planets the first approximate description assumes constant mass density. This gives rise to gravitational potential, which is harmonic oscillator potential.

   The oscillator frequency Ω is a purely classical quantity and for gravitational harmonic oscillator given by

   $$\Omega = (\frac{r_S}{R})^{1/4} \times \frac{c}{R} \ . \tag{3.1}$$

   For the Sun one has $r_s/R \simeq 3 \times 10^{-5}/7$. $\Omega \sim 1.9 \times 10^{-2}$ /s. The rotation period would be $T = 330.5$ s $\simeq 5.5$ min). The actual rotation period is about 25 d. The observed rotation period is much longer than that predicted by the gravitational harmonic oscillator model: one has $\Omega/\Omega_{obs} \simeq 4 \times 10^5$.

Therefore the treatment of the system as consisting of independent masses in the gravitational field prevailing in the interior of a star or a planet fails.

3.2 Could a generalization of quantum Platonism to astrophysical systems work?

In [L4] I develop a models for atoms and nuclei based on what one might call quantum Platonism stating that the monopole flux tubes connecting nucleons of nucleus and nucleus and electrons of atoms to a rigid network consisting of Platonic solids containing the particles at their vertices. These flux tubes are something totally new from the point of view of standard nuclear and atomic physics. The model led to a nice description of the periodic table based on Platonic solids.

The fractality of the TGD Universe suggests that this idea might generalize to the level of stars and planets.

1. The basic objects would be spherical surfaces with radii R_n carrying a constant mass density. The reason is that for spherical surfaces with a constant density gravitational torque vanishes identically. Rigidity implies a rotation with a rotational frequency Ω. If the shells are independent, Ω can depend on the shell. The shells would however be connected by flux tubes to form a rigid structure (here the notion of tensegrity is appropriate). Platonic solids would not play any role now.

2. The mass $M(R_n)$ at the surface R_n experiences the gravitational force created by the total mass $M_{tot,k} = \sum_{k \leq n} M_k$ at the shells R_k, $k \leq n$, which would be however compensated by the monopole flux tubes making the system rigid.

   One can assign to this mass gravitational Planck constant $\hbar_{gr,n} = GM_{tot,n}M_k/\beta_0 \equiv r_{s,n}M_k/2\beta_0$. The Equivalence Principle allows us to replace M_k with any mass since it disappears from the quantization conditions.

   The basic quantization condition would state that the angular momentum L_n at shell $R = R_n$ is quantized as a multiple of the gravitational Planck constant $\hbar_{gr,n} = r_{s,n}M_k/\beta_0$.

   $$\frac{L_n}{M_k} = m(n)\frac{r_{s,n}}{\beta_0} \quad . \tag{3.2}$$

   Here $m(n)$ is an integer.

3. In the TGD framework classical physics is an exact part of quantum physics, which motivates the use of a classical expression for the angular momentum of the "mass shell".

   $$L_n = xM_nR_n^2\Omega_n \quad . \tag{3.3}$$

   Here x is a coefficient characterizing the geometry of the rigid body. Its value for a spherical mass shell is $x = 2/3$.

4. If the system rotates like a single rigid body, one must have $\Omega_n = \Omega$. This means an analogy with the gravitational harmonic oscillator although the frequency is widely different and the reason for this would be the rigid body constraints. This gives the quantization condition

   $$\Omega = m(n)\frac{r_{s,n}}{R_n}\beta_0\frac{c}{R_n} \quad . \tag{3.4}$$

   The choices of $m(n)$, M_n, and R_n are restricted by this condition. Additional constraints could come from the lengths of the flux tubes binding the system to a rigid structure. Now the lengths of flux tubes should be such that there are no net forces in the equilibrium situation.

5. The system could also decompose into several structures rotating with different angular velocities Ω and there is indeed evidence for this. It would seem that in this case the gravitational interaction between the structural components must be taken into account.

