Mysteries associated with lightnings, ball lightnings and the electrosphere of Earth

May 24, 2022

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Abstract

Lightning and ball lightning are electrospheric phenomena involving several poorly understood aspects. Also the origin of the electrosphere of Earth remains a mystery. In the TGD framework it is possible to deduce information about magnetic and electric bodies of Earth (briefly MB and EB) by using empirical inputs and these phenomena.

A model, which allows us to understand these phenomena in the TGD framework, is developed. The model relies on the TGD based model of dark matter residing at the flux tubes of the magnetic body. The gravitational magnetic bodies of both Earth and Sun are important. The notion of the electric body of Earth as an analog of the cell membrane acting as a generalized Josephson junction is developed. Lightning and ball lightning would be associated with the analog of action potential.

Contents

1 Introduction

Lightning and ball lightning are electrospheric phenomena involving several poorly understood aspects. Also the origin of the electrosphere of Earth is still a mystery. In the TGD framework it is possible to deduce information about magnetic and electric bodies of Earth (briefly MB and EB) by using empirical inputs and these phenomena.

1. Ball lightings are known to be real are not understood. Ball lightning-like phenomena can be created also artificially in microwave ovens using match. Matches contain organic material and this serves as a good hint.

2. There is a New Scientist article, which gives a popular representation of ball lightings (`https://cutt.ly/0HkW59F`.

   The theory of Cameron [D1] is mentioned in the article. The theory assumes that lightnings are essentially phenomena associated with the electromagnetic radiation field alone and neglects the fact that plasma is very probably involved. The theory relies on exact solutions of Maxwell's equations and proposes that ball lightnings involve monochromatic electromagnetic fields which are knotted and linked making the field configurations topologically nontrivial. Both magnetic and electric field lines can be knotted.

   This does not however imply topological stability since the linearity of Maxwell's equations implies that these field configurations are unstable. The finding that lifetime is long enough for microwave lengths does not conform with the fact that visible light is involved.

   Another theory mentioned in the article is by Boerner and proposes that lightning comes from another dimension. What this could actually mean, is of course a highly non-trivial question.

3. The basic mystery is how ball lightning can survive for so long a time. An ordinary plasma ball is not expected to do so. This suggests that ball lightning obeys non-linear dynamics and is some kind of topological entity robust by their topological non-triviality.

4. A very natural expectation is that ball lightning is a self-organizing system consisting of plasma which radiates. Self-organization requires energy feed. It could come as a Coulombic energy from the electric field of Earth through which part of the plasma of ball lightning has arrived.

   Here one encounters a problem. The electric resistance of the atmosphere causes a dissipation of the energy so that the charged particles cannot accelerate to high energies. How could lightning avoid this?

5. Two problems are always better than one. The second puzzle is that ordinary lightnings involve relativistic electrons and gamma rays [F2, F1] (for the TGD view of lightnins and related phenomena see [K1, K4, K3, K5, K7]). This is impossible in standard physics due to the already mentioned electric resistance of the atmosphere. Could ball lightning involve a new phase of matter, for which the dissipation is very small. Perhaps because it interacts very weakly with the ordinary matter of the atmosphere?

6. The third mystery is that the surface of Earth carries a negative charge, which creates an electric field. This field is essential for the generation of lightning. The origin of this field is however not understood.

7. There is also a fourth problem. Dark matter exists but there is no generally accepted theory of dark matter. All experiments trying to detect proposed candidates for dark matter particles (the particle physicist's way to solve a problem is to propose a new particle) have failed. There is of course also the mystery of life but it is better to stop here.

In the sequel a TGD based model for electrosphere is deduced by using various empirical inputs and the TGD based view about dark matter and the model of quantum biology inspired by it. A model, which allows us to understand these phenomena in the TGD framework, is developed. The model relies on the TGD based model of dark matter residing at the flux tubes of the magnetic body. The gravitational magnetic bodies of both Earth and Sun are important.The notion of the electric body of Earth as an analog of the cell membrane acting as a generalized Josephson junction is developed. Lightning and ball lightning would be associated with the analog of action potential.

2 The TGD view of ball lightning and other mysteries

What could TGD say about the mysteries associated with the Earth's electrosphere?

