EEG and the structure of magnetosphere

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Abstract

Roughly 15 years ago I proposed the idea that Earth's magnetosphere (MS) could serve as a sensory canvas in the sense that biological systems, in particular the vertebrate brain, could have sensory representations realized at the "personal" magnetic body (MB) closely associated with the MS of the Earth. EEG would make communications to and control by MB possible.

At that time I did not yet have the idea about number theoretical realization of the hierarchy of Planck constants $h_{eff} = nh_0$ in the framework of adelic physics fusing the physics of sensory experience and cognition. This hierarchy is crucial for understanding the basic aspects of living matter such as metabolism, coherence in long scales, correlates of cognition, and even evolution.

Also the concept of zero energy ontology (ZEO) forming now the basis of the quantum TGD was missing although there was already the about communication to past using negative energy signals. ZEO is now in a central role in the understanding of self-organization - not only the biological one. The new view about time predicting that time reversal occurs in ordinary state function reductions (SFRs) allows to understand homeostasis as self-organized quantum criticality.

For these reasons it is interesting to consider the notion of sensory canvas from the new perspective. This article discusses besides the earlier ideas about the MS also the proposal that it is possible to associate EEG bands to the regions of MS via the correspondence between EEG frequency with the distance of the region from Earth. Also the idea that the structure of MS could be a fractal analog of the vertebrate body is tested quantitatively by comparing various scales involved.

Contents

1 Introduction

Roughly 15 years ago I proposed the idea that Earth's magnetosphere could serve as a sensory canvas in the sense that biological systems, in particular the vertebrate brain, could have sensory representations realized at the "personal" magnetic body (MB) closely associated with the magnetosphere of the Earth [K6, K5]. EEG would make communications to and control by MB possible [K4, K9].

During fifteen years a considerable progress has occurred. At that time I did not have yet the idea about the number theoretical realization of hierarchy of Planck constants $h_{eff} = nh_0$ in the framework of adelic physics fusing the physics of sensory experience and cognition [L3, L4]. This hierarchy is crucial for understanding the basic aspects of living matter such as metabolism, coherence in long scales, correlates of cognition, and even evolution.

Also the concept of zero energy ontology (ZEO) [L8] forming now the basis of the quantum TGD was missing although there was already the about communication to past using negative energy signals. ZEO is now central role in the understanding of self-organization [L7] - not only the biological one. The new view about time predicting that time reversal occurs in ordinary state function reductions (SFRs) allows to understand homeostasis as self-organized quantum criticality [L21].

For these reasons it is interesting to consider the notion of sensory canvas from the new perspective.

1.1 Some basic ideas of TGD inspired quantum biology

The following list gives the basic elements of TGD inspired quantum biology.

1. Many-sheeted space-time allows the interpretation of the structures of macroscopic world around us in terms of space-time topology. Magnetic-/field body (MB) acts as intentional agent using biological body (BB) as a sensory receptor and motor instrument and controlling the BB and inheriting its hierarchical fractal structure. The quantum coherence of MB in turn induces the coherence of biomatter.

   That MB receives sensory input motivates the idea that MB serves as a kind of sensory canvas [K6, K5]. This idea generalizes: the information received can be also more abstract information and the layers of the MB could define a hierarchy of increasingly abstract representations of the sensory data [L9, L22].

   Fractal hierarchy of EEGs and its variants can be seen as communication and control tools of MB. Also collective levels of consciousness have a natural interpretation in terms of MB.

   MB makes also possible entanglement in macroscopic length scales. The braiding of magnetic flux tubes makes possible topological quantum computations and provides a universal mechanism of memory. One can also undersand the real function of various information molecules and corresponding receptors by interpreting the receptors as addresses in quantum computer memory and information molecules as ends of flux tubes which attach to these receptors to form a connection in quantum web.

2. MB carrying dark matter as $h_{eff} = nh_0 > h$ phases of the ordinary matter and forming an onion-like structure with layers characterized by large values of Planck constant is the key concept of TGD inspired view about Quantum Mind to biology.

   MB is identified as intentional agent using biological body as sensory receptor and motor instrument [K12, K11]. EEG and its fractal variants are identified as a communication and control tool of the MB and a fractal hierarchy of analogs of EEG is predicted. Living system is identified as a kind of Indra's net with biomolecules representing the nodes of the net and magnetic flux tubes connections between then.

   The reconnection of magnetic flux tubes and phase transitions changing Planck constant and therefore the lengths of the magnetic flux tubes are identified as basic mechanisms behind DNA replication and analogous processes and also behind the phase transitions associated with the gel phase in cell interior. The braiding of magnetic flux makes possible universal memory representation recording the motions of the basic units connected by flux tubes. Braiding also defines topological quantum computer programs updated continually by the flows of the basic units [K14, K13, K15]. The model of DNA as topological quantum computer is one application. In ZEO the braiding actually generalize to 2-braiding for string world sheets in 4-D space-time and brings in new elements.

3. ZEO makes possible a p-adic description of intentions and cognitions and their transformations to action. Time mirror mechanism (see **Fig.** `https://cutt.ly/DcDKyTj`) based on sending of negative energy signal to geometric past would apply to both long term memory recall, remote metabolism, and realization of intentional acting as an activity beginning in the geometric past in accordance with the findings of Libet. ZEO gives a precise content to the notion of negative energy signal in terms of zero energy state for which the arrow of geometric time is opposite to the standard one.

   The associated notion of causal diamond (CD) is essential element and assigns to elementary particles new fundamental time scales which are macroscopic: for electron the time scale is.1 seconds, the fundamental biorhythm. An essentially new element is time-like entanglement which allows to understand among other things the quantum counterparts of Boolean functions in terms of time-like entanglement in fermionic degrees of freedom.

4. The assignment of dark matter with a hierarchy of Planck constants gives rise to a hierarchy of macroscopic quantum phases making possible macroscopic and macrotemporal quantum coherence and allowing to understand evolution as a gradual increase of Planck constant.

5. One can also understand genetic code. The model for dark nucleons leads to a surprising conclusion: the states of nucleons correspond to DNA, RNA, tRNA, and amino-acids in a natural way and vertebrate genetic code as correspondence between DNA and amino-acids emerges naturally [L2, L5]. This suggests that genetic code is realized at the level of dark nuclear physics. The chemical realization would provide only a secondary representation of the code.

   The recent findings support the view that the genetic code is actually universal and realized at the fundamental level in quantum TGD. Hitherto unknown realizations in living matterare suggestive [L12]. Second realization of the genetic code would be associated with communications using dark photons. It would be in terms of dark photon triplets defining 3-chords of light and realized in terms of icosahedral and tetrahedral Hamiltomnian cycles giving rise to a set of bio-harmonies having interpretation as correlates of emotions at the molecular level [L1, L10, L12]

1.2 Some questions

MB has roles as both sensory canvas and controller of the ordinary matter with standard value $h_{eff}0nh_0 = h$ using EEG and its fractally scaled variants for these purposes. This raises some questions.

1.2.1 Could magnetosphere be a living and metabolizing organism?

h_{eff} is a measure for algebraic complexity and analogous to IQ. h_{eff} tends to be reduced spontaneously. Metabolic energy is needed to preserve the distribution of h_{eff} and also to drive self-organization.

Could one think that MB is a higher level organism utilizing energy arriving from the Sun. Could solar radiation and solar wind provide metabolic energy to the Earth's magnetosphere (MS) accompanied by "personal" MBs. Could MB also receive metabolic energy produced by photosynthesis at the surface of the Earth?

Could the rotating inner MS transfer energy from solar radiation and transfer it to the nightside of the Earth. Could also solar wind provide energy to magnetopause, plasma pause, plasma sheet and neural sheet which are self-organizing highly dynamical structures? Could these regions of the MS serve as a sensory canvas?

1.2.2 Could the anatomy of the magnetosphere be regarded as a scaled variant of the anatomy of a vertebrate?

The anatomy of the MS (see the illustrations of `https://cutt.ly/kcDKzqL`) resembles that of a vertebrate. The TGD Universe is fractal and this inspires the question whether there is something deeper behind this resemblance: could the anatomy of the MS be scaled up anatomy of the organism? This would be natural if the "big" part of the personal MB assignable to the MS serves as a sensory canvas.

The correspondence need not be a strict scaling. Conformal transformations define a more general correspondence and the correspondence respecting only topology is even more general correspondence.