3.3 The prediction of the rotation frequency of the Sun as a test

The formula for Ω gives rise to the first prediction in the case of the Sun and planets (or at least their cores in the case of giant planets).

1. At the uppermost layer $r_{s,n} = r_s$, $R_n = R$, and $m(n) \equiv m$, which gives

$$\Omega = \frac{2\pi}{T} = \frac{m}{\beta_0}\frac{r_s}{R}\frac{c}{R} \quad , \tag{3.5}$$

and

$$\frac{cT}{R} = 2\pi\frac{\beta_0}{m}\frac{R}{r_s} \quad . \tag{3.6}$$

For the Sun one has $R = 7 \times 10^8$ m , $r_S = 3 \times 10^3$ m, and $T \sim 25$ d. $m = 1$ gives 79.16 d and $m = 3$ gives 26.4 d. This corresponds to a small quantum number limit. There the model might work. In the case of Earth one has $R = 6.37 \times 10^6$ m, $r_S = .01$ m and $T = 24h$. In this case one obtains the estimate $m \simeq 983$ so that a large quantum number limit would be in question.

2. It is interesting to look at some special cases.

   (a) For a constant average mass density one would have $M_{total,n} \propto R_n^3$. In this case one would have $m(n) \propto 1/R_n$. The number of "mass shells" is bounded by the condition $m(n) < 1$ in this case.

   (b) An interesting situation is encountered when $m(n)$ is constant. If one

$$\Omega\beta_0 = m(n)\frac{r_{s,n}}{R_n^2} \quad . \tag{3.7}$$

   For $m_n = m$ the $r_{s,n}$ must be proportional R_n^2, which implies $M_{total,n} \propto R_n^2$. The average mass density would behave like $1/R$ and would increase for small radii. In the interior of the solar core, having radius $.2R_{Sun}$, the density is roughly 100 times higher than the average density. For the Earth the density at the core is roughly four times that in the crust. For the Sun $1/R$ behaviour of the average density does not predict strong enough variation of the density for the Sun.

   (c) $m(n) \propto R_n$ would give $M_{total,n} \propto R_n$ and could be more realistic. This corresponds to the stringy formula $M_{tot,n} \propto R_n$. The average density would behave like $1/R^2$.

   (d) The density of the photosphere is roughly by a factor 10^{-9} lower than the mean density of the Sun. The findings of Moshina [E3] and the evidence for anomalous gamma rays suggest that there is a solid surface consisting of M_{89} nuclei at monopole flux tubes and defining the uppermost "mass shell" [L10].

3.4 The quantum gravitational quantization of angular momentum favours decomposition to rigid spherical mass shells

The simplest proposal for the quantum gravitational quantization of the angular momentum is that the angular momentum of a rotating planet or star is multiple of $\hbar_{gr}$ for the pair M of the object and any "small" mass m. By the Equivalence Principle, the outcome does not depend on m.

1. The consistency condition

$$L_k = x(k)M_k R_k^2 \Omega \geq \hbar_{gr,k} \tag{3.8}$$

for the angular momentum must be satisfied for for the orbital sphere k . Since M_k can appear (and appears) as the "small" mass in $\hbar_{gr,k}$, it can be eliminated from both sides of the equation.

2. There are two options for $\hbar_{gr,k}$ depending on whether it characterizes

   (a) the entire system including also orbital spheres $l > k$ or

   (b) only the orbital spheres $l \leq k$. This is intuitively natural option since the orbital sphere k "sees" only the gravitational field of orbital spheres $l \leq k$ For $\hbar_{gr,k}/M_k = GM_k/\beta_0$, the conditions are easier to satisfy than for $\hbar_{gr,k}/M_k \equiv= GM/\beta_0$ since the value range of n is larger for this option.

