Time reversal and the anomalies of rotating magnetic systems

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Abstract

Free energy phenomena can be defined as phenomena exhibiting thermo-dynamical anomalies such as generation of gradients rather than their disappearance. Concentration gradients can develop, electric fields as potential gradients can emerge due to generation of charge separations, and temperature gradients can be created. The failure of the second law in its standard form also manifests itself as over-unity energy production, cooling of the environment, and generation of structures rather than their decay characterizing self-organization.

The general explanation of these phenomena would rely on the change of the arrow of time in ordinary ("big") state function reduction (BSFR) reversing the arrow of time in the quantum measurement theory based on zero energy ontology (ZEO). This implies a new view about self-organization and also an explanation for self-organized (quantum) criticality. BSFR would take place at the level of the magnetic body (MB) carrying dark matter as $h_{eff} = nh_0$ phases and controlling ordinary matter, and BSFR would be macroscopic for large values of h_{eff}.

In this article the anomalies in rotating magnetic systems (RMSs) discovered by Russian researchers Godin and Roschin are discussed as a particular free energy phenomenon. The time evolution of a rotating magnetic system (RMS) could be seen as an emergence of a very simple life form receiving and storing metabolic energy from the motor driving the RMS, and liberating it at the moment of "death" as dark photons transformed to ordinary photons, whose counterparts in ordinary living matter are biophotons.

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1 Introduction

The study of so called free energy phenomena is not counted as a respected science in academic circles. The theories about them are thought to belong to the garbage can of science, and the best manner to get a reputation of a crackpot is to wonder publicly whether there might be something behind these phenomena.

As a heretic of theoretical physics and an academic persona non-grata, I have learned that intelligent discussions with colleagues is impossible. However, people interested in esoteric subjects like homeopathy, water memory, cold fusion, free energy and overunity systems, rotating magnetic systems, etc... have been keenly interested to inform me about their findings and ideas and I have enjoyed explaining my own views. The lack of academic position means that there is nothing to lose anymore, so that I have adopted "What if..." attitude to these phenomena and have developed possible explanations for these phenomena assuming that we live in the TGD Universe.

1.1 Development of ideas

During years this topic has not left me in peace: being interested in this kind of phenomena is like being a drug addict but despite the heavy social sanctions by well-intentioned colleagues I have not been able to get rid of my intellectual perversion.

This activity has been also important for the development of TGD itself and gradually it has become clear that there is some new physics behind these claims but that the lack of theory prevents developing a new technology even if it were possible. The problem with the inventors has been typically that they are pragmatic people dreaming of becoming rich and more interested in instant success rather than understanding these phenomena as such. This attitude is easy to understand already from the fact that experimental work requires funding.

I do not anymore remember for certain how the notions of negative energy and signals propagating in non-standard direction of time emerged but certainly these discussions helped them to evolve. The intuitive idea was that the arrow of time need not be always the same and the signals propagating backwards in time are possible (I talked only about time whereas after the advent of TGD inspired theory of consciousness I distinguish between subjective and geometric time [L14]). These signals would effectively carry negative energy. This inspired several ideas.

1. The system can extract energy from environment by sending negative energy signals for some system able to receive them: by energy conservation the system gets positive energy as a recoil. The analog of a population reversed laser would be an ideal energy provider. In principle also the extraction of thermal energy from the environment is possible.

    This would make possible a mechanism that I have called quantum credit card or remote metabolism. In biology, part of an organism needing metabolic energy instantaneously could send negative energy to as system in the geometric past. This might be crucial for a survival in jungle.

    The time reversed signal could also act as a control signal and initiate a response already in the geometric past - also helping to survive in jungle. The obvious question is whether the Libet's [J1] finding that conscious decision to raise finger is preceded by neural activity

involves negative signals to geometric past initiating the neural activity leading to the raising of the finger.

2. Communications with effective superluminal velocity by time reflection become possible. The signal sent to the geometric future or past reflects back in time direction   like the light of a lamp from a wall and returns back to the sender so that it would be possible to get information essentially instantaneously about an arbitrary distant object and effectively super-luminal communications become possible.

    Time reversal and the fact that hierarchy of Planck constants makes possible arbitrarily long quantum coherence lengths implies that finite light velocity ceases to be a barrier against communications with distant civilizations, and it might be un-necessary to build space-ships carrying huge amounts of fuel. In fact, there   it has been proposed that the states of consciousness induced by psychedelics could make this kind of communications possible and I have proposed a detailed model for what might happen [L3].

3. Memories (anticipations) as communications with the geometric past (future) - seeing in the direction of time - would also be possible. Here the work with zero energy ontology (ZEO) [L14] has led to a picture, which involves this kind of communications but the astonishing and totally insane looking conclusion (which I am still trying to challenge) forced by ZEO is that memories would be stored in geometric future!

4. Control actions using negative energy signals can be imagined. Motor actions would be quite generally realized in this manner.   One proposed application is remote replication of DNA and also remote transcription and translation can be imagined if the genetic code can be realized in terms of light signals [K12] [L19].

    The notion of bio-harmony [L1, L18] indeed provides a universal realization of dark genetic code with codons realized as 3-chords consisting of dark photons (music of light) with 64 allowed chords define bio-harmony serving as a correlates for mood/emotion. The chemical realization would be only one of the many realizations [L21].

    In these communications dark genes would appear as addresses consisting of N codons represented as chords realized as 3-chords consisting of dark photons. The $3N$-photons representing genes would be analogous to baryons bound states of 3 quarks and Galois confinement would be the analog of color confinement for protons [L20, L23]. $3N$-cyclotron resonance would be the basic mechanism: $3N$-resonance is in a key role also in ordinary radio communications.

5. The notion of negative energy signals requires time reversal. Fantappie [J3] proposed that in living matter   it makes sense to talk about syntropy, which increases in biological self-organization processes. The interpretation of syntropy would be as time reversed entropy which   increases in reversed time direction. Time reversed dissipation would lead to an apparent extraction of energy from the environment and generation of structures rather than their decay.

    If I had proceeded in a logical manner, the question would have been obvious: when does the arrow of time change?   I did not however make this question. The answer to this question emerged via the construction of TGD inspired theory of consciousness as a generalization of quantum measurement theory bringing the observer a genuine part of the system. In standard quantum measurement theory, the observer still remains an outsider and the conflict between non-deterministic state function reduction and deterministic unitary time evolution is a problem that has led to a plethora of various ad hoc explanations called for some reason interpretations.

