Quantum Mind, Magnetic Body, and Biological Body

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Abstract

The article is devoted to detailed aplications of TGD inspired view about Quantum Mind. Magnetic body carrying dark matter and forming an onionlike structure with layers characterized by large values of Planck constant is the key concept. Magnetic body is identified as intentional agent using biological body as sensory receptor and motor instrument. EEG is identified as a communication and control tool of the magnetic body and a fractal hierachy 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 model of DNA as topological quantum computer is discussed as an application.

A general model for qualia is introduced. The identification of the correlates of the fundamental qualia as quantum number increments for a subsystem is in a complete analogy with the identification of quantum numbers as characterizers of physical states. A general classification of qualia based on thermodynamical notions is discussed and a mechanism generating sensory qualia is proposed. Also the question whether some qualia could correspond also to those of magnetic body is raised.

The capacitor model for sensory receptor based on the idea that sensory qualia are generated in the analog of di-electric breakdown introducing a flow of large number of particles with quantum numbers characterizing the quale. A model for the cell membrane as sensory receptor and as qualia chart with lipids serving as its pixels is developed. Although sensory rorgans are assumed to define the seats if the fundamental qualia, also neurons would define sensory homunculi not necessarily responsible for sensory mental images at our level of self hierarchy. Cell membrane is assumed to be a quantum critical system taken to mean that it is near to a vacuum extremal of so called Kähler action. This explains large parity breaking in living matter (chiral selection) very difficult to understand in standard model. The model explains the peak frequencies of visible light for photoreceptors and predicts that biophotons and bunches of EEG photons result as decay products of same dark photons with energies mostly in visible range.

The model of nerve pulse relies on the hypothesis that axonal membrane defines a Josephson junction. The ground state of the axon corresponds to a propagating soliton sequence for the phase difference over the membrane mathematically analogous to a sequence of coupled gravitational penduli with a constant phase difference between neighboring penduli. Nerve pulse is generated as one kicks one of the oscillating penduli. The model of nerve pulse explains the generation of EEG. The resonance frequencies of EEG can be understood as sums and differences of the harmonics of cyclotron frequencies of biologically important dark ions and of Josephson frequency.

1 Introduction

Quantum biology-rather than only quantum brain- is an essential element of Quantum Mind in TGD Universe. Cells, biomolecules, and even elementary particles are conscious entities and the biological evolution is evolution of consciousness so that it would be very artificial to restrict the discussion to brain, neurons, or microtubules. The basic new physics inspired ideas behind TGD inspired quantum biology have been discussed already in the first article but deserve to be listed.

- Many-sheeted space-time allows the interpretation of the structures of macroscopic world around us in terms of space-time topology. Magnetic/field body acts as intentional agent using biological body as a sensory receptor and motor instrument and controlling biological body and inheriting its hierarchical fractal structure. Fractal hierarchy of EEGs and its variants can be seen as communication

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and control tools of magnetic body. Also collective levels of consciousness have a natural interpretation in terms of magnetic body. Magnetic body makes also possible entanglement in macroscopic length scales.

- Zero energy ontology (ZEO) makes possible the proposed p-adic description of intentions and cognitions and their transformations to action. 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.

- The assignement 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.

- p-Adic physics can be identified as physics of cognition and intentionality. The hierarchy of p-adic length scales predicts a hierarchy of universal metabolic quanta as increments of zero point kinetic energies. Megentropic entanglement possible for number theoretic entanglement entropy makes sense for rational (and even algebraic) entanglement and leadsto the identification of life as something residing in the intersection of real and p-adic worlds.

In the following I briefly summarize some applications. I am of course forced to leave details to the books about TGD inspired theory of consciousness at my homepage [8, 9, 10, 12, 34, 13, 14, 15].

2 Quantum mind and magnetic body

The notion of magnetic/field body is probably the feature of TGD inspired theory of quantum biology which probably creates strongest irritation in standard model physicist. A ridicule as some kind of Mesmerism might be the probable reaction. The notion of magnetic/field body has however gradually gained more and more support and it is now an essential element of TGD based view about living matter. In the following I discuss the basic applications in the hope that the overall coherency of the picture might force some readers to take this notion seriously. The notion of magnetic body leads to a dramatic modification of the views about functions of brain and biological systems in general. I will talk mostly about magnetic body although it is clear that field body has also electric parts (electric flux quanta with cell membrane and various electrets populating living matter) as well as radiative parts realized in terms of "massless extremals" or topological light rays [25] providing correlates for EEG and its fractal analogs.

2.1 Magnetic body as intentional agent and experiencer

In TGD Universe brain would be basically a builder of symbolic representations assigning a meaning to the sensory input by decomposing sensory field to objects and making possible effective motor control by magnetic body containing dark matter. A concrete model for how magnetic controls biological body and receives information from it is discussed in the model for the nerve pulse [37] and for the hierarchy of EEGs [38, 39].

Also magnetic body could have sensory qualia, which should be in a well-defined sense more refined than ordinary sensory qualia [33]. The quantum number increments associated with cyclotron phase transitions of dark ion cyclotron condensates at magnetic body could relate to the cognitive and possibly also emotional content of sensory input and would indeed have interpretation as higher level sensory qualia. On the other hand, the positive/negative emotional coloring itself might be the core of what it is to be emotion and most naturally relates to the sign of negentropy increment in quantum jump so that it would not be a quale in the sense that visual colors are.

Right brain sings – left brain talks metaphor could characterize this emotional-cognitive (holistic-reductionistic) distinction for higher level qualia and would correspond to coding of sensory input from brain by frequency patterns *resp.* temporal patterns (analogs of phonemes). Fourier analysis indeed transforms local data into holistic data.

These qualia could be seen as somatosensory qualia at the level of magnetic body. One must be however cautious with interpretations. It is not all obvious whether the qualia should be assigned with body alone or magnetic body alone or both. Out of body experiences and various illusions such as train illusion and the disgusting sensation about falling when one is near the edge of cliff could be virtual world experiences resulting from the relative motion of the magnetic body with respect to the biological body: the sensory sensation would correspond to to the interference effects for dark photon radiation between the biological body and magnetic body [21].

TGD framework fundamental qualia are associated with sensory receptors although also neuronal qualia are possible. The new view about time allows to overcome the arguments suggesting that qualia must be solely at the level of brain (say the pain in phantom limb).

Remote mental interactions between magnetic body and biological body are a key element of this picture. Remote mental interactions in the usual sense of the world would occur between magnetic body and some other, not necessary biological, body. This would include receival of sensory input from and motor control of other than own body. Also inanimate matter (no negentropic entanglement) possesses magnetic bodies (so that also psychokinesis could be based on the same mechanism). Magnetic body for which dissipation is much smaller than for ordinary matter (proportional to $1/\hbar$), could continue its conscious existence after biological death and find another biological body and use it as a tool of sensory perception and intentional action.

2.2 Summary about the possible roles of the magnetic body in living matter

An attractive working hypothesis is that dark matter and negentropic entanglement can be assigned to the magnetic bodies. For instance, the dark elementary particles at the ends of the magnetic flux tubes connecting (say) biomolecules could be entangled negentropically. Negentropic entanglement, which is not identifiable as ordinary bound state entanglement, can be applied to explain the stability of high energy phosphate bond in ADP and ATP and of DNA polymers, which are highly charged and thus expected to be unstable [29]. This also allows to interpret metabolic energy transfer as a transfer of negentropic entanglement at the deeper level.

2.2.1 The anatomy of magnetic body

Consider first the anatomy of the magnetic body.

1. Magnetic body has a fractal onion like structure with decreasing magnetic field strengths and the highest layers can have astrophysical sizes. Cyclotron wave length gives an estimate for the size of particular layer of magnetic body. $B = .2$ Gauss is the field strength associated with a particular layer of the magnetic body assignable to vertebrates and EEG. This value is not the same as the nominal value of the Earth's magnetic field equal to .5 Gauss and follows from the TGD based explanation of the quantal effects of ELF em fields on vertebrate brain known for decades [61]. It is quite possible that the flux quanta of the magnetic body correspond to those of wormhole magnetic field and thus consist of two parallel flux quanta which have opposite time orientation. This is true for flux tubes assigned to DNA in the model of DNA as a topological quantum computer [30, 31].

2. The layers of the magnetic body are characterized by the values of Planck constant and the matter at the flux quanta can be interpreted as macroscopically quantum coherent dark matter. This picture makes sense only if one accepts the generalization of the notion of imbedding space [18].

3. In the case of wormhole magnetic fields it is natural to assign a definite temporal duration to the flux quanta and the time scales defined by EEG frequencies are natural. Encouragingly, the inherent time scale .1 seconds assignable to electron as a duration of zero energy space-time sheet in zero energy ontology having positive and negative energy electron at its ends would correspond to 10 Hz cyclotron frequency for ordinary value of Planck constant. For larger values of Planck constants the time scale scales as $\hbar$. Quite generally, a connection between p-adic time scales of EEG and those of electron and lightest quarks is highly suggestive since light quarks play key role in the model of DNA as topological quantum computer.

4. TGD predicts also a fractal hierarchy of scaled variants of electro-weak and color physics so that ZXG, QXG, and GXG corresponding to Z^0 boson, W boson, and gluons appearing effectively as massless dark particles below some biologically relevant length scale suggest themselves. In this phase quarks and gluons are unconfined and electroweak symmetries are unbroken so that gluons, weak bosons, quarks and even neutrinos might be relevant to the understanding of living matter. In particular, long ranged entanglement in charge and color degrees of freedom becomes possible. For instance, TGD based model of atomic nucleus as nuclear string suggests that biologically important fermionic could be actually chemically equivalent bosons and form cyclotron Bose-Einstein condensates.

This picture would mean that dark matter -usually believed to interact extremely weakly with the ordinary matter- would become a key player in biology. The failure to observe dark matter would be the completely wrong view about its nature. In TGD framework dark matter would make itself visible both via classical em fields and via the phase transitions transforming dark photons to ordinary ones. For instance, bunches of EEG photons and biophotons could be interpreted as decay products dark photons [38].

2.2.2 Some functions of the magnetic body

The list of possible functions of the magnetic body is already now rather impressive.

1. Magnetic body controls biological body and receives sensory data from it. Together with zero energy ontology and new view about time explains Libet's strange findings about time lapses of consciousness [73] in terms of time taken for the sensory signals from biological body to propagate to the appropriate layer of the magnetic body [38]. EEG, or actually fractal hierarchy of EXGs assignable to various body parts makes possible communications to and control by the various layers of the magnetic body. WXG could induce charge density gradients by the exchange of W boson. Also the gluonic counterparts of EXG:s -QXG- are possible.

2. The flux sheets of the magnetic body traverse through DNA strands. The hierarchy of Planck constants and quantization of magnetic flux predicts that the flux sheets can have arbitrarily large width [28]. This leads to the idea that there is hierarchy of genomes corresponding to ordinary genome, supergenome consisting of genomes of several cell nuclei arranged along flux sheet like lines of text, and hypergenomes involving genomes of several organisms arranged in a similar manner. The prediction is coherent gene expression at the level of organ, and even of population.

   For instance, one could see the observed correlations between EEGs of two improvising musicians [72], the findings of Germine [74] and also those of Persinger and colleagues about macro-entanglement [69] as an experimental support for both macroscopic entanglement between brain and for the crucial role of magnetic body as a space-time correlate for this entanglement. In this picture the great leaps in evolution, in particular, the emergence of EEG, could be seen as the emergence of a new larger layer of magnetic body characterized by a larger value of Planck constant. For instance, this would allow to understand why the quantal effects of ELF em fields [61] requiring so large a value of Planck constant that cyclotron energies are above thermal energy at body temperature are observed for vertebrates only.

3. Magnetic body makes possible information processing in a manner highly analogous to topological quantum computation [30]. The model of DNA as topological quantum computer [30] assumes that flux tubes of wormhole magnetic field connect DNA nucleotides with the lipids of the lipid layer of nuclear or cell membrane. The flux tubes would continue through the membrane and split during topological quantum computation. The time-like braiding of flux tubes makes possible topological quantum computation via timelike braiding and the induced space-like braiding makes possible the representation of memories. The model allows general vision about the deeper meaning of the structure of cell and makes testable predictions about DNA. A good metaphor is dancers with feet connected to the walls of the dancing hall by threads. The dance representing quantum computation is coded to the braiding of the threads.