   It turns out that for the harmonic oscillator model, the surface mass density σ for the orbital for a constant average density for the object behaves like $\sigma \propto 1/r_k$ so that mass of the orbital increases like r_k so that the condition becomes increasingly difficult to satisfy for large orbitals. The example of the Sun demonstrates that this poses a realistic upper size for the radius of the object.

3. Assuming that L_k satisfies also classical expression, the condition for the *entire* system reads as

$$L = I\Omega = xR^2\Omega = n\frac{r_s}{2\beta_0} \quad . \tag{3.9}$$

   For orbital spheres with too small radii, the condition might not be satisfied and they would have vanishing angular momentum and could be effectively non-rotating.

4. Irrespective of whether one uses $\hbar_{gr,k}/M_k = GM/beta_0$ for all orbitals rather than $\hbar_{gr,k}/M_k = GM_k/beta_0$, the condition $n \geq 1$ gives a nontrivial consistency condition at the uppermost layer as

$$\frac{x2\pi R}{cT} > (\frac{r_s}{2\beta_0})^{1/2} \quad . \tag{3.10}$$

   Here T is the rotation period of the system. Substituting the values $\beta_0 = 1$ assumed to hold true in the solar interior, the value of x is estimated to be $x \simeq .07$ for the Sun, the rotation period $T = 25$ d for the Sun, and the Scwartschild radius $r_s = 3$ km one obtains $R > 1/\sqrt{x} \times 5.6 \times 10^8$ m to be compared with the radius of the Sun $R_{Sun} = 7 \times 10^8$ m.

   (a) For $x = .07$, the right hand side of the condition cannot be satisfied. x should be near 1 but already for a ball with constant mass density having $x = 2/5$ the conditions fails to be satisfied. Something clearly goes wrong although the condition is almost satisfied.

   (b) For $x = 2/3$ which corresponds to rigid mass shell, one would obtain $R > 6.86 \times 10^7$ m so that the condition could be satisfied for $R = 7 \times 10^7$ m. One would have $n = 1$. This suggests that the outermost spherical shell is analogous to a valence shell as a rigid spherical shell and carries all angular momentum. This would conform with the solar model developed in [L10].

3.5 Could the radii of the mass shells correspond to the radii of harmonic oscillator orbitals?

Since Ω is constant as for the harmonic oscillator, an attractive option is that the radii R_n are given by the formula applied in the case of the gravitational harmonic oscillator.

1. The gravitational potential energy of particle with mass m in the gravitation field of mass M for constant mass density is given by

$$\frac{V(R)}{m} = \frac{GM(R)}{R} = \frac{GMR^2}{R_{Sun}^3} = \frac{r_s}{R_{Sun}}(\frac{R}{R_{Sun}})^2 \quad . \tag{3.11}$$

   From this one can deduce the frequency of the oscillator and the energy spectrum and the orbital radii. As already found, the prediction for the rotation frequency Ω is quite too large for the Sun and planets: the reason of course is the physical difference between single particle model and rigid sphere model.

2. The orbital radii for a quantum harmonic oscillator are given by

$$r_k = \sqrt{k+1/2}r_0 \ , \quad \frac{r_0}{R_{Sun}} = \sqrt{\frac{1}{2\beta_0}}(\frac{r_S}{R_{Sun}})^{1/4} \ . \tag{3.12}$$

   Note that the oscillator parameters are determined by the entire system whereas the quantization condition for the angular momentum involves $n(k)\hbar_{gr,k}$ only for the mass below radius R_k. In the case of the Sun, this gives for $\beta_0 = 1$ the estimate $r_0 \simeq 3.22 \times 10^6$ m, rather precisely $\Lambda_{gr} = R_E/2$.

   For $\beta_0 \simeq 2^{-11}$ applying to the planetary system ($n = 1$ orbit has radius larger than R_{Sun}), one obtains $r_0 \simeq 3.85R_{Sun}$ so that the model fails, also the minal radius $r_0/\sqrt{2}$ is larger than R_{Sun}.