1. TGD inspired theory of consciousness is basically an extension of quantum measurement theory allowing to get rid of the basic paradox of quantum measurement theory. There are two kinds of state function reductions (SFRs) "big" SFR and "small" SFR (briefly BSFR and SSFR) [L14].

    SSFRs are counterparts of "weak" measurements which are much like classical measurements and do not involve any dramatic changes. The sequence of SSFRs gives rise to a conscious

entity -self - as a sequence of moments of consciousness. Subjective time as a sequence of SSFRs correlates with the geometric time. BSFRs are counterparts of ordinary quantum measurements and have a dramatic effect: in a very general sense one can say that self dies and reincarnates with an opposite arrow of geometric time.

2. There is a hierarchy of magnetic bodies carrying dark matter as phases of ordinary matter with effective value $h_{eff} = nh_0$ of Planck constant. n corresponds to the dimension of an extension of rationals. The extensions define evolutionary hierarchies with increasing complexity. n serves as a measure of algebraic complexity and as a universal IQ, and also characterizes the scale of quantum coherence. For instance, genes are characterized by the value of h_{eff} associated with their MB.

Since MBs have higher universal IQ than ordinary biomatter, they control the biochemistry. In particular, they would control DNA and DNAs MB would actually realize genetic codons in terms of dark proton triplets. Also dark photon triplets would provide this kind of realization crucial for control of and communication with ordinary biomatter.

3. ZEO implies a theory of self-organization [L12] and of self-organized quantum criticality (SOQC) relying on time reversal: this idea emerged while developing a TGD inspired model for the action so called stress proteins playing a central role in biology [L22]. The dissipation of a system in reversed time direction looks like extraction of energy from the environment. Also SOQC becomes possible since criticality, since a state, which is a repeller, becomes an attractor in reversed time direction. The system seems to tend to criticality for an observer with an opposite arrow of time.

4. The findings of Minev et al [L11] provide experimental support for this picture [L11] as also Libet's findings interpreted originally to mean that conscious experience of free will is cause by neural activity starting by a fraction of second earlier. If BSFR occurs the arrow of causality is changed and the act of free will causes the neural activity.

2 ZEO based view about rotating magnetic systems

Free energy phenomena can be defined as phenomena exhibiting thermo-dynamical anomalies such as generation of gradients rather than their disappearance. Concentration gradients can develop, electric fields as potential gradients can emerge due to generation of charge separations [L2, I3, I2], and also temperature gradients can be created.

The failure of the second law in its standard form manifests itself also as over-unity energy production, cooling of the environment, and generation of structures rather than their decay characterizing self-organization [L12]. The general explanation would be change of the arrow of time in macroscopic BSFR occurring at the level of MB and inducing effective change of the arrow of time at the level of ordinary matter.

Rotating magnetic system (RMS) studied by Russian researchers Godin and Roschin [H1] is taken as an example and a tentative model for more general free energy phenomena can be abstracted from this model.

2.1 Does time reversal take place in RMS?

RMSs have been one of my interests for years. Russian researchers Roschin and Godin published an article [H1] about the strange behavior of RMSs years ago. To me it seemed to satisfy all scientific standards and provided a lot of data for a serious model building.

1. It was observed that the system started to accelerate at a rotation velocity which was not far from 10 Hz, which is by the way alpha frequency, key resonance frequency of EEG and also corresponds to the secondary p-adic mass scale of the electron in TGD. System received energy from some source and it could be utilized by decoupling the motor forcing the rotation and by coupling a load to the system. Furthermore, the temperature around the system was reduced by 6-8 degrees Kelvin and cylindrical magnetic walls were generated. In absence of

a load system had to be stopped since the acceleration reached the limit posed by mechanical stability. Also the increase of the load eventually stopped the rotation.

2. A further effect was the weight loss (gain) of the system rotating in clockwise (counterclockwise) direction. One guess is that this is due to some lifting force, even antigravity has been proposed as a reason. The weight loss was reported to be as high as 35 per cent.

3. In a dark room corona discharges are observed around the converter rotor as a blue-pink glowing luminescence and a characteristics ozone smell. The cloud of ionization covers the area of a stator and rotor and has therefore a toroidal shape. Also a series of horizontal yellowish-white luminescent bands spaced along the height of the roller surface and separated from one other by about a roller radius were observed. This suggest a high voltage electron discharge from the surface of the roller magnets. It was however not accompanied by sounds characteristic of arc discharge, which suggests an emission coming from a larger surface rather from a point source.

4. Also the change of the radioactive decay rates is reported suggesting that nuclear physics was affected somehow. This is of course in a sharp conflict with the reductionistic dogma stating that nuclear physics and condensed matter physics are totally isolated. "Cold fusion" [C2, C1, C3] is not the only phenomenon challenging this dogma and TGD suggests and explanation of "cold fusion" and related anomalies in terms of fusion of dark nuclei proposed to play a key role also in the prestella evolution [L13, L4, L17].

During years I have developed several models for the behaviour of the system and remote metabolism has been one of the proposed mechanisms.

1. Using the terminology which did not yet involve ZEO,   I argued that the system could send negative energy to its magnetic body (MB) carrying dark matter as $h_{eff} = nh_0$ phases of ordinary matter and in this manner get its rotational energy. If the MB absorbs thermal energy of the environment by sending negative energy to it, one can understand the reduction of the temperature of the air.

2. These models are summarized in two chapters of a book, whose topics might be called fringe physics. In the [K2] the system of Russian researchers Godin and Roschin and also some other systems are discussed. There are indee also other magnetic systems reported to exhibit over-unity behavior: one of them is the system invented by Yildiz and discussed in [K2]. Second similar system is studied in the Flyaway project reported also to exhibit cooling of the environment [K2].   In [K6] the possible relevance of the RMSs for morphogenesis is discussed.

3.   A general disappointing feature of these systems is that a continual energy production is not possible and the replication of the observations is difficult. This serves as a valuable hint in the construction of possible new physics models for the behavior of the system.

In discussions with a friend of mine interested in RMSs at practical level, suddenly an idea about a very concrete connection with ZEO, which I had not explicitly realized earlier, emerged.

