Comments on the Recent Experiments by the Group of Michael Persinger

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Abstract

Michael Persinger's group reports three very interesting experimental findings related to EEG, magnetic fields, photon emissions from brain, and macroscopic quantum coherence. The findings also provide support for the proposal of Hu and Wu that nerve pulse activity could induce spin flips of spin networks assignable to cell membrane. In this article I analyze the experiments from TGD point of view. It turns out that the experiments provide support for several TGD inspired ideas about living matter - namely, magnetic flux quanta as generators of macroscopic quantum entanglement, dark matter as a hierarchy of macroscopic quantum phases with large effective Planck constant, DNA-cell membrane system as a topological quantum computer with nucleotides and lipids connected by magnetic flux tubes with ends assignable to phosphate containing molecules, and the proposal that "dark" nuclei consisting of dark proton strings could provide a representation of the genetic code. The proposal of Hu and Wu translates into the assumption that lipids of the two layers of the cell membrane are accompanied by dark protons which arrange themselves to dark protonic strings defining a dark analog of DNA double strand.

Contents

1   Introduction

Michael Persinger's group reports [J4, J5, J6] three very interesting experimental discoveries relating to EEG, magnetic fields, photon emissions from brain, and macroscopic quantum coherence.

In the first article [J4] entitled *Congruence of Energies for Cerebral Photon Emissions, Quantitative EEG Activities and ~ 5 nT Changes in the Proximal Geomagnetic Field Support Spin-based Hypothesis of Consciousness* correlations between cerebral photons emissions, EEG, and changes of the proximal geomagnetic field are reported. The findings provide support for the proposal of Hu and Wu [J7] that nerve pulse activity could induce spin flips of spin networks assignable to cell membrane motivated by the observation that the magnetic spin-spin interaction between protons at a distance of 10 nm (cell membrane thickness) corresponds to energies for which frequency is in EEG range.

In the second article [J5] entitled *Demonstration of Entanglement of Pure Photon Emissions at Two Locations That Share Specific Configurations of Magnetic Fields:*

Implications for Translocation of Consciousness the group reports an excess correlation between "pure" photon emissions at two locations separated by few meters that share specific correlations of frequency modulated magnetic fields. The photon emissions were from LEDs in the experiment consider. In an earlier similar experiment, which is also discussed, they were from chemical reactions occurring in solutions contained by cell cultures.

In the third article [J6] entitled *Experimental Demonstration of Potential Entanglement of Brain Activity over 300 Km for Pairs of Subjects Sharing the Same Circular Rotating, Angular Accelerating Magnetic Fields: Verification by s_LORETA, QEEG Measurements* an excess correlation of brain activity of subject persons separated by 300 km and sharing the same circular rotating, angular accelerating magnetic fields is reported.

It turns out that the experiments provide support for several TGD inspired ideas about living matter: magnetic flux quanta as generators of macroscopic quantum entanglement, dark matter as a hierarchy of macroscopic quantum phases with large effective Planck constant, DNA-cell membrane system as a topological quantum computer with nucleotides and lipids connected by magnetic flux tubes with ends assignable to phosphate containing molecules, and the proposal that "dark" nuclei consisting of dark proton strings could provide a representation of the genetic code. The proposal of Hu and Wu [J7] translates into the assumption that lipids of the two layers of the cell membrane are accompanied by dark protons which arrange themselves as dark protonic strings defining representation for DNA sequences.

In the sequel I briefly explain my own interpretation of these experiments and their outcomes from TGD point of view and show that a nice interpretation of the findings emerges. Before going into this it is however appropriate to summarize briefly those aspects of TGD-based view about living matter which are relevant for the interpretation of the experiments.

1.1 Key aspects of the TGD-inspired vision about living matter

The following are the key ingredients of TGD-inspired vision about living matter needed for our argument:

1. The notion of many-sheeted space-time is the first new element [K9, K10]. Space-times are 4-D surfaces in 8-D space-time $M^4 \times CP_2$ so that one has what might be called sub-manifold gravity. Any physical system corresponds to a space-time sheet characterizing its shape and size. The outer boundaries of macroscopic objects correspond to causal boundaries at which the signature of the induced metric of the space-time surface changes. Therefore space-time surfaces are topologically non-trivial in all scales and we directly perceive it. Space-time surfaces form a fractal hierarchy in the sense that subsystems of a system correspond to space-time sheets topologically condensed on it via the formation of wormhole contacts which are regions of space-time with an Euclidian signature of the induced metric.

   Also the notion of classical field is topologized. Various classical fields are subject to what might be called topological field quantization. For instance, radiation

fields decompose to topological light rays and magnetic field to magnetic flux quanta (flux tubes and flux sheets). Topological field quantization is of special importance in living matter and leads to the notion of field body and magnetic body as additional structural and functional parts of a living system.

2. p-Adic physics [K16] defines a further basic element. p-Adic number fields are proposed to serve as correlates for cognition in the sense that one can speak about p-adic space-time sheets as correlates for cognition and for intentions [K13, K18] The quantum jump transforming p-adic space-time sheet to a real one corresponds to a transformation of intention to action. The generation of though in turn corresponds to an opposite of this transition. Zero energy ontology makes this picture internally consistent and no breaking of conservation laws is implied.

   p-Adic length scale hypothesis [K14] states that p-adic primes near powers of 2 are of special physical significance and Mersenne primes $M_n = 2^n - 1$ especially so. A possible explanation for the importance of these primes is that evolution corresponds to a gradually increasing complexity. The primes slightly below power of two are simple in the sense that all digits in their pinary expansion are '1':s expect possibly for some of the first ones, and are physically especially interesting because they should have emerged first if the number theoretical evolution proceeds from simple to more complex. Mersenne primes have only '1':s in their pinary expansion so that they are the simplest possible primes and indeed seem to correspond to fundamental physical scales. This leads to quite powerful predictions in particle physics context.

   In the scales of living matter a number theoretical miracle occurs: in the length scale range from 10 nm (cell membrane thickness to 2.5 μm (size scale of cell nucleus) as many as four Gaussian Mersenne primes $M_{G,n} = (1 + i)^n - 1$ occur and correspond to p-adic primes near p^k, $k = 151, 157, 163, 167$.

3. The hierarchy of *effective* Planck constants [K8] coming as integer multiples $\hbar_{eff} = n\hbar$ of the ordinary Planck constant was partially motivated by the findings of Blackman [J2] and others related to the unexpected effects of ELF em fields on vertebrate brain. These effects look quantal but this should not be possible since the cyclotron energies in the magnetic field $.2 \times 10^{-4}$ T (2/5 times the nominal value of the Earth's magnetic field $B_E = .5 \times 10^{-4}$ T) are 10 orders of magnitude below the thermal threshold.

   This led to the hypothesis about the value spectrum of Planck constants. The phases of ordinary matter with non-standard value of effective Planck constant are identified as dark matter. Later two different - possibly equivalent - reductions of the hierarchy to that for *effective* values of $\hbar$ have emerged in TGD framework [K18].

   One of the most speculative ideas related to the dark matter hierarchy is based on the observation that a simple model for dark proton implies that the states of dark proton are in 1-1 correspondence with DNA, RNA, tRNA, and amino-acids, and that there is a simple rule reproducing vertebrate genetic code [K12, K11]. Dark nuclei defined by sequences of dark protons would define the analogs of DNA sequences so that genetic code would not be a outcome of random biochemical selection but a basic element of particle physics, and biological systems

would only define a secondary representation of the fundamental genetic code. This proposal has far reaching implications. Surprisingly, the findings of the first article [J4] supporting the hypothesis of Hu and Wu [J7] about proton spin networks combined with the dark DNA hypothesis lead to a concrete model for the proton spin networks as paired dark DNA sequences assignable to the two lipid layers of the cell membrane.