3. The maximum value k_{max} of k is determined by the radius R of the system as

$$k_{max} = (\frac{R_{Sun}}{r_0})^2 - \frac{1}{2} \ . \tag{3.13}$$

   For the Sun one obtains $k_{max} = 4.7851 \times 10^4$. The distance d between two orbital spheres at the surface of the Sun is $d \simeq r_0/(2\sqrt{k_{max}+1/2}) \simeq 7.36$ km.

One can criticize this picture.

1. The harmonic oscillator model for the radii can be criticized as ad hoc since, at least in the standard model, the density of matter increases towards the center. This implies that harmonic oscillator potential is replaced with a more complex potential and that ω for the classical orbits depends on the radius. On the other hand, Ω for the rigid mass shell model is not the same thing as ω.

2. The rigid body behavior requires that the monopole flux tubes make the Sun stable against a gravitational collapse. Could this stabilization mechanism be modelled in terms of an additional non-gravitational contribution to the gravitational potential acting as a repulsive harmonic force. This would decrease the effective value of G and therefore also the value of the parameter r_0 and the nice prediction $R_0 = \Lambda_{gr}$ would be lost.

3. The model does not fix the mass densities σ_k associated with the mass shells unless one requires that the mass average density is constant. This allows us to get the total mass correctly. In the standard model the mass density increases towards the center and for the Sun the density at the center is roughly 100 times higher than the average density. The M_{89} model [L10] proposes that the upper most layer consist of M_{89} nucleons and has mass about $5 \times 10^{-3} M_{Sun}$ equal to the missing nuclear mass of the Sun. The model gives this mass as an estimate if the maximal distance between flux tubes is 2 Compton lengths for M_{89} nucleons.

   If each layer has this mass, this predicts $M_{Sun} \simeq 5 \times 137 \times 10^{-3} M_{Sun} \simeq .34 M_{Sun}$ so that the order of magnitude is correct but a factor of 1/3 is missing. One possibility is that the uppermost harmonic oscillator layer consists of 3 M_{89} layers with this mass. The condition that the deeper layers have the same mass implies $\sigma \propto 1/R_n^2$ behavior. If the topmost layer consists of 3 M_{89} layers, the deeper layers should consist of $(R^{max}/R_k)^2 \simeq k_{max}/k_n$ layers of this kind.

   The surface mass density σ for the layer is fixed and only the change of h_{eff} can change it if one assumes that a single nucleon takes volume determined by Compton length proportional to h_{eff}/h. Dark variant of the layer would consist of $(h_{eff}/h)^2$ layers with thickness $(h_{eff}/h)512$ proton Compton lengths.

4. One can also criticize the definition of the radius of the Sun as a quantum system. The mass densities of convective zone is by a factor 1/800 lower that the density of the core. Could one assume the radius of the solar core $R_{core} \sim .2R_{Sun}$ be a more appropriate identification for the radius of quantum Sun? The radii for the core radius and mass vary. One estimate is $M_{core} = M_{Sun}/2$ and $R_{Core} = R_{Sun}/4$. The value of $r_0/R_{Sun} = (r_s/R_{Sun})^{1/4}$ would

scale by the factor $(M_{core}/M_{Sun}) \times (R_{Sun}/R_{core})^{1/4} \simeq 2^{1/4}$. The estimate for $k_{max} = (R_{Sun}/r_0)^2 - 1/2$ would change to $\sqrt{2}(k_{max+1/2}) - 1/2 \simeq \sqrt{2} \times 138.5 - .5 \simeq 195.4$. This is not enough to overcome the problem.

5. The thickness of the upper most layer in the harmonic oscillator model is $\Delta R/R_{Sun} = 1/2(k_{max} + 1/2)$ giving for $k_{max} = 137$ $\Delta R \sim 7 \times 10^8 m/2 \times 137 \sim 2.55 \times 10^6$ m, roughly one third of the Earth's radius. One can wonder whether the M_{89} layers are actually present in the convective zone but are not counted in the estimates for the density of the convective zone based on the assumption that nuclear reactions are not possible in the convective zone.