2.1 Dark matter in the TGD Universe

TGD predicts an entire hierarchy of phases of ordinary matter behaving like dark matter (and perhaps being the dark matter) in that they have very weak direct interaction with ordinary matter. These phases reside at the magnetic body (MB).

1. The notion of MB distinguishes between Maxwellian and TGD based views about electromagnetism. The flux tubes of MB can carry monopole flux which makes them topologically stable. Ball lightning could involve a tangle of a monopole flux tube carrying plasma and thus highly stable topologically. In fact, practically all structures in the fractal Universe of TGD would involve this kind of tangles: also galaxies and stars.

2. These phases are labelled by the value of effective Planck constant $h_{eff} = nh_0$, which can be larger than $h = n_0 h_0$. The estimate for n_0 is given by $n_0 = (7!)^2$.

   The larger the value of h_{eff} the longer the spatial and temporal scales of quantum coherence are, and the lower the dissipation rate is. In particular, ohmic resistance is reduced. Also the very weak interactions with ordinary matter reduce ohmic resistance for charged dark matter particles.

   $h_{eff}/h_0 = n$ has an interpretation as the dimension of algebraic extension of rationals assignable with a polynomial defining the space-time regions at fundamental level [L1, L2]. It measures algebraic complexity and one could even speak about universal IQ. MBs with large value of h_{eff} would naturally receive information from and control the ordinary matter and represent higher levels in the master slave hierarchy of self-organizating systems.

3. The value of h_{eff} can be very large and one can assign it to the flux tubes mediating various kinds of interactions such as electromagnetic and gravitational, and even weak and color interactions.

   Gravitational Planck constant $h_{eff} = h_{gr} = GMm/v_0$ introduced originally by Nottale [E1] is associated with flux tubes of a large mass M and particle with mass m. $v_0 \leq c$ is a parameter with dimensions of velocity and can have varying values. The gravitational Compton length is given by $\Lambda_{gr} = GM/v_0$ and does not depend on m: this reflects the Equivalence Principle. Also cyclotron energies $E_c = \hbar_{gr} eB/m$ are independent of m.

   Gravitational flux tubes would play a fundamental role in the TGD based quantum gravitational view about living matter. In particular metabolic energy would be stored at gravitational magnetic flux tubes with length scales given by Earth size as energy of dark protons. The delocalization of the dark proton to the surface of Earth would reduce the magnitude of gravitational potential energy.

   This gravitational potential energy would be liberated as metabolic energy in a transition $h_{gr} \to h$ implying delocalization of dark. A correct value of metabolic energy currency is predicted [L4] if dark protons appear as triplets: ATP mechanism indeed involves proton triplets. Also a new metabolic energy quantum assignable to electron triplets is predicted and there is evidence for its necessity from the fact that cilia do not have ATP machinery but certainly need metabolic energy.

2.2 Pollack effect in cellular scales

What would drive particles, say protons, from ordinary matter to the MB and how would this be visible as properties of ordinary matter? The Pollack effect is a possible answer.

1. Pollack effect occurs in water bounded by a gel phase in presence of energy feed, for instance infrared (IR) radiation. Negatively charged regions, exclusion zones (EZs) are formed in water. They have a very high density of negative charge. As if every fourth proton of water would have left the region so that the effective stoichiometry is $H_{1.5}O$. Several exotic effects are associated with EZs.

2. EZs love cleanness and eliminate impurities from their interior. This does not conform with the second law of thermodynamics and can be seen as evidence for the reversal of the arrow of time.

3. As already noticed, the presence of gel phase and energy feed is needed to create EZs. This suggests that a primitive life form is in question. In biology both cell and DNA are basic examples of negatively charged regions which could be basically EZs.

The energies of particles indeed increase with h_{eff} as a rule as it is easy to verify by looking at some examples.

1. The TGD explanation for the Pollack effect is that the energy fed to the system increases the value of h to $h_{eff} > h$ for the protons and makes them dark particles at the magnetic flux tubes MB. If gravitational MB is in question, quantum gravitation would become a key player in quantum biology. The quantum gravitational model explains besides metabolism also bio-catalysis [L4] and allows us to understand how DNA could act as a topological quantum computer [L5].