4. Magnetic flux tubes carrying dark matter take central role in TGD inspired quantum biology. The knotting and braiding of the flux tubes makes possible topological quantum computation and leads to the hypothesis that DNA and cell membrane connected by flux tubes form a topological quantum computer [K7]. Flux tubes can connect sub-systems of living organisms or even different organisms to form coherent structural and functional units. Indeed, the large value of $\hbar_{eff}$ makes possible macroscopic quantum coherence. In particular, biomolecules can be connected by flux tubes to coherent structures. The reconnection of flux tubes plays a key role in the proposed model bio-chemical reactions and bio-catalysis. Inportant are also the phase transitions changing the value of Planck constant inducing in turn a change of the length of the flux tube identified as a quantal length scale depending of $\hbar_{eff}$. These phase transitions could be responsible for the phase transitions changing dramatically the density of matter in cellular interior (say sol-gel transition).

   Cyclotron Bose-Einstein condensates at magnetic flux tubes are proposed to be a characteristic of living systems [K2]. Cyclotron frequencies are classical (no dependence on Planck constant) but cyclotron energies scale like $\hbar_{eff}$ so that for a large enough value of the effective Planck constant cyclotron energies of dark photons are above thermal threshold, and can induce macroscopic quantum coherence. Dark photons decay to bunches of ordinary photons and an attractive hypothesis is that bio-photons result as decay products of dark photons.

   The notion of magnetic body emerges naturally. Any physical system is accompanied by magnetic fields which in TGD Universe defines separate entity, which can be called magnetic body. Magnetic body is identified as an intentional agent using biological body as sensory receptor and motor instrument. Magnetic body has an onion like structure corresponding to the hierarchy of space-time sheets defining physical system, say biological body. The size of the magnetic body is much larger than that of biological body. 10 Hz frequency corresponds to a layer with size large than the size scale of Earth.

5. Zero energy ontology (ZEO) [K1] is a further basic element. In zero energy ontology physical states are zero energy states consisting of pairs of positive and negative energy states having opposite net quantum numbers and being localized to the opposite light-like boundaries of $CD \times CP_2$, where CD is the causal diamond identified as an intersection of future and past directed light-cones and defining a structure analogous to a double pyramid (a convenient shorthand for $CD \times CP_2$ is simply CD).

   The interpretation of zero energy states is as counterparts of pairs of initial and final states of physical events in positive energy ontology. CDs form a fractal

hierarchy with CDs within CDs. The size scales of CDs come as integer multiples of CP_2 size scale about 10^4 Planck lengths. One can interpret CD as an embedding space correlate for a "spotlight of consciousness" in the sense that the conscious experience of self associated with a given CD is about the region defined by CD. Space-time sheets within CD serve as correlates for selves at space-time level.

Also elementary particles are expected to be accompanied by CDs, and one especially important prediction is that the time scale of the CD associated with electron is .1 seconds, which corresponds to the fundamental 10 Hz bio-rhythm. All elementary particles correspond to macroscopic time scales and u and d quarks would correspond to time scales between 1 ms and .1 seconds.

1.2   Cell membrane as super-conductor and a model for EEG

The proposal is that the cell membrane is accompanied by super-conducting dark magnetic flux tubes [K15]. Cooper pairs of electrons, protons, and biologically important fermionic ions would be the carriers of supra currents besides bosonic ions such as Ca^{++} and Mg^{++}. Note that the new exotic nuclear physics suggested by TGD allows to imagine that fermionic nuclei could appear as bosonic variants with essentially the same chemical properties [K12].

Josephson currents through cell membrane have frequency $f = eV/\hbar_{eff}$ so that in this case the energy $E = eV$ identifiable as the energy of electron or proton gained in traversing the cell membrane is a classical quantity whereas Josephson frequency is quantal [K15]. The situation is opposite to this for cyclotron frequences and energies. Obviously, large values of $\hbar_{eff}$ correspond to low Josephson frequencies. Soliton sequences associated with the Sine-Gordon equation governing the dynamics for small variations of membrane potential would represent ground states of axonal membranes mathematically, analogous to sequences of mathematical penduli rotating in phase. Nerve pulse generation would mean a perturbation in which one pendulum is kicked [K15].

There are two alternative models for the cell membrane as a Josephson junction [K2].

1. For the conservative option [K2] the cell membrane is a far-from-vacuum extremal and various charged particles experience only the electromagnetic field. The energy scale of excitations is determined by the electric voltage and is given by $E = eV$. Nerve pulse generation would be associated with this kind of membranes. Josephson radiation with harmonics of $f = eV/\hbar_{eff}$ is one signature of super-conductivity.

   One also ends up with an explanation of EEG in this framework [K6]. The function of EEG would be communication of sensory data from cell membrane to the magnetic body and control of biological body via flux sheets traversing through DNA, where genetic expression is activated by the control signals. EEG frequencies are linear combinations of harmonics of Josephson frequencies and of the increments of cyclotron frequencies. Cyclotron transitions can be also accompanied by a spin flip. This model allows one to identify EEG bands. The hierarchy of Planck constants suggest a generalization of EEG and its variants

(say EKG) to a fractal hierarchy obtained by scaling EEG. For large enough values of $\hbar$ cyclotron contributions to EEG energies would correspond to energies above thermal threshold as also Josephson frequency (Josephson energy $E = eV_{thr}$, where V_{thr} is the value of resting potential at which nerve pulse is generated is just at the thermal threshold). This would make possible the correlation of EEG with the brain state and also quantum biocontrol by using photons with EEG frequencies.

2. For the non-conservative option [K5] cell membrane is near-to vacuum extremal. The classical Z^0 fields predicted by TGD dominate over em fields, and the voltage must be replaced by a combination of Z^0 and em voltages. By assuming that the Weinberg angle is considerably smaller in this phase than in the standard phase the energies gained by various ions correspond to visible photons. This hypothesis allows one to understand the frequencies for which photoreceptors - which do not directly generate nerve pulses - are most sensitive. Near-vacuum extremal property obviously implies high sensitivity to perturbations making the sensory receptor optimal.

An interesting possibility is that the far-from-, respectively near-to-vacuum extremal options are realized for the neurons of left *resp.* right hemisphere. This option finds support from the observation of Persinger et al [J4] that visible photon emissions are mostly from the right hemisphere. Another possibility is that glial cells as cells which do not generate nerve pulses correspond to near-to vacuum extremals. The identifications do not exclude each other.

1.3   Learning to apply the notion of induced field

The geometrization of classical gauge fields and gravitational fields relying on the induction of spinor connection of CP_2 and $M^4 \times CP_2$ metric to the space-time surface is one of the key ideas of TGD and it is useful to get more concrete understanding of the induced fields since this notion will be applied in the sequel.

1.3.1   The basic objection and its resolution

The basic objection against the induced fields is that they reduce the dynamics to that of only 4 field like variables since the 8 embedding space coordinates take the role of field variables and 4 of them are eliminated by general coordinate invariance as field variables. Besides this preferred extremals of Kähler action represent space-time surfaces carrying very restricted kind of patterns of induced gauge fields analogous to Bohr orbits.

Many-sheeted space-time however saves the situation. Each system creates its own field body represented in terms of topological field quanta. If these field bodies have common M^4 projection, a test particle topologically condenses to each of these field body (touches each of them), and the effects of these fields sum up although fields do not interfere as they would do in ordinary field theory.