4 A model for the pre-planetary solar system and the formation of the planetary system

The goal is to understand what preplanetary system did look like and how it led to the formation of the planetary system. The standard view was that it was a rotating disk. Now a good guess is that this system is replaced with spherical disks satisfying Nottales quantization conditions and that the explosions of the M_{89} layers of the Sun implied a gravitational instabilities leading to the formation of planets by gravitational condensed of a shell to a planet.

4.1 A model for the pre-planetary system

By Equivalence Principle the spectrum of the orbits in the gravitational field of the star allows arbitrarily planetary masses. One can ask whether the pre-planetary medium could consist of these kinds of rotating rigid spherically symmetric mass shells, whose radii are determined by the generalization of the Nottale's quantization conditions

$$L(shell) = IR^2\Omega = n\hbar_{gr} \ . \tag{4.1}$$

By Equivalence Principle, the masses of the shells could be arbitrarily small and the expanding and rotating mass shells from the Sun, produced by the explosions of the M_{89} layers of parts of them, could fuse with the static mass shells so that their mass would increase and they would slow down. Eventually these mass shells would come to rest and suffer a gravitational collapse to planets in the way proposed in [L9]. Gradually the nearby environment of the Sun would be cleaned and the rocky planets, which would be the newest ones, would in a good approximation correspond as such to the M_{89} mass shells.

By baryon number conservation the M_{89} layer must decay to m_{107}/m_{89} which are in a good approximation at rest in the final state. Therefore the baryonic mass of the planet possibly formed in this way from a portional of the layer with mass $x \times 1500 M_E$ is $x(m_{107}/m_{89}) \times M_{layer} = x \times 3M_E$.

By angular momentum conservation the angular moment of the radially expanding shell

$$L_{exp} = (2/3) \times x(m_{107}/m_{89}) \times M_{layer} R^2\Omega \ , \quad M(layer)1500M_E \ . \tag{4.2}$$

would be conserved and equal to its initial value

$$L_0 = (2/3) \times x\frac{m_{107}}{m_{89}} \times M_{layer} R^2\Omega \ . \tag{4.3}$$

Therefore the quantity $R^2\Omega$ would be conserved so that the rotation velocity of the expanding sphere would decrease during the expansion. The sphere would collapse with the already existing spheres and could fuse with them if the the value of Ω is consistent with the quantization conditions. After than the structure could suffer a gravitational collapse a planet or possibly ring like structure in which angular momentum is conserved.

The quantization conditions for the pre-existing rigid spheres are formally very similar to those for the planet. Only spheres are allowed (no gravitational torques) and the angular momentum $mR^2\Omega$ for the circular orbits of the planet with mass M_P is replaced with the angular momentum $I_P R^2 = (2/3)M_S R^2$ of the spherical shell. If a fusion takes place in the collision, the mass of the expanding sphere increases and it slows down. Eventually a system satisfying Nottale's quantization conditions emerges.

4.2 Shell model for the planets

One can also ask whether C the shell model could work for the planetary interiors.

1. For the rocky planets the approximation as a rigid rotator looks natural. For the giant planets it far from clear whether one can approximate the entire system as a rigid rotator or as the inner core, which would have mass of order M_E if the proposed mechanism as an explosion of the Sun throwing out mass of this order followed by a gravitational condensation of a gaseous envelope makes sense.

2. The Earth serves as a representative example for the rocky planets. One can apply scaling to the consistency condition. One has $\hbar_{gr,E}/\hbar_{gr,S} = M_E/M_S = 3 \times 10^{-6}$, $R_E/R_{Sun} = 1/109$ $x_E/x_S = .331/.07 \simeq 47.3$. For other rocky planets the value of x does not differ much from that for the Earth. $\Omega_E/\Omega_S \simeq 25$.