1. Could the transition to the accelerating mode be interpreted as a BSFR for the MB of the system. BSFRs are possible in all scales and they indeed look like deterministic classical time evolutions as the findings of Minev et al show in atomic scales [L11]. ZEO based interpretation would be as time reversed time evolutions starting from the final state of BSFR in the geometric future of the observer [L11]. This BSFR would correspond to some moment of subjective time of the rotating system whose MB is in principle a conscious entity. This subjective time would correspond to some geometric time. As in Minev's experiment this time would be   in the geometric future of the observer at temporal distance T.

2. The apparently accelerating motion of the RMS would be de-accelerating motion with a reversed arrow of time and caused by dissipation of energy. Its duration would be T.   The time reversed time evolution at MB would induce effective time reversed time evolution of the ordinary matter and explain the lowering of its temperature. The MB of the system

would correspond to the cylindrical magnetic walls. The energy dissipated by the rotating system could be transferred via its MB to ordinary matter in the environment.

3. What about the weight loss. The BSFR should lead to a configuration in which the system is lifted from its resting configuration to a higher height and the returns back but with a reversed arrow of time. This lift requires an energy feed to compensate the gravitational energy. The system should make BSFR directly to this state: is the surplus energy kinetic energy in vertical direction?

   There is also symmetry breaking involved: for an opposite direction of rotation the effective weight increases. What would happen in BSFR that the rotational energy of system would instantaneously increase. Does the magnetic system receive from its MB or some large MB a rotational angular momentum, which is a multiple of $\hbar_{gr} = GMm/v_0$ [K11, K10] [L9]. Does it also receive from MB a vertical momentum, whose sign depends on the direction of rotation?

4. One should also understand the generation of plasma phase. The absence of sounds expected if the source of plasma is point-like inspires the proposal that the plasma was due to the generation of ions in BSFR or in the leakage of dark ions from MB occurring in reversed time direction after BSFR. The latter option is thermodynamically more plausible. The ionizaton would have increased for the first option and decreased for the latter option.

   The transformation of dark cyclotron photons to ordinary photons could have ionizde the atoms in the vicinity of the system. The known ionization energy and the assumption that the knowledge of cyclotron frequencies (a good guess is that 10 Hz frequency is in question) would give a precise estimate for the value of $h_{eff} = h_{gr}$ and it should correspond to the value deduced for it in living systems.

5. The original arrow of time is probably re-established at the MB of the system. The BSFR would be followed by a second BSFR re-establishing the original arrow of time. The rarity of the effect would suggest that the arrow of time of a given system tends to force the arrow of time of its sub-systems to be the same.

2.2   What happened in BSFR?

What happened to the MB in BSFR? How the dark matter at MB was generated? The first guess is that energy was liberated from MB in BSFR and transferred to the RMS.

1. Was BSFR a quantum coherent cyclotron transition for the dark ions at the flux walls of the MB leading to generation of dark cyclotron photons transforming to ordinary photons received by the RMS? The large value of h_{eff} would have made the energies of the ordinary photons resulting from dark cyclotron photons so large and that they would have ionized the atoms near the rotating system.

2. Could the transformation of dark photons to ordinary photons have provided both energy, momentum, and angular momentum to the rotating system? The momentum should have been in the direction of angular momentum to explain the dependence of the weight change on the direction of rotation.

3. The dark photons liberated in BSFR transforming simultaneously to ordinary photons should give their kinetic energy to the RMS. BSFR would correspond to an instantaneous change $h \to h + \Delta h$ such that $\Delta h = ph$, $p = .35$ is true corresponding to effective weight loss of 35 per cent.

   BSFR would be followed by a time reversed motion in which the value of h is reduced: in ordinary time direction this looks like an increase of the height h interpreted in terms of a gradual weight loss.

The TGD inspired model of bio-catalysis inspires an alternative option.

The shortening of magnetic flux tubes connecting reactants by a reduction of h_{eff} liberates energy (quite generally, energy of system increases as function of h_{eff}) is increased the value of h_{eff} for MB. The shortening of the flux tubes brings reactants together and the liberated energy makes for the reactants possible to overcome the potential wall hindering the reaction. One could imagine that a reduction of h_{eff} happened also now. The dark magnetic flux sheets would have transformed to ordinary magnetic flux walls detected by the experimenters and have liberated their dark cyclotron energy.

The proposal that the "death" of the rotating system as a primitive organism is involved conforms with the general vision. As the organism dies, dark photons transform to ordinary photons since the values of h_{eff} are spontaneously reduced and metabolic energy feed increasing the values of h_{eff} is absent. Dying organisms indeed emit biophotons having energies in visible and UV range. This is even used as a diagnostic tool to estimate the age of vegetables. In the recent case the bio-photons would correspond to photons inducing the ionization of the air.

2.2.1   Estimate for the transfer of energy from MB to the rotating system

The reported effective weight loss allows to build a quantitative model for what happens in BSFR. This model applies to both options. In particular, one can estimate the vertical kinetic energy provided for the RMS.

1. The energy of the system resting on elastic springs before BSFR is

$$E_0 = k\frac{h^2}{2} + Mgh \ .$$

   $h = 0$ is true for the situation without any weight. The vanishing of net force gives $h_0 = -Mg/k$ for the equilibrium position and $E_0 = -M^2 g^2/2k = -kh_0^2/2$ for the energy.

   If one would have a genuine weight loss of $\Delta M = pM$, $p \simeq .35$, one would have in equilibrium

$$h_a = (1 - p)h_0 \ .$$

2. Suppose that BSFR gives for the system a vertical upwards directed velocity v_0. This leads to a reduction of the magnitude of h and would have been interpreted by experimenters as a gradual weight loss changing the equilibrium position. The maximum value h_{max} of h corresponds to t the moment of BSFR and would correspond to the value from which the weight loss is estimated: one has $h_{max} = (1 - p)h_0$.

   Energy is given by

$$E = \tfrac{M}{2}(\tfrac{dh}{dt})^2 + \tfrac{k}{2}h^2 + Mgh$$

$$\equiv \tfrac{M}{2}(\tfrac{dh_1}{dt})^2 + \tfrac{k}{2}h_1^2 - \tfrac{M^2 g^2}{2k} \ .$$

   One has a harmonic oscillator for a shifted coordinate $h_1 = h + Mg/k$.