One prediction is the coloring of braid strands realized by an association of quark or antiquark to nucleotide so that scaled up dark copy of QCD in cellular length scale would be involved. Color and spin of quarks and antiquarks would thus correspond to the quantum numbers assignable to braid ends. Color isospin could replace ordinary spin as a representation of qubit and quarks would naturally give rise to qutrit, with third quark would have interpretation as unspecified truth value. Fractionization of these quantum numbers takes place which increases the number of degrees of freedom.

This prediction would relate closely to the discovery of topologist Barbara Shipman [40] that the model for the honeybee dance suggests that quarks are in some manner involved with cognition - something totally unimaginable unless one accepts the possibility of fractal hierarchies of electroweak and hadronic physics. Also microtubules associated with axons connected to a space-time sheet outside axonal membrane via lipids could be involved with topological quantum computation and actually define an analog of a higher level programming language.

4. The strange findings about the behavior of cell membrane are summarized in [49] and discussed in TGD framework in [37]. Mention only the finding that metabolic deprivation does not lead to the death of cell, the discovery that ionic currents through the cell membrane are quantal, and that these currents are essentially similar than those through an artificial membrane, suggest that the ionic currents are dark ionic Josephson currents along magnetic flux tubes. A high percent of biological ions would be dark and ionic channels and pumps would be responsible only for the control of the flow of ordinary ions through cell membrane.

A further important finding is that the water in the cell interior in gel phase is ordered and nearer to ice that liquid [49]. This explains nicely the stability of DNA and various biopolymers as being due to the fact that depolymetrization by hydration is not possible in this phase. One could envisage the resting state of cell as a cellular winter during which proteins are folded or frozen to unfolded configurations by strong hydrogen bonds. External perturbation feeds energy to the system and induces periods during which the ice is frozen and proteins wake up and begin to unfold or fold and form aggretates as a response to the perturbation and return to the ground state after the energy of the signal is dissipated.

5. These findings together with the discovery that also nerve pulse seems to involve only low dissipation lead to a model of nerve pulse in which dark ionic currents automatically return back as Josephson currents without any need for pumping. This does not exclude the possibility that ionic channels might be involved with the generation of nerve pulse. In TGD inspired model [37] nerve pulse would result as a perturbation of $f \simeq 1$ kHz frequency soliton sequence mathematically equivalent to a situation in which a sequence of gravitational penduli rotates with constant phase difference between neighbors except for one pendulum which oscillates and oscillation moves along the sequence with the same velocity as the kHz wave. The oscillation would be induced by a "kick" for which one can imagine several mechanisms. Nerve pulse would be like dissonance in background harmony. This view conforms with the general vision that any equilibium in living matter is homeostasis rather than analog of equilibrium in mechanical system.

The model explains some features of nerve pulse not explained by Hodkin-Huxley model. These include the mechanical changes associated with axon during nerve pulse, the outwards force generated by nerve pulse with a correct prediction for its order of magnitude, the adiabatic character of nerve pulse, and the small rise of temperature of membrane during pulse followed by a reduction slightly below the original temperature.

The model predicts that the time taken to travel along any axon is a multiple of time dictated by the resting potential so that synchronization is an automatic prediction and would have nothing to do with transmitters. Not only kHz waves but also a fractal hierarchy of EEG (and EXG) waves are induced as Josephson radiation by voltage waves along axons and microtubules and by standing waves assignable to neuronal (cell) soma. The value of Planck constant involved with flux tubes determines the frequency scale of EXG so that a fractal hierarchy results.

The model forces to challenge the existing interpretation of nerve pulse patterns and the function of neural transmitters. Neural transmitters need not represent actual/only) signal but could be more

analogous to links in quantum web. The transmitter would code the address of the receiver, which could be a gene inside neuronal nucleus. Nerve pulses would build a connection line between sender and receiver of nerve pulse along which actual signals would propagate. Also quantum entanglement between receiver and sender can be considered.

6. Acupuncture points, meridians, and Chi are key notions of Eastern medicine and find a natural identification in terms of magnetic body lacking from the western medicine. Also a connection with well established notions of DC currents and potentials discovered by Becker and with TGD based view about universal metabolic currencies as differences of zero point energies for pairs of space-time sheets with different p-adic length scale emerges [35]. The spectrum for increments of zero point kinetic energies represents lines which cannot be explained in terms of molecule physics and the empirical evidence for them is discussed in [24]

   Chi would correspond to these fundamental metabolic energy quanta to which ordinary chemically stored metabolic energy would be transformed. The identification nearest in spirit to the the original intuition would be in terms of negentropic entanglement. Meridians would most naturally correspond to flux tubes with large $\hbar$ along which dark supra currents flow without dissipation and transfer the metabolic energy between distant cells. Acupuncture points would correspond to points between which metabolic energy is transferred and their high conductivity and semiconductor like behavior would conform with the interpretation in terms of metabolic energy storages.

   The energy gained in the potential difference between the points would help to kick the charge carrier to a smaller space-time sheet. It is possible that the main contribution to the of charge at magnetic flux tube is magnetic energy and slightly below the metabolic energy quantum and that the voltage difference gives only the lacking small energy increment making the transfer possible. Also direct kicking of charge carriers to smaller space-time sheets by photons is possible and the observed action spectrum for IR and red photons corresponds to the predicted increments of zero point kinetic energies.

7. The notion of magnetic body implies the notion of magnetic motor actions. Magnetic flux tubes and their motor actions could play key role in bio-catalysis and explain the magic ability of biomolecules to find each other. The model of DNA as topological quantum computer [30] suggest that not only DNA and its conjugate but also some amino-acid sequences acting as catalysts could be connected to DNA and other amino-acids sequences or more general biomolecules by flux tubes acting as colored braid strands. The shortening of the flux tubes in a phase transition reducing the value of Planck constant would make possible extremely selective mechanisms of catalysis allowing precisely defined locations of reacting molecules to attach to each other. With recently discovered mechanism for programming sequences of biochemical reactions (based on idea that each step in the reaction sequence means key allowing to open the door to the room containing the next key) [55] this would make possible to understand the miraculous looking feats of bio-catalysis. Second key mechanism would be the re-connection of the magnetic flux tubes changing the topology of the Indra's net formed by magnetic flux tubes having biomolecules at their nodes.

8. Water memory is one of the highly disputed notions and motivated by the claimed effects of homeopathy. Water memory for which the work of the group led by HIV Nobelist L. Montagnier [50] gives support would be naturally based on the coding of the biologically relevant properties of molecules to the cyclotron frequencies of its magnetic body. Water memory could rely on the copies of this magnetic body.

   Quite surprisingly, the finding of the group suggest also that genetic code might have higherto unknown realization. TGD indeed predicts several realizations, for instance those based on electromagnetic field patterns [28]. The model of watermemory [36] in turn led to a theoretical surprise [31]. One could understand DNA, RNA, tRNA, and aminoacids in terms of states of dark nucleons constructed from three quarks and that vertebrate genetic code follows as a prediction in the sense that the numbers of counterparts of DNA codons coding for given amino-adic are predicted correctly [16]. Prebiotic evolution as a process leading to a chemical realization of fundamental codes and counterparts of biomolecules existing already at the level of elementary particle physics together

with the reduction of metabolic currencies to increments of zero point energies would solve two egg or hen problems of theoretical biology.

There is no reason to assume that dark genes would not be still there and in close interaction with ordinary genes and in principle they could make possible controlled evolution analogous to industrial R&D process based on the construction of new genetic variants at the virtual world level of dark genes and the transcriptions to ordinary genes so that the new options could be tested under real life situations.

9. Although not directly related to the notion of magnetic body, the ability to construct "stories", temporally scaled down or possible also scaled up representations about the dynamical processes of external world, deserves to be mentioned. This ability might be actually one of the key aspects of intelligence [30]. There is direct empirical evidence for this activity in hippocampus [60]. The phase transitions reducing or increasing the value of Planck constant would indeed allow to achieve this by scaling the time duration of the zero energy space-time sheets providing cognitive representations.

2.2.3   Direct experimental evidence for the notion of magnetic body carrying dark matter

The list of nice things made possible by the magnetic body is impressive and one can ask whether there is any experimental support for this notion. The evidence from water memory has been already mentioned. An explanation for the impressive list of anomalies of water [43] discussed in [17] provide one possible manner to justify the notion. For instance, it is known that in attosecond time scales water behaves as $H_{1.5}O$ [44, 45, 46] as if part of hydrogen atoms would be dark.

The findings of Peter Gariaev and collaborators give evidence for the representation of DNA sequences based on the coding of nucleotide to a rotation angle of the polarization direction as photon travels through the flux tube and for the decoding of this representation to gene activation [52], for the transformation of laser light to light at various radio-wave frequencies having interpretation in terms of phase transitions increasing $\hbar$ [53, 51], and even for the possibility to photograph magnetic flux tubes containing dark matter by using ordinary light in UV-IR range scattered from DNA [54].

2.3   DNA as topological quantum computer

The vision about how DNA might act as a topological quantum computer (TQC) [41] is few years old [30]. TQC means that the time-like braidings of braid strands define TQC programs and M-matrix (generalization of S-matrix in zero energy ontology) defining the time-like entanglement between states assignable to the end points of strands define the TQC program coded as unitary time evolution for Schrödinger equation in the standard framework. One can end up to the model in the following manner.

1. Darwinian selection for which the standard theory of self-organization provides a model, should apply also to TQC programs. TQC programs should correspond to asymptotic self-organization patterns selected by dissipation in the presence of metabolic energy feed. The spatial and temporal pattern of the metabolic energy feed characterizes the TQC program - or equivalently - sub-program call.

2. Since braiding characterizes the TQC program, the self-organization pattern should correspond to a hydrodynamical flow or a pattern of magnetic field inducing the braiding. Braid strands must correspond to magnetic flux tubes of the magnetic body of DNA. If each nucleotide is transversal magnetic dipole it gives rise to transversal flux tubes, which can also connect to the genome of another cell. As a matter fact, the flux tubes would correspond to what I have used to call wormhole magnetic fields [26] having pairs of space-time sheets carrying opposite magnetic fluxes. The wormholes themselves could have interpretation as dark scaled variants of ordinary elementary particles. The large value of Planck constant would zoom up the magnetic fields associated with ordinary elementary particles from weak scale to much longer length scale given by cell size or even a longer length scale.

3. The output of TQC sub-program is probability distribution for the outcomes of state function reduction so that the sub-program must be repeated very many times. It is represented as four-dimensional patterns for various rates (chemical rates, nerve pulse patterns, EEG power distributions,...) having also identification as temporal densities of zero energy states in various scales.

   By the fractality of TGD Universe there is a hierarchy of TQCs corresponding to p-adic and dark matter hierarchies. Programs (space-time sheets defining coherence regions) call programs in shorter scale. If the self-organizing system has a periodic behavior each TQC module defines a large number of almost copies of itself asymptotically. Generalized EEG could naturally define this periodic pattern and each period of EEG would correspond to an initiation and halting of TQC. This brings in mind the periodically occurring sol-gel phase transition inside cell near the cell membrane. There is also a connection with hologram idea: EEG rhythm corresponds to reference wave and nerve pulse patters to the wave carrying the information and interfering with the reference wave.

4. Fluid flow would naturally induce the braiding which requires that the ends of braid strands must be anchored to the fluid flow. Recalling that lipid mono-layers of the cell membrane are liquid crystals and lipids of interior mono-layer have hydrophilic ends pointing towards cell interior, it is easy to guess that DNA nucleotides are connected to lipids by magnetic flux tubes and hydrophilic lipid ends are stuck to the flow. Also nerve pulse patterns could induce the flow of lipids inducing the braiding so that nerve pulse patterns would define TQC programs and be coded into memories.

5. The topology of the braid traversing cell membrane cannot be affected by the hydrodynamical flow. Hence braid strands must be split during TQC. This also induces the desired magnetic isolation from the environment. Halting of TQC reconnects them and make possible the communication of the outcome of TQC.

This is one possible realization and it is of course clear that one can imagine several alternatives. There are several problems related to the details of the realization.

1. How nucleotides A,T,C,G are coded to the strand color and what this color corresponds to physically? There are two options which could be characterized as fermionic and bosonic.