   In the replacement of the Sun with the Earth for $\beta_0 = 1$, the L.H.S. of the consistency condition is scaled by the factor $47.3 \times 25 \times (1/109)^2 \simeq .1$ and the R.H.S by the factor 3×10^{-6}. The values of the integer n can be as large as $n = 3 \times 10^5$, having interpretation in terms of a large quantum number limit. The situation is the same for the other rocky planets.

   There is however a difficulty at the surface of the Earth. The quantization condition for angular momentum $R^2\Omega = nr_s/2\beta_0$ would give in the case $\beta_0 = 1$ the estimate $n \sim 7.8 \times 10^6$. This is by factor 26 larger than the upper bound from the quantization condition for the angular momentum. The upper bound for n scales as R_E/R and for $R \sim 250$ km it is possible to satisfy the condition. $x = 2/3$ instead of $x = 1/3$ would give $R \sim 500$ km.

   The radius of the "inner inner" core is estimated to be in the range [300,750] km (see this). Does this mean that only the inner inner core, which is indeed solid, can be modelled as a quantum mechanical rigid body.

3. The parameter $r_0 = \sqrt{1/2\beta_0}(\frac{r_S}{R})^{1/4}R$ is obtained from the its value for the Sun by the scaling $(M_E/M_S)^{1/4}R_E/R_S \simeq 3.8 \times 10^{-4}$ giving $r_{0,E} \simeq 3.8 \times 10^{-4} \times .085 \times 7 \times 10^5$ km $\simeq 22.6$ km. This corresponds to the minimal thickness of the Earth's crust.

4. The parameter $k_{max} + 1/2 = (R_E/r_{0,E})^2$ is obtained by the scaling $(M_S/M_E)^{1/2} \simeq (3.333 \times 10^5)^{1/2} \simeq 577.3$ from the value 137.5 for the Sun.

4.3 Model for the formation of planets as mini bigbangs

According to the vision of [L5, L6], planets could have formed in an explosion of a surface layer of the Sun. The model for the missing nuclear mass suggests that this layer could have consisted of M_{89} monopole flux tubes.

1. The explosion of M_{89} layer would have been caused by the transformation of the layer to ordinary M_{107} baryons. This could have occurred in several steps through intermediate hadron physics labelled by $p \simeq 2^k$. The explosion would have liberated a huge amount of energy since the number of nucleons would have been preserved and thrown out (part of) the layer. The mass shell would have been like a rocket using nuclear mass as fuel.

   The explosion would create an expanding spherical layer of ordinary $M107$ nuclear matter, which could have gravitationally condensed to a proto planet since the monopole flux tubes making it a rigid sphere would split in the explosion.

2. Suppose M_{89} layer was a fraction x of the missing nuclear mass about $1500M_E$. This predicts the number of M_{89} baryons as $N_{89} = M_{layer}/m_{89} = .005M_{Sun}/m_{89}$. The number of M_{107} nucleons produced in the explosion would be the same and the corresponding M_{107} baryonic mass of the planet would be $M_{layer}/512 = x \times 3M_E$. If one half of the M_{89} mass is in the interior of the Sun as an analog of a dipole, the upper bound is $1.5M_E$.

3. Also the cores of outer planets could have emerged by this mechanism and the condensation of the matter from the environment could have created the gaseous envelope.

In the gravitational condensation a rigid spherical surface would transform to a planet at Bohr orbit describable by the Nottale's atomic model for the planetary system.

1. The angular momentum quantization condition for the rigid sphere would be replaced by the quantization condition for angular momentum as $L/M = nr_s/\beta_0$, $\beta_0 \simeq 2^{-11}$ plus Newton's law, which for the rigid sphere would correspond to the vanishing of torque guaranteed by the sphericality.