3. Energy conservation

$$E = E_0 + \frac{Mv_0^2}{2}$$

   gives

$$\frac{dh}{dt} = \sqrt{-\frac{kh^2}{M} - 2gh + 2\frac{E_0}{M} + v_0^2} \ .$$

   The maximum value of h/h_0 corresponds to $dh/dt = 0$ giving

$$\frac{h_{max}}{h_0} = 1 - \sqrt{-\frac{Mv_0^2}{2E_0}} \quad .$$

and is equal to $1 - p$ if the proposed model makes sense. This gives

$$p = \sqrt{-Mv_0^2/2E_0} = (v_0/g)\omega \quad , \quad \omega = \sqrt{k/M}$$

ω is the oscillation frequency of the oscillator for the collective oscillation of the spring system. v_0 is given by

$$v_0 = p\frac{g}{\omega} \quad .$$

4. The expression for p allows to express kinetic energy $E_K = Mv_0^2/2$ as

$$E_K = \frac{M}{2}v_0^2 = p^2\frac{M^2g^2}{2k} = p^2\frac{M}{2}(\frac{g}{\omega})^2 = p^2Mg|h_0| \quad .$$

E_K would be the energy given by dark photons to the vertical motion of the RMS in BSFR (note that part of energy goes to rotating motion of rollers).

A reasonable estimate for h_0 gives order of magnitude for E_K. For $M = 100$ kg, $h_0 = 1$ cm and for $p = .35$ one has $E_K \simeq 1.2$ J. Joule corresponds to 6.2×10^{18} eV.

5. Does the model make sense quantitatively? If the dark photons have energy of 2 eV, the energy of 1.2 J corresponds to 3.7×10^{18} dark photons. This number dark cyclotron photons with eV energy transform to ordinary photons or at least provide their energy to the system.

Suppose that about 10^{19} dark photons are emitted in a cyclotron phase transition of a Bose-Einstein condensate of 10^{19} ions. If these ions reside at magnetic wall of height $L = 10$ m, radius .5 m, and thickness of .05 m, the number density of ions is $n = 4 \times 10^{19}\text{m}^{-3}$ so that single ion or ion Cooper pair would take a volume of $V = 4$ μm^3. This corresponds to the size scale of the cell nucleus.

2.2.2 Estimate for the value of $\hbar_{eff}$ from the transfer of angular momentum

One can also make an order of magnitude estimate the value of $\hbar_{eff}$ from the angular momentum gain during the acceleration.

1. The magnitude for the angular momentum of the magnetic system is

$$L = nM_R\omega R^2 = n2\pi fR^2 \quad .$$

n a numerical constant and $R \sim .5$ m is the radius of the system. M_R is the total mass of rollers with order order of magnitude $M_R \simeq 10$ kg. f denotes the rotation frequency $f \sim 10$ Hz. The gain of angular momentum is

$$\frac{\Delta L}{hbar} = \frac{n2\pi M_R fR^2}{\hbar} \times \frac{\Delta f}{f}$$
$$\equiv n \ X \ \times \ \frac{\Delta f}{f} \quad .$$

The order of magnitude of $X = \frac{2\pi fM_R R^2}{\hbar}$ is from $\hbar = 6.6 \times 10^{-34}$ Js given by $X \sim 10^{36}$. For $\Delta f/f \sim .1$ one has $\Delta L/\hbar \sim 10^{35}$.

2. Dark ions have angular momentum, which consists of the spin part $h_{eff}s$, s the spin of the ion. For the ordinary value of Planck constant the spin part is negligible as compared to the orbital angular momentum at the magnetic wall. In the recent case $h_{eff}/h \sim 10^{14}$ would give for $N = 10^{19}$ the estimate $L =\sim 10^{33}\hbar$, which is 2 orders of magnitude smaller than the rough estimate. The large number of walls could increase L by this amount.

3. The orbital angular momentum of dark ion can be estimated classically and is of order $l_{rot} = (M_I/m_p)Am_p v_I R_w$, where $A = M_I/m_p$ is the mass number of the ion, and $R_w = 1$ m provides an order of magnitude estimate for the radius of magnetic wall. For iron the mass number is 56.

   For $N = 10^{19}$ this gives the estimate $L/\hbar \sim A \times 10^{34}(v_I/c)(R_w/m)$. The factor v_I/c reduces the value of $L/\hbar$ and it might be that the order of magnitude is the same as for the spin contribution.

   Quantum classical correspondence and angular momentum quantization $L/hbar = n_1 \times \hbar_{eff}/hbar$ gives

   $$n_1 \times \frac{\hbar_{eff}}{hbar} \sim A(v_I/c) \times 10^{15}(R/m) .$$

   $A = 56$ for iron allows for small values of n_1 non-relativistic velocities and $\frac{\hbar_{eff}}{hbar} \sim 10^{14}$ suggested by biological applications. Since mere spin flip corresponds to $n_1 = 1$ spin and orbital contributions are of the same order of magnitude.

4. Note that for dark photons orbital angular momentum would be proportional to ER_w and since $E \sim 2$ eV is much smaller than M_I the orbital angular momentum of photon would be negligible as compared to its spin.

2.2.3 How to understand the large value of h_{eff}?

How could one understand the large value of $h_{eff} = n\hbar_0$, where one has $\hbar = 6\hbar_0$ [L6] The value of h_{eff} is typically of order $h_{eff} \sim 10^{14}\hbar_0$ for the biologically important ions such as Fe^{2+} crucial for the metabolism and respiratory system and - as it seems - important also now. The 10 Hz cyclotron frequency of Fe^{2+} assignable to $B_{end} = .2$ Gauss should correspond to an energy of order few eV assignable to bio-photons [K4, K5] consisting of visible and UV photons. A dark photon with energy 2 eV and frequency 10 Hz would correspond to $\hbar_{eff}/\hbar = 1.9 \times 10^{13}$.

In the TGD framework h_{eff} can be assigned with the magnetic flux tubes mediating interactions of given type. Quantum coherence length would be proportional to the value of h_{eff} and its value should reflect the range of long range interactions shortened by screening. For the flux tubes mediating electromagnetic interactions $h_{eff} = h_{em}$ would be relatively small since electromagnetic screening destroys quantum coherence in some scale.

The flux tubes accompanying valence bonds would be a basic example in this respect [L8]. The values of h_{eff} would increase along the row of the periodic table since Coulomb binding energies would decrease with h_{eff}. This would directly relate with the fact that the molecules containing atoms near the right end of the row are important for metabolism.

For gravitational flux tubes the value of $h_{eff} = h_{gr}$ would be large since gravitational interaction is not screened.