Could one gain useful insights by formulating this idea quantitatively? Could the scales of the body parts of the vertebrate(say human)body and MS correspond to each other at the order of magnitude level? Could the ratios of scales for the corresponding parts of the MS and human body be nearly the same?

The sensory canvas idea is discussed earlier at the level of the brain in [**?**, K5] but restricting the consideration to the cyclotron frequencies for magnetic fields involved with various parts of the MS. The distance of the part of the MS gives an upper bound for the frequencies involved with the communications between it and the biological body. Could one associateEEG bands with the parts of the MS? The frequency scale correspondence indeed predicts frequencies in EEG range and it is possible to assign EEG bands to the parts of the MS.

2 The structure of the magnetosphere of Earth

It is interesting to try to relate the model for sensory representations to the structure of Earth's MS. To achieve this, I will provide a brief novice's overview about the structure of MS. I will use partially TGD based language in which magnetic field lines are replaced by magnetic flux tubes and the formation of the plasma corresponds to the leakage of the supra currents from the magnetic flux tubes.

I will also briefly consider TGD based qualitative models for the phenomena, many of which are not well understood in Maxwellian theory. Examples of such phenomena are Alfven waves which are not proven to result from Maxwellian theory, and magnetic dynamo of Earth whose working mechanism is not really understood. Also the mechanism of auroras becomes very concrete when field lines are replaced with flux tubes [K1].

2.1 Magnetosphere

Solar wind [F4, F8, F7] determines the large scale structure of the magnetic field of Earth to a high extent. The basic structural components are transition regions and regions between them.

1. At the bow shock the solar wind arriving at a supersonic velocity of 500 km/s encounters Earth's magnetic field and is transformed to a subsonic flow and dissipates energy inside magnetosheath where the plasma is denser and hotter than in the solar wind. The distance of the bow shock is roughly 12-14 R (R denotes Earth's radius).

2. The shocked solar wind cannot penetrate Earth's magnetic field and a cavity called MS is formed. Interplanetary magnetic field and MS is separated by a transition region called magneto-pause, which is accompanied by a plasma mantle. At the day-side magneto-pause is at a distance of about 10 R but when the solar wind is particularly strong, it can move down to 6-7 R. At the night side MS is stretched into long cylindrical magneto-tail of length about 1000 R and radius about 20 R.

MS consists of clearly separated regions with widely different densities and temperatures. The main division is into the inner and outer MSs. In the inner MS (also known as plasma sphere) magnetic field lines are co-rotating with the Earth: in the outer MS they are stationary.

Boundaries are the regions at which self-organization typically occurs.

1. Magneto-pause contains an ionic current determined by the discontinuity of the magnetic field and orthogonal to it. This region is highly dynamic.

2. The boundary between inner and outer MSs is known as plasmapause. Also this region is dynamical and its shape and size varies as response to solar wind. The analog is liquid is the boundary between two compressible liquid flows: other flow is rotating and other flow stationary.

3. Outer MS consists of a plasma sheet, which is between magnetic lobes carrying magnetic fluxes, which have opposite directions and are bounded by the magnetopause. In the plasma sheet the magnetic flux flows between the northern and southern lobes to give rise to closed field lines. Neutral sheet is in the equatorial region and starts at $10 \pm 3R_E$. Also this region is dynamic.

Both magnetopause, plasma pause and neutral sheet are expected to be highly dynamical self-organizing regions and are especially interesting from the point of view of magnetospheric consciousness.

2.2 Outer magnetosphere

2.2.1 Magnetic lobes

The outer MS at the night side, magneto-tail, consist of northern and southern magnetic lobes which are cavities having very low ionic density of about.01 ions per cubic cm. The low density can be understood as resulting from the absence of the solar wind in this region. By Maxwell's

equations the magnetic field is approximately constant in the region where the flow lines are parallel (if sources can be neglected). According to [F3] the value of the magnetic field is about 30 nT in the interior of the lobes. The relatively strong magnetic field inside lobes serves as a magnetic energy battery feeding energy to the plasma sheet.

Magneto-tail is a cylindrical structure with radius of order $R_m = 20R$. Magnetic lobes extend up to $r \sim 1000R$. The magnetic field lines remain actually closed. In the TGD framework this means the existence of a closed supra-current circuitry formed by the magnetic flux tubes.

2.2.2 Plasma sheet and magneto-pause

Magnetic lobes are separated by a plasma sheet in the equitorial plane consisting of hot (5×10^6 K), low density plasma (.3-.5 ions/cm^3 as opposed to.01 ions/cm^3 inside lobes) with magnetic field $\sim$ 10 nT. Plasma sheet extends from $8R$ to about $60R$ and has thickness of order few R, and gets thinner with increasing distance. Plasma sheet disappears at the so called neutral point, where the magnetic field vanishes. In the plasma sheet the magnetic flux from the southern lobe flows to the northern lobe. Near the Earth plasma sheet reaches the high latitude auroral ionosphere. The value of the magnetic field immediately above the magnetic sheet is 20 nT.

In the TGD framework the plasma sheet can be seen as resulting from the leakage of the supra currents from the magnetic flux tubes of Earth's magnetic field to a larger space-time sheet. This supra-current leakage would be caused by the inertia of the ions and electrons in the region where the magnetic flux tubes are highly curved. The leakage occurs also in the magneto-pause, where the tangential component of the magnetic field is discontinuous and a surface current orthogonal to B generating the discontinuity flows.

In the magneto-pause the magnetic flux tubes of the inner and outer region are parallel. The reconnection of the parallel flux tubes of the magnetic fields of Earth and Sun allows the transfer of the ions of the solar wind to the MS. Magneto-pause is accompanied by a plasma mantle, which could be partially due to the leakage of ions to a larger space-time sheet accompanying the reconnection process.

There is a convective flow of ions towards the plasma sphere along the plasma sheet. In the TGD framework this motion must take place at a larger space-time sheet or involves a hopping between magnetic flux tubes: in both cases a breaking of the propposed super-conductivity is implied.

Plasma sheet also has a boundary layer in which the tangential component of the magnetic field is discontinuous. This requires a surface current orthogonal to the axis of the sheet. This current would result as the ions from the magnetic flux tubes leak out from flux tubes to a larger space-time sheet by their inertia in the highly curved portion of the flux tube caused by the tangential discontinuity.

2.2.3 Cusps

Southern and northern cusps are funnel-shaped regions which on the day side consist of closed highly compressed flux tubes of dipole field and on the night side of almost open flux tubes stretched deep into the magnetospheric tail. In this funnel magnetic field is orthogonal to the magneto-pause and the magnetic flux tubes of the solar magnetic field can penetrate the MS. This implies that solar plasma contained in the solar magnetic field lines penetrates deeply into the magneto-tail by reconnecting with the field lines of Earth's magnetic field near poles. This gives rise to auroras [F9].

Reconnection can be seen as resulting from the penetration of the solar magnetic flux tubes at the upper boundary of the magneto-pause along the plasma sheet to highly stretched flux tubes along the boundary of the plasma sheet. The transformation to open flux tubes can happen only if the solar flux tubes reconnect with the flux tubes of the solar magnetic field penetrated into the plasma sphere. Thus auroras can be seen as a phenomenon involved with the boundary between plasma sheet and lobes.

Cusps, and to some extent also plasma mantle, serve as a channel along which the solar wind feeds "magnetometabolic" energy to the MS needed to run the geodynamo system [F1] (the notion of super-conducting geodynamo will be introduced later). The dipole field generated solely by the convective currents in Earth interior would die out in a few thousands of years. The field

inside lobes serves as a storage of magnetic energy and is recharged by the energy of the solar ions leaking into the magnetic tail in the reconnection process. One could see the cusps also as a communication channel between solar and Earth's magnetic structures, kind of magnetic "ears" of magnetic Mother Gaia.

2.3 Basic structure of the inner magnetosphere

Inner MS is a toruslike structure whose extension varies between 4R (day side) and 8R (night side). In the inner MS the typical density is about 1 ion per cubic centimeter.

Inner MS is bounded by a transition layer of thickness of $\sim R$ (magneto-pause). In this region the density of the ions drops rapidly.

Inner MS contains plasma sphere whose radius varies in the range 2R-4R at day side and 2R-6R at night side. Plasma has an ionospheric origin. The density of the cold plasma consisting mainly of protons ($T \sim 1$ eV) sphere varies in the range $10 - 10^3$ ions/cm^3, whereas the temperature is $\sim 5 \times 10^3$ K. The cold, dense plasma of the plasma sphere is frozen around magnetic flux lines which co-rotate with Earth.