1.3.2　How could one generate dark photons with large $\hbar$?

The observation which led to the proposal of the effective hierarchy of Planck constants, was that microwaves with frequency of f_h modulated by ELF frequency f_l induce in vertebrate brain effects which could be understood in terms of cyclotron frequencies assignable to quantal cyclotron transitions in an endogenous magnetic field $B_{end} = .2$ Gauss for which cyclotron frequency was equal to ELF frequency: $f_c = f_l$. These effects are possible only if the cyclotron energy is above thermal energy, and this led to the proposal about the hierarchy of Planck constants. '

The key question is how the modulation by ELF frequency could generate dark photons with large $\hbar_{eff}$. A possible answer to this question comes from another question. Topological field quantization forces one to ask what is exactly implied by the amplitude modulation of fields.

The simplest modulation corresponds to a multiplication of rapidly oscillating field with a slowly varying oscillating amplitude so that amplitudes with frequencies $f_h \pm f_l$ result ('h' and 'l' refer to "high" and "low"). The natural thing to do is to develop the two amplitudes with frequencies $f_h \pm f_l$ in Fourier series in time interval $T = 1/f_l$. All harmonics of f_l appear and coefficients of the expansion are proportional to $1/(f_h - (n \pm 1)f_l)$. Maximal amplitudes correspond to $f_h \simeq (n \pm 1)f_l$. This suggests that when this almost-resonant condition is satisfied the generation of dark photons with frequency f_l and energy $\hbar_{eff}f_l$, with $\hbar_{eff} \simeq f_h/f_l$, can take place at a considerable rate. If this argument is correct, one could generate dark photons with given $\hbar_{eff}$ by using modulation satisfying the condition $f_h/f_l = \hbar_{eff}$.

In the case of ELF em fields interacting with brain this is not enough since microwave photons have energies below the thermal threshold E_{th}. Bio-systems however contain photons with energy above thermal threshold - say bio-photons with frequencies f in visible range or infrared Josephson photons generated by cell membrane Josephson currents; the fields associated with MEs ("massless extremals", topological light rays) accompanying these many-photon states can be modulated by the ELF modulated microwaves. Since one can say that a modulation of modulation is also a modulation, the outcome is modulation (f, f_{ELF}) producing dark photons with $\hbar_{eff} \simeq f/f_{ELF}$ with energies about E_{th}.

This mechanism would explain the "scaling law of homeopathy"' [K11] stating that fields with low frequencies f_l are somehow transformed to fields with high frequencies f_h and vice versa. The proposal has been that large $\hbar_{eff}$ photons with $\hbar_{eff} \simeq f_h/f_l$ decay to ordinary photons or vice versa. This transformation has quite concrete description: $\hbar_{eff} = n$ photons correspond to n-furcations of space-time surface made possible by the non-determinism of Kähler action. All n-sheets of the n-furcation would be present and each of them would carry photon with frequency f_l and total energy would be $\hbar_{eff}f_l = f_h$.

1.3.3　How to describe time-varying magnetic fields?

The topological flux quantization for static magnetic fields is easy to understand. The description of time varying magnetic fields in terms of flux quanta is however a non-trivial exercise in thinking in terms of topological field quanta.

Flux quantization implies that the magnetic dipole field decomposes into closed flux tubes with a straight part inside dipole and a portion outside the dipole carrying

return flux in roughly opposite direction also arranged to flux tubes.

The basic assumption is that the flux tube structure of dipole field is not lost but is only re-arranged as the dipole field oscillates. As the dipole strength decreases the flux tubes along field lines outside the dipole contract so that eventually the closed flux tubes of dipole field degenerate to those of wormhole magnetic fields [K17] restricted inside the dipole and consisting of parallel flux tube space-time sheets with same M^4 projection and carrying opposite magnetic field strength and having distance of order CP_2 length along CP_2 direction. A charged particle topologically condensing at both sheets experiences the sum of the magnetic fields, which vanishes. As the sign of dipole changes, the flux tubes in the interior of dipole begin to move to the exterior of the dipole. In operational sense this dynamics is approximated well by Maxwell's theory or vice versa.

How are the electric electric fields associated with the time-varying magnetic fields predicted by Faraday law represented? These fields are rotational with flux lines rotating around the magnetic field. In Maxwell's theory one would have single vortex like structure. In TGD this vortex-like structure decomposes into smaller vortices assignable to individual flux tubes just like the rotational flow of super-fluid decomposes into smaller vortices satisfying quantization condition analogous to the quantization of the magnetic flux.

Also the geometro-dynamics for the flux quanta of electric field is possible and in this case magnetic fields induced by time dependent electric fields are assignable to flux quanta. Cell membrane is a good example of this kind of situation. Quite generally, the geometro-dynamics of topological field quanta together with the possibility to have varying overlapping M^4 projections allows to reproduce the smooth dynamics of Maxwell fields.

2 First article

The first article has the title *Congruence of Energies for Cerebral Photon Emissions, Quantitative EEG Activities and ~ 5 nT Changes in the Proximal Geomagnetic Field Support Spin-based Hypothesis of Consciousness*, which already summarizes the findings.

2.1 Findings

In the article [J4] Persinger's group reports simultaneous changes in photon emissions, EEG activity, and alterations of proximal geomagnetic field when a person sitting in dark is imagining white light or not.

According to the article's abstract, "the hypothesis by Hu & Wu that networks of nuclear spins in neural membranes could be modulated by action potentials was explored by measurements of the quantitative changes in photon emissions, electroencephalographic activity, and alterations in the proximal geomagnetic field during successive periods when a subject sitting in the dark imagined white light or did not. During brief periods of imagining white light the power density of photon emissions from the right hemisphere was about 10^{-11} Wm^{-2} that was congruent with magnetic energy within the volume associated with a diminishment of ~ 7 nT as predicted by the

dipole-dipole coupling relation across the neuronal cell membrane. Spectral analyses showed maxima in power from electroencephalographic activity within the parahippocampal region and photon emissions from the right hemisphere with shared phase modulations equivalent to about 20 ms. Beat frequencies (6 Hz) between peak power in photon (17 Hz) and brain (11 Hz) amplitude fluctuations during imagining light were equivalent to energy differences within the visible wavelength that were identical to the intrinsic 8 Hz rhythmic variations of neurons within the parahippocampal gyrus. Several quantitative solutions strongly suggested that spin energies can accommodate the interactions between protons, electrons, and photons and the action potentials associated with intention, consciousness, and entanglement."

The authors interpret the results in terms of entanglement identified as enhanced correlations. Entanglement in this sense does not correspond to quantum entanglement. To my opinion (quantum) coherence would be a more standard manner to interpret the findings. Quantum coherence of course also makes possible quantum entanglement.

Spin flips, whose importance for consciousness has been emphasized by Hu and Wu [J8], would occur between spin triplet and singlet states of pairs of protons belonging to the spin network. The basic finding is that the energy changes are accompanied by changes in EEG power.

Note that spin flips are possible also for cyclotron states proposed to be important for consciousness in TGD approach. In the case of electron the change of the energy in spin flip is in excellent approximation the same as in the transition $n \to n \pm 1$ of cyclotron state characterized by integer n (radial wave functions of electron in constant magnetic field correspond to those of harmonic oscillator). For ions the Lande factor g characterizes the effective nuclear angular momentum and appears in the spin flip energy and also now the frequencies involved are in EEG range.

The correlation of photon emissions with imagination of white light supports the hypothesis that EEG photons are responsible for communications to and control of biological body by magnetic body.