2. The behavior of EZs suggests breaking of the second law of thermodynamics and therefore reversal of the arrow of time. In the TGD Universe the time reversal could occur in long scales at MB carrying phases with a large value of h_{eff}. The basic prediction of TGD inspired theory of quantum measurement (extending to a theory of consciousness) indeed is that the arrow of time changes in the ordinary state function reduction (SFR),"big" SFR (BSFR) as it is called in TGD. In "small" SFRs (SSFRs), which are counterparts for "weak" measurements, the arrow of time is not changed.

2.3 Pollack effect in the scale of Earth

The surface of Earth is known to be negatively charged so that Earth has an electric field.

1. The electric field strength has a nominal value $V_E = 120$ V/m and varies in the range 100-300 V/m, as one can for instance learn from the excellent lectures of Feynman (`https://cutt.ly/OHkAWFs` or from Wikipedia `https://cutt.ly/PHkACG2`).

   The number density dn/dA of unit charges e per unit area would be about $(137/4\pi)eV/m = (137/4\pi)10^8/m^2$ making one unit charge per area corresponding to the size of a large neuron about 10^{-4} m. This volume of water happens to have a mass about 1 Planck mass.

2. The field extends to the height of about $h_E = 50$ km at which height the conductivity of the atmosphere is so high that the electric field vanishes in good approximation above this height. The voltage at this height is about $V_E = 5 \times 10^5$ V. There must be a layer of positive charge concentrated at this height and neutralizing in a good approximation the positive charge so that electrosphere would contain structure analogous o a pair capacitor plates.

3. The origin of the Earth's electric field is not known but it is known to be relevant for life.

The fractality of the TGD Universe suggests that the Pollack effect can be realized also in the Earth scale. The dark part of the magnetic field of Earth involving monopole flux tubes could carry dark protons and possibly also other dark particles. This would create the electric field of Earth. One could see the biosphere as a living organism, Mother Gaia.

1. If the Pollack effect takes protons to the (gravitational) MB of Earth, Earth becomes negatively charged and creates an electric field. One dark proton per size scale of a large neuron (water blog having roughly Planck mass) would be transferred to the (gravitational) MB of Earth.

2. The energy of a unit charge received as it travels from the height of $h_E = 50$ km to the surface of Earth without ohmic resistance of 5×10^5 eV, which corresponds to electron mass. Electrons travelling from Earth upwards would gain relativistic energy in this field. Protons travelling downwards would gain the same energy. The photons radiated by accelerated electrons and protons would have gamma ray energies. This would explain the association of relativistic electrons and gamma rays to lightning.

3. Most of the screening positive dark charge should reside at the height of about $h_E \sim 50$ km. The magnetosphere of Earth has a much larger size of about $10R_E$ at the day-side of Earth. This suggests that the densities of the dark charged particles (at least protons and electrons) sum up to zero at higher heights.

   The natural option is based on the approximation that the space above h_E is a perfect conductor. In a perfect conductor the surface charge indeed prevents the penetration of the external electric field inside it.

   The dark protonic charge from hydrogen bonds and possibly also dark electronic charge would basically screen the electric charge of Earth at higher heights of order Earth radius.

4. What could the dark positive charge at the height h_E consist of? One could consider dark protons but also dark ions at the oppositely charged boundaries of the conductor. Dark ions play a key role in the TGD based view of quantum biology. They could be metal ions for which the valence electrons are gravitationally dark and at similar U-shaped vertical flux tubes as the dark protons of H bonds [L4].

Why just the height h_E?

1. p-Adic length scale hypothesis $p \simeq 2^k$ [K2] favours Mersenne primes $M_k = 2^k - 1$ (k is prime) and their Gaussian analous $M_{G,k} = (1+i)^k - 1$. Could $h_E = 50$ km correspond to Gaussian Mersenne? The answer is negative. The corresponding p-adic length scale is proportional to $\sqrt{p} \propto 2^{k/2}$. The twin pair $(k_1, k_2) = (239, 241)$ defines a pair of Gaussian Mersennes. $M_{G,151}$ corresponds to cell membrane thickness $L(151) = 10^{-8}$ m and $L(239)$ is scaled by a factor $2^{44} \simeq 1.6 \times 10^{13}$ to $L(239) \simeq 160$ km, that is $3h_E$, $h_E = .5 \times 10^5$ km.