In the TGD framework this means that flux tubes co-rotate and thus change shape. In the equatorial plane the density of the plasma sphere drops sharply down to ~ 1 ions/cm^3 at $r = 4R$. This transition region is known as a plasma pause. During magnetic storms the outer radius decreases since the pressure of the solar wind compresses the plasma sphere. The day-night variation of the shape of the plasma sphere is rather small. Within this region the magnetic field in a reasonable approximation has dipole shape with radiation belts forming an exception.

2.4 Radiation belts and ring currents

Plasma sphere (i.e. inner magnetosphere) contains the inner and outer van Allen radiation belts [F2] (extending from $2R$ to $4R$ at the day side and from $2R$ to $9R$ at the night side).Inner radiation belt extends from distance $.2R_E$ to $2R_E$. Outer radiation belt extends from distance $3R_E$ to $10R_E$ and is regarded as part of non-rotating outer MS. Both the inner and outer belts extend up to latitude of 60 degrees. The boundaries of the belts follow magnetic field lines except at the Northern and Southern tips. This region contains ring currents.

One of the functions of the radiation belts is to prevent the penetration of the biologically harmful high energy cosmic rays to the ionosphere. In fact, the inner protonic belt results from the decay of the cosmic ray neutrons to protons. Second function (in TGD universe!) is to act as a part of a controlled dynamo system giving rise to the MS of Earth (for the standard theory of geodynamo see [F1]).

It has been found that the energies of the ions in the radiation belts are much higher than one might expect [F5]. This might be understood if part of the ions runs as supra currents along the magnetic flux tubes. Super-conductivity is broken only by the leakage of the supra currents from the magnetic flux tubes. This could explain the success of magnetohydrodynamics based on the assumption of effective super conductivity.

2.4.1 Inner radiation belts

There are actually two separate inner radiation belts: the one containing protons and the one containing electrons. Protons in the inner belt have energies at 10-100 MeV range and readily penetrate space crafts. The inner radiation belts are concentrated around the equator in the range $(1.1 - -3.3)R$ (these numbers depend on the conventions used and should not be taken too literally). In the protonic belt the maximum of the flux density is at $2R$: in the electronic belt the maximum flux density is at about $1.4R$. The inner belts are relatively stable and there is no night-day difference. The inner belts feel magnetic storms and vary with the 11 year period of solar activity.

What is interesting is that the inner belts are also sensitive to human technology. The inner belt has lowered above the East Coast of US from 300 km to 10 km [J1]: this process is associated with power transmission along magnetic field line and the usage of the ionosphere-resonance frequency 60 Hz as the frequency of household current.

During the last decade two new belts have formed inside inner belts [F4], [J1]. The new electronic belt has maximum electron flux at $r \sim 2R$ (earlier flux maximum was at $r \sim 1.4R$). The second newcomer consists mostly of O^+ ions but contains also He^+. This process has been seen as a part of magnetic re-self-organization process occurring in the scale of the entire helio-magnetosphere implying rapid changes of planetary MSs [J1].

2.4.2 Outer radiation belt

Outer belt contains mainly electrons with energies up to 10 MeV and is produced by the injection of charged particles during geomagnetic storms. This makes the outer belt much more dynamical than the inner one. The cross section of the outer radiation belt is banana shaped. The outer belt ranges from 3R to 6R (at night side). The maximum for the density of electrons above MeV energy occurs at 4R.

2.4.3 Ring currents

Radiation belts contain ring currents. Electronic ring current rotates in the same direction as Earth whereas protonic current runs to the opposite direction. In the outer belt only electronic current is present. Quiet time ring current in the inner electronic *resp.* protonic belts consist mainly of hydrogen ions resp. electrons but during magnetic storms also O^+ ions are present (note however the presence of the new O^+ belt). Ring current has the effect that the magnetic field gets stronger at the outer side of a given belt and weaker at the inner side.

3 Frequency scales associated with the magnetosphere

3.1 Cyclotron frequencies in magnetic lobes and plasma sheet

The values of important magnetic transitions frequencies in various regions of the MS are crucial if one wants to construct a general vision about sensory and motor representations at the magnetic sensory canvas. In the inner MS dipole approximation allows to estimate the spatial dependence magnetic transition frequencies.

In magnetosheath and magnetolobes the average values of the magnetic field are 10 nT and 30 nT respectively. Immediately above the magnetosheath the value of the magnetic field is 20 nT. Magnetosheath could thus allow place coding by the magnetic transition frequency scale whereas magnetolobes are not taylor made for this purpose. Note that the thickness of the magnetic flux tubes in the field of 10 nT $= 2^{-9}B_E$, $B_E = 5 \times 10^4$ nT is from the quantization of magnetic flux equal to about 55 μm and thus corresponds to a biological length scale. This length scale corresponds to the p-adic length scale $L(11, 16)$ ($L_p(n) = p^{(n-1)/2}L_p$). Already this encourages to think that plasma sheet might be involved with bio-control.

The strength of the interplanetary magnetic field depends on the intensity of solar wind and varies between $.2 - 80$ nT and has average of 6 nT. Interestingly, the maximum value 80 nT corresponds to the p-adic length scale $L(173) = 20$ μm.

1. Proton

In the case of proton there are three especially interesting frequencies to be considered: cyclotron frequency $f_c = eB/2\pi m_p$, spin flip frequency and the frequency of combined spin flip and $\Delta n = 1$ transitions. The frequencies of these transitions in magnetic field of $.5 \times 10^{-4}$ T are $f_c = 300$ Hz, $f_{flip} = 838$ Hz, $f_1 = 532$ Hz and $f_2 = 1138$ Hz. In a field of 10 nT the values of the transition periods $T = 1/f$ are $T_c = 16.7$ sec, $T_{flip} = 6$ sec, $\tau_1 = 9.3$ sec, and $\tau_2 = 4.4$ sec. For a field of 30 nT the values are obtained by dividing by three. Plasma sheet contains also He^{++} and He^+ ions and for these the cyclotron times are 2τ and 4τ. For O^+ ion which is also present cyclotron time varies between 1 min 20 s and 4 minutes. All these time scales are typical time scales of human consciousness. For the interplanetary magnetic field protonic cyclotron times are 13.9 min, 27.8 sec, and 2.1 sec for the minimum, average, and maximum respectively.

2. Electron

For electrons the cyclotron frequency is 282 Hz for 10 nT so that electronic cyclotron transitions cannot represent ionic cyclotron transitions in brain (if they occur at the flux tubes of Earth's magnetic field!). Spin flip combined with cyclotron transition represents however an important exception. In this case the non-vanishing transition frequency is due to the anomalous magnetic moment of electron and the frequency in the reference field of $.5 \times 10^{-4}$ T is 2255 Hz. This gives $T(e) = 2.24$ sec. Note that also $n = 3$ protonic cyclotron transition gives rise to nearly the same period.

It is interesting to notice that these time scales are important time scales of human consciousness and that both protonic spin flip time scale and $T(e)$ nearly half of the 5 second time scale associated with the Comorosan effect [I5, I2] discussed in [K10]. If Earth's magnetic field is accompanied by dark flux sheets in entire MS carrying field $B_{end} = 2B_E/5$, then the value of $T(e)$ would become $T(e) = 5$ seconds for $B_E = 11.2$ nT.

To sum up:

1. The average magnetic field in plasma sheet corresponds to a definite p-adic length scale.

2. The mysterious time scale of the Comorosan effect pops up as a basic magnetic transition time in magnetic lobes and plasma sheet and is related to bio-control by enhancing catalytic rates: it is however essential that the "dark" counterpart $B_{end} = 2B_E/5$ of B_E associated with living matter is in question.

3. Plasma sheet is found to be a complex self-organizing system with the velocity distribution of ions representing complex features (such as "eyes" and "wings" !) [F6].

These findings force to seriously consider the possibility that plasma sheet and magneto-pause and perhaps even magnetic lobes might perform high level bio-control utilizing MEs and supra-currents along magnetic flux tubes forming the extension of the endogenous magnetic circulation to the entire MS.

3.2 Estimates for the natural frequency scales assignable to various parts of the magnetosphere

The part of MS having distance R from the center of Earth corresponds naturally to frequency scale $f = 1/R$. This allows a rough estimate for the frequencies needed for the communications between various parts of MS. What is highly non-trivial is that these scales are in EEG range and that one can even assign EEG bands to the regions of MS.