2.2   TGD inspired interpretation of the findings

What has been observed is correlation between EEG, emission of visible photons, and weakening of Earth's magnetic field with the change of magnetic energy equal to the energy of radiated photons. There is also evidence that spin flip transitions for protons are involved.

2.2.1   What is the origin of the visible photons?

The basic question concerns the origin of the visible photons.

1. An attractive general hypothesis is that the visible photons result in the transformation of dark EEG photons to ordinary visible photons. In TGD based model EEG (and its predicted fractal variants) correspond to dark photons with large *effective* value of $\hbar$ - call it $\hbar_{eff}$ - and energy $E = h_{eff}f$ in infrared or visible range and perhaps even in UV. Also bio-photons would result from these large $\hbar$ "dark" photons as they decay to bunches of ordinary photons. The wavelengths of dark photons with given energy are scaled by $\hbar_{eff}/\hbar$ predicted to be integer. The transformation of EEG photons to ordinary visible photons could

explain the correlation between EEG and visible photon emission reported by Persinger's group. This kind of process would generate also biophotons.

2. The mechanism providing energy for dark photons (in particular EEG photons) would provide it also for the visible photons. According to the authors, the energy would come from the Earth's magnetic field which I as inhabitant of many-sheeted space-time take liberty to translate to "measured magnetic field". What is interesting is that magnetic body would serve as a provided of metabolic energy. It is interesting to notice that in TGD based cosmology matter is created from the dark energy identified as Kähler magnetic energy assignable to magnetic flux tubes.

3. Authors conclude that the energy liberated per action potential is $E = eV_{rest}$. In TGD framework it could correspond to either a photon of Josephson radiation or the energy liberated when an electron traverses the cell membrane. What is troublesome is that this energy corresponds to IR photon just above thermal threshold rather than visible photon. The non-conservative model for the cell membrane mentioned above (applying to photo-receptor cells at least) could explain why visible photons rather than infrared photons with energy $E = eV_{rest}$ correspond to photons of the Josephson radiation.

4. The model based on the observation of Hu and Wu [J7] suggesting that action potentials affect a spin network of protons (possibly at opposite ends of lipid of two lipid layers making cell membrane) looks like a totally different explanation from what would come first in mind in TGD framework. Could the spin network proposal of Hu and Wu be integrated to the picture of living matter provided by TGD? This is the question to be considered next.

2.2.2   The spin network hypothesis of Hu and Wu from TGD point of view

The hypothesis of Hu and Wu [J7] states that nuclear spin networks of nuclei associated with the cell membrane are relevant for consciousness in the sense that action potential induces modulations of the coupling parameters describing the magnetic interaction between neighboring spins of the spin network.

1. A direct calculation using the value of proton magnetic moment gives that the magnetic field created by proton at distance defined by cell membrane thickness of 10 nm is 3 nT. There are also other factors involved, and the estimate of Hu is that the field is about 5 nT.

2. The crucial observation is that the classical spin-spin interaction energy for two protons at distance $d = 10$ nm defined by cell membrane thickness and given by $E_{s-s} = -\mu \cdot B$, where B is the dipole field created by proton, corresponds to a frequency of the order 10^{-14} eV and thus is in EEG range. This can be seen by a direct calculation by assuming that proton creates a dipole field with Lande factor of proton.

   The frequencies assignable to the energies of neighboring interacting proton spins at distance d are in EEG range also when the effects of the environment are taken

into account. For instance, the Hamiltonian for a rotationally symmetric nearest neighbor spin-spin interaction characterized in terms of so called J-factor, predicts in the case of protons frequency differences ΔE between singlet and triplet states varying in the range 5-25 Hz.

For heavier nuclei these interaction energies scale down like $1/A^2$, A the mass number, so that a naive conclusion would be that the frequencies tend to be below 5 Hz scale. Proton would therefore be in a completely unique position. That EEG frequencies result in case of proton suggest that cell membrane thickness is not 10 nm by a pure accident (not that p-adic length scale hypothesis fixes assigns it to the p-adic length scale $L(k = 151)$, where $k = 151$ characterize Gaussian Mersenne prime.

The fact that the frequencies for energy differences of singlets and triplets are in EEG range is highly relevant also from TGD point view since this energy range makes it possible for EEG frequencies to induce spin flips.

1. In TGD framework fermionic spin and fermion numbers in various modes of second quantized induced spinor field (1 or 0) are predicted to serve as correlates for Boolean cognition [K4] so that there are good reasons to expect that also spin flips are important. One might even think that protonic and even nuclear spins could be utilized to build Boolean representations.

2. The basic objection against the proposal of Hu and Wu is same as that against the findings of Blackman and others: quantum coherence is not possible since the energy differences corresponding to (say) frequency of 5 Hz is about 12 orders of magnitude below thermal threshold. Trom the basic relation $E = h_{eff}f$ it is clear that the objection can be circumvented for large values of effective Planck constant, which can take raise the energies involved to those of IR or perhaps even visible photons.

3. Authors conclude that the energy emitted per single action potential is $E = eV_{rest}$ which corresponds to IR photon just at the thermal threshold. It is however visible photons which are emitted. Why not photons with the Josephson energy $E = eV_{rest}$ just at the thermal threshold?

   If the photons would result when electron or proton traverses cell membrane and liberates potential energy as a photon or if the emitted IR photon could be interpreted as a photon of Josephson radiation this would be the case. TGD allows also to imagine that the cell membranes in question correspond to the non-conservative option for the model of cell membrane as Josephson junction for which V_{rest} contains Z^0 potential as a dominating contribution and gives rise to Josephson photons with energies in visible range.

   If one takes the proposal of Hu and Wu seriously, the visible photons would have different origin, and one must perhaps give up the assumption that the estimate of authors forces the identification of basic energy quantum emitted in the process considered as $E = eV_{rest}$.

Authors state that the energy associated with visible photon emission should be equivalent to the energy emitted in the emission of photons. What can one conclude from this?

1. An attractive possibility would be "dark" spin network formed by spin-coupled protons, whose members are associated with the lipids of the two lipid layers with lipids. The number of the lipids per cell membrane would be roughly $N_l = r^2/d^2$, with lipids thickness estimated to be $d \sim .1$ nm. For $r \sim 10^{-4}$ m corresponding to a relatively large neuron this would give $N_l = 10^{14}$.

   This number would give also the maximum number of spin pairs participating in phase transition and an estimate for the value of $\hbar_{eff}$ from $N_l \Delta E_{s-s} = E_{ph}$ as

   $$N_l = \frac{E_{ph}}{E_{s-s}} = \frac{f_{ph}}{f_{s-s}} \ .$$

   Suppose that all dipoles make a simultaneous spin flip with energy change $\Delta E = hf$, $f_{s-s} = 5$ Hz generating an energy of $E_{ph} = 1 eV$ corresponding to a frequency of 2.4×10^{14} Hz. This requires $N_l \sim .5 \times 10^{14}$. It is encouraging that the rough estimates are consistent with each other.

2. That all protonic spin pairs make a simultaneous spin flip between singlet and triplet states of neighboring pairs looks like a phase transition. This suggests strongly macroscopic quantum coherence. What looks extremely strange is that a single visible photon should be emitted in the process since the entire magnetized region would behave like single spin! In standard physics this is not possible. TGD however leads to a possible realization of this kind of process as a mechanism of psychokinesis [L1].