1. The gravitational Planck constant $\hbar_{gr}$ was originally introduced by Nottale [E2] [K11, K10] and would be assignable to flux tubes (presumably non-monopole flux tube) connecting dark mass M_D and mass m (M and m touch the flux tubes but do not define its ends as assumed originally) mediating gravitational interactions. $\hbar_{gr}$ is given by

   $$\hbar_{gr} = \frac{GM_D m}{v_0} , \tag{2.1}$$

   where $v_0 < c$ is velocity parameter. For the Bohr orbit model of inner planets Nottale assumes $M_D = M(Sun)$ and $\beta_0 = v_0/c \simeq 2^{-11}$. The possible interpretation of the velocity parameter v_0 has been discussed in [L9] [K8].

2. A crucial property of $\hbar_{gr}$ is that the value of cyclotron energy is universal in the sense that it does not depend on the mass m of the charged particle - this conforms with the Equivalence Principle. Cyclotron energy is given by

$$E_c = \frac{GMZeB}{\beta_0} = \frac{\hbar ZeB}{m_{eff}} \quad , \quad m_{eff} = \frac{r_S}{2\hbar\beta_0} \tag{2.2}$$

Here $r_S = 2GM_D$ is the Schwarschild radius. For Earth one has $r_S = 8.87$ mm. Effectively the mass m of ion is replaced with $m_{eff} = 2\hbar\beta_0/r_S$ determined by Schwartschild radius $r_S = 2GM_D$ and the value of $\beta_0 = v_0/c$.

Note that the gravitational Compton length of the charged particle equals to $\lambda_{gr} = GM_D/\beta_0 = r_S/2\beta_0$ and does not depend on m: : also this conforms with the Equivalence Principle and is analogous to the independence of the acceleration of a particle in gravitational field on its mass.

3. For Earth the estimate [L10] using as starting point the order of magnitude $\hbar_{eff} \sim 10^{14}$ for biologically important ions gives an estimate $M/M_D \sim .5 \times 10^4$ giving $\beta_0 = 4.4 \times 10^{-4}$ rather near to $\beta_0 = 2^{-11} \simeq 5 \times 10^{-4}$ which is near the value deduced by Nottale for the inner planets of Sun.

These estimates for M_D and v_0 would give $\lambda_{gr} = r_S/2\beta_0 \simeq r_S/4.4 \simeq 2$ mm. This brings in mind the millimeter sized neuronal blobs in brain. What raises the eyebrows of a skeptic, is the possible connection between brain dynamics and the inner structure of Earth.

4. M_D should correspond to a dark mass assignable to Earth. Earth has an outer core occupying 15 per cent of its volume, inner core occupying 1 per cent of the volume and innermost inner core with radius 300 km occupying fraction 10^{-4} of the volume (see http://tinyurl.com/y8vf7vc3) suggests that the innermost inner core consists of dark mass with density twice the average density.

If one has $M_D = 2 \times 10^{-4}M_E$, the density of the innermost inner core would be 2ρ, where ρ is the average density of Earth. From Wikipedia (see http://tinyurl.com/ma6xqnh) one learns that the average density ρ_E of Earth is $5.52 \times \rho_W$, $\rho_W =$ kg/dm^3 and the density in the inner core varies in the range $\rho/\rho_w \in [12.6 - 13.0]$. The lower limit is approximately $2 \times \rho$. This suggests that the density of the innermost inner core is somewhat larger than 2ρ.

2.3   How the dark matter at MB was generated?

How the dark matter at the MB of the system was generated?

1. The dark part of the Earth's magnetic field B_E equal to $B_{end} = 2B_E/5$ carrying monopole flux and having strength .2 Gauss from the experiments of Blackman [J2] for which iron ions have cyclotron frequency f_c near 10 Hz, which is alpha frequency.

Did the approach of the rotation frequency to the alpha resonance frequency induce a resonant coupling of the MB of the system with the B_{end} feeding ordinary ions to MB where they transformed to dark ions?

2. This would be completely analogous to the Pollack effect occurring in water bounded by gel and irradiated by say IR light, and leading to charge separation involving the formation of exclusion zones (EZs) as negatively charged regions [L2, I3]. TGD based model for Pollack effects assumes that the protons go to the dark magnetic flux tubes and form dark nuclei as nuclear strings. The model forms a basic pillar of the TGD view about living matter and is discussed in [L2].

The "metabolic" energy for increasing the value of h_{eff} would have been provided by the motor. The situation would be similar to that in living systems. One could interpret the effect as a formation and death of a primitive living system - essentially artificial life. There are also other examples of similar systems discussed from TGD point of view in [K7] and [L15].

2.4 The model does not allow over-unity function but what about energy storage to MB?

The model excludes continual over-unity energy production. One can however consider a new kind of energy storage mechanism in which the MB of the system carries the energy. This kind of energy storage might be more practical than the storage to fuel. MB would serve as a kind of battery.

MB contains only a finite amount of stored cyclotron energy. Also the fact that the BSFR occurs in the geometric future of the observer at a finite temporal distance T explains why continuous energy production lasting for a long time is not possible. Practical applications would require the increase of T. One could also consider the possibility that the situation is stable against the transformation of dark matter at MB to ordinary matter and that the liberation of energy from MB could be initiated and stopped when needed. Also external MBs could as energy storage could be considered. The dark part of MB of Earth or even Sun is one possibility.

2.5 BSFR as a general mechanism of free energy phenomena?

The proposed mechanism could be quite general and apply to several - if not all - free energy devices breaking the second law and exhibiting other thermo-dynamical anomalies already listed. I have discussed these systems from TGD point of view in the chapters of [K3].

The not so good news is that the mechanism could provide a general explanation for the failure to produce energy in a continuous manner. In the case of the RMSs, the energy liberated could be energy stored to MB and would have been provided by the motor. One can hope that the value of the parameter T could be increased and that one could use MB as a new kind of energy storage. This of course does not diminish the value of these systems since they would provide examples about very simple forms of life.

To explain the poor replicability, I have proposed that these devices are critical systems in the sense that they work in the desired manner only for critical values of the parameters. In the TGD framework, all systems are quantum critical systems in some scale and the prediction is that at the level of "world of classical worlds" (WCW), the number of quantum critical degrees of freedom is actually infinite.

Criticality implies that the system is unstable against perturbations and analogous to a ball at the top of a very steep hill. How can it stay near criticality? Here self-organized quantum criticality for the MB of the system could come in rescue. In the time reversed direction the repelling critical state becomes an attractor. This would explain the empirically well-established self-organized criticality.