The basic correspondence is given by the formula $f = 1/R$: favored frequencies are harmonics of this fundamental frequency. Takin the Schuman resonance frequency 7.8 Hz as reference and Earth radius as length unit, one has

$$\frac{f}{Hz} = \frac{R_E}{R} \times 2\pi \times 7.8 = \frac{R_E}{R} \times 49$$

Table 1 summarizes the frequency scales assignable to the size scales of various regions of the MS.

Some remarks are in order.

1. Plasmapause corresponds to frequency range 10-12.5 Hz containing alpha band and also frequencies often included in theta band.

2. Neutral sheet corresponds to the range 3.8-7.0 Hz above delta band.

3. The outer van Allen belt corresponds to delta band in EEG. Therefore also the delta band of EEG dominating during deep sleep appears naturally also at the day-side. Note that outer van Allen belt belongs to the non-rotating outer magnetosphere.

4. Night-side magnetopause and plasma sheet contain frequencies in delta band which dominates during deep sleep.

Region	R/R_E range	f/Hz range	EEG bands
plasma sheath	...-1000	...-0.049 (20 s)	
inner MS	1-10	49.0-4.9	$\theta, \alpha, \beta, \gamma$
plasmapause	4.0-5.0	12.5-10.0	θ, α
inner van Allen belt	.2-2.0	75.0-7.5	θ, β, γ
outer van Allen belt	3.0-10.0	5.1-1.5	δ
day-side magnetopause	8.0-10.0	6.25-4.9	θ
night-side magnetopause	10.0-200.0	4.9-.2 (5 s)	δ
plasma sheet	10.0-60.0	4.9-.82	δ
neutral sheet	7.0-13.0	7.0-3.8	δ

Table 1: The frequency scales f assignable to the size scales R of various regions of the MS (MS)

5. The lower bound for frequencies from the size of magnetopause at night-side corresponds to the period 5 s assignable to the Comorosan effect [I5, I2] [K10].

6. Day-side regions of the MS correspond to θ, α, β and γ bands.

These findings encourage to ask whether the communications between the brain (and possibly also other parts of body, at least central nervous system) and MS could be in terms of EEG.

3.3 Could one regard magnetosphere as a scaled variant of biological body?

Sensory canvas hypothesis allows two options. MS could be the sensory canvas for the brain or for the entire nervous system and body. The structure of the MS suggests that it could correspond to a sensory map of the entire body.

1. Inner MS could be the sensory canvas for the brain or part of it and Earth perhaps to some nucleus, say pineal gland.

2. Magnetopause would correspond to skin and magnetic lobes would correspond to to the interior of the body. Plasma sheet would correspond to the interior of the body and the neutral sheet at which the direction of magnetic field changes to the spine.

3. Left and right body parts would correspond to northern and southern magnetic lobes.

4. The inner MS could correspond to the part of the nervous system assignable to the head and neck and involve cranial nerves associated with vision, hearing, and smell. Outer MS could correspond to tactile senses.

5. The neutral sheet at the night side of the outer MS could correspond to the spinal cord, which has dorsal and ventral parts which could correspond to flux tubes with opposite fluxes.

6. Plasma sheet would contain the spinal nerves leading to the magnetopause as the counterpart of the skin.

The frequency-distance correspondence suggests a rather detailed correspondence between EEG bands and magnetospheric regions. Delta band dominating during deep sleep should correspond to the magnetopause, plasma sheet, and neutral sheet.

A quantitative formulation for this hypothesis is in terms of fractality. The scales of the body and corresponding parts of the MS should be in constant proportion and the ratios of the corresponding scales should be the same for body and MS.

Magnetopause has thickness $D \simeq 1000$ km. Magnetopause corresponds to skin and the first guess is that the ratio of smallest and largest length $L = 200R_E$ associated with the MS has same value as the corresponding ratio for human body. One has $D/L = 1340$. The ratio the human

Region	$y = R/R_E$ r	r
Earth	1.0	3.5 mm
plasmapause	4.0-5.0	1.4-1.7 cm
inner van Allen belt	0.2-2.0	.84-7.4 mm
outer van Allen belt	3.0-10.0	1.3-4.2 cm
day-side magnetopause	8.0-10.0	2.8-3.6 cm
night-side magnetopause	10.0-200.0	3.6-80.0 cm
plasma sheet length	10.0-60.0	3.6 cm-21.5 cm
plasma sheet thickness	5.0-10.0	1.8 cm-3.6 cm
neutral sheet	7.0-13.0	2.4-4.6 cm

Table 2: The scaled down radii $r = .5 \times 10^{-9} R = y \times 3.5$ mm for various regions of the MS (MS) with radius $R = yR_E$

body length $l \sim 1$ m of the human skin thickness $d \simeq .5$ mm is $l/d = 2 \times 10^3$. The order of magnitude is same. $D/L = 2 \times 10^3$ would give a perfect fit.

$R_E = 6.37D$ and the ratio $x = d/D = .5 \times 10^{-9}$ allows to scale down various scales $L = yR_E = 6.37yD$ of MS to $xL = y \times 3.5$ mm to see whether they are consistent with the corresponding scales of body suggested by the above intuitive considerations.

Table 2 summarizes the scaled down length scales for various regions of the MS.

Using these scaled down estimates one can try to identify the correspondence between body parts of human body and parts of MS.

1. Pineal gland has radius 3.7 mm which is not far from the size scales 3.5 cm assigned to Earth.

2. Most scales correspond to the scales of brain nuclei which have diameter of 5 cm. Apart from pineal gland these structures of MS are expected to appear as pairs associated with Northern and Souther magnetic lobes.

3. Night-time magnetopause would correspond to a structure with radius .76 m and could correspond to the entire body. Plasma sheet corresponds to size scales in the range $3.6 - 21.5$ cm, perhaps the upper limit corresponds to brain size scale.

One can also ask whether the length scales of DNA and proteins, cell membrane thickness, size scale of cell nucleus, and the range of size scales for cells and neurons could have counterparts at the level of MS and whether one might identify possible candidates for the counterparts for these structures.

Given the size scale d of the molecular or cellular structure the scaled up system should have size scale $R = .29 \times 10^9 d$. System with size 1 nm - roughly the size scale of the DNA codon - corresponds to a system with a size scale 29 cm not far from the size of the brain hemisphere. DNA letter with size scale .33 nm corresponds to scale 9-7 cm. Could the interpretation of the counterpart of the DNA codon as brain hemisphere make sense? Could the brain consisting of three parts be seen as a counterpart of the genetic codon with 3 letters?

The assignment of genetic codon with the brain does not seem to make sense but here an old idea about a hierarchy of codes is suggestive. Ordinary genetic code would correspond to Mersenne prime $M_7 = 2^7 - 1$ and have 2^6 codons. Memetic code assignable to Mersenne prime $M_{M_7} = M_{127} = 2^{127} - 1$ would have 2^{126} codons representable also as sequences of 21 ordinary genetic codons. One could say that one has an abstraction hierarchy in which genetic code corresponds to 64 statements and memetic codons to statements about these statements.

Individual brains do not certainly give rise to analogs of DNA sequences. Here however the notion of magnetic body (MB) providing an abstracted representation of the brain and the biological body is suggestive. The images of neurons at MB near to each other at MB need not be near to each other at the brain level: it is enough that they are functionally similar. This would realize the analog of RAM.

Pietch [J2] found that the shuffling of the neurons of the salamander brain does not lead to the loss of its functionality. This supports the view about the brain as an analog ofRAM.

Region	d	R
DNA codon	1.0 nm	29 cm
lipid layer cell membrane	2.5-5.0 nm	.73-1.45 m
tubulin	10.0 nm	2.9 m
cell nucleus	1.0 μm	290 m
cell	2.5-25.0 μm	.73-7.3 km
neuron	2.5-100.0 μm	.73-29.2 km

Table 3: The scaled up size scales $R = .29 \times 10^9 d = y \times 29$ cm for basic biomolecules, cells, and neurons with size scale $d = y$ nm

In an analogous way human and perhaps also other than human brains could serve as analogs for the codons of memetic code mapped to the MB to form linear or even higher-dimensional analogs of the genome. Cultural evolution could mean the emergence of the memetic code.