2. The idea that Gaussian Mersennes define fundamental lengths is too beautiful an idea to be given up too easily. The ionosphere extends from 48 km to about 960 km. Thermosphere extends from 90 km to 500 km.

   Could one think of a conductor-like structure with thickness $L(241) = 320$ km with boundaries at $h_E = 50$ km and $L(241) = 320$ km extending from $h_E = 50$ km to $h_{E,1} = 410$ km and having a vanishing total charge so that above this distance Earth would look negatively charged and carry electric field, whose strength would be scaled down from its value at the surface of Earth by a factor $(R_E/(R_E + h_{E,1})^2 \sim 1$.

3. One can argue that this field would have been observed long ago so that the conducting region must extend much farther. Despite this objection, one can ask whether these layers could exist and correspond to membrane-like preferred extremals, which are minimal surfaces in $H = M^4 \times CP_2$. Note that the E^3 projection is not minimal surface but analogous to a soap bubble [L3]. Also the cell membrane would be accompanied by this kind of pair of surfaces and magnetic flux tubes would traverse it.

4. TGD predicts that any astrophysical object necessary has a non-vanishing but arbitrarily small Kähler charge, which is accompanied by electromagnetic charge. The reason is that a long range gravitational field defined by the induced metric unavoidably implies a long range Kähler electric field.

5. One can argue that this electric field would have been observed so that the conducting region must extend much farther. Despite this objection, number theoretic intuitions give the right to ask whether these layers could exist and correspond to membrane-like preferred extremals, which are minimal surfaces in $H = M^4 \times CP_2$. Note that the E^3 projection is not minimal surface but analogous to a soap bubble [L3]. Also the cell membrane would be accompanied by this kind of pair of surfaces and magnetic flux tubes would traverse it.

6. If dark ions of opposite charges (perhaps as pairs of a dark metallic ion and valence electrons) reside at the proposed layers with the distance $L(241)$, they could correspond to dark ionic matter that I have assigned with the MB of Earth. As a matter of fact, one could say that they reside in the electric body of Earth defined by the boundaries of this conductor. Could this pair define the analog of the double lipid-layered cell membrane and could the Earth

itself define the analog of a cell nucleus? DNA is negatively charged and is responsible for the negative charge of the cell nucleus and perhaps of the entire cell. What could this analogy suggest in the case of Earth?

In the TGD Universe, one can ask whether the Earth is a living organism, Mother Gaia as an analogy of a monocellular organism but in the scale of Earth.

1. The capacitor plates would define the analog of a cell membrane having membrane potential 5×10^5 eV, which is 10^7 times higher than the membrane potential $V \sim .05$ eV and corresponds to electron rest mass. Also monocellulars can exhibit action potential and lightning would be its analog. Ordinary cells form dark (generalized Josephson junctions). For them ohmic currents are replaced with oscillating Josephson currents with Josephson frequency $f_J = eV/h_{eff} \simeq m_e v_0/GMm$.

   One can also imagine a gravitational Josephson current defined by the gravitational potential of the Earth. In this case the energy scale is about eV. In the electric case it is 10^7 times higher.

2. For $M = M_E$, $v_0 = c$ and $m = m_p$ this would give $f_J \simeq 10^5$ Hz, which is not far from the cyclotron frequency of electron in the endogenous magnetic field $B_{end} = .2$ Gauss deduced from Blackman's findings [J1] and identified as the monopole flux part of the Earth's magnetic field B_E with the nominal value .5 Gauss.

3. Also solar gravitational MB is important in the model and the model of photosynthesis and ATP involves it in an essential manner [L4]. For Sun with $M_S \simeq 3 \times 10^5 M_E$, $v_0/c \simeq 2^{-11}$ and $m = m_p$, Josephson frequency would $f_J \simeq 1$ Hz. This is the average value for DNA cyclotron frequency in B_{end}, which only weakly depends on the length of the DNA strands since the nucleotides have a negative unit charge.

2.4 Models for lightning and ball lightning

The model for the ball lightning would be as follows.

1. Lightnings would involve the transfer of dark matter to the surface of Earth and they could arrive to the surface of Earth along gravitational flux tubes. Just like action potential, lightning would correspond to a local breakdown of superconductivity. Ball lightning could be born at flux tubes sy heights below h_E and generate plasmoids as primitive life forms.