   The hierarchy of effective Planck constants could resolve the paradox. If one has $\hbar_{eff}/\hbar \simeq E_{ph}/\Delta E \simeq .5 \times 10^{14}$, the emitted photon would be large $\hbar$ dark photon with frequency 5 Hz and the energy of visible photon and geometrically would corresponds to a n-furcation of space-time with $n = \hbar_{eff}/\hbar$ sheets each carrying single 5 Hz photon. Each dipole pair emits ELF photon but they combine to single dark ELF photon with the energy of single photon.

It seems that it is not natural to assign the photon emission to cyclotron transitions ionic cyclotron B-E condensates or to the transitions associated with the cell membrane Josephson junctions. Also the model based on the observation of Hu and Wu is very attractive. This does not add a completely new element to TGD. One can find a nice connection with one of the TGD inspired basic ideas about genetic code, namely the dark realization of genetic code as sequences of dark protons.

1. About 7 years ago I constructed a model for dark nuclei identifying them as strings of dark nucleons [K12, K11]. The model of dark nucleon yielded a compete surprise: the states of the nucleon were in 1-1 correspondence with DNA, RNA, tRNA, and amino-acids and vertebrate genetic code could be understood in a simple manner. This led to the vision that dark proton sequences allow a virtual world realization of genetic code making possible a kind of R&D department developing and testing various genetic alternatives. The genetic discoveries are however useful only if they can be used. This requires a generalization of transcription process allowing to transcribe DNA and RNA and perhaps even tRNA, and amino-acids to their dark counterparts and vice versa. This requires

that dark nucleon sequences have same size scale as ordinary DNA, RNA, and amino-acids and that they could accompany the biomolecules.

This fixes the size scale of dark proton to be of the order of the volume defined by the length L corresponding to single nucleotide in nucleotide sequence. The value of Planck constant would be of the order $\hbar_{eff}/\hbar \sim L/r_p \simeq 2.3 \times 10^5$, $r_p = \hbar/m_p \simeq 1.3 \times 10^{-15}$ m and $L \simeq .3$ nm.

2. At the same time I also constructed a model of DNA and cell membrane acting as a topological quantum computer [K7]. DNA nucleotides would be connected to lipids of the inner lipid layer of the cell membrane by magnetic flux tubes, whose braiding would define the topological quantum computer programs. The braids would continue from the outer lipid layers to the membranes of other cells and in this manner bind the cells to a kind of network. The strands could have at their ends molecules containing phosphates to make possible transfer of metabolic energy to the system.

3. Dark protons could be generated in the ionization of OH group to OH^- as proton drops to dark space-time sheet and possibly becomes a part of dark proton sequences.

   (a) The basic process would be formation of dark water in this manner and the rich spectrum of anomalies of water could be understood in terms of temperature dependence fraction of dark protons [K5].

   (b) OH groups are also associated with the hydrophilic ends of lipids such as fatty acids, glycerolipids, and phospholipids, which are the basic structural element of cell membranes. In phospholipids OH is associated with phosphate. In the DNA strand the phosphates contain O^- identifiable as OH^- resulting when proton of H drops to dark space-time sheet and possibly becomes part of dark proton sequence.

   (c) Also carbohydrates, in particular sugars, which are basic building brick of metabolism and defined the sugar backbone of DNA and RNA, contain a large number of OH groups. The model of DNA as topological quantum computer led to a proposal that magnetic flux tubes have OH or OH^- groups as their ends. These observations would allow magnetic flux tubes have dark protons at either or both ends. According to the earlier proposal [K7] magnetic flux tubes to have OH and $O =$ at their ends. Earlier picture need not to be modified if the cell membrane carries dark double DNA strand connected to the ordinary DNA double strand inside nucleus. Similar connections would be natural also between DNA and amino-acids and their dark counterparts possibly associated with the cell membrane and reconnection of the color magnetic flux tubes could allow to build and manipulate these connections.

4. This would predict that single DNA codon, which corresponds to a length of .33 nm along DNA strand is connected to single lipid by magnetic flux tube or three color magnetic flux tubes to corresponding proton consisting of 3 quarks. This seems to be consistent with the width of single lipid in lipid bilayer if one takes

seriously the illustration of the Wikipedia article. Note that in the earlier model single nucleotide was assumed to be connected by a magnetic flux tube to *single lipid*.

5. A further natural working hypothesis is that the proton pairs assignable to the OH^- groups at the hydrophilic ends of opposite lipid layers can also be connected by triplets of (color) magnetic flux tubes giving rise to the dipole-dipole interaction. This connection need not be permanent and could disappear or appear by the reconnection of the magnetic flux tubes. This could correspond to the transiotion to singlet state for proton pairs and would require energy. The working hypothesis of [K7] indeed is that during topological quantum computation the connection is split so that the cell is isolated from external world. The connection would be restored as the computation halts. Photon emission would therefore be seen as a signature of topological quantum computation.

The fact that the proton cyclotron frequency 300 Hz in $B_{end} = .2$ Gauss is the only cyclotron frequency above EEG range, one can ask whether biologically important dark ions form cyclotron Bose-Einstein condensates (possibly also Cooper pairs if fermions), dark protons form a cell membrane spin network, and dark electrons arrange to dark Cooper pairs making cell membrane a super-conductor. This would provide a unified picture about the role of various particle in TGD inspired vision about living matter.

2.2.3   Correlation of photon emissions with the weakening of the Earth's magnetic field

Authors say *During brief periods of imagining white light the power density of photon emissions from the right hemisphere was about 10^{-11} Wm^{-2} that was congruent with magnetic energy within the volume associated with a diminishment of $\sim 7\ nT$ as predicted by the dipole-dipole coupling relation across the neuronal cell membrane.*

The experiment is to some extent a replication of earlier experiment of [J3] in which it was observed that visible photon emissions mainly from the right hemisphere is accompanied by a weakening of the horizontal component of the Earth's magnetic field. Decreases over 10 to 15 s of 15 nT and 5 nT at 0.25 m and 1 m from the right side of the head of the subject person were associated with the same magnitude of energy (10^{-11} J) that was associated with the net increase in photon emissions during that period. This energy - assuming each action potential is associated with energy of $eV_{rest} = 1.9 \times 10^{-20}$ J - would be the equivalent of the activity of about 1 billion neurons.

1. If I have understood correctly, the weaking of the magnetic field outside the head of the subject person would be due to magnetic energy change associated with the spin flips taking place in the cell membrane and absorbing the needed energy from this magnetic field. This would obviously represent a new kind of metabolic activity: magnetic field would provide the needed metabolic energy instead of ATP-ADP process. That magnetic body could directly use its magnetic energy to control biological processes, would mean quite a dramatic modification of the usual view about metabolism.

2. The nuclear magnetization disappears for a moment in a transition from spin triplet to spin singlet state, which then spontaneously decay to triplet state again. The excitation of singlet state requires energy so that the magnetic field outside should weaken if it pays the energy bill. The contribution of magnetic dipoles to the horizontal magnetic field component measured outside the head of the subject person disappears and if the direction of dipole magnetization correlates with the direction of the magnetic field the strength of the magnetic field is reduced. The correlation would guarantee that the magnetic fields from different pairs of dipoles do not interfere to zero. Some kind of ordering of the orientations of neurons perhaps induced by the layered structure of cortex and of the almost collinearity of the myelinated axons of white matter is required.

3. Spin-flip transition from triplet to singlet state would change the contribution of magnetic dipoles to the net magnetic field and thus affect the net magnetic field experienced by a test particle. Could this explain the reduction of B_E by factor about 1.8×10^{-4}? At distance of order .1 meter the dipole field created by proton is very small: by a factor 10^{-21} weaker than the 9 nT field created at distance of $d = 10$ nm. The fields of neurons each containing a contribution of about 10^{14} protons sum up and the estimate is that there are 10^9 active neurons. The resulting net factor of 10^{23} could make possible reduction by 9 nT.