One can also consider other size scales. **Table 3** summarizes the scaled up size scales for basic biomolecules, cells, and neurons.
From the table one finds that the lipids of the lipid layers of cell membrane still correspond to human size scales. This inspires the crazy idea that perhaps humans and possibly other higher animals correspond at the level of MB to analogs of lipids for cell membrane like structures. Larger structures - such as cell and neuron - could correspond to social structures reponsible for collective consciousness generated in the cultural evolution.

4 The model for h_{eff} preserving communications based on variable value of β_0

Nottale's gravitational Planck constant $\hbar_{gr} = GMm/v_0$ contains the velocity parameter v_0 as the only parameter. In the perturbative expansion of the scattering amplitudes $\beta_0 = v_0/c$ appears in the role of fine structure constant.

There is however a problem.

1. The model for the effects of ELF radiation on vertebrate brain inspired by a generalization of Nottale's hypothesis by replacing the total mass M in the case of Earth by $M_D \simeq 10^{-4} M_E$ suggests that in this case the dark particles involved couple only to a part of mass identifiable as dark mass M_D.

2. Since only GM appears in the basic formulas, the alternative option is that the value of G is reduced to G_D. This conforms with the fact that in the TGD framework CP_2 length is the fundamental parameter G is a prediction of the theory and therefore can vary.

3. A further option is that the parameter $\beta_0 = v_0/c \leq 1$ is variable and equals to $\beta_0 = 1$ or to a value not much smaller than 1, say $\beta_0 = 1/2$.

These three options are discussed in [L13]. The cautious conclusion is that the third option is the most plausible one. In the sequel I will develop a model for the communications between dark matter phases with $h_{eff} = nh_0$ satisfying $h_{eff} = h_{gr}$ based on the third option. One can consider two options for the communications depending on whether the value of h_{eff} changes as (for instance) in the communications between dark and ordinary matter or whether it is preserved.

1. If the value of h_{eff} can change, energy conservation for $E = h_{eff} f$ allows energy resonance whereas the frequency changes. The simplest option is that the dark photon transforms to say ordinary photon with the same amplitude

2. If the value h_{eff} is preserved, one has both energy and frequency resonance. In the case of cyclotron radiation, the simultaneous occurrence of energy and frequency resonances poses strong conditions on the values of the magnetic fields, the values of charged particle masses, and the parameter β_0 at the ends of the communication line.

4.1 Conditions for frequency - and energy resonance

The condition that the frequency is the same at both ends implies for cyclotron frequencies $f_c = ZeB/2\pi m$ the condition

$$\frac{Z_1 B_1}{m_1} = \frac{Z_2 B_2}{m_2} \quad . \tag{4.1}$$

For $h_{eff} = h_{gr}$ the condition that the cyclotron energy $E_c = GMZeB/v_0$ at both ends is same implies

$$\frac{Z_1 B_1}{v_{0,1}} = \frac{Z_2 B_2}{v_{0,2}} \quad . \tag{4.2}$$

Together these conditions give

$$\frac{m_1}{m_2} = \frac{Z_1 B_1}{Z_2 B_2} = \frac{\beta_{0,1}}{\beta_{0,2}} \quad . \tag{4.3}$$

For instance, if the two particles are proton and electron, one obtains

$$\frac{\beta_{0,1}}{\beta_{0,2}} \simeq \frac{m_e}{m_p} \quad .$$

This ratio is is consistent with the values $\beta_{0,2} = 1$ and $\beta_{0,1} = 2^{-11}$ in the accuracy considered. Is this a mere accident?

4.2 Resonance conditions for communications from the Earth's surface to the magnetosphere?

The simplest option is that the interacting particles have the same values of mass and β_0 and magnetic fields are identical. This is achieved if the flux tubes have constant thickness. Whether this is the case is not clear.

However, the idea that the flux tube picture about magnetic fields is locally consistent with the Maxwellian view inspires the question whether also the magnetic field strength at the flux tubes of B_{end} behaves like $B_{end} \propto 1/r^3$ as B_E in dipole approximation behaves.

B_{end} is by flux conservation proportional to $1/S$, where S is the area of the flux tube. sOne would have $S \propto r^3$. The constancy of B_{end}/m would suggest $m \propto 1/r^3$. If the charged particles are ions characterized by the A/Z ratio.

This would suggest that the regions of tubes/sheets in frequency resonance are at distances

$$\frac{r}{r_0} = (\frac{Z}{Z_0})^{-1/3} (\frac{A_0}{A})^{-1/3}$$

for ions Z_0, A_0 at the surface of the Earth. The heaviest ions would be nearest to the surface of Earth. Energy resonance condition

$$B_{end}(r)/\beta_{0,2} = B_{end}(R_E)/v_{0,1}$$

would give the additional condition

$$\frac{\beta_{0,2}}{\beta_{0,1}} = (\frac{R_E}{r})^3 = \frac{Z}{Z_0} \times \frac{A_0}{A} \quad .$$

β_0 would be quantized and would decrease with the distance.

4.3 Magnetosphere as sensory canvas

TGD leads to a model of the "personal" magnetic body (MB) as being associated with the Earth's MS. Different regions of the body and brain would be mapped to regions of the MS, which would give rise to sensory representations at the personal MB [K6, K5]. Personal MB, which would have size scale of at least of the Earth's MS, would also control biological body.

1. An interesting finding relates to the values of the magnetic field $B_{end} \simeq 2B_E/5$ (perhaps identifiable as the monopole flux part of B_E) and the value of $B \sim 10$ nT in the magnetotail at the night-side of the Earth.

   One has $B/B_{end} \sim 2^{-11}$ so that for dark proton-dark electron communications between the Earth's surface and this region of outer MS the resonance conditions would be satisfied for $\beta_0 = x$ and $\beta_0 = 2^{-11}x$, where $x < 1$ not far from unity.

2. Could the parameter β_0 characterize particles and act as a tunable control parameter allowing to achieve energy resonance? Also the values of B are tunable by changing the thickness of the flux tubes as a kind of motor action of MB.

This idea can be applied to the h_{eff} preserving communications between biological body and the MS of the Earth.

1. The quantum coherence condition suggests that the communications are optimal when the wavelength of dark photon is larger than the distance considered: $\lambda > r$ or equivalently the frequency satisfies $f \leq c/r$ (one has $c = 1$ in the units used). If the structure of the MS has distances from the Earth's surface below r_{max} then the frequencies $f \leq 1/r_{max}$ are optimal.

2. Given the distance r_{max} and assuming $B = B_{end}$ at the surface of Earth, one obtains for the cyclotron frequencies the condition

$$f_c = \frac{ZeB_{end}}{2\pi m} \leq \frac{1}{r_{max}} \quad .$$

   For instance, EEG frequency 10 Hz corresponds to 3×10^7 m. The cyclotron frequency of DNA sequence does not depend on its length and composition since DNA has constant charge per unit length. One has $f_c \simeq 1$ Hz so that the corresponding distance is $r = 3 \times 10^8$ m, that is $r = 46.9R_E$.

   Remark: B_{end} probably has a spectrum. Music experiences relies on frequency scale and if the audible frequencies correspond to cyclotron frequencies then eB_{end}/m is variable. This suggests that the spectrum of B_{end} covers at least the range of the audible frequencies spanning roughly 10 octaves [K7].

5 Further observations making bells ringing

There are direct observations suggesting that magnetosphere at the level of MB could be a quantum coherent system.

5.1 Magnetosphere as self-organizing system

ZEO is now in a central role in the understanding of self-organization [L7]. The new view about time predicts that time reversal occurs in ordinary ("big"") state function reductions (BSFRs) occurring for dark matter at MB whose quantum coherence controls ordinary matter. This has several implications.

1. Dissipative processes occurring in reversed time direction looks like self-organization in the standard time direction. The dissipation of the time reversed system looks like extraction of energy from the environment - an active gain of metabolic energy.

2. Quantum criticality has a description in terms of quantum fluctuations with $h_{eff} > h$ and homeostasis can be understood as self-organized quantum criticality. Dissipation makes possible for the system to stay near criticality contrary to what criticality means by definition.

3. A further implication is that BSFRs look in all scales for an observer with standard time direction like time averages of classical deterministic time evolutions leading to the final 3-D state of BSFR and associated with the final zero energy state. Hence the Universe looks classical in ZEO and the question about the scale in which quantum behavior transforms to classical becomes obsolete. The findings of Minev *et al* [L6] support this picture [L6].

The view that MS is a self-organizing system is supported by the observations accumulated about the magnetic self-organization of the solar system during the last decades reviewed in [J1]. According to this report we are living a period of transition basically due to a penetration of highly charged material from the interstellar space into the interplanetary space from an interstellar plasma structure containing various kinds of magnetic structures.