   (a) Magnetic flux tubes having quark and anti-quark at their ends with u,d and u_c, d_c coding for A,G and T,C. CP conjugation would correspond to conjugation for DNA nucleotides.

   (b) Wormhole magnetic flux tubes having wormhole contact and its CP conjugate at its ends with wormhole contact carrying quark and anti-quark at its throats. The latter are predicted to appear in all length scales in TGD Universe.

2. How to split the braid strands in a controlled manner? High T_c super conductivity provides a possible mechanism: braid strand can be split only if the supra current flowing through it vanishes. A suitable voltage pulse induces the supra-current and its negative cancels it. The conformation of the lipid controls whether it it can follow the flow or not.

3. How magnetic flux tubes can be cut without breaking the conservation of the magnetic flux? The notion of wormhole magnetic field could save the situation now: after the splitting the flux returns back along the second space-time sheet of wormhole magnetic field. An alternative solution is based on reconnection of flux tubes. Since only flux tubes of same color can reconnect this process can induce transfer of color: "color inheritance": when applied at the level of amino-acids this would give strong constraints on the model of protein folding [32]. Reconnection makes possible breaking of flux tube connection for both the ordinary magnetic flux tubes and wormhole magnetic flux tubes.

4. How magnetic flux tubes are realized? The interpretation of flux tubes as correlates of directed attention at molecular level suggests a rather concrete picture. Hydrogen bonds are by their asymmetry natural correlates for a directed attention at molecular level. Also flux tubes between acceptors of hydrogen bonds must be allowed and acceptors can be seen as the subjects of directed attention and donors as objects. Examples of acceptors are aromatic rings of nucleotides, $O =$ atoms of phosphates, etc.. A connection with metabolism is obtained if it is assumed that various phosphates

$XMP, XDP, XTP, X = A, T, G, C$ act as fundamental acceptors and plugs in the connection lines. The basic metabolic process $ATP \rightarrow ADP + P_i$ allows an interpretation as a reconnection splitting flux tube connection, and the basic function of phosphorylating enzymes would be to build flux tube connections as also of breathing and photosynthesis.

The model makes several testable predictions about DNA itself. In particular, matter-antimatter asymmetry and slightly broken isospin symmetry at the level of dark quarks have counterparts at DNA level induced from the breaking of these symmetries for quarks and antiquarks associated with the flux tubes. DNA cell membrane system is not the only possible system that could perform TQC like activities and store memories in braidings: flux tubes could connect biomolecules and the negentropic braiding could provide an almost definition for what it is to be living. Even water memory might reduce to braidings.

The model leads also to an improved understanding of other roles of the magnetic flux tubes containing dark matter. Phase transitions changing the value of Planck constant for the magnetic flux tubes could be key element of bio-catalysis and electromagnetic long distance communications in living matter. There is also a fascinating connection with Peter Gariaev's work [54] suggesting that the phase transitions changing Planck constant have been observed and wormhole magnetic flux tubes containing dark matter have been photographed in his experiments [27].

3 A general model for qualia

The connection between the general theory of qualia and quantum measurement theory and thermodynamics turned out to be a breakthrough in the development of the ideas related to qualia. In TGD framework the contents of consciousness is determined as some kind of average over the sequence of very large number of quantum jump and this suggests strongly that non-geometric qualia allow a statistical description generalizing ordinary thermodynamical ensemble to the ensemble formed by the prepared states in the sequence of quantum jumps after the last 'wake-up' of self.

1. There are geometric qualia corresponding to zero modes expressing the result of quantum measurement in each quantum jump. All geometric information about space-time surface should reduce to geometric qualia. For instance, geometric data given by visual, auditory, and tactile senses should reduce to conscious information about zero modes or about increments of zero modes in quantum jump.

2. The sequence of the prepared states can be modelled as a statistical ensemble of Fock states, which suggests that thermodynamics is basically part of theory of consciousness. The ensemble of prepared states gives rise to a large number of statistical qualia. The relationship $dE = TdS - PdV + \mu dN + B \cdot dM...$ generalizes to TGD context. Each intensive-extensive variable pair in the differential should correspond to a non-geometric quale, which results only when there is a gradient (flow) of the extensive variable in the direction of the subjective time. Super-canonical thermodynamics should obviously map ordinary thermodynamics to the level of conscious experience.

3. Since subjective existence corresponds to quantum jumps, it is natural to assume that only the increments of zero modes and quantum numbers are experienced consciously. Statistical interpretation also suggests that an averaging over the increments occurs. The possibility of sub-selves makes possible to have sequences of sub-selves (mental images) of finite subjective time duration and this makes possible structured subjective memories (for instance, it becomes possible to remember the digits of a phone number). A further working hypothesis analogous to functionalism is universality: kinesthetic qualia depending on the quantum number increments are universal. Thus the increments of Poincare and color and electro-weak quantum numbers define what might be called universal kinesthetic qualia.

3.1 A possible classification of qualia

The thermodynanical expression for dE suggests a general classification of qualia consistent with the 'holy trinity' of existences implied by TGD.

1. Emotions as order-disorder qualia

$T-S$ pair correspond subjective existence and generalizes to disorder-order type, information theoretic qualia about the state of self. The fact that emotions correlate strongly with peptides which are also informational molecules, supports the identification of the qualia associated with various entropy growth rates as emotions. The entropy of sub-self in turn characterizes the sharpness of the mental image. The discovery of the notion of number theoretic negentropy as a measure of conscious information allows to replace entropy with negentropy but the idea remains the same.

2. Kinesthetic qualia defined by generalized forces

p-V pair corresponds to the geometric existence and is replaced with generalized force-generalized coordinate pairs in quantum fluctuating degrees of freedom. Quite generally, the rates for the increase for a maximum number of mutually commuting Poincare, color and electro-weak quantum numbers define what might be called kinesthetic qualia. Senses of force and torque, hearing, and intensity of color sensation can be regarded as examples of generalized kinesthetic qualia.

3. Generalized chemical qualia

$\mu - N$ pair corresponds to 'objective existence' defined by quantum histories and N is generalized to a number of particle like excitations in the Fock state resulting in the state preparation. In this case there must be a flow of particle number in the direction of the subjective time, that is Bose-Einstein condensation type process for, say Cooper pairs. The particle numbers in question can be numbers of ions of Cooper pairs in various magnetic states, numbers of particles with given quantum numbers, numbers of join along boundaries bonds, etc.. and one should understand chemical qualia, color vision, and perhaps also sensations of pain and pleasure as generalized chemical qualia.

4. Boolean qualia

Boolean consciousness can be assigned with fermionic states since the Fock state basis for fermions naturally forms a representation of Boolean algebra. Besides fermion number also various spin like variables automatically associated with the fermionic oscillator operator algebra can code for truth values. Zero energy ontology and negentropic entanglement allow to code rules $A \rightarrow B$ by time-like entanglement in fermionic degrees of freedom with the states in the superposition representing special instances of the rule. 'This is true' experience wold correspond to the negentropic Boolean entanglement. One could interpret M-matrices as coding of laws of physics to the structure of zero energy state itself. In positive energy ontology this is not possible.

3.2 The mechanisms generating sensory qualia

One can imagine two basic mechanisms generating sensory qualia.

1. Quantum phase transition in which single particle transition occurs coherently for some macroscopic quantum phase produces qualia defined by the increments of quantum numbers in the transition. Quantum phase transition could be induced by the transition frequency: quantum phase transition leading to the generation of new kind of macroscopic quantum phase would be in question. The magnetic quantum phase transitions at super-conducting magnetic flux tubes provide a basic example of this mechanism.

2. The flow of particles with fixed quantum numbers between "electrodes" during "di-electric breakdown" of what might be called a quantum capacitor induces qualia defined by the quantum numbers of the particles involved. The "electrodes" carry opposite net quantum numbers. Second electrode corresponds to the sub-self defining the quale mental image. Obviously cell interior and exterior are excellent candidates for the electrodes of the quantum capacitor. Also neuron and postsynaptic neuron. In fact, living matter is full of electrets defining capacitor like structures. The capacitor model applies to various chemical qualia and also to color vision and predicts that also cells should have senses.

3.3 Could some sensory qualia correspond to the sensory qualia of the magnetic body?

Concerning the understanding of a detailed model for how sensory qualia are generated, the basic guideline comes from the notion of magnetic body and the idea that sensory data are communicated to the magnetic body as Josephson radiation associated with the cell membrane. This leaves two options: either the primary a sensory qualia are generated at the level of sensory receptor and the resulting mental images negentropically entangle with the "feeling of existence" type mental images at the magnetic body or they can be also generated at the level of the magnetic body by Josephson radiation -possibly as cyclotron transitions. The following arguments are to-be-or-not-to-be questions about whether the primary qualia must reside at the level of sensory receptors.

1. Cyclotron transitions for various cyclotron condensates of bosonic ions or Cooper pairs of fermionic ions or elementary particles are assigned with the motor actions of the magnetic body and Josephson frequencies with the communication of the sensory data. Therefore it would not be natural to assign qualia with cyclotron transitions. One the other hand, in zero energy ontology motor action can be regarded formally as a time reversed sensory perception, which suggests that cyclotron transitions correlated with the "feeling of existence" at magnetic body entangled with the sensory mental images. They could also code for the pitch of sound as will be found but this quale is strictly speaking also a geometric quale in the 4-D framework.

2. If Josephson radiation induces cyclotron transitions, the energy of Josephson radiation must correspond to that of cyclotron transition. This means very strong additional constraint not easy to satisfy except during nerve pulse when frequencies varying from about 10^{14} Hz down to kHz range are emitted the system remains Josephson contact. Cyclotron frequencies are also rather low in general, which requires that the value of $\hbar$ must be large in order to have cyclotron energy above the thermal threshold. This would however conform with the very beautiful dual interpretation of Josephson photons in terms of biophotons and EEG. One expects that only high level qualia can correspond to a very large values of $\hbar$ needed.

   For the sake of completeness it should be noticed that one might do without large values of $\hbar$ if the carrier wave with frequency defined by the metabolic energy quantum assignable to the kicking and that the small modulation frequency corresponds to the cyclotron frequence. This would require that Josephson frequency corresponds to the frequency defined by the metabolic quantum. This is not consistent with the fact that very primitive organisms possess sensory systems.

3. If all primary qualia are assigned to the magnetic body, Josephson radiation must include also gluons and light counter parts of weak bosons are involved besides photons. This is quite a strong additional assumption and it will be found that the identification of sensory qualia in terms of quantum numbers of quark pair restrictes them to the cell membrane. The coding of qualia by Josephson frequencies is however possible and makes it possible to regenerate them in nervous system. The successful model explaining the peak frequencies of photoreceptors in terms of ionic cyclotron frequencies supports this view and provides a realization for an old idea about spectroscopy of consciousness which I had already been ready to give up.

3.4 Summary about qualia

The general vision about sensory qualia and geometric qualia in TGD Universe would be as follows.

1. The basic assumption is that sensory qualia correspond to increments of various quantum numbers in quantum jump. Standard model quantum numbers- color quantum numbers, electromagnetic charge and weak isospin, and spin are the most obvious candidates. Also cyclotron transitions changing the integer characterizing cyclotron state could corresponds to some kind of quale- perhaps 'a feeling of existence'. This could make sense for the qualia of the magnetic body. Boolean qualia could result in the similar manner with fermion number in given mode and spin like quantum numbers of fermions coding for the Boolean truth values.

2. Geometric qualia could correspond to the increments of zero modes characterizing the induced CP_2 Käjhler form of the partonic 2-surface and of the moduli characterizing the causal diamonds serving as geometric correlates of selves. This moduli space involves the position of CD and the relative position of tips as well as position in CP_2 and relative position of two CP_2 points assigned to the future and past boundaries of CD. There are good motivations for proposing that the relative positions are quantized. This gives as a special case the quantization of the scale of CD in powers of two. Position and orientation sense could would represent this kind of qualia. Also kinematical qualia like sensation of acceleration could correspond to geometric qualia in generalized 4-D sense. For instance, the sensation about motion could be coded by Lorentz boots of sub-CD representing mental image about the object.