4. Triplet-to-singlet spin flip transition taking its energy from the magnetic field is the interpretation suggested by the experiments. The return to the ground state would liberate this energy as large $\hbar_{eff}$ quanta with energies of visible photons transforming later to ordinary visible photons. Therefore the radiated energy could indeed be magnetic energy also in TGD. Of course, also metabolism might drive particles directly to the excited cyclotron states and is expected provide the energy needed to regenerate the magnetic fields since the energy of visible photons is lost.

5. In TGD Universe the correlation of the photon emission with changes (about 7 nT) in the measured magnetic field identified as the Earth's magnetic field B_E having nominal value of $.5 \times 10^{-4}$ T does not force to assign dark photons with the magnetic flux tubes of the Earth's magnetic field.

   (a) One can of question the assignment of 7 nT weakening to B_E as a Maxwellian description not applying in TGD framework. The changes of the horizontal component of the magnetic field are detected outside the head of the subject person is it possible to assign this change to any particular magnetic field? How to distinguish between magnetic fields associated with different space-time sheets? TGD predicts that test particles "feel" their sum if these magnetic space-time sheet have projection in the same region of Minkowski space.

   The possibility to move the flux tubes in such a manner that only the flux quanta of one particular component of the many-sheeted magnetic field contribute to the projection, would allow to analyze the field into these components. Note that un Maxwell's theory this is not possible. The change in the measured magnetic field could be induced by a flux tube carrying 7 nT field

assignable to the proton spin network and having a projection to the same M^4 volume as a flux tube of the Earth's magnetic field or the endogenous magnetic field has. Therefore it might not be easy to distinguish between changes of B_E and B_{end}.

(b) The experimental findings of Blackman et al [J2] about the effects of ELF frequencies on vertebrate brain however encourages an interpretation in terms of cyclotron frequencies for magnetic field in "dark" endogenous magnetic field $B_{end} \simeq 2B_E/5$ (this predicts that Ca^{++} cyclotron frequency is 15 Hz, which is not far from 17 Hz). It is of course possible that the flux tubes of the Earth's magnetic field thicken inside the brain so that the strength of the magnetic field is reduced accordingly.

2.2.4 Can one understand the ELF frequencies involved?

Authors state: *Spectral analyses showed maxima in power from electroencephalographic activity within the parahippocampal region and photon emissions from the right hemisphere with shared phase modulations equivalent to about 20 ms.*

The time scale of 20 ms appears also in the experiments of articles 2 and 3 in which rotating and frequency modulated magnetic fields where applied. This time scale corresponds to 50 Hz frequency, which has been found to have biological effects [J9]. The cyclotron frequency of Lithium (bosonic ion) for $B_{end} = .2$ Gauss equals to 50.1 Hz (see the appendix of appendix of [K3]).

Authors continue : *Beat frequencies (6 Hz) between peak power in photon (17 Hz) and brain (11 Hz) amplitude fluctuations during imagining light were equivalent to energy differences within the visible wavelength that were identical to the intrinsic 8 Hz rhythmic variations of neurons within the parahippocampal gyrus.*

Can one understand the ELF frequencies involved? In TGD framework [K3] cyclotron states of electrons, protons, and of ions are possible [K3].

1. Ca^{++} is one important bosonic ion able to form cyclotron Bose-Einstein condensates and the 17 Hz frequency for the power of photon fluctuations could correspond to $f(Ca^{++}) = 15$ Hz: note that the strength of the endogenous magnetic field is expected to be under homeostatic control and thus vary in some range.

2. 11 Hz frequency is perhaps too far from alpha frequency 10 Hz but rather near to cyclotron frequency 11.4 Hz for Mn^{++} or 10.8 Hz of Fe^{++} in the field $B_{end} = .2$ Gauss (see the appendix of appendix of [K3]).

3. The superposition of effects on test charges caused by MEs associated with 17 Hz and 11 Hz frequencies would give 6 Hz beat frequency. Note that K^+ and Cl^- (fermionic ions) have cyclotron frequencies 7.5 Hz and 8.5 Hz and their Cooper pairs might relate to parahippocampal 8 Hz frequency.

3 Second article

Second article has the title *Demonstration of Entanglement of Pure Photon Emissions at Two Locations That Share Specific Configurations of Magnetic Fields: Implications*

for Translocation of Consciousness.

In the article [J5] the group reports an excess correlation between "pure" photon emissions at two locations separated by few meters that share specific correlations of frequency modulated magnetic fields. The photon emissions were from chemical reactions.

According to the article's abstract, "the experimental demonstration of non-locality for photon emissions has become relevant because bio-photons are coupled to conscious activity and cognition. The experimental condition that produces doubling of photon emissions from two loci during simultaneous chemical reactions when exposed to a sequence of circular rotating magnetic fields with differential phase and group angular velocities was applied to photons from LEDs (light-emitting diodes). A significant but weaker enhancement of photon emissions as measured by photomultiplier tubes occurred when the two LEDs were activated simultaneously within two loci separated by several meters. The effect suggests that under optimal conditions photons emitted from two, magnetic field congruent, loci become macroscopically entangled and that the two loci display properties of a single space. Implications for the transposition of consciousness over large distances are considered."

What was observed was enhanced visible photon emission from LEDs subject to the same magnetic stimulation as the cell culture dishes (neurons) in the earlier experiment [J1]. The size of the effect was however smaller. If the effect is real, the presence of organic matter (the cell culture dishes) is not absolutely necessary for the effect although it enhances it. The conclusion of the authors is that photons are carriers of consciousness. TGD inspired interpretation is that the experiment provides support for the identification of magnetic flux tubes as generators of macroscopic quantum coherence.

3.1   Experimental arrangement and results

The article describes first earlier similar experiment [J1] using instead of LEDs chemical reactions occurring in cell culture dishes (neurons) and leading to a doubling of photon emissions serving as a signature for coherence - or entanglement as authors express it. LEDs were motivated by the hypothesis that photon field can be equated with consciusness, and to test this the cell culture dishes were replaced with LEDs. A weaker but significant enchancement of LED emissions is indeed reported.

In the following I shall consider mostly the earlier experiment [J1] involving cell culture dishes which is identical to the recent one except for the mentioned replacement.

1. The distance between the cell culture dishes was a few meters as was also the distance of the solenoids from the sample located circularly around it. If I have understood correctly, the circular arrangements of solenoids were in parallel planes around the cell culture dishes (neurons) and the solenoids were directed radially to the dishes: otherwise it would not be possible to achieve a rotating magnetic field.

2. Each set of eight solenoids in circular arrangement around the cell culture dish received identical patterns of piecewise constant magnetic fields generated by potentials having 8 different values: the duration of single constant piece was 1

ms. Each solenoid created a magnetic field, whose lines emanating from the end of the solenoid were directed to the center of the cell culture dish.

3. Figure 1 of [J5] describes the shapes of the AD (accelerating angular velocity, decreasing "phase" modulation) and DI (decelerating angular velocity, increasing "phase" modulation). AD configuration was represented for 8 minutes and followed by DI configuration induced the effect and it occurred immediately after the initiation of DI phase.

Consider now a more detailed description of the AD and DI phases of magnetic stimulation.