This picture could also apply to "cold fusion" [L7, L4, L17]. The poor replicability of "cold fusion" suggests that it is a critical phenomenon and that a time reversal is involved.

1. TGD based model relies on the notion of dark nuclei realized as dark proton sequences at the magnetic flux tubes assignable to flux tubes with proton Compton length scale up to electron Compton length. This would give rise to dark scaled up versions nuclei having a scaled down binding energy scale. The Coulomb wall preventing cold fusion would be lowered.

2. These dark nuclei would be produced also in Pollack effect in water bounded by a gel phase [I3]: irradiation by say IR photons generates regions from which a considerable fraction of protons goes somewhere so that negatively charged exclusion zones (EZs) are formed. The TGD based proposal is that part of protons (one proton per two water molecules so that stoichiometry changes to $H_{1.5}O$) is transferred to magnetic flux tubes as dark protons forming dark nuclear strings (TGD based model for nuclei is as nuclear strings [K9]). In living matter dark protons would form sequences of dark proton triplets realizing genetic code and dark analogs of DNA,RNA,tRNA, and amino-acids (AAs) accompanying ordinar DNA,RNA, tRNA and AAs.

3. Also in the case of "cold fusion" the change of the arrow of time would allow to overcome the problems posed by the critical character of the final state.

4. I have proposed that also the tunnelling occurring in the ordinary nuclear reactions corre-
spond to BSFR leading to temporary time reversal and followed by a BSFR back to the
original time directions [L13]. In the case of "cold" fusion the incoming particles would not
be ordinary nuclei but dark nuclei with much smaller binding energy so that it would be
much easier to overcome the Coulomb wall.

3   About possible applications

The basic mechanism of RMS is proposed to involve a transfer of energy from environment as
metabolic energy to MB of RMS followed by time reversed period which looks like energy extraction
from MB to RMS and possibly doing work, could generalize and have some application to biology.

3.1   APTPase as RMS?

ATPase can be regarded as a molecular generator (acting in mode reverse to that of the motor)
transforming metabolic energy to the energy needed by ADP→ ATP transformation [I4]. The
working mechanism of ATPase is not well-understood.

I have already earlier tried to understand ATPase as an RMS [K2]. ATPase is analogous to the
rotating shaft of a power plant and transforms metabolic energy to the energy of ATP molecule
by transforming ADP to ATP. The rotation frequency of the shaft is around $f = 300$ Hz. The
interpretation as proton's cyclotron frequency in the endogenous magnetic field $B_{end} = 2B_E/5$
identified as the monopole flux part of B_E is suggestive. ADP molecule transforming to ATP is
the analog of the load. The energy would come from the metabolic energy feed.   Could ATPase
be regarded as RMS performing time reversals periodically?   The simplest option would be
that ATPase as a periodic system is analogous to breathing, which could be regarded as a sequence
of CDs which make continual Karma's cycle with half-periods of cycle having opposite arrows of
time. The in-breath with the negative arrow of time would extract metabolic energy to MB and
breathing out would give it to ATPase and to the ADP→ ATP transformation. MB would get its
energy from metabolism from the flow of protons through the mitochondrial membrane transferred
to dark protons at MB.

This mechanism might also apply to the RMS itself. The period would be near 10 Hz and
would decompose to two half-periods with opposite arrows of time. This would make it easier to
understand how the energy is transferred to the load. System would be breathing with a frequency
near alpha frequency.

3.2   Oumuamua as a rotating magnetic system and primitive life form?

The strange object known as Oumuamua (briefly O in the sequel) has gained a lot of attention. I
have not had time to seriously check why O is so strange that Harward's top astronomer Avi Loeb
regards it as evidence for alien life. Now I decided to do this and read a popular article `https:
//cutt.ly/ukqHCTw`) describing the basic features of O. Wikipedia contains a more technical article
[E1](`https://cutt.ly/NkqH9OG`) about O.

O indeed has several strange features.

1. O had no tail as comets have: the tail is due to evaporation caused by the solar radiation.
Artistic vision about O is as a long cylinder looking like rock. This vision is misleading
since what was actually seen was a point-like object.

2. The reflectivity of O was highly varying and could be more than 10 times higher than for
an average comet. From this it was deduced that O must have a shape of a cigar or a thin
pancake. The spinning motion of O would be a tumbling characteristic for a rotor which
rotates around a non-principal axis. This motion could explain the variations in reflectivity
with a period of $T = 14$ hours.

An interesting question is whether the period could allow an interpretation od T in terms of
p-adic length scale hypothesis. The hint comes from the fact that r magnetic system of Godin
and Roschin starts to accelerate when the rotation period approaches $T(127, 2) = .1$ seconds
assignable to the Mersenne prime $M_{127} = 2^{127} - 1$. This time scale defines   electron's

secondary p-adic time scale, alpha rhythm and the cyclotron frequency of iron in the endogenous magnetic field $B_{end} = .2$ Gauss proposed to form the monopole part of the Earth's magnetic field. In [L16] it was proposed that period doubling of $T(127, 2)$ occurs corresponding to the values $h_{eff} = 2^k h$ scaling $T(127, 2)$ by a power 2^k so that the time scales $2^k T_e$ appear as important time scales. 26 second time scale assignable to the Earth's pulsation was assigned with $k = 8$. One has $T = .96 \times 2^{19} T(127, 2) \simeq T(136, 2)$ not far from a period doubling with $k = 19$.

3. O experienced a non-gravitational acceleration. Solar radiation pressure has been proposed as a reason. This would however suggest that solar light evaporates part of O:s mass and this causes a formation of a tail. No tail was observed.

   Could O have used an analog of a solar sail? The surface of the solar sail could have absorbed or perhaps even reflected the solar radiation and provided the momentum as a recoil to O. If the solar sail had a suitable shape, it perhaps prevented the radiation from reaching O itself and the formation of tail by evaporation. This shield mechanism would be somewhat similar to how the Earth's magnetic field shields life at the surface of Earth from the effects of cosmic rays and solar wind.

In the TGD framework the natural question is whether the magnetic body (MB) of O - having much larger size than O itself - could have served as a highly effective solar sail. Did the solar photons from the Sun give their energy and momentum to the MB of O? Did MB absorb the photons and transform them to dark photons providing their energy for dark Bose-Einstein condensate of ions at the MB of O making it a primitive intelligent life form? Did solar light push MB away from the Sun and did O follow it?