3. One can in principle distinguish between qualia assignable to the biological body (sensory receptors in particular) and magnetic body. The basic question is whether sensory qualia can be assigned only with the sensory receptors or with sensory pathways or with both. Geometric qualia might be assignable to the magnetic body and could provide third person perspective as a geometric and kinematical map of the body and its state of motion represented using the moduli space assignable to causal diamonds (CD). This map could be provided also by the body in which case the magnetic body would only share various mental images.

   The simplest assumption consistent with neuro-science is that sensory qualia are assigned with the cell membrane of sensory receptor and perhaps also with the neurons receiving data from it carried by Josephson radiation coding for the qualia and possibly partially regenerating them if the receiving neuron has same value of membrane potential as the sensory receptor when active. Note that during nerve pulse also this values of membrane potential is achieved for some time.

4 Model for sensory receptor

The emergence of zero energy ontology, the explanation of dark matter in terms of a hierachy of Planck constants requiring a generalization of the notion of imbedding space, the view about life as something in the intersection of real and p-adic worlds, and the notion of number theoretic entanglement negentropy lead to the breakthrough in TGD inspired quantum biology and also to the recent view of qualia and sensory representations including hearing allowing a precise quantitative model at the level of cell membrane.

Also in the recent view long range weak forces however play a key role [24]. They are made possible by the exotic ground state represented as almost vacuum extremal of Kähler action for which classical em and Z^0 fields are proportional to each other wheras for standard ground state classical Z^0 fields are very weak. Neutrinos are present but it seems that they do not define cognitive or Boolean representations in the time scales characterizing neural activity. Electrons and quarks for which the time scales of causal diamonds correspond to fundamental biorhythms - one of the key observations during last years- take this role.

4.1 Capacitor model of sensory qualia

In capacitor model of sensory receptor the increments of quantum numbers are amplified as particles with given quantum numbers flow between the plates of capacitor like system and the second plate defines the subself responsible for the mental image. The generation of complementary qualia assignable to the two plates and bringing in mind complementary colors is predicted. The capacitor is at the verge of di-electric breakdown. The interior and exterior of the receptor cell are the most plausible candidates for the capacitor plates with lipid layers defining the analog of di-electric able to changes its properties. Josephson currents generating Josephson radiation could communicate the sensory percept to the magnetic body but would not generate genuine sensory qualia there (the pitch of sound would be interpreted as a geometric quale). The coding is possible if the basic qualia correspond in one-one manner to ionic Josephson currents. There are sensory receptors which themselves do not fire (this is the case for hair cells for hearing and tactile receptor cells) and in this case the neuron next to the receptor in the sensory pathway would take the role of the quantum critical system.

The notion of sensory capacitor can be generalized. In zero energy ontology the plates could be effectively replaced with positive and negative energy parts of zero energy state or with cyclotron Bose-Einstein condensates corresponding to two different energies. Plates could also correspond to a pair of space-time sheets labeled by different p-adic primes and the generation of quale would correspond in this case to a flow of particles between the space-time sheets or magnetic flux tubes connected by contacts defining Josephson junctions.

The ensuing general model of how cell membrane acts as a sensory receptor allows a concrete model for sensory capacitor.

1. The most important implication concerning the model of sensory receptors however relate to the vacuum degeneracy of Kähler action. It has been clear from the beginning that the nearly vacuum extremals of Kähler action could play key role key role in living systems. The reason is their criticality making them ideal systems for sensory perception. These extremals carry classical em and Z^0 fields related to each other by a constant factor and this could explain the large parity breaking effects characterizing living matter. The assumption that cell membranes are nearly vacuum extremals and that nuclei can feed their Z^0 charges to this kind of space-time sheets (not true for atomic electrons) in living matter leads to a modification of the model for the cell membrane as Josephson junction. Also a model of photoreceptors explaining the frequencies of peak sensitivity as ionic Josephson frequencies and allowing the dual identifications Josephson radiation as biophotons (energies) and EEG radiation (frequencies) emerge since the values of Planck constant can be very large. The value of the Weinberg angle in this phase is fixed to $sin^2(\theta_W) = .0295$, whereas in standard phase the value is given by $sin^2(\theta_W) = .23$. The significance of this quantitative success for TGD and TGD inspired quantum biology cannot be over-estimated.

2. DNA as topological quantum computer model plus certain simplifying assumption leads to the conclusion that the spectrum of net quantum numbers of quark antiquark pair define the primary qualia assignable to a nucleotide-lipid pair connected by a magnetic flux tube. The most general prediction is that the net quantum numbers of two quark pairs characterize the qualia. In the latter case the qualia would be assigned to a pair of receptor cells.

3. Composite qualia result when one allows the nucleotide-lipid pairs of the membrane to be characterized by a distribution of quark-antiquark pairs. Cell membrane -or at least the axonal parts of neurons- would define a sensory representation in which is a pair of this kind defines a pixel characterized by primary qualia. Cells would be sensory homunculi and DNA defines a sensory hologram of body of or of part of it. Among other things this would give a precise content to the notion of grandma cell.

4. Josephson frequencies of biologically important ions are in one-one correspondence with the qualia and Josephson radiation could re-generate the qualia or map them to different qualia in a one-one and synesthetic manner in the neurons of the sensory pathway. For large values of Planck constant Josephson frequencies are in EEG range so that a direct connection with EEG emerges and Josephson radiation indeed corresponds to both biophotons and EEG. This would realize the notion of sensory pathway which originally seemed to me a highly non-realistic notion and led to the vision that sensory qualia can be realized only at the level of sensory organs in TGD framework.

5. At the level of brain motor action and sensory perception look like reversals of each other. In zero energy ontology motor action can be indeed seen as a time reversed sensory perception so that the model of sensory representations implies also a model for motor action. Magnetic body serves as a sensory canvas where cyclotron transitions induced by Josephson frequencies induce conscious sensory map entangling the points of the magnetic body with brain and body.

4.2   Could cell correspond to almost vacuum extremal?

The question whether cell could correspond almost vacuum extremal of Kähler action was the question which led to the realization that the frequencies of peak sensitivity for photoreceptors correspond to the Josephson frequencies of biologically important ions if one accepts that the value of the Weinberg

angle equals to $sin^2(\theta_W) = .0295$ instead of the value .23 in the normal phase, in which the classical elecromagnetic field is proportional to the induced Kähler form of CP_2 in a good approximation. The assumption about the value of Weinberg angle can be used as the basic objection against the model. Another implication made possible by the large value of Planck constant is the identification of Josephson photons as the counterparts of biophotons one one hand and those of EEG photons on the other hand. These observation in turn led to a detailed model of sensory qualia and of sensory receptor. Therefore the core of this argument deserves to be represented also here although it has been discussed in [37].

4.2.1   Cell membrane as almost vacuum extremal

Although the fundamental role of vacuum extremals for quantum criticality and life has been obvious from the beginning, it took a long time to realize how one could model living cell as this kind of system.

1. Classical electric fields are in a fundamental role in biochemistry and living biosystems are typically electrets containing regions of spontaneous electric polarization. Fröhlich [48] proposed that oriented electric dipoles form macroscopic quantum systems with polarization density serving as a macroscopic order parameter. Several theories of consciousness share this hypothesis. Experimentally this hypothesis has not been verified.

2. TGD suggests much more profound role for the unique di-electric properties of the biosystems. The presence of strong electric dipole fields is a necessary prequisite for cognition and life and could even force the emergence of life. Strong electric fields imply also the presence of the charged wormhole BE condensates: the surface density of the charged wormholes on the boundary is essentially equal to the normal component of the electric field so that wormholes are in some sense 'square root' of the dipole condensate of Fröhlich! Wormholes make also possible pure vacuum polarization type dipole fields: in this case the magnitudes of the em field at the two space-time sheets involved are same whereas the directions of the fields are opposite. The splitting of wormhole contacts creates fermion pairs which might be interpreted as cognitive fermion pairs. Also microtubules carry strong longitudinal electric fields.

   This formulation emerged much before the identification of ordinary gauge bosons and their super-partners as wormhole contacts. In the recent view about TGD based on the weak form of electric-magnetic duality wormhole magnetic flux tubes having magnetically charged wormhole throats at their ends could be interpreted as scaled up variants of elementary particles having a large value of Planck constant.

   Cell membrane is the basic example about electret and one of the basic mysteries of cell biology is the resting potential of the living cell. Living cell membranes carry huge electric fields: something like 10^7 Volts per meter. For neuron resting potential corresponds to about .07 eV energy gained when unit charge travels through the membrane potential. In TGD framework it is not at all clear whether the presence of strong electromagnetic field necessitates the presence of strong Kähler field. The extremely strong electric field associated with the cell membrane is not easily understood in Maxwell's theory and almost vacuum extremal property could change the situation completely in TGD framework.

1. The configuration could be a small deformation of vacuum extremal so that the system would be highly critical as one indeed expects on basis of the general vision about living matter as a quantum critical system. For vacuum extremals classical em and Z^0 fields would be proportional to each other. The second half of Maxwell's equations is not in general satisfied in TGD Universe and one cannot exclude the presence of vacuum charge densities in which case elementary particles as the sources of the field would not be necessarily. If one assumes that this is the case approximately, the presence of Z^0 charges creating the classical Z^0 fields is implied. Neutrinos are the most candidates for the carrier of Z^0 charge. Also nuclei could feed their weak gauge fluxes to almost non-vacuum extremals but not atomic electrons since this would lead to dramatic deviations from atomic physics. This would mean that weak bosons would be light in this phase and also Weinberg angle could have a non-standard value.

2. There are also space-time surfaces for CP_2 projection belongs to homologically non-trivial geodesic sphere. In this case classical Z^0 field can vanish and the vision has been that it is sensible to speak about two basic configurations.

   (a) Almost vacuum extremals (homologically trivial geodesic sphere).

   (b) Small deformations of non-vacuum extremals for which the gauge field has pure gauge Z^0 component (homologically non-trivial geodesic sphere).

   The latter space-time surfaces are excellent candidates for configurations identifiable as TGD counterparts of standard electroweak physics. Note however that the charged part of electroweak fields is present for them.

3. To see whether the latter configurations are really possible one must understand how the gauge fields are affected in the color rotation.

   (a) The action of color rotations in the holonomy algebra of CP_2 is non-trivial and corresponds to the action in $U(2)$ sub-group of $SU(3)$ mapped to $SU(2)_L \times U(1)$. Since the induced color gauge field is proportional to Kähler form, the holonomy is necessary Abelian so that also the representation of color rotations as a sub-group of electro-weak group must correspond to a local $U(1)$ sub-group local with respect to CP_2 point.

   (b) Kähler form remains certainly invariant under color group and the right handed part of Z^0 field reducing to $U(1)_R$ sub-algebra should experience a mere Abelian gauge transformation. Also the left handed part of weak fields should experience a local $U(1)_L$ gauge rotation acting on the neutral left handed part of Z^0 in the same manner as it acts on the right handed part. This is true if the $U(1)_L$ sub-group does not depend on point of CP_2 and corresponds to Z^0 charge. If only Z^0 part of the induced gauge field is non-vanishing as it can be for vacuum extremals then color rotations cannot change the situation. If Z^0 part vanishes and non-vacuum extremal is in question, then color rotation rotation of W components mixing them but acts as a pure $U(1)$ gauge transformation on the left handed component.

   (c) It might not be without importance that for any partonic 2-surface induced electro-weak gauge fields have always U(1) holonomy, which could allow to define what neutral part of induced electroweak gauge field means locally. This does not however hold true for the 4-D tangent space distribution. In any case, the cautious conclusion is that there are two phases correponding to nearly vacuum extremals and small deformations of extremals corresponding to homologically non-trivial geodesic spheres for which the neutral part of the classical electro-weak gauge field reduces to photon field.

4. The unavoidable presence of long range Z^0 fields would explain large parity breaking in living matter, and the fact that neutrino Compton length is of the order of cell size would suggest the possibility that within neutrino Compton electro-weak gauge fields or even longer scales could behave like massless fields. The explanation would be in terms of the different ground state characterized also by a different value of Weinberg angle. For instance, of the p-adic temperature of weak bosons corresponds to $T_p = 1/2$, the mass scale would be multiplied by a factor $\sqrt{M_{89}}$ and Compton lengths of weak bosons would be around 10^{-4} meters corresponding to the size scale of a large neuron. If the value of Planck constant is also large then the Compton length increases to astrophysical scale.