This energy feed is inducing various kinds of processes affecting not only the atmo-, iono-, and MSs of Earth but also solar and other planetary MSs. Also interplanetary transmitting properties are affected. The Schumacher-Levy comet, which for few years ago collided with Jupiter and among other things a induced plasmoid train and had dramatic effects on Jupiter's MS, is referred to as a "Comet" SL-9 in [J1]. I am not sure whether "Comet" was meant to suggest that SL-9 was actually a plasma magnetic structure from the interstellar space. There is also evidence that we are moving to a similar temperature instability that occurred about 10.000 years ago and which might have initiated the development of the bicameral society in turn leading to the modern society much later.

This process could be also seen as a re-self-organization and evolution of consciousness in solar length scale as a reaction to the encounter of heliospheric and interstellar magnetic intelligences. The penetration of interstellar plasmoid like structures to the interplanetary space through the solar magneto-pause could be interpreted as a failure of the magneto-immune system of the helio- MS. The interaction of the planetary MSs with these intelligent (benevolent?) plasmoid like structures would in turn induce the re-self-organization. Needless to say, the interaction of the two intelligences might have far-reaching consequences for the evolution of ordinary life.

5.2 Connection with the Comorosan effect

Comorosan effect means that the irradiation of living manner by visible light over a period which is a multiple of $\tau_C = 5$ seconds implies enhanced catalytic activity [I5, I2]. According to private communication, this effect is not restricted to living or even organic matter. TGD explains the effect [K10] but the deeper explanation of the time scale of $\tau_C = 5$ seconds has remained a longstanding challenge.

The 5 second time scale associated with Comorosan effect is the spin flip time scale associated with proton's $\Delta n = 1$ cyclotron transition in the field of $B_{end} = 13.32$ nT (which could correspond to the value of $B_E = 5B_{end}/2 = 33.3$ nT in magnetic lobes). τ_C is also associated with proton's $\Delta n = 3$ cyclotron transition and the electronic cyclotron spin flip in the field of $B_{end} = 2/5B_E = 11.2$ nT (plasma sheet). Lungs contain magnetic particles giving rise to ~ 10 nT magnetic field and thus for $B_{end} = 2B_E/5$ to $n = 3$ protonic cyclotron transitions and electronic cyclotron spin flips in 5.5 second scale, which is very near to τ_C. Perhaps the Comorosan effect is used by the outer MS to affect the behavior of living matter and lungs are involved with this process.

5.3 Plasma sheet as a "microchip"

Plasma sheet should be a seat for magnetospheric sensory representations in theta and delta bands and among other things provide a model of magnetospheric self. If the plasma sheet has this kind of role, it should manifest itself in its properties. The plasma sheet should be self-organizing, complex structure rather than a system near thermal equilibrium. In the TGD framework, the plasma sheet could also perform bio-control.

There is a fascinating finding about the "memory chip" character of the organization of the ionic velocity distribution in the plasma sheet [F6]. The belief was that the distribution is a Maxwellian thermal distribution but a complex organization of the number of ions as a function of

speed and direction relative to the direction of the local magnetic field has been detected [F6]. By coloring the bins representing small volumes of the velocity space, one finds that 3-dimensional features like "eyes" and "wings" appear! The proposed interpretation is that these features code for the history of ionic currents.

One cannot exclude the possibility that these ionic currents could reflect even our sensory experiences. The prediction is that also other transition regions (in particular magneto-pause) should exhibit similar complex self-organization patterns. The simplest possibility is that the velocity patterns of ordinary electrons reflect the underlying pattern of dark matter at the dark magnetic flux tubes forming perhaps some kind of sensory representations.

6 Pollack effect, lightnings and ball lightnings

Ball lightning (see this) is a phenomenon challenging the standard physics. Years ago I wrote about ball lightning and identifying it as a plasmoid, a kind of a primitive life form analogous to a cell. When I learned from the experimental and theoretical work done during this millennium and decided to sharpen my views.

The analogs of ball lighting can be produced in laboratories in strong electric fields using an electric discharge from carbon electron to silicon wafer [**?**]. Pure silicon is very rare in nature and appears in the forms of Si oxides, silicates, in particular SiO_2 (see this). Quartz crystals and glass consist of silicon dioxide. In the experiment involving a silicon wafer the globules are divided into two groups: those having sizes in the range .2-.8 mm (high voltages) and .8-1.4 mm (low voltages). The sizes of ball lightning vary from a few millimeters to about 100 cm.

In DC voltage, the wafer decomposes to globules of various sizes. They can last as long as 6-8 second unlike sparks. The proposed explanation is that the globles are evaporated Si. Larger globules have at their surface silicate oxide assumed to be formed in the interaction with air. Larger balls have tube-like extrusions and smaller balls at their surface. They can also rotate and bounce: the energy should come from their decay as an exogenic process. There is evidence for the self-propulsion which brings in mind the motion of bacteria using cilia [**?**].

Leo Vuyk has an article about these ball lightning-like objects containing a large number of illustrations (see this).

The theoretical proposal is that ball lightning [**?**] (see this) is formed as the lightning strikes on the soil and SiO_2 crystals evaporate and transform to Si and Oxygen. There is support for this from direct observations of the spectrum of ball lightning containing spectral lines assignable to the elements in the soil. The spectra associated with ordinary lightning do not contain similar lines. How the chemical reaction producing Si and O_2 ions from SiO_2 ions could take place is far from clear. A lot of energy is needed for this process to occur. Where does this energy come from?

There is also the so-called microwave theory of ball lightning. Microwave wavelengths vary in the range of 1 mm-30 cm as also the sizes of ball lightning. The ball lightning would correspond to microwave cavities with a dynamical size and shape.

In the sequel a TGD inspired model for the ball lightning-like structures in silicon and for the real ball lightnings is developed relying on the TGD view of space-time predicting fractality and inspiring the hypothesis that biosphere could be regarded as a system analogous to neuronal membrane and that lightnings could be analogous to nerve pulses, the identification of dark matter as phases with non-standard value of Planck constant allowing quantum coherence in arbitrarily long scales, the TGD view of quantum gravitation and its role in quantum biology [L15, L14], and the TGD inspired model of nerve pulse [L20].

6.1 TGD view of lightnings

The background for the TGD based model of lightnings and ball lightnings is provided by the TGD view of magnetosphere [K6, K5] [L11] that I have developed during the last decades. The magnetic bodies (MBs) of living systems and even the MB of the biosphere would be controlling agents. These MBs are predicted to have a hierarchical onion-like structure [L18, L19] (monopole flux tubes inside monopole flux tubes). They would carry dark matter as phases of the ordinary matter labelled by the value of effective Planck constant having a number theoretic interpretation.

EEEG and its possibly existing scaled variants would make possible the communications to and control by these MBs.

The TGD based view of ball lightning relies on the fractality of the TGD Universe suggesting fractality also at the level of the biosphere. This inspires the notion of the biosphere as an analog of the cell membrane. The TGD view of nerve pulse [K8] and its up-to-date version [L20] inspire the idea that lightning is a scaled up variant of nerve pulse.

6.1.1 Biosphere as analog of neuron

The fractality of the TGD Universe inspires the idea that the Earth ground-atmosphere pair as an analog of neuronal interior-exterior membrane. The background for this discusses is formed by the TGD view of magnetosphere [K6, K5] [L11]. The magnetic bodies (MBs) of living systems and even the MB of biosphere would be controlling agents. Tbese MBs would have a hierarchical onion-like structure [L18, L19].

1. The Earth ground-atmosphere pair is analogous to the cell interior-cell exterior pair. The surface of the Earth is negatively charged and analogous to the cell interior. This negative charge creates an electric field of strength 100-300 V/m (see this). The height h for the clouds varies in the range .5-16 km. For a cloud at height of 10 km this corresponds to an electrostatic energy $.1 - .3$ MeV and for h=16 km one has .48 MeV. In the case of electrons with rest mass of .5 MeV, these energies are relativistic and could relate to the observed relativistic energies associated with the lightning.

2. The thunder cloud (see) has a positive charge near the top of the cloud and negative charge in the middle to lower part of the thunder cloud. At bottom there is a small positive charge known to be important. The negative charge of the cloud repels the negative charge at ground so that ground becomes positively charged below the cloud. Does this induce a local depolarization of the ground-cloud system as the analog of cell membrane?