1. During AD phase the accelerated rotation of the magnetic field was achieved by creating a magnetic pulse of duration 20,18, 16,..., $T_n = 20 - 2n,...$ ms to subsequent solenoids so that only single solenoid contributed to the net magnetic field at any moment. This series was repeated for every rotation of 2π. During AD phase the frequency modulation was slowed down meaning the frequency decreased and also this process was same for every rotation of 2π. The optimal duration of AD phase was about 4-5 minutes.

2. During DI phase decelerated rotation was achieved by in increasing the subsequent durations by 2 ms so that a series of pulses with durations 18 ,20, 22,...,$T_n = 20 + 2n,...$ ms was obtained. During this period frequency modulation was increased.

3. What "frequency modulation of phase" precisely means? Pictures of AD and DI temporal patterns of voltages (equivalently magnetic fields) feeded to the solenoids inducing a series of values of magnetic field are given Fig. 2 of [J5].

   A more detailed description can be found from the earlier article by Persinger's group [J1]. The voltage range [-5 V, 5V] was discretized to 8 pieces and the possible discretized voltages in this range are represented by 8 bits. The bit patterns were selected so that they were "physiologically patterned". The value of the magnetic field inside solenoid for n:th bit was proportional to V_n. The duration of each voltage was 1 ms - basic frequency of brain synchrony.

   During AD pattern a) with decreasing frequency and during DI pattern b) with inreasing frequency was used. The numbers of points which composed each pattern were 859 (duration was 859 ms) for AD and 230 (duration of 230 ms) for DI. Only a part of the pattern could be represented since the duration of single 2π rotation was 104 ms, which corresponds to 10 Hz, a fundamental bio-rhythm (Unless there was scaling of the bit duration).

4. Within the center of the 8-solenoid configuration the value of the magnetic field averages to 1 μT. A natural assumption that this magnetic field contributes to the net effective value of the endogenous magnetic field B_{end} inducing small variations of B_{end} in turn modulating cyclotron frequencies.

   The modulated cyclotron frequency should be higher that frequency of modulation and thus higher than 1 kHz. For B_{end} this leaves only electron with cyclotron frequency $f_c = 6 \times 10^5$ Hz under consideration. The effect would be on electron

Cooper pairs in the case of cell culture dishes or electrons in the case of LEDs. Electrons are indeed essential also for the function of LED.

5. The frequencies $f_n = 1/T_n$ defined by the durations of magnetic field vary during AD phase between 50 Hz and and 157 Hz. During DI phase the frequencies vary between 50 Hz and 30 Hz. In [J9] it is reported that 50 Hz frequencies have biological effects. As already noticed, 50.1 Hz corresponds to cyclotron frequency for Lithium (bosonic ion) for $B_{end} = .2$ Gauss.

3.2 Reconnection of magnetic flux tubes as a mechanism generating macroscopic quantum coherence

A doubling of the rate of emissions of visible photons immediately after the AD phase in the earlier experiment [J1] and weaker enhancement in the recent experiment using LEDs instead of cell culture disches, is interpreted as a signature of entanglement. Quantum coherence is perhaps a more appropriate manner to express the findings of the two experiments although quantum coherence makes possible also quantum entanglement. To my opinion the experiments provide support for the basic prediction of TGD inspired quantum biology that magnetic flux tubes are generators of macroscopic quantum coherence.

What seems necessary is that some flux tubes emanating from the solenoids must reconnect to form flux tubes connecting the two cell culture dishes or LEDs: reconnection is indeed one of the fundamental processes in TGD inspired theory of living matter. Without reconnection the flux tubes of the two magnetic fields remain disjoint and cannot induce macroscopic quantum coherence. The reconnection can occur only if the temporal and spatial patterns of the rotating and modulated magnetic fields are identical. These flux tube connections would induce quantum coherence by effectively binding the two systems to single system.

The doubling of the photon emission rate in the earlier experiment involving cell culture can be understood by the well-known rule that in incoherent emission the total rate is N times the individual rate, and in coherent emission N^2 times the individual rate: now N equals to 2. Also destructive interference becomes possible when the summed amplitudes are in opposite phases. This would reduce the rate below the predicted based on incoherence.

Also the enhancement of the photon emission rate from LEDs in a similar arrangement supports the view that macroscopic quantum coherence generated by the magnetic field patterns is relevant and implies that the amplitudes describing the emission of photons from the two LEDs add coherently with some probability so that constructive or possibly also destructive interference occurs. To make this statement more precise, one would need a detailed quantum model for LEDs.

3.3 Why AD followed by DI is needed to induce enhanced photon emissions?

Why should AD period followed by DI period be most effective in inducing photon emissions? Why the flux quanta (flux tubes) do not induce any effects, when the angular velocity is constant and frequency is absent (constant magnetic field)?

1. Accelerated rotation during AD period corresponds at quantum level to an application of magnetic flux tubes from directions $\phi_n = n \times 2\pi/8$ such that the duration of the pulse is reduced in discrete steps. The process should generate frequencies coming as harmonics of $f_n = 1/T_n$. The patterns of magnetic field consisting of periods of constant magnetic field lasting 1 ms and fixed for AD and DI to be "physiologically patterned" determines the Fourier decomposition. The duration of 1 ms brings in harmonics of kHz resonance frequency.

2. The variation of the duration of the magnetic field makes it possible to scan a wide range of resonance frequencies of the cell culture. The process would be like tuning a radio. At special frequencies resonant coupling to the frequency of magnetic field and to the frequency defined by the duration of magnetic field becomes possible and enhanced dark photon emissions take place. If the fundamental frequency were not varied, the effect would occur only for very special pulse durations.

3. Why the visible photons were observed only during the beginning of DI phase? If the emitted photons were dark having very long wave length but energy of visible photon, they would not have been detected during AD phase. The decay of dark photons after the beginning of DI phase to bunches of ordinary photons could explain the observed enhanced emissions of visible photons.

3.4 Why the magnetic pulses from a given direction arrived with frequency of 10 Hz?

The magnetic pulses arriving from a given direction to the cell culture dish/LED came with a frequency of 10 Hz. That a fundamental biorhythm is in question, cannot be an accident. In TGD framework 10 Hz frequency corresponds to the secondary p-adic time scale assignable to electron and defines the size scale of causal diamond assigned with electron. This conforms with the assumption that electronic Cooper pairs are fundamental for consciousness serving also as carriers of super-current through cell membrane. In fact, all elementary particles correspond in zero energy ontology to macroscopic time scales via the secondary p-adic time scales associated with them and for quarks the time scales correspond to frequencies of order 10 ms.

4 Third article

Third article has the title *Experimental Demonstration of Potential Entanglement of Brain Activity over 300 Km for Pairs of Subjects Sharing the Same Circular Rotating, Angular Accelerating Magnetic Fields: Verification by s_LORETA, QEEG Measurements.*

In the third article [J6] the group reports excess correlation of brain activity of individual subjects separated by 300 km and sharing the same circular rotating, angular accelerating magnetic fields.

According to the article's abstract, "in order to test the presence of excess correlation, or entanglement, pairs of subjects separated by 300 km were either exposed or not exposed to specific configurations of circular magnetic fields with changing angular

velocities that dissociated the phase and group components. When one person in the pair was exposed to sound pulses but not to light flash frequencies within the classical electroencephalographic band, there were discrete changes in power within the cerebral space of the other person even though they were not aware of the stimulus times and separated by 300 km. The intra-cerebral changes that only occurred if the magnetic fields were activated around the two cerebrums simultaneously were discrete and involved about single, punctate volumes of about 0.13 cc (125 mm^3). The potential energy from the applied magnetic field within this volume was calculated to be about 6×10^{-14} J and with an average brain power frequency of 10 Hz would result in 6×10^{-13} W. Assuming $\pi \cdot 10^{-2}$ m^2 for the surface area of the cerebrum, this is equivalent to $\sim 2 \cdot 10^{-11}$ Wm^{-2}. This power density is the same order of magnitude as that associated with photon emission during cognition. Given the average of 6×10^6 neurons per 125 mm^3, the induced energy is equivalent to about 10^{-20} J per neuron. This value can be considered a quantum of universal energy and would be congruent with a condition that could promote non-locality."