5. From the equations for classical induced gauge fields in terms of Kähler form and classical Z^0 field (see the appendix of any of the books about TGD)

$$\gamma = 3J - \tfrac{p}{2}Z^0 \ , \quad Q_Z = I_L^3 - pQ_{em} \ , \quad p = sin^2(\theta_W) \tag{4.1}$$

it follows that for the vacuum extremals the part of the classical electro-weak force proportional to the electromagnetic charge vanishes for $p = 0$ so that only the left-handed couplings to the weak gauge bosons remain. The absence of electroweak symmetry breaking and vanishing or at least

smallness of p would make sense below the Compton length of dark weak bosons. If this picture makes sense it has also implications for astrophysics and cosmology since small deformations of vacuum extremals are assumed to define the interesting extremals. Dark matter hierarchy might explain the presence of unavoidable long ranged Z^0 fields as being due to dark matter with arbitrarily large values of Planck constant so that various elementary particle Compton lengths are very long.

6. The simplest option is that the dark matter -say quarks with Compton lengths of order cell size and Planck constant of order $10^7\hbar_0$ - are responsible for dark weak fields making almost vacuum extremal property possible. The condition that Josephson photons correspond to EEG frequencies implys $\hbar \sim 10^{13}\hbar_0$ and would mean the scaling of intermediate gauge boson Compton length to that corresponding to the size scale of a larger neuron. The quarks involved with with DNA as topological quantum computer model could be in question and membrane potential might be assignable to the magnetic flux tubes. The ordinary ionic currents through cell membrane -having no coupling to classical Z^0 fields and not acting as its sourse- would be accompanied by compensating currents of dark fermions taking care that the almost vacuum extremal property is preserved. The outcome would be large parity breaking effects in cell scale from the left handed couplings of dark quarks and leptons to the classical Z^0 field. The flow of Na$^+$ ions during nerve pulse could take along same dark flux tube as the flow of dark quarks and leptons. This near vacuum extremal property might be fundamental property of living matter at dark space-time sheets at least.

4.2.2 Ionic Josephson frequencies defined by the resting potential for nearly vacuum extremals

If cell membrane corresponds to an almost vacuum extremal, the membrane potential potential is replaced with an effective restoing potential containing also the Z^0 contribution proportional to the ordinary resting potential. The surprising outcome is that one could understand the preferred frequencies for photoreceptors [56] as Josephson frequencies for biologically important ions. Furthermore, most Josephson energies are in visible and UV range and the interpretation in terms of biophotons is suggestive. If the value of Planck constant is large enough Josephson frequencies are in EEG frequency range so that biophotons and EEG photons could be both related to Josephson photons with large $\hbar$.

1. One must assume that the interior of the cell corresponds to many fermion state -either a state filled with neutrinos up to Fermi energy or Bose-Einstein condensate of neutrino Cooper pairs creating a harmonic oscillator potential. The generalization of nuclear harmonic oscillator model so that it applies to multi-neutrino state looks natural.

2. For exact vacuum extremals elementary fermions couple only via left-handed isospin to the classical Z^0 field whereas the coupling to classical em field vanishes. Both K_+,Na_+, and Cl_- $A-Z = Z+1$ so that by p-n pairing inside nucleus they have the weak isospin of neuron (opposite to that of neutrino) whereas Ca_{++} nucleus has a vanishing weak isospin. This might relate to the very special role of Ca_{++} ions in biology. For instance, Ca_{++} defines an action potential lasting a time of order .1 seconds whereas Na_+ defines a pulse lasting for about 1 millisecond [65]. These time scales might relate to the time scales of CDs associated with quarks and electron.

3. The basic question is whether only nuclei couple to the classical Z^0 field or whether also electrons do so. If not, then nuclei have a large effective vector coupling to em field coming from Z^0 coupling proportional to the nuclear charge increasing the value of effective membrane potential by a factor of order 100. If both electrons and nuclei couple to the classical Z^0 field, one ends up with difficulties with atomic physics. If only quarks couple to the Z^0 field and one has $Z^0 = -2\gamma/p$ for vacuum extremals, and one uses average vectorial coupling $\langle I_L^3 \rangle = \pm 1/4$ with + for proton and - for neutron, the resulting vector coupling is following

$$
\begin{aligned}
(\frac{Z-N}{4} - pZ)Z^0 + q_{em}\gamma &= Q_{eff}\gamma \ , \\
Q_{eff} &= -\frac{Z-N}{2p} + 2Z + q_{em} \ .
\end{aligned}
\tag{4.2}
$$

Here γ denotes em gauge potential. For K^+, Cl^-, Na^+, Ca^{++} one has $Z = (19, 17, 11, 20)$, $Z - N = (-1, -1, -1, 0)$, and $q_{em} = (1, -1, 1, 2)$. Table 1 below gives the values of Josephson energies for some values of resting potential for $p = .23$. Rather remarkably, they are in IR or visible range.

$E(Ion)/eV$	$V = -40\ mV$	$V = -60\ mV$	$V = -70\ mV$
Na^+	1.01	1.51	1.76
Cl^-	1.40	2.11	2.46
K^+	1.64	2.47	2.88
Ca^{++}	1.68	2.52	2.94

Table 1. Values of the Josephson energy of cell membrane for some values of the membrane voltage for $p = .23$. The value $V = -40$ mV corresponds to the resting state for photoreceptors and $V = -70$ mV to the resting state of a typical neuron.

4.2.3   Are photoreceptors nearly vacuum extremals?

In Hodgkin-Huxley model ionic currents are Ohmian currents. If one accepts the idea that the cell membrane acts as a Josephson junction, there are also non-dissipative oscillatory Josephson currents of ions present, which run also during flow equilibrium for the ionic parts of the currents. A more radical possibility is that that the dominating parts of the ionic currents are oscillatory Josephson currents so that no metabolic energy would be needed to take care that density gradients for ions are preserved. Also in this case both nearly vacuum extremals and extremals with nearly vanishing Z^0 field can be considered. Since sensory receptors must be highly critical the natural question is whether they could correspond to nearly vacuum extremals. The quantitative success of the following model for photoreceptors supports this idea.

Photoreceptors can be classified to three kinds of cones responsible for color vision and rods responsible for black-white vision. The peak sensitivities of cones correspond to wavelengths (405, 535, 565) nm and energies (3.06, 2.32, 2.19) eV. The maximum absorption occurs in the wave length range 420-440 nm, 534-545 nm, 564-580 nm for cones responsible for color vision and 498 nm for rods responsible black-white vision [56, 66]. The corresponding photon energies are (2.95, 2.32, 2.20) eV for color vision and to 2.49 eV for black-white vision. For frequency distribution the maxima are shifted from these since the maximum condition becomes $dI/d\lambda + 2I/\lambda = 0$, which means a shift to a larger value of λ, which is largest for smallest λ. Hence the energies for maximum absorbance are actually lower and the downwards shift is largest for the highest energy.

From Table 2 above it is clear that the energies of Josephson photons are in visible range for reasonable values of membrane voltages, which raises the question whether Josephson currents of nuclei in the classical em and Z^0 fields of the cell membrane could relate to vision.

Consider first the construction of the model.

1. Na$^+$ and Ca^{++} currents are known to present during the activation of the photoreceptors. Na^+ current defines the so called dark current [56] reducing the membrane resting potential below its normal value and might relate to the sensation of darkness as eyes are closed. Hodgkin-Huxley model predicts that also K^+ current is present. Therefore the Josephson energies of these three ion currents are the most plausible correlates for the three colors.

2. One ends up with the model in the following manner. For Ca^{++} the Josephson frequency does not depend on p and requiring that this energy corresponds to the energy 2.32 eV of maximal sensitivity for cones sensitive to green light fixes the value of the membrane potential during hyperpolarization to $V = .055$ V, which is quite reasonable value. The value of the Weinberg angle parameter can be fixed from the condition that other peak energies are reproduced optimally. The result of $p = .0295$.

The predictions of the model come as follows summarized also by the Table 3 below.

1. The resting potential for photoreceptors is $V = -40$ mV [57]. In this case all Josephson energies are below the range of visible frequencies for $p = .23$. Also for maximal hyperpolarization Na^+ Josephson energy is below the visible range for this value of Weinberg angle.

2. For $V = -40$ mV and $p = .0295$ required by the model the energies of Cl^- and K^+ Josephson photons correspond to red light. 2 eV for Cl^- corresponds to a basic metabolic quantum. For Na^+ and Ca^{++} the wave length is below the visible range. Na^+ Josephson energy is below visible range. This conforms with the interpretation of Na^+ current as a counterpart for the sensation of darkness.

3. For $V = -55$ mV - the threshold for the nerve pulse generation- and for $p = .0295$ the Josephson energies of Na^+, Ca^{++}, and K^+ a correspond to the peak energies for cones sensitive to red, green, and blue respectively. Also Cl^- is in the blue region. Ca^{++} Josephson energy can be identified as the peak energy for rods. The increase of the hyperpolarization to $V = -59$ mV reproduces the energy of the maximal wave length response exactly. A possible interpretation is that around the criticality for the generation of the action potential ($V \simeq -55$ mV) the qualia would be generated most intensely since the Josephson currents would be strongest and induce Josephson radiation inducing the quale in other neurons of the visual pathway at the verge for the generation of action potential. This supports the earlier idea that visual pathways defines a neural window. Josephson radiation could be interpreted as giving rise to biophotons (energy scale is correct) and to EEG photons (for large enough values of $\hbar$ the frequency scales is that of EEG).

4. In a very bright illumination the hyperpolarization is $V = -65$ mV [57], which the normal value of resting potential. For this voltage Josephson energies are predicted to be in UV region except in case of Ca^{++}. This would suggests that only the quale 'white' is generated at the level of sensory receptor: very intense light is indeed experienced as white.

The model reproduces basic facts about vision assuming that one accepts the small value of Weinberg angle, which is indeed a natural assumption since vacuum extremals are analogous to the unstable extrema of Higgs potential and should correspond to small Weinberg angle. It deserves to be noticed that neutrino Josephson energy is 2 eV for $V = -50$ mV, which correspond to color red. 2 eV energy defines an important metabolic quantum.

Ion	Na^+	Cl^-	K^+	Ca^{++}
$E_J(.04 \ mV, p = .23)/eV$	1.01	1.40	1.51	1.76
$E_J(.065 \ V, p = .23)/eV$	1.64	2.29	2.69	2.73
$E_J(40 \ mV, p = .0295)/eV$	1.60	2.00	2.23	1.68
$E_J(50 \ mV, p = .0295)/eV$	2.00	2.49	2.79	2.10
$E_J(55 \ mV, p = .0295)/eV$	2.20	2.74	3.07	2.31
$E_J(65 \ mV, p = .0295)/eV$	2.60	3.25	3.64	2.73
$E_J(70 \ mV, p = .0295)/eV$	2.80	3.50	3.92	2.94
$E_J(75 \ mV, p = .0295)/eV$	3.00	3.75	4.20	3.15
$E_J(80 \ mV, p = .0295)/eV$	3.20	4.00	4.48	3.36
$E_J(90 \ mV, p = .0295)/eV$	3.60	4.50	5.04	3.78
$E_J(95 \ mV, p = .0295)/eV$	3.80	4.75	5.32	3.99
Color	R	G	B	W
E_{max}	2.19	2.32	3.06	2.49
energy-interval/eV	1.77-2.48	1.97-2.76	2.48-3.10	

Table 2. The table gives the prediction of the model of photoreceptor for the Josephson energies for typical values of the membrane potential. For comparison purposes the energies E_{max} corresponding to peak sensitivities of rods and cones, and absorption ranges for rods are also given. R,G,B,W refers to red, green, blue, white. The values of Weinberg angle parameter $p = sin^2(\theta_W)$ are assumed to be .23 and .0295. The latter value is forced by the fit of Josephson energies to the known peak energies.

It interesting to try to interpret the resting potentials of various cells in this framework in terms of the Josephson frequencies of various ions.

1. The maximum value of the action potential is +40 mV so that Josephson frequencies are same as for the resting state of photoreceptor. Note that the time scale for nerve pulse is so slow as compared to the frequency of visible photons that one can consider that the neuronal membrane is in a state analogous to that of a photoreceptor.