   This raises an objection against the idea that dark protons are at gravitational monopole flux tubes and that their energies are of the order of the gravitational binding energy in the gravitational field of Earth of order .5 eV. If dark protons experience the Coulombic force of Earth, their Coulomb energies are in the range .8-2.4 MeV below the ionosphere at height $h_I = 80$ km, which defines the minimum height of the lower boundary of the ionosphere. The problem disappears since the dark protons at monopole flux tubes are at much larger heights, where the electric field of the Earth vanishes. However, the dark matter at parts of the MB at heights smaller than h_I the electric energy dominates and their role in biology should be very different.

3. Neuronal membrane is hyperpolarized and the nerve pulse is initiated when depolarization takes the membrane potential below a critical value. Could lightning be seen as an analog of nerve pulse induced when cloud-ground depolarization takes place? Thunder storm would be analogous to a conduction of a nerve pulse pattern.

6.1.2 TGD view of nerve pulse

The TGD based model of nerve pulse [L20] relies on the Pollack effect inducing a charge separation between cell interior/exterior and its MB.

1. Pollack effect [I3, I1, I6, I4] occurs in water in the presence of a gel phase. Also energy feed is required and in standard Pollack effect solar radiation provides it. The Pollack effect generates what Pollack calls the fourth phase of water. It has the effective stoichiometry $H_1.5O$ and every fourth proton of water has gone somewhere. In the TGD based model they would transform to dark protons at the gravitational MB of the Earth.

2. Pollack effect inside the cell would generate negatively charged EZs making the cell negatively charged. The dark protons would reside at the gravitational MB of Earth having astrophysical size and are therefore effectively outside the system. The negative charge of EZs induces positive polarization charges in the cell exterior. The properties fo EZ suggest that second law holds in a reversed time direction and large scale quantum coherence zero

energy ontology (ZEO) [K17], predicting that the arrow of time changes in the ordinary state function reductions, can explain this.

3. In the nerve pulse generation, the reverse Pollack effect would occur and neutralize the negative charge of the cell interior locally [L20]. This would induce a local depolarization.

   The reverse Pollack energy generates dark photons and is received by the water in the neuron exterior. This would induce Pollack effect in the cell exterior and generate a negative charge as EZ outside the cell so that membrane potential would change its sign temporarily. An effective charge transfer induced by the Pollack effect and its reversal occurs: a kind of quantum flip-flop is in question. The possibly Ohmic ionic currents associated with the nerve pulse are generated as a consequence but could be seen as a side effect rather than a cause of the nerve pulse.

4. In zero energy ontology (ZEO), nerve pulse corresponds to two pairs of BSFRs ("big" state function reductions) corresponding the reduction of membrane potential to its negative and the reversal of this process [L20]. Each pair involves a temporary change of arrow of time: this would conform with the formation of EZs.

6.1.3 Lightning as an analog of nerve pulse?

Could lightning and nerve pulse be generated by the same mechanism?

1. The fractality of the TGD Universe inspires the proposal that the Earth's biosphere and its MB [K6, K5] [L11, L18, L19] are analogous to a cell membrane or even neuronal membrane or possibly a collection of basic units analogous to those of neuronal membranes. In the lightning strike, a charge separation between ground and its MB would transform to a charge separation between cloud and its MB. Lightning would be induced by the depolarization just as in the case of neuronal membrane.

   The assumption distinguishing sharply between TGD and standard physics is that the primary charge separation does not occur between cell interior and exterior but between interior/exterior and its MB.

2. In the initial, rather stationary situation, the Pollack effect at the ground has generated EZs and made the Earth surface negatively charged. The electric field of the Earth gives rise to the analog of the resting potential of neutrons as the voltage between ground and (say) the cloud. Negatively charged EZs at the ground induce the small positive charge (known to be important) at the bottom of the cloud by polarization.

3. The reverse Pollack effect would occur at the ground and partially neutralize the negative charge of the ground locally and induce a local depolarization. The energy transfer by dark photons to the cloud would induce Pollack effect in the cloud generating negatively charged EZs and lead to a local depolarization in the cloud, which effectively looks like a transfer of negative charge to ground. This would change the sign of the electric field locally or at least reduce its strength.

   A moving thunderstorm accompanied by lightning strikes would be analogous to the nerve pulse conduction. The ion currents between cloud and ground are analogs of various ionic fluxes during the nerve pulse. Both oscillating Josephson currents along the gravitational monopole flux tubes and Ohmic currents are possible.

   Also nerve pulse conduction would be seen as a temporal sequence of local lightning at discrete positions at discrete times. This conforms with the TGD based model for nerve pulse in terms of propagating Sine-Gordon solitons associated with a sequence of effective mathematical pendulums [K8] [L20].

It would be interesting to relate the parameters of nerve pulse conduction (say conduction velocity) to the parameters of the propagation of thunderstorms. Also the parameters corresponding to those appearing in the TGD based model of nerve pulse in terms of Josephson junctions

and dark Josephson currents would be highly interesting. The dream would be a quantum model for a thunderstorm.

6.1.4 Biosphere as a Josephson junction

What could the identification of the biosphere as a Josephson junction or collection of them could mean? Consider first the neuronal membrane [L20].

1. In the case of the neuronal membrane, one has a collection of Josephson junctions defined by monopole flux tubes assignable to membrane proteins believed to act as channels and pumps. This collection can be idealized with a continuous Josephson junction with the phase difference associated with supra phases at the two sides obeying Sine-Gordon equation [K8].

2. The Coulomb energy $E_J = ZeV$ allows an interpretation as a Josephson energy of charge Z (say Cooper pair with $Z = 2$). For $\hbar_{eff} = \hbar_{gr}GMm/\beta_0$ the corresponding frequency is $f_J = ZeV/h_{eff}$. This frequency depends on the mass m of dark charge assignable to gravitational monopole flux tubes. M could correspond to some large mass, such as the mass of Earth, Sun, or Moon.

3. The generalized Josephson energy assignable to the junction is assumed to be sum of E_J and of the difference of cyclotron energies assignable to the flux tubes arriving to the cell membrane from the cell interior and exterior. The difference of cyclotron energies would give the dominating contribution to the generalized Josephson energy and would be equal to the cyclotron energy at the gravitational magnetic body. For this option, ordinary Josephson energy would code membrane potential oscillations and even nerve pulse to a small modulation of the generalized Josephson energy and - frequency.

4. At the gravitational MB, assumed to be an onion-like structure consisting of nearly spherical layers [L18, L19], cyclotron resonance must occur in the receival of the dark Josephson radiation. The condition for this is that the dark cyclotron energy $E_c = \hbar_{gr}ZeB/m = GMZeB/\beta_0$ (by Equivalence Principle, there is no dependence on m) is equal to the generalized Josephson energy.

5. If there is no cyclotron contribution to the generalized Josephson energy, it reduces to the ordinary Josephson energy $E_J = ZeV$ and the resonance condition implies that M must correspond to the mass $M_M \simeq 1.02M_E$ of the Moon! [L20].

   This does not occur if the cyclotron contribution dominates and the cyclotron resonance condition can be satisfied for M_E and the variation of membrane potential is coded to a sequence of resonances analogous to a sequence of nerve pulses. Nerve pulse patterns could indeed be preceded as a reaction of the MBs of sensory receptors to dark Josephson radiation.

Could this picture of the cell membrane as a Josephson junction generalize to the recent situation?

1. Suppose that also in the recent case the generalized Josephson energy involves the difference of dark cyclotron energies besides the ordinary Josephson energy and that it dominates. Suppose that one replaces the mass M, say the mass of Earth, appearing in $\hbar_{gr}$ by the mass M_S of say Sun. Assume that the Earth's mass appears in $\hbar_{gr}$ for neurons.

2. If the membrane potential scales as $V \to (M/M_E)V$, the resonance conditions remain true since they do not depend on M at all. This would extend the Equivalence Principle so that it would apply to both M and m. Neuronal membranes could couple to the gravitational MBs of both Sun, Earth and even Moon.

   The scaling factor of V would be $M_S/M_E \simeq 3 \times 10^5$ and in the case of membrane potential would give $V = .05$ eV $\to V = 15$ keV. The height h of the thunder cloud varies in the range $[.5, 16]$ km. The ratio h_{max}/h_{min} of the maximum and minimum heights is $h_{max}/h_{min} = 32$, which is a power or 2 and brings in mind p-adic length cdale hypothesis.