A connection with the rotating magnet system studied by Godin and Roschin is suggestive. This system had strange features.

1. The rotating system was accompanied by thin cylindrical magnetic walls in the direction of rotation axis.

2. As the rotation frequency approached 10 Hz (alpha frequency), the rotation started to accelerate and the system's effective weight either increased or decreased depending on the direction of rotation.

3. Also the air around the system was ionized and was cooled by a few degrees. This is not in accordance with thermodynamics.

In the TGD based model the system is regarded as a primitive life form.

1. The magnetic walls would correspond to the magnetic body (MB) of the system containing dark ions in TGD sense, in particular iron ions having very high value of $h_{eff} = nh_0$ and defining giving rise to cyclotron Bose-Einstein condensate to which the energy of the motor driving the system would have been stored. MB would have gained part of the energy feeded by the motor as analog of metabolic energy.

2. Eventually the system made a macroscopic state function reduction ("big" state function reduction (BSFR) [L14]). In TGD based theory of consciousness BSFR means what might be called death and reincarnation with an opposite arrow of time - this in a completely universal sense [K1].

3. The time reversed dissipation by transformation of dark photons to ordinary photons looked for outsiders with the standard arrow of time like absorbing energy from the environment causing the cooling. The energy and momentum of the photons would have caused effective loss of weight and accelerated rotation.

Could O be an analogous system? Elongated cigar shape would favor MB consisting of thin magnetic walls forming an ideal solar sail gathering the energy and momentum of solar photons by transforming them to dark photons of BE condensate. MB would have shielded O just like it shields life forms at Earth so that it O have avoided evaporation.

Is O a product of an advanced engineering or a primitive life form? It might be that the latter option is correct. As astronomer Avi Loeb suggests the interstellar space might be teeming these entities. If so, primitive life would populate the interstellar space.

4 Appendix: Gravitational interactions of dark matter at MB

In TGD inspired quantum biology biosystems are controlled by dark matter at magnetic bodies (MBs) of systems involved. Also Earth's MB is involved.The cyclotron energies of biologically important ions and even larger subsystems should be in the biophoton energy range which gives an estimate for the value of h_{eff}, which is very large.

4.1 Nottale hypothesis

The assumption is that dark ions in question are at gravitational flux tubes mediating gravitational interaction and have the value of $h_{eff} = h_{gr} = GM_D m/v_0$ proposed by Nottale [E2] [K11]: v_0 is velocity parameter and has value $\beta_0 = v_0/c \simeq 2^{-11}$ for the inner planets of Sun. This value is the natural first guess also in the case of Earth. M_D denotes the dark mass which need not be the mass of Earth. Note that Schwartshild radius is given by $r_s = 2GM$ and for Earth has value is $r_s = .887$ cm.

Nottale's hypothesis implies that cyclotron energies are universal in the sense that they do not depend on the mass of the particle: this conforms with Equivalence Principle. The cyclotron energy for cyclotron frequency $f_c = ZeB/m$ is given by $E_c = \hbar_{eff}f_c$ and for $h_{eff} = h_{gr}$ one has $E_c = (GM_D/v_0)ZeB$. Also the value of gravitational Compton length given by $\lambda_{gr} = \hbar_{gr}/m0GM/v_0 = r_s/2v_0$ is mass independent and therefore universal.

Note that the values of h_{gr} differ for different ions so that only ions with the same mass are at the same flux tubes: the ions are neatly separated to flux tubes according to their mass and charge like books in a book shelf. Dark biological ions would not form random soup as in the biochemical picture.

4.2 The notion of endogenous magnetic field

The endogenous magnetic field of $B_{end} = 2B_E/5$, where $B_E = .5$ Gauss is the Earth's magnetic field, is deduced from the experimental findings of Blackman [J2] and is identified as the monopole flux part of B_E having also ordinary Maxwellian path with vanishing monopole flux. Monopole flux is possible in the TGD framework by the non-trivial topology of CP_2 but not in Maxwellian theory. The special feature of monopole flux is that it does not require currents to create the magnetic field. This can explain the maintenance of Earth's magnetic field [L5].

The condition that the cyclotron energy is 2 eV for 10 Hz cyclotron frequency of iron ion in B_{end} allows to estimate the value of h_{eff} in this case as $h_{eff} = 10^{13}$. Note that $h_{eff} = h_{gr}$ is proportional to the mass of the ion. Using this rough estimate for $h_{gr} = h_{eff}$ one obtains an estimate for M_D as $M_D = v_0 h_{eff}/Gm(Fe)$. For $v_0 = 2^{-11}$ this gives $M_D = 2 \times 10^{-4} M_E$, where M_E is the Earth's mass.

4.3 Identification of the dark mass M_D as mass of the innermost core of Earth

A possible identification of M_D is as the mass of the innermost core of Earth. Its radius is estimated to be 400 km For average density ρ_E of Earth this would give mass $M_D = xM_E$, $x = 2.4 \times 10^{-4}$. The actual density in the core is higher and a good estimate is $\rho_{inn} = 5\rho_E$. This would give $x \simeq 1.2 \times 10^{-3} M_E$. Of course, not all of this mass need be dark. The Schwartschild radius $r_S = 2GM_D$ would be $r_S = xr_S(E)$ giving 2.1 μm in the first case and 11.0 μm in the second case. Cell size scales are in question.

4.4 Bohr orbit model for dark matter at MBs

Since M_D has a physical interpretation, it is interesting to look whether it would make sense to assume that dark particles at the magnetic body of Earth and at the personal magnetic bodies co-rotating with Earth could reside at Bohr orbits in the gravitational field generated by M_D just like the model for the planetary orbits originally proposed by Nottale assumes. These orbits could correspond to flux tubes.

It is straightforward to generalize the basic formulas for hydrogen atom:

$$\alpha = \frac{e^2}{4\pi\hbar} \to \frac{GM_D m}{4\pi\hbar_{gr}} = \frac{\beta_0}{4\pi} \quad,$$

$$r_n = \frac{n^2}{2\alpha^2}\frac{\hbar}{m} \to n^2\frac{(2\pi)^2}{\beta_0^3}x r_s(E) \quad,$$

$$r_s(E) = 2GM_E \quad, \quad x = \frac{M_D}{M_E} \quad. \tag{4.1}$$

For $x = 10^{-3}$,which corresponds to the estimate M_D from $\rho_D = 5\rho_E$ in the core and $\beta_0 = 2^{-11}$, this would give $r_1 = 1.1\times 10^3$ km to be compared with the radius of Earth given by $R_E = 6.4\times 10^3$ km and with the radius of the solid inner core about 1.22×10^3 km. If the density is 6 times higher in the inner core, one has $r_1 = R_E$.