2. For neurons the value of the resting potential is -70 mV. Na^+ and Ca^{++} Josephson energies 2.80 eV and 2.94 eV are in the visible range in this case and correspond to blue light. This does not mean that Ca^{++} Josephson currents are present and generate sensation of blue at neuronal level: the quale possibly generated should depend on sensory pathway. During the hyperpolarization period with -75 mV the situation is not considerably different.

3. The value of the resting potential is -95 mV for skeletal muscle cells. In this case Ca^{++} Josephson frequency corresponds to 4 eV metabolic energy quantum as the table below shows.

4. For smooth muscle cells the value of resting potential is -50 mV. In this case Na^+ Josephson frequency corresponds to 2 eV metabolic energy quantum.

5. For astroglia the value of the resting potential is -80/-90 mV for astroglia. For -80 mV the resting potential for Cl^- corresponds to 4 eV metabolic energy quantum. This suggests that glial cells could also provide metabolic energy as Josephson radiation to neurons.

6. For all other neurons except photo-receptors and red blood cells Josephson photons are in visible and UV range and the natural interpretation would be as biophotons. The biophotons detected outside body could represent sensory leakage. An interesting question is whether the IR Josephson frequencies could make possible some kind of IR vision.

4.3 General model for sensory receptor

The identification of quantum number increments in quantum jump for a subsystem representing subself and the capacitor model of sensory receptor are already more than decade old ideas.

The concrete realization of this vision is based on several ideas that I have developed during last five years.

1. The vision about dark matter as a hierarchy of phases partially labeled by the value of Planck constant led to the model of DNA as topological quantum computer [30]. In this model magnetic flux tubes connecting DNA nucleotides with the lipids of the cell membrane define strands of the braids defining topological quantum computations. The braid strand corresponds to so called wormhole flux tube and has quark and antiquark at its ends. u and d quarks and their antiquarks code for four DNA nucleotides in this model.

2. Zero energy ontology assigns to elementary particles so called causal diamonds (CDs). For u and d quarks and electron these time scales are (6.5, .78, 100) ms respectively, and correspond to fundamental biorhythms. Electron time scale corresponds to 10 Hz fundamental biorhythm defining also the fundamental frequency of speech organs, .78 ms to kHz cortical synchrony [59], and 160 Hz to cerebrellar synchrony [58]. Elementary particles therefore seem to be directly associated with neural activity, language, and presumably also hearing. One outcome was the modification of the earlier model of memetic code involving the notion of cognitive neutrino pair by replacing the sequence of cognitive neutrino pairs with that of quark sub-CDs within electron CD. Nerve pulses could induce the magnetization direction of quark coding for bit but there are also other possibilities. The detailed implications for the model of nerve pulse [37] remain to be disentangled.

3. The understanding of the Negentropy Maximization Principle [19] and the role of negentropic entanglement in living matter together with the vision about life as something in the intersection of real and p-adic worlds was a dramatic step forward. In particular, space-like and time-like negentropic entanglement become basic aspects of conscious intelligence and are expected to be especially important for understanding the difference between speech and music.

4. The most important implication concerning the model of sensory receptors however relate to the vacuum degeneracy of Kähler action. It has been clear from the beginning that the nearly vacuum extremals of Kähler action could play key role key role in living systems. The reason is their criticality making them ideal systems for sensory perception. These extremals carry classical em and Z^0 fields related to each other by a constant factor and this could explain the large parity breaking effects characterizing living matter. The assumption that cell membranes are nearly vacuum extremals and that nuclei can feed their Z^0 charges to this kind of space-time sheets (not true for atomic electrons) in living matter leads to a modification of the model for the cell membrane as Josephson junction [37]. Also a model of photoreceptors explaining the frequencies of peak sensitivity as ionic Josephson frequencies and allowing the dual identifications Josephson radiation as biophotons (energies) [47] and EEG radiation (frequencies) emerge since the values of Planck constant can be very large. The value of the Weinberg angle in this phase is fixed to $sin^2(\theta_W) = .0295$, whereas in standard phase the value is given by $sin^2(\theta_W) = .23$. The significance of this quantitative success for TGD and TGD inspired quantum biology cannot be over-estimated.

The ensuing general model of how cell membrane acts as a sensory receptor has unexpected implications for the entire TGD inspired view about biology.

1. DNA as topological quantum computer model plus certain simplifying assumption leads to the conclusion that the spectrum of net quantum numbers of quark antiquark pair define the primary qualia assignable to a nucleotide-lipid pair connected by a magnetic flux tube. The most general prediction is that the net quantum numbers of two quark pairs characterize the qualia. In the latter case the qualia would be assigned to a pair of receptor cells.

2. Composite qualia result when one allows the nucleotide-lipid pairs of the membrane to be characterized by a distribution of quark-antiquark pairs. Cell membrane -or at least the axonal parts of neurons- would define a sensory representation in which is a pair of this kind defines a pixel characterized by primary qualia. Cells would be sensory homunculi and DNA defines a sensory hologram of body of or of part of it. Among other things this would give a precise content to the notion of grandma cell.

3. Josephson frequencies of biologically important ions are in one-one correspondence with the qualia and Josephson radiation could re-generate the qualia or map them to different qualia in a one-one and synesthetic manner in the neurons of the sensory pathway. For large values of Planck constant Josephson frequencies are in EEG range so that a direct connection with EEG emerges and Josephson radiation indeed corresponds to both biophotons and EEG. This would realize the notion of sensory pathway which originally seemed to me a highly non-realistic notion and led to the vision that sensory qualia can be realized only at the level of sensory organs in TGD framework.

4. At the level of brain motor action and sensory perception look like reversals of each other. In zero energy ontology motor action can be indeed seen as a time reversed sensory perception so that the model of sensory representations implies also a model for motor action. Magnetic body serves as a sensory canvas where cyclotron transitions induced by Josephson frequencies induce conscious sensory map entangling the points of the magnetic body with brain and body.

4.4   Cell membrane as a map with pixels colored by qualia

The identification of sensory qualia in terms of quantum number increments and geometric qualia representing geometric and kinematic information in terms of moduli of CD, the assignment of sensory qualia with the membrane of sensory receptor, and capacitor model of qualia are basic ideas behind the model. The communication of sensory data to magnetic body using Josephson photons is also a key aspect of the model.

4.4.1   Lipids as pixels colored by qualia

The proposed vision about qualia requires a lot of new physics provided by TGD. What leads to a highly unique proposal is the intriguing coincidence of fundamental elementary particle time scales with basic

time scales of biology and neuro science and the model of DNA as topological quantum computer [30].

1. Zero energy ontology brings in the size scale of CD assignable to the field body of the elementary particle. Zero energy states with negentropic time-like entanglement between positive and negative energy parts of the state might provide a key piece of the puzzle. The negentropic entanglement beween positive energy parts of the states associated with the sub-CD assigbnable to the cell membrane and sub-CD at the magnetic body is expected to be an important factor.

2. For the standard value of $\hbar$ the basic prediction would be 1 ms second time scale of d quark, 6.5 ms time scale of u quark, and .1 second time scale of electron as basic characterizes of sensory experience if one accept the most recent estimates $m(u) = 2$ MeV and $m(d) = 5$ MeV for the quark masses [42]. These time scales correspond to 10 Hz, 160 Hz, and 1280 Hz frequencies, which all characterize neural activity (for the identification of 160 Hz frequency as cerebellar resonance frequency see [58]). Hence quarks could be the most interesting particles as far as qualia are considered and the first working hypothesis would be that the fundamental quantum number increments correspond to those for quark-anti-quark pair. The identification in terms of quantum numbers of single quark is inconsistent with the model of color qualia.

3. The model of DNA as topological quantum computer led to the proposal that DNA nucleotides are connected to the lipids of the cell membrane by magnetic flux tubes having quark and antiquark at its ends such that the u and d quarks and their antiquarks code for the four nucleotides. The outer lipid layer was also assumed to be connected by flux tubes to the nucleotide in some other cell or in cell itself.

4. The model for DNA as topological quantum computer did not completely specify whether the flux tubes are ordinary flux tubes or wormhole flux tubes with possibly opposite signs of energy assigned with the members of the flux tube pair. Although it is not necessary, one could assume that the quantum numbers of the two parallel flux tubes cancel each other so that wormhole flux tube would be characterized by quantum numbers of quark pairs at its ends. It is not even necessary to assume that tne net quantum numbers of the flux tubes vanish. Color confinement however suggests that the color quantum at the opposite ends of the flux tube are of opposite sign.

    (a) The absence of a flux tube between lipid layers was interpreted as an isolation from external world during the topological quantum computation. The emergence of the flux tube connection means halting of topological quantum computation. The flux tube connection with the external world corresponds to sensory perception at the level of DNA nucleotide in consistency with the idea that DNA plays the role of the brain of cell [20]. The total color quantum numbers at the ends of the flux tubes were assumed to sum up to zero. This means that the fusion of the flux tubes ending to the interior and exterior cell membrane to single one creates a flux tube state not localized inside cell and that the interior of cell carries net quantum numbers. The attractive interpretation is that this preocess represents the generation of quale of single nucleotide.

    (b) The formation of the flux tube connection between lipid layers would involve the transformation of both quark-antiquark pairs to an intermediate state. There would be no kinematic constraints on the process nor to the mass scales of quarks. A possible mechanism for the separtion of the two quark-antiquark pairs associated with the lipids from the system is double reconnection of flux tubes which leads to a situation in which the quark-antiquark pairs associated with the lipid layers are connected by short flux loops and separated to a disjoint state and there is a long wormhole flux tube connecting the nucleotides possibly belonging to different cells.

    (c) The state of two quark pairs need not have vanishing quantum numbers and one possibility is that the quantum numbers of this state code for qualia. If the total numbers of flux tubes are vanishing also the net quantum numbers of the resulting long flux tube connecting two different cells provide equivalent coding. A stronger condition is that this state has vanishing net quantum numbers and in this case the ends of the long flux tube would carry opposite quantum numbers. The end of flux tube at DNA nucleotide would characterize the quale.

5. Two identification of primary qualia are therefore possible.

   (a) If the flux tubes have vanishing net quantum numbers, the primary sensory quale can be assigned to single receptor cell and the flow of the quantum numbers corresponds to the extension of the system with vanishing net quantum numbers in two-cell system.

   (b) If the net quantum numbers of the flux tube need not vanish, the resulting two cell system carries non-vanishing quantum numbers as the pair of quark-antiquark pairs removes net quantum numbers out of the system.

6. If the net quantum numbers for the flux tubes vanish always, the specialization of the sensory receptor membrane to produce a specific quale would correspond to an assignment of specific quantum numbers at the DNA ends of the wormhole flux tubes attached to the lipid layers of the cell membrane. The simplest possibility that one can imagine is that the outer lipid layer is connected to the conjugate DNA nucleotide inside same cell nucleus. This option would however assign vanishing net quantum number increments to the cell as whole and is therefore unacceptable.

7. The formation of a temporary flux tube connection with another cell is necessary during the generation of quale and the question is what kind of cell is in question. The connection of the receptor to cells along the sensory pathway are expected to be present along the entire sensory pathway from DNA nucleotide to a nucleotide in the conjugate strand of second neuron to DNA nucleotide of the third neutron.... If Josephson photons are able to regenerate the quale in second neuron this would make it possible to replicate the quale along entire sensory pathway. The problem is that Josephson radiation has polarization orthogonal to axons and must propagate along the axon whereas the flux tube connection must be orthogonal to axon. Hence the temporary flux tube connection is most naturally between receptor cells and would mean horizontal integration of receptor cells to a larger structure. A holistic process in directions parallel and orthogonal to the sensory pathway would be in question. Of course, the flux tube could be also curved and connect the receptor to the next neuron along the sensory pathway.

8. The specialization of the neuron to sensory receptor would require in the framework of positive energy ontology that -as far as qualia assignable to the electro-weak quantum numbers are considered - all DNA nucleotides are identical by the corresponds of nucleotides with quarks and antiquarks. This cannot be the case. In zero energy ontology and for wormhole flux tubes it is however enough to assume that the net electroweak quantum numbers for the quark antiquark pairs assignable to the DNA wormhole contact are same for all nucleotides. This condition is easy to satisfy. It must be however emphasized that there is no reason to require that all nucleotides involved generate same quale and at the level of neurons sensory maps assigning different qualia to different nucleotides and lipids allowing DNA to sensorily perceive the external world are possible.