2. The large value of h_{eff} and topological stability of monopole flux tubes would explain the long life time of ball lightning.

3. The self-organization of living matter would produce via the Pollack effect plasmoid-like negatively charged systems in microscales. Ball lightning could be seen as an analog of a cell. It would also have the counterpart of the cell membrane and a good guess is that its thickness is scale for .5 m sized ball lightning to .5 cm which happens to be one half of the Scwartshild radius of Earth which defines the gravitational Compton length. Whether ball lightning is negatively charged can be tested if it can be produced in a microwave oven.

2.5 Is the proposal consistent with the model of metabolism based on quantum gravitation?

One can worry about the consistency with the dark gravitational model of metabolism [L4].

1. The quantum gravitational model of metabolism gives an estimate for the height of the metabolic dark protons. If the dark protons at a U-shaped flux tube correspond to a stationary orbit in the gravitational field of Earth, the height from the Earth's surface would be about $h_g = 1.5R_E$. For proton triplets one obtains the correct value of the metabolic currency. The strong electric field near the surface of Earth would correspond to a rather short length scale as compared to this scale. The ratio $h_E/h_g \simeq 5 \times 10^{-3}$ is rather small. The gravitational potential energy difference is scaled roughly by this factor downwards so

that the protons at this height cannot liberate metabolic energy quantum as gravitational potential energy.

TGD assigns to electrons metabolic energy quantum which is by factor m_e/m_p smaller than the standard metabolic energy quantum by factor of order 1/10 smaller than the protonic gravitational energy liberated at height h_E.

Most of the screening dark positive charged would be at a height which is much smaller than the height at which the gravitational potential energy is of order .5 eV for metabolic energy currency. This is possible since the scale of MB of the Earth is about $10R_E$ at the day-side.

2. The electric field is in good approximation given as a gradient of potential and the voltage between points A and B is same alon all space-time sheets. Therefore the voltage should be the same also along the gravitational flux tubes if they connect A and B. Does this mean that gravitational dark protons coming from higher heights than 50 km receive huge energy of about electron mass m_e.

The metabolic dark protons at the gravitational flux tubes should be able to avoid this electric field: otherwise they would have energy of order m_e. How? One can imagine 4 options.

1. The proposal of [L4] is that the transformation $h_{gr} \to h$ for dark protons involves a reconnection of the gravitationally dark flux tube with flux tube having much smaller value of h_{eff} and also accompanying dark hydrogen bond. If these flux tubes extend to a height somewhat larger than $h = 50$ km, the acceleration could be avoided by reconnection and staying at this height. The gain of metabolic energy communicated to the surface of Earth by dark photons would be essentially the same. The naive estimate for the value of h_{eff} for these flux tubes would be $h_{eff}/h_{gr} \sim h_E/R_E \sim 1/100$.

2. The presence of solar gravitational MB was proposed in [L4]. In this case the gravitational Compton length would be $\Lambda_{gr} = GM_S/v_0$, $v_0 \simeq 2^{-11}$. This would correspond to the scale of 6×10^6 m, to be compared with Earth's radius $R_E = 6.4 \times 10^6$ m! Also in this case the reconnection would make it possible to avoid the acceleration in the electric field.

3. The model of genetic code also requires both dark protons and dark neutrons [L6, L4]. Dark neurons are possible if strong and weak interactions are dark and thus are not screened below the Compton length of the bosons mediating them. This means a scaling of their typical length scaled up by h_{eff}/h: for weak bosons and for h_{gr}, the scale would be GM/v_0 and about .45 cm for $M = M_E$ and and about R_E for $M = M_S$.

   The dark nucleon sequences at the flux tubes would be dark nuclei, which in the TGD based model are indeed string-like entities [K6]. Dark neutrons could propagate through the electric field without acceleration. Dark weak bosons would be effectively massless below the scaled up weak scale and this could explain chiral selection in living matter, which is very difficult to understand in the standard model.

4. If the gravitational portions of the flux tubes through the analog of the cell membrane act as Josephson junctions, the energy would not be dissipated as for Ohmic currents. There would be only a rapidly oscillating current with Josephson frequency. For the solar gravitational flux tubes the oscillation frequency would be about 1 Hz. It is not clear to me whether this could solve the problem.

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