   Note that the scaling down by M_{Moon}/M_E would give $V = .5$ meV, which corresponds to the scale of miniature membrane potentials modulating neuronal membrane potential.

3. The ratio of the maximum and minimum electric fields strengths is roughly $E_{max}/E_{min} = 3$ and considerably smaller that the ratio $h_{max}/h_{min} = 32$ so that the correlation between E_{max} and h is weak. In the absence of a correlation between E and h, and at the height of 10 km, the range would be $[.1, .3]$ MeV. A cloud at height of $h = 16$ km, which is also possible, corresponds to an electrostatic energy in the range $[3.2, 9.6]$ MeV.

   As noticed, this model can explain the relativistic electron energies assigned with the lightning. The electrons would propagate along monopole flux tubes with a large value of h_{eff} and dissipation would be absent.

There are many interesting questions to be answered.

1. Both the cell membrane and ionosphere can be seen as a capacitor like system or battery. The lower boundary of the ionosphere is at the height h_I between 80-600 km. Ionosphere contains a layer of electrons and can seen as an analog of negatively charged conductor plate of a capacitor formed by the positively charged Earth surface and ionosphere. Radio waves are reflected back from the ionosphere. Schumann resonances are associated with it.

2. Neuronal membrane corresponds to the p-adic length scale L(151)= 10 nm and its lipid membranes to L(149). L(151) corresponds to Gaussian Mersenne. Can one assign a Gaussian Mersenne also to the ionosphere?

   After the Gaussian prime $G(167)$ defining p-adic length scale of 2.5 μ m, size of cell, the next Gaussian Mersenne is $G(239)$ and corresponds to $L(239) \simeq$ 160 km and has $G(241)$ as Gaussian twin prime. 160 km is roughly the height of the lower boundary of the F region (ionosphere decomposes to D,E, and F regions and the electron density is highest in the F region).

   The scale of 80 km is one half of $G(239)$ brings in mind lipid layers of the cell membrane to which one assigns capacitor plates. Could one think that the crust of Earth with thickness between 4.7 and 69 km defines the analog of the second capacitor plate.

3. In the cell membrane, the transversal scale of channels and pumps is about 10 nm and corresponds to the p-adic length scale $L(151)$ and the same as cell membrane thickness. What could be the counterparts of the membrane proteins assumed to be accompanied by Josephson junctions?

   Thunder storms (see this) are known to decompose to cells. Either these cells or thunder clouds could correspond to the basic units of cell membrane with the size scale $L(151)$. In the TGD based quantum view of hydrodynamics [K16], these structures would be hydrodynamical vortices (such as tornadoes) accompanied by monopole flux tube structures.

   Thunder clouds are at heights varying in the range [.5,10] km and the height and diameter of clouds is 10-20 km. Could this scale or the size scale of the cell correspond to the size scale of the basic unit of cell membrane and therefore to $L(239)$. This scale is however several orders of magnitude smaller than $L(239)$.

6.2 Ball lightning in the TGD framework

Could one understand the generation of ball lightning in this framework?

1. Suppose that in the normal situation the Pollack effect [I3, I1, I6, I4] for the water at the soil has somehow generated EZs and SiO_2 ions from Si and water of the soil or atmospheric oxygen. This would explain the negative charge of the ground. The Pollack effect would not require energy feed now since the binding energy liberated in the formation of SiO_2 crystals would take care of energy conservation. A situation in which part of water corresponds to $H_{1.5}O$ ions would be energetically favored.

   Note that this mechanism could be very general and make possible a quantum gravitational control of molecular transitions with binding energies in eV range. This would make it possible to establish plasma-like state typical for electrolytes by the Pollack effect and also induce a temporary decay of the biomolecules by the reverse Pollack effect providing the energy making it possible to overcome the energy barrier. This would be essential for biocatalysis.

2. In the reverse Pollack effect associated with the lightning strike, dark protons from MB would transform ordinary protons and return to the ground. The liberated energy would make possible the decay of SiO_2 molecules to Si and O_2. Ordered water would transform to ordinary water getting its oxygen ions from SiO_2.

3. This situation is not energetically favored. The Pollack effect would take place and lead to the original situation in a time scale of a few seconds. The slow time scale could relate to the large value of $\hbar_{gr}$. The liberated gravitational binding energy in the Earth's gravitational field for a single dark proton is below .5 eV, which corresponds to the nominal value of metabolic energy currency [L15, L14].

   Note that the counterpart of the membrane potential energy $E = eV$ is in the recent case in the range .1-30 MeV and much higher than the scale of the molecular binding energies. These energies are consistent with the finding that gamma rays accompany lightning strikes.

6.2.1 Connection with crop circles, UFOs, and glass balls in the Moon

A connection with crop circles is highly suggestive. I have discussed crop circles from the TGD point of view in [K2, K3] in a rather speculative spirit but starting from empirical facts published by professional biologists. There are reports that the crop circle formation occurs in presence of light balls analogous to ball lightning. The formation of crop circles can be understood in terms of the interaction of microwaves with crop stems causing effects similar to those taking place as one puts a tomato in a microwave oven. The size scale range for ball lightning conforms with the wavelength range for microwaves. Therefore the microwave theory seems to be consistent with the model based on the Pollack effect. The light ball would be an analog of the nerve pulse in the scale of the biosphere.

Meteorite iron is found at crop circles: they could arrive from the gravitational MB along gravitational flux tubes. Also small glass balls, encountered also on the Moon, are reported. They could emerge in the transformation of Si and O_2 to SiO_2 as the Pollack effect takes place.

What is fascinating is that crop circles look like intentional constructs expressing discrete geometric symmetries. Could the plasma balls be intelligent conscious entities, a new kind of life form and could they represent the primordial life forms, kind of proto cells? This kind of plasma balls are also reported in UFO encounters. Systematic observations of the plasma balls are performed in Hessdalen and the plasma balls are reported to behave like intelligent and intentional entities.

The gravitational MB of these entities would correspond to that of the Sun. Could this mean that their theoretical IQ, defined by the gravitational Planck constant of the Sun, is dramatically higher than ours? Probably this is not the case: the gravitational Compton frequency for the Sun is around 50 Hz. This is the cyclotron frequency of Lithium for $B_{end} = .2$ Gauss. It is known that too low Li depletion in the soil tends to induce depression and suicidal behavior. 50 Hz corresponds to EEG frequency so that life forms with EEG would interact with the gravitational MB of the Sun.

6.2.2 Are we silicon based life forms?

Computationalists tend to think that silicon based life will emerge in future. However, if the above considerations make sense, Si, chemically similar to Carbon and appearing as quartz in soil, could play a central role in life already now! Maybe the people claiming that quartz have very special effects on the state of consciousness, are right. In fact, I have had an opportunity to experience these effects myself.

Intriguingly, molten silica shows several characteristics observed in liquid water (see this) and the amorphous glass phase of silica resembles liquid in many aspects.

Interestingly, silicon di-oxide is used in MOSFETs. In [L17, L16], I have considered a model for how ordinary computers could become conscious entities. This requires the failure of statistical determinism in long enough time scales. The proposed condition would be that the gravitational Compton frequency 67 GHz for Earth (microwave wavelength), which corresponds to a wavelength of .5 cm for Earth (the size scale of a snowflake), is longer than the clock frequency. This condition is not quite true for recent computers.

If ordinary computers can be conscious, the properties of MOSFETs must be in a crucial role. Is this possible?

1. The SiO_2 in MOSFETs could have a glassy, spin glass-like structure to give them high representative capacity and there is some evidence for this. The transistors should also define Josephson junctions. The alternative, more promising option, discussed in [L16], is that the conscious computer is based on the representation of bits in terms of Josephson junctions.

2. MOS is obtained by growing a layer of Si on top of SiO_2. However, the idea about the local transformation of SiO_2 to Si and O_2 with Si in vapour phase by an analog of the Pollack effect does not look plausible since protons are not available now.

   Electrons should be transformed to dark electrons at the gravitational MB of Earth and the formation of SiO_2 would make possible energy conservation. The transformation of electrons back to ordinary electrons liberates energy and should induce the decay of SiO_2. The needed energy is few eVs. However, the gravitational binding energy for electrons in the field of Earth has an upper bound of order .25 meV. Note that the melting temperature of SiO_2 corresponds to the energy .134 eV. It seems that the only possibility that one can imagine is provided by dark variants of quantum coherent many-electron states.

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