The model should be consistent with the assignment of the fundamental bio-rhythms with the CDs of electron and quarks.

1. Quark color should be free in long enough scales and cellular length scales are required at least. The QCD in question should therefore havelong enough confinement length scales. The first possibility is provided by almost vacuum extremals with a long confinement scale also at the flux tubes. Large $\hbar$ for the cell membrane space-time sheet seems to be unavoidable and suggests that color is free in much longer length scale than cell length scale.

2. Since the length of the flux tubes connecting DNA and cell membrane is roughly 1 micrometer and by a factor of order 10^7 longer than the d quark Compton length, it seems that the value of Planck constant must be of this order for the flux tubes. This however scales up the time scale of d quark CD by a factor of 10^{14} to about 10^4 years! The millisecond and 160 ms time scales are much more attractive. This forces to ask what happens to the quark-anti-quark pairs at the ends of the tubes.

3. The only possibility seems to be that the reconnection process involves a phase transition in which the closed flux tube structure containing the two quark pairs assignable to the wormhole contacts at lipid layers is formed and leaks to the page of the Big Book with pages partially labeled by the values

of Planck constant. This page would correspond to the standard value of Planck constant so that the corresponding d quark CDs would have a duration of millisecond. The reconnection leading to the ordinary situation would take place after millisecond time scale. The standard physics interpretation would be as a quantum fluctuation having this duration. This sequence of quark sub-CDs could define what might be called memetic codon representation of the nerve pulse sequence.

4. One can also consider the possibility is that near vacuum extremals give rise to a copy of hadron physics for which the quarks associated with the flux tubes are light. The Gaussian Mersennes corresponding to $k = 151, 157, 163, 167$ define excellent p-adic time scales for quarks and light variants of weak gauge bosons. Quark mass 5 MeV would with $k = 120$ would be replaced with $k = 163$ (167) one would have mass 1.77 eV (.44 eV). Small scaling of both masses gives 2 eV and .5 eV which correspond to basic metabolic quanta in TGD framework. For quark mass of 2 MeV with $k = 123$ $k = 163$ (167) one would give masses .8 eV (.05 eV). The latter scale correspond to Josephson energy assignable with the membrane potential in the ordinary phase.

In this case a phase transition transforming almost vacuum extremal to ordinary one takes place. What this would mean that the vacuum extremal property would hold true below much shorter p-adic length scale. In zero energy ontology the scaling up of quark masses is in principle possible. This option looks however too artificial.

4.4.2 Overall view about the representation of qualia as colors of the pixels at cell membrane

This picture leads to the following overall view about qualia. There are two options depending on whether single quark-antiquark pair or two of them labels the qualia. In the following only the simpler option with single quark-antiquark pair is discussed.

1. All possible pairings of spin and electroweak isospin (or em charge) define 16 basic combinations if one assumes color singletness. If arbitrary color is allowed, there is a nine-fold increase of quantum numbers decomposable to color singlet and octet qualia and further into 3×15 qualia with vanishing increments of color quantum numbers and 6×16 qualia with non-vanishing increments of color quantum numbers. The qualia with vanishing increments for electroweak quantum numbers could correspond to visual colors. If electroweak quantum numbers of the quark-anti-qiuark pair vanish, one has 3×7 *resp.* 6×8 combinations of colorless *resp.* colored qualia.

2. There is a huge number of various combinations of these fundamental qualia if one assumes that each nucleotide defines its own quale and fundamental qualia would be analogous to constant functions and more general qualia to general functions having values in the space with $9 \times 16 - 1$ points. Only a very small fraction of all possible qualia could be realized in living matter unless the neurons in brain provide representations of body parts or of external world in terms of qualia assignable to lipid-nucleotide pairs. The passive DNA strand would be ideal in this respect.

3. The basic classification of qualia is as color qualia, electro-weak quale, and spin quale and products of these qualia. Also combinations of color qualia and and electroweak and spin quale are possible and could define exotic sensory qualia perhaps not yet realized in the evolution. Synesthesia is usually explained in terms of sensory leakage between sensory pathways and this explanation makes sense also in TGD framework if there exists a feedback from the brain to the sensory organ. Synesthesia cannot however correspond to the product qualia: for "quantum synesthesia" cross association works in both directions and this distinguishes it from the ordinary synesthesia.

4. The idea about brain and genome as holograms encourages to ask whether neurons or equivalently DNA could correspond to sensory maps with individual lipids representing qualia combinations assignable to the points of the perceptive field. In this framework quantum synesthesia would correspond to the binding of qualia of single nucleotide (or lipid) of neuron cell membrane as a sensory representation of the external world. DNA is indeed a holographic representation of the body (gene expression of course restricts the representation to a part of organism). Perhaps it is this kind of representation also at the level of sensory experience so that all neurons could be little

sensory copies of body parts as holographic quantum homunculi. In particular, in the associative areas of the cortex neurons would be quantum synesthetes experiencing the world in terms of composite qualia.

5. The number of flux tube connections generated by sensory input would code for the intensity of the quale. Josephson radiation would do the same at the level of communications to the magnetic body. Also the temporal pattern of the sequence of quale mental images matters. In the case of hearing this would code for the rhythmic aspects and pitch of the sound.

4.4.3   About detailed identification of the quantum correlates of qualia

One can make also guesses about detailed correspondence between qualia and quantum number increments.

1. Visual colors would correspond to the increments of only color quantum numbers. Each biologically important ion would correspond to its own color increment in one-one correspondence with the three pairs of color-charged gluons and these would correspond to blue-yellow, red-green, and black white [37]. Black-white vision would mean a restriction to the $SU(2)$ subgroup of color group. The model for the cell membrane as a nearly vacuum extremal assigns the peak frequencies corresponding to fundamental colors with biologically important ions. Josephson radiation could induce artificially the same color qualia in other neurons and this might provide an manner to communicate the qualia to the brain where they could be re-experienced at neuronal level. Some organisms are able to perceive also the polarization of light. This requires receptors sensitive to polarization. The spin of quark pair would naturally code for polarization quale.

2. Also tastes and odours define qualia with "colors". Certainly the increments of electroweak numbers are involved but since these qualia do not have any directional flavor, spin is probably not involved. This would give 3×4 basic combinations are possible and can certainly explain the 5 or 6 basic tastes (counted as the number of different receptors). Whether there is a finite number of odours or not has been a subject of a continual debate and it might be that odours already correspond to a distribution of primary qualia for the receptor cell. That odours are coded by nerve pulse patterns for a group of neurons [62] would conform with this picture.

3. Hearing seems to represent a rather "colorless" quale so that electroweak isospin suggests again itself. If we had a need to hear transversely polarized sound also spin would be involved. Cilia are involved also with hair cells acting as sensory receptors in the auditory system and vestibular system. In the case of hearing the receptor itself does not fire but induces a firing of the higher level neuron. The temporal pattern of qualia mental images could define the pitch of the sound whereas the intensity would correspond to the number of flux tube connections generated.

   The modulation of Josephson frequencies -rather than Josephson frequencies as such- would code for the pitch and the total intensity of the Josephson radiation for the intensity of the sound and in fact any quale. Pitch represents non-local information and the qualia subselves should be negentropically entangled in time direction. If not, the experience corresponds to a sequence of sound pulses with no well-defined pitch and responsible for the rhythmic aspects of music. Right brain sings-left brain talks metaphor would suggests that right and left brain have different kind of specializations already at the level of sensory receptors.

4. Somato-sensory system gives rise to tactile qualia like pain, touch, temperature, proprioception (body position). There are several kinds of receptors: nocireceptors, mechanoreceptors, thermoreceptors, etc... Many of these qualia have also emotional coloring and it might be that the character of entanglement involved (negentropic/entropic defines the emotional color of the quale. If this is the case, one might consider a pure quale of touch as something analogous to hearing quale. One can argue that directionality is basic aspect of some of these qualia -say sense of touch- so that spin could be involved besides electroweak quantum numbers. The distribution of these qualia for the receptor neuron might distinguish between different tactile qualia.

5   Model for nerve pulse

The basic idea behind the model of nerve pulse is that some kind of quantum jump reduces the magnitude of membrane potential below the threshold leading to the generation of nerve pulse. Several identifications of this quantum jump have been discussed during years but no really convincing option has been found. The evolution of ideas about dark matter hierarchy and associated hierarchy of Planck constants led to a breakthrough in several sectors. The assignment the predicted ranged classical weak and color gauge fields to dark matter hierarchy was the crucial step and led among other things to a model of high T_c superconductivity [22, 23] providing interpretation for the basic scales of cell in terms of the p-adic length scale hypothesis and Gaussian Mersennes.

5.1   Background

The model for nerve pulse is discussed in detail in [37]. TGD inspired model for high T_c super-conductivity involving dark electrons with large $\hbar$ in an essential manner is a prequisite for the model and is discussed in [22, 23]. The basic philosophy behind the model discussed in detail in is following.

1. In TGD Universe the function of EEG and its variants is to make possible communications from the cell membrane to the magnetic body and the control of the biological body by the magnetic body via magnetic flux sheets traversing DNA by inducing gene expression. This leads to the notions of super- and hyper-genome predicting coherent gene expression at level of organs and population.

2. The assignment the predicted ranged classical weak and color gauge fields to dark matter hierarchy was a crucial step in the evolution of the model, and led among other things to a model of high T_c superconductivity predicting the basic scales of cell, and also to a generalization of EXG to a hierarchy of ZXGs, WXGs, and GXGs corresponding to Z^0, W bosons and gluons.

3. Dark matter hierarchy and the associated hierarchy of Planck constants plays a key role in the model. For instance, in the case of EEG Planck constant must be so large that the energies of dark EEG photons are above thermal energy at the physiological temperature. The assumption that a considerable fraction of the ionic currents through the cell membrane are dark currents flowing along the magnetic flux tubes explains the strange findings about ionic currents through cell membrane. Concerning the model of nerve pulse generation, the newest input comes from the model of DNA as a topological quantum computer and experimental findings challenging Hodgkin-Huxley model as even approximate description of the situation.

4. The identification of the cell interior as gel phase containing most of water as structured water around cytoskeleton - rather than water containing bio-molecules as solutes as assumed in Hodkin-Huxley model - allows to understand many of the anomalous behaviors associated with the cell membrane and also the different densities of ions in the interior and exterior of cell at qualitative level. The proposal of Pollack [49] that basic biological functions involve phase transitions of gel phase generalizes in TGD framework to a proposal that these phase transitions are induced by quantum phase transitions changing the value of Planck constant. In particular, gel-sol phase transition for the peripheral cytoskeleton induced by the primary wave would accompany nerve pulse propagation. This view about nerve pulse is not consistent with Hodkin-Huxley model.

5.2   New view about nerve pulse generation

The basic hypothesis has been that quantum jump takes the resting potential below the threshold for the generation of nerve pulse. One can imagine several manners for how this could happen. According to [63] nerve pulse propagation seems to be an adiabatic process and thus does not dissipate: the authors propose that 2-D acoustic soliton is in question. Adiabaticity is what one expects if the ionic currents are dark currents (large $\hbar$ and low dissipation) or even supra currents. Furthermore, Josephson currents are oscillatory so that no pumping is needed. Combining this input with the model of DNA as topological quantum computer (TQC) leads to a rather precise model for the generation of nerve pulse [37].

1. The system would consist of two superconductors- microtubule space-time sheet and the space-time sheet in cell exterior- connected by Josephson junctions represented by magnetic flux tubes defining also braiding in the model of TQC. The phase difference between two super-conductors would obey Sine-Gordon equation allowing both standing and propagating solitonic solutions. A sequence of rotating gravitational penduli coupled to each other would be the mechanical analog for the system. Soliton sequences having as a mechanical analog penduli rotating with constant velocity but with a constant phase difference between them would generate moving kHz synchronous oscillation. Also moving oscillations in EEG range can be considered and would require larger value of Planck constant in accordance with vision about evolution as gradual increase of Planck constant.