4.1   Experimental arrangement and results

If I have understood correctly, the experimental arrangement was roughly following.

1. Two individual subjects were involved. The second subject was 300 km away. The other subject received stimuli at various frequencies of sound or flashes of light while the first person was unaware of these stimuli. Both members of the pair were exposed to a rotating, circular magnetic field whose frequency modulation would vary with rotation angle. This guarantees that the phase and group velocities of the magnetic field varied and were different.

2. It seems safe to assume that the magnetic field pattern used to stimulate brains of subject persons was identical with that applied in the second experiment.

Authors report a correlation between individual subjects in the sense that there were discrete changes in EEG power within the cerebral space of the second person even if he/she was not aware of the stimulus. The effect occurred only if the phase and group velocities assignable to the magnetic field were different. Authors interpret this as entanglement identified as excess correlation if the fields were activated around cerebrum simultaneously and were discrete and involved about single punctuate volumes of about 125 mm^3. Entanglement in this sense need not correspond to quantum entanglement although it could make it possible.

Authors introduce what they call quantum universal energy $E = 10^{-20}$ J, and estimate the that this is the induced energy per neuron transferred from the magnetic field to energy of EEG. In particle physicist's units this gives $E = 6.24 \times 10^{-2}$ eV. This would naturally correspond to energy gained by electron or proton in the resting potential E_{rest}, which is above $E_{min} = 6.15 \times 10^{-2}$ eV. Note that threshold potential for nerve pulse generation corresponds to energy $E_{thr} = 5.5 \times 10^{-2}$ eV. On the other hand, also the first experiment and predecessor of the second experiment involved visible photon emissions which suggests that also visible photons were emitted and they came from the transitions of the proton spin network associated with cell membrane proposed by Wu and Hu [J7].

4.2 TGD based interpretation

TGD interpretation should rely on the notion of magnetic body and a model for neuronal membrane as a super-conductor - at least electronic but possibly also ionic super-conductor), cyclotron Bose-Einstein condensed of biologically important ions, and the spin network of dark protons associated with the cell membrane discussed in TGD based model for the outcome of the experiment described in the first article.

1. The flux tubes of the rotating magnetic field would connect the subject persons into a single coherent unit reacting to the stimuli posed to second subject like a single unit. TGD assigns to the magnetic bodies large effective value of Planck constant so that photons with energies of order E would correspond to much longer wavelengths essential for the coherence in scales of the order of a few wave lengths.

2. The wave length $\lambda = 300$ km could correspond to the Planck constant $\hbar_{eff} \simeq \lambda/\lambda_0 = 1.5 \times 10^{10} \times \hbar$, where one has $\lambda_0 = c/E\hbar \simeq 20$ μm is the wavelength of photon with "quantum universal energy". This energy is in IR region just around thermal threshold. The corresponding period and frequency are $T = c/\lambda = 1$ ms and $f = 1$ kHz, which correspond to fundamental time scales for cell membrane with 1 ms defining the time scale of nerve pulse and 1 kHz defining an important resonance frequency in brain associated with the generation of coherence. Probably this is not an accident. The authors indeed mention that the effect is maximal at distance of 300 km.

Concerning the detailed interpretation of the experiment there are several options. First, TGD suggests two alternative models for cell membrane as Josephson junction involving currents of electron Cooper pairs and possibly also bosonic ions or Cooper pairs of fermionic ions. For the conservative option the cell membrane would be far-from- vacuum extremal carrying strong induced Kähler field. For the non-conservative option the cell membrane would be near-to-vacuum extremal making it maximally sensitive to sensory input. Secondly, the universal quantum suggests emission of dark IR photons, whereas the emission of visible photons associated with cognition suggests visible photons.

1. The "quantum universal energy" $E = eV_{rest} = 6.24 \times 10^{-2}$ eV would naturally correspond to the energy gained by electron or proton in a membrane potential slightly above the threshold potential. Also the conservative option for cell membrane as Josephson junction would predict Josephson radiation emitted at multiples of Josephson frequency $E = eV_{rest}$ or $E = eE_{thr}$.

2. The non-conservative option for the cell membrane as Josephson junction predicts that the emitted photons have visible energies. This option might be realized for photoreceptors in retina, which react to the sensory stimulus by variation of membrane potential instead of nerve pulse. The correlation of cognition with the emission of visible photons also allows one to consider the possibility that some neurons are near-to-vacuum extremals (also glial cells as cells which do not generate nerve pulses could be such). Since visible photon emissions are mostly from the right hemisphere, one can ask whether the emissions from the

left hemisphere are in IR region and those from right hemisphere in visible region and whether the different ground states of neurons as far-from- respectively near-to- vacuum extremals could distinguish between right and left hemisphere.

3. How does the spin network model based on dark proton strings relate to this? Since the photons have biological functions, the energies of all kinds of EEG photons should be in the same region of spectrum: visible or IR for a given hemisphere. For near-to-vacuum extremals the argument of Hu and Wu would be modified by replacing ordinary magnetic field with a combination of Z^0 magnetic field and ordinary magnetic field. This would imply that the energy scale would increase just as it does when Z^0 electric field dominates over em electric field. Therefore also the photons emitted by spin network at the right hemisphere would be dark EEG photons with energies of visible photons.

4. An alternative interpretation encouraged by the photon emission associated with cognition is that λ_0 corresponds to the energy of visible photon resulting in the transformation of dark ELF photon produced in the triplet-to-singlet transition of proton pair associated with the cell membrane as described in the interpretation of the first experiment. For a photon with energy 1.77 eV at the red end of visible spectrum this would give $\hbar_{eff} = 4.3 \times 10^{11}$. Interestingly, Cyril Smith [J10] reports on the basis of his own experimentation that the transformation of low energy photons to high energy photons and vice versa takes place for frequency ratio $f_h/f_l = 2 \times 10^{11}$: the interpretation would be also in this case in terms of $\hbar_{eff}$ [K11].

5   Conclusions

The results of the experiments of Persinger et al can be understood in the framework of TGD and the findings allow to develop more precise view about the role of dark electrons, protons, and ions in TGD inspired quantum biology.

1. The identification of the magnetic flux quanta connecting two systems as generators of macroscopic quantum coherence finds experimental support.

2. The proposal of Hu and Wu about proton spin networks associated with cell membrane has a TGD counterpart in terms of dark proton strings allowing interpretation as dark DNA. The spin-paired protons are assigned to the hydro-philic ends of the two lipids in the layers of the cell membrane and the dark proton strings define an analog of DNA double strand. The model of Wu and Hu is subject to the same objections as the model for cyclotron Bose-Einstein condensates and is circumvented by introducing the hierarchy of effective Planck constants.

3. The fact that photon emissions are detected only from the right hemisphere suggests that both options for the cell membrane as Josephson junction are realized: far-from-vacuum extremal option for the neurons of the left hemisphere with emissions in infrared and near-to vacuum extremal for the neurons of the right hemisphere.

To sum up, the resulting framework allows an overall view about the roles of both dark electrons, dark protons, and dark ions in quantum biology according to TGD.

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