2. Angular momentum conservation poses strong constraints on the model, in particular on the orbital rotation frequency of the planet. One prediction is that the planets should preferentially rotate in the same counter clockwise direction as the Sun is spinning (this fact is not well understood). Only Venus and Uranus are exceptions to this rule and in the case of Venus it is thought that a collision with a fast moving asteroid has changed the rotation direction. One cannot of course exclude the possibility that the M_{89} layer of the Sun can also rotate in a direction opposite to that of the Sun.

3. A quantitative test is provided by checking whether the rotational angular momenta of the planets are nearly the same or by dissipation somewhat smaller than the angular momentum associated with the M_{89} layer. The prediction is

$$L_{layer,spin} = (2/3)M_{layer}R_{Sun}^2\Omega_{Sun} = L_{E,rot}M_E d_E^2\Omega_{E,rot} \quad . \tag{4.4}$$

.

Substituting the numbers $M_{layer} = 1500M_E$, and $d_E = AU = 1.49 \times 10^8$ km, $T_{E,rot} = 365$ d, $T_{Sun} = 25$ day, one obtains $L_{layer}/L_{E,rot} = 1.11$. The discrepancy could be due to the dissipation.

This simple picture fails for the other planets.

1. For the circular orbits the Kepler's laws alone implies $L_P/L_E = (M_P/M_E)^{3/2}(R_P/R_E)^{1/2}$. Since the radii and masses of the giant planets are considerably larger than M_E, the angular momenta must be considerably larger than $3L_E$, which would be considerably larger that the upper for the momentum of M_{89} layer from the conservation of the angular momentum in the transformation of the exploded spherical layer to planet Earth.

   One can imagine that the explosion initiated the gravitational condensation of a rotating cloud around the radially expanding spherical layer and that this layer condensed to form the giant planet.

2. If baryon number and angular momentum are conserved in the transformation of a fraction x_P of the M_{89} layer to a planet or a seed of planet, one has $M_P/M_E = x_P = L_P/L_E$. One the other, one has $L_P/L_E = (M_P/M_E)^{3/2}(R_P/R_E)^{1/2}$. These conditions imply $M_P/M_E = R_E/R_P$, which does not make sense except in the case of the Earth. Certainly Earth is very special.

   (a) For Mars one has $M_M/M_E = .1$ and $R_E/R_M \simeq .25$ as predicted by the Bohr orbitology. This might make sense if the radius of Mars has increased from $.1R_E$ to $.25R_E$.

   (b) For Venus one has $M_V/M_E = 4/5$ and $R_E/R_V \simeq 5/4$. The discrepancy is not very large. The radius should have decreased from $R_E/R_V = 5/4$ to $R_V/R_E \simeq 4/5$ for which it can correspond to a Bohr orbit. Could Bohr quantization have forced the change of the radius and angular momentum. The opposite rotation direction of Venus could have been caused by a collision with an asteroid. The second option is that the rotation direction of M_{89} layer was opposite to that for the Sun.

   Maybe one could understand the reduction of the radius as being due to the Bohr quantization condition whose generalization is the key aspect of ZEOP. Indeed, the integers n in the condition $L = n\hbar_{gr}$ are rather small for $\beta_0 = 2^{-11}$. In a more realistic treatment there are also non-circular Bohr orbits and there is degeneracy with respect to the angular momentum quantum number. Could the decrease of the radius of an elliptical orbit have led to a circular orbit? This would have led to

(c) For Mercury one has $M_{Me}/M_E = .055$ and $R_E/R_{Me} = 5/3$. One should have $M_{Me}/M_E = R_E/R_{Me}$ would give $R_{Me} \simeq 18R_E$. This does not satisfy the Bohr quantization condition for a circular orbit. The reduction of the radius of the Mercury by a factor 1/30 should have taken place. Again one can ask whether a highly elliptical orbit could have transformed to a nearly circular orbit in order to satisfy the Bohr quantization condition?

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