$r_n \propto 1/\beta_0^3$ makes r_n very sensitive to β_0. For $\beta_0 = 2^{-12}$ one would have $r_1 = 1.4R_E$. Values of r_1 larger than R_E are natural for MB. Therefore it is possible to have $r_1 \geq R_E$ for reasonable values of parameters.

4.5   Are the rotation velocities of Earth and dark matter at MBs same?

The rotation velocity of Earth is 460 m/s and much smaller than the velocity parameter β_0. There are two options.

Option I The rotation velocities for the biological body at the surface of Earth and MB possibly above it should be the same to guarantee that they would stay in contact. If the flux tubes are above Earth the dark matter would behave like a stationary satellite. An analogous hypothesis has been studied for planetary orbits [K11].

Option II: Dark matter is localized at circular magnetic flux tubes in which case it can rotate with different velocity.

Suppose that the dark matter at MB couples gravitationally only to M_D as the hypothesis that only particles with the same value of h_{eff} appear in the same vertex suggests. This hypothesis can be of course challenged: the usual assumption is that gravitation couples in the same manner to all forms of matter.

With this assumption Newton's equation for circular orbit in the equitorial plane (it need not be same as for Earth's rotational axis, also magnetic axis could define it) gives

$$\beta^2 = (\frac{v}{c})^2 = \frac{GM_D}{r_n} = x \times \frac{r_s(E)}{2n^2 r_1} \quad. \tag{4.2}$$

$r_1 = (1/\alpha gr)(\hbar_{gr}/m)$ is the counterpart of Bohr radius $a_0 = \hbar/\alpha m_e$ and given by

$$r_1 = \frac{4\pi}{\,}\beta_0^2 GM_D = \frac{2\pi}{\beta_0^2}r_s \quad,$$

where r_s is Schwartschild radius for dark mass M_D. Parameterizing r_n as $r_n = n^2 r_1 = n^2 y R_E$ one has

$$\beta^2 = \frac{xy}{n^2} \times \frac{r_s(E)}{2R_E} \quad. \tag{4.3}$$

$x = 10^{-3}$ and $y = 1$ give $\beta = 2.6 \times 10^{-4}$, which corresponds to $v_{rot} = .8 \times 10^4$ m/s, which is by factor 20 higher than β_{rot}.

This would require **Option II**.

What about **Option I**. $\beta \propto 1/n$ proportionality suggests that the lowest orbit above the Earth's surface has $n > 1$ (for the model of solar planets Earth as $n = 3$). The required value of n would be however rather high.

One can however change also the values of x and y. For $x = 2 \times 10^{-4}$ and $y = 1/6$ and $n = 3$ ($n = 1$ orbit is near the boundary of the solid core and $n = 3$ orbit is the first one above

Earth's surface and corresponds to $r_3 \simeq 1.5 R_E$) β would be reduced by factor $1/3\sqrt{30} \simeq 1/16.4$. The personal MB would be like a stationary satellite for this option. The increase of β_0 by factor 1.14 would reduce r_3 to R_E.

4.6 Gravitational binding energy of proton and metabolic energy currency

There are two further intriguing observations supporting the notion of MB.

1. Getting a proton to the layers of MB with size of order Earth radius and even larger size requires energy to compensate for the gravitational binding energy. For proton the gravitational binding energy at the surface of Earth would be $E_{gr} = GM_E m_p/R_E = m_p g R_E$ and is $E_{gr} \simeq .67$ eV. Remarkably, this energy is near the metabolic energy quantum appearing as a universal energy currency in biology often taken to have a nominal value of .5 eV!

   Could the metabolic energy quantum given for the particle allow it to get from the gravitational field of Earth to the highest layers of personal MB - that is to delocalize the wave function to MB scale. Besides this energy would be required to increase h_{eff}.

2. There is also another intriguing observation. The ionization of biologically important atoms is poorly understood since thermal ionization is not possible. Could the transfer of atoms to the layers of MB in ionized thermosphere provide an ionization mechanism?

   The Planck distribution for photon energy as a function of frequency at the temperature prevailing at the Earth's surface has maximum, which corresponds to the energy $E_{max} \simeq 2.4T = .082$ eV. $E_{th}/E_{gr} \simeq .012$ implies that thermal energy at the maximum of distribution can kick the proton to the height of $R = 76$ km. The Planck distribution as a function of wavelength has $E_{max} \simeq 4.8T \simeq .164$ eV giving $R = 152$ km. The lower boundary of the thermosphere, where molecules and atoms are ionized is at height 80 km. The upper boundary is at 600 km.

   Could the ionization of protons take place at the thermosphere by kicking the hydrogen atoms to the lower boundary of the thermosphere, where they are ionized and return back to the surface of Earth along flux tubes? The kicking of heavier atoms to the thermosphere would require energies proportional to the mass number of the atom above thermal energies. Of course, even simpler mechanism can be considered: heavier atoms could be ionized in the thermosphere and brought to the surface of Earth along flux tubes.

One can estimate the gravitational binding energy in Earth's gravitational field also from the energy of Bohr orbit. The binding energy for the Bohr orbit is in the case of proton given by generalizing $E_n = (\alpha^2/2n^2)m_e$ given by

$$E_n = \frac{\beta_0^2}{32\pi^2 n^2} m_p \quad .$$

Remarkably, the value of binding energy is universal in the sense that it does not depend at all on the value M_D of the dark mass. This could be seen as a consequence of Equivalence Principle. The above considerations suggest that only the dark masses with the same value of h_{gr} couple to each other gravitationally via gravitons travelling along flux tubes and the binding energy per particle should be the same in all cases.

For $\beta_0 = 2^{-11}$ this would give $E_n = (2^{-27}/\pi^2 n^2)m_p \simeq .75$ eV, which is not too far from .67 eV given by the classical estimate. The improved value of β_0 would be $\beta_0 = \sqrt{.67/.75} \times 1^{-11} \simeq 4.6 \times 10^{-4}$.

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