2. During nerve pulse one pendulum would be kicked so that it would start to oscillate instead of rotating and this oscillation pattern would move with the velocity of 1 kHz soliton sequence. The velocity of 1 kHz wave and nerve pulse is fixed by periodic boundary conditions at the ends of the axon implying that the time spent by the nerve pulse in traveling along axon is always a multiple of the same unit: this implies 1 kHz synchrony. The model predicts the value of Planck constant for the magnetic flux tubes associated with Josephson junctions and the predicted force caused by the ionic Josephson currents is of correct order of magnitude for reasonable values of the densities of ions. The model predicts kHz em radiation as Josephson radiation generated by moving soliton sequences. EEG would also correspond to Josephson radiation: it could be generated either by moving or standing soliton sequences (latter are naturally assignable to neuronal cell bodies for which $\hbar$ should be correspondingly larger): synchrony is predicted also now.

3. The previous view about microtubules in nerve pulse conduction can be sharpened. Microtubular electric field (always in the same direction) could explain why kHz and EEG waves and nerve pulse propagate always in same direction and might also feed energy to system so that solitonic velocity could be interpreted as drift velocity. This also inspires a generalization of the model of DNA as TQC since also microtubule-cell membrane systems are good candidates for performers of TQC. Cell replication during which DNA is out of game seems to require this and microtubule-cell membrane TQC would represent higher level TQC distinguishing between multi-cellulars and mono-cellulars.

4. New physics would enter in several manners [24]. Ions should form Bose-Einstein cyclotron condensates. The new nuclear physics predicted by TGD predicts that ordinary fermionic ions (such as K^+, Na^+, Cl^-) have bosonic chemical equivalents with slightly differing mass number. Anomalies of nuclear physics and cold fusion provide experimental support for the predicted new nuclear physics [16]. Electronic supra current pulse from microtubules could induce the kick of pendulum inducing nerve pulse and induce a small heating and expansion of the axon. The return flux of ionic Josephson currents would induce convective cooling of the axonal membrane. A small transfer of small positive charge into the inner lipid layer could induce electronic supra current by attractive Coulomb interaction. The exchange of dark scaled up variants of ordinary $W^{\pm}$ bosons is a natural manner to achieve this if new nuclear physics is indeed present. A lot of unkown is involved but model builder assuming that dark matter is responsible for the special properties of living matter must tolerated this.

5.3   The function of neural transmitters

TGD leads to a general view about the functions of membrane oscillations, nerve pulse and neural transmitters. The binding of various information molecules to the corresponding receptors gives rise to neuronal qualia analogous to tastes and odors but providing information about external world whereas ordinary receptors give information about nearby environment. At our level of hierarchy these qualia probably are coded to emotions in consistency with the finding that neurotransmitters can be identified as information molecules. Neurotransmitters might be also seen as conscious links in quantum web.

5.4   Microtubular level

The view about what happens at the micro-tubular level during synchronous neuronal firing relies on a many-sheeted model for sol-gel phase transitions as conscious bits and on the seesaw mechanism of remote

metabolism according to which sol-gel transitions induces gel-sol transitions elsewhere in the cell and vice versa. Micro-tubular surfaces can be seen as analogs of cortical sensory and motor areas providing kind of conscious log files about sensory and motor history of the cell in terms of conformational transitions of tubulin dimers representing conscious bits.

What happens at the micro-tubular level during the nerve pulse, how gel phase differs from sol phase, and what occurs in sol-gel transition, belong to the principal challenges for quantum theories of consciousness. Charge entanglement associated with various bosonic ions allows to tackle these questions. The Bose-Einstein condensates of hydrogen atoms at tubular $k = 139$ space-time sheets with size scale of 5 Angstrom ($p \simeq 2^k$ labels space-time sheets whose scale is given by $L(k) = 2^{(151-k)/2}L(151)$, where $L(151) \simeq 10$ nm corresponds to cell membrane thickness) form a bundle behaving like a liquid crystal identifiable as the gel phase. Positive and negative energy IR photons at energy of .1 eV belong to the predicted fractal hierarchy of metabolic currencies, and allow to control the stability of this B-E condensate so that a precisely targeted control of the cellular state by local sol-gel transitions becomes possible. Albrecht-Buehler has demonstrated that photons with this energy have a maximal effect on cells.

Negative energy MEs (topological light rays) are especially important: they make possible intentional action at the micro-tubular level, they are crucial for the understanding of the micro-temporal quantum coherence, and have also inspired the notions of remote metabolism and quantum credit card. The newest discovery along this line is what might be called seesaw mechanism of energy metabolism. Seesaw mechanism minimizes dissipative losses and allows to understand how micro-tubular surfaces provide dynamical records for the cellular sol-gel transitions, and thus define fundamental micro-tubular representation of declarative long term memories. Also the notion of micro-tubuli as quantum antennae [25] becomes precisely defined.

The model of DNA as topological quantum computer [30] brings in a new element. Microtubule-axonal membrane system could perform topological quantum computation just as DNA-membrane (nuclear and perhaps also cell membrane) system has been proposed to do. The braiding of the magnetic flux tubes connecting microtubules to axon would define TQC programs and also provide a representations for sensory input from sensory organs in time scale shorter than millisecond if one assumes that gel-sol-gel transition of microtubule accompanies the nerve pulse. The entire sensory pathway from sensory receptor to brain would define linear representations of nerve pulse patterns and this might explain why the lengths of sensory pathways are maximized. Whether one it one say that nerve pulse is initiated at microtubular or axonal level or by both collectively is not clear since the magnetic flux tubes connecting these two systems make them to act like single coherent whole.

6   Model for EEG

The emergence of zero energy ontology, the explanation of dark matter in terms of a hierachy of Planck constants requiring a generalization of the notion of imbedding space, the view about life as something in the intersection of real and p-adic worlds, and the notion of number theoretic entanglement negentropy led to a breakthrough in TGD inspired quantum biology and also to the recent view of qualia and sensory representations including hearing allowing a precise quantitative model at the level of cell membrane.

Also long range weak and color forces play a key role. Long range weak forces are made possible by the exotic ground state represented as almost vacuum extremal of Kähler action for which classical em and Z^0 fields are proportional to each other whereas for far form vacuum extremals with large Planck constant classical Z^0 fields are very weak and long range color forces strong. In this phase color forces are very weak. This leads to a correct prediction for the frequencies of peak sensitivity for photoreceptors - something highly non-trivial remembering that also the large parity breaking effects in living matter find a natural explanation. Second quantitative key observation was that for electrons and quarks the time scales of causal diamonds correspond to fundamental biorhythms assignable to central nervous system.

The general model for EEG follows neatly from this picture combined with the general model of high T_c superconductivity. A fractal hierarchy of EEGs extending over a wide frequency range beginning from visible photon frequencies and its generalizations identified in terms of Josephson radiation is predicted with levels labeled by p-adic length scales and the value of $\hbar$ at various levels of dark matter hierarchy. Cell membrane would represent only one level in this hierarchy. Besides EEG one would have its counterparts

for various organs, organelles and even cell. Also the possibility of ZEG, WEG and QEG corresponding to Z^0 bosons, W bosons, and gluons must be considered. The fractal hierarchy of EEGs is described in two chapters of the book "TGD and EEG" [38, 39].

6.1   Fractal hierarchy of EEGs

EEG is replaced with a fractal hierarchy of EEGs corresponding to various values of Planck constants involved.

1. There are three contributions to EEG besides the contributions due to the neural noise and evoked potentials. These contributions correspond to Schumann frequencies, cyclotron frequencies f_c of biologically important ions in magnetic field $B_{end} = .2$ Gauss, and to the Josephson frequencies f_J associated with Josephson junctions assigned with cell membranes. If Josephson radiation modulates cyclogtron radiation also the frequencies $mf_J \pm nf_c$ appear in the spectrum.

2. In standard model $f_J = ZeV/\hbar$ would determined by the membrane potential and would correspond to energy in infrared. This sounds completely reasonable. TGD however suggests that cell membrane as a critical system correspond to an almost vacuum extremal. This predicts classical Z^0 field proportional to em field to which nuclei and neutrinos are assumed to couple. This would explain chiral selection in living matter and predict correctly the frequencies of peak sensitivity for photoreceptors as Josephson frequencies assignable to the biologically most important ions. The effective couplings of ions to membrane potential are modified and the Josephson frequencies correspond to energies in visible and UV range. Bio-photons and EEG could be seen as manifestations of one and same thing: Josephson radiation with a large value of Planck constant with energies of biophotons and frequencies of EEG.

3. An important point is that the ions involved must behave like bosons. For cyclotron condensates either Cooper pairs of ordinary fermionic ions or exotic ions chemically similar to their standard counterparts obtained from neutral bosonic atom by making one or more neutral color flux tubes connecting nucleons charged. For Josephson radiation only the latter option works. TGD based nuclear physics indeed predicts this kind of nuclei and there is experimental evidence for their existence [16].

4. For cyclotron frequencies the extremals are assumed to be far from vacuum extremals carrying very small classical Z^0 fields but nonvanishing classical W fields and color fields (with $U(1)$ holonomy). The corresponding flux quanta would naturally correspond to flux sheets traversing through DNA strands while Josephson radiation would propagate along flux tubes parallel to the cell membrane. Far from biological body one expects both kinds of flux quanta to fuse to form larger ones so that one has parallel space-time sheets carrying cyclotron *resp.* Josephson radiation. Wormhole contacts between Josephson and cyclotron flux sheets would induce a non-linear interaction giving rise to a superposition of harmonics of Josephson and cyclotron frequencies.

5. Josephson frequencies are assignable to the cell membrane and would naturally correspond to the communication of sensory data to the magnetic body. This would suggest that cyclotron frequencies are assignable to the magnetic flux sheets going through DNA strands responsible for quantum control via genome expression. This picture might be too naive. Josephson radiation would induce transitions between cyclotron states should generate sensory representations at magnetic body so that both frequencies would be involved with sensory representations. Furthermore, the identification of motor action as time reversal of sensory perception allwed by zero energy ontology would mean that same mechanisms are at work for negative energies (phase conjugate radiation). Resonance is achieved if the condition $mf_J = nf_c$ is satisfied. For small values of integers m and n the condition is quite restrictive. Schumann frequencies can be assigned with the magnetic body of Earth and would correlate with the collective aspects of consciousness.

6. The model of hearing forces to assume quite a wide spectrum of Planck constants- at least the values coming as powers of two and the safest assumption is that at least integer multiples of

the ordinary Planck constant are possible. Josephson radiation and cyclotron radiation have same scale if $B_{end} \propto 1/\hbar$ proportionality holds true. For 5 Hz Josephson frequency and membrane potential and for V=.70 mV corresponding to the resting potential of neuron one obtains $r = (0.96, 1.20, 1.34, 1.01) \times 2^{47}$. For Ca^{++} ion r is very near to a power of 2.

6.2   Basic aspects of EEG

Consider now how one could understand basic characteristics of EEG during wake-up and sleep in this framework.

1. For small amplitudes and for the lowest harmonics this implies that alpha band to which the cyclotron frequencies most biologically important bosonic ions correspond has as satellites theta and beta bands. Higher harmonics correspond to gamma and higher bands having also satellites.

2. For large amplitudes EEG becomes chaotic which is indeed the property of beta band during say intense concentration or anxiety. The findings of Nunez about narrow 1-2 Hz wide bands at 3,5,7 Hz and 13,15,17 Hz confirm with the prediction of satellite bands and fix the Josephson frequency to 5 Hz. This picture explains the general characteristics of EEG in wake-up state qualitatively and quantitatively.

3. In order to understand the characteristics during various stages of deep sleep one must assume that the cyclotron frequency scale of ions is scaled down by a factor of $1/2$. The simplest explanation is that the value of Planck constant increases by a factor 2 in a phase transition having interpretation as a leakage of cell membrane space-time sheet between the pages of Big Book defined by the generalized imbedding space. During stage 4 sleep only only DNA cyclotron frequencies in delta band are around 1 Hz and just above the thermal threshold are predicted to be present. This stage could correspond to a value of Planck constant which is 4 times its value in wake-up state.

The generalization of the model for EEG hierarchy to the case of ZEGs is straightforward and Josephson frequency spectrum is the same. Any atom, almost always boson, has an exotically charged counterpart with same statistics so that very rich spectrum of Bose-Einstein condensates results.

6.3   The effects of ELF em fields on brain

The experimental data about the effects of ELF em fields at cyclotron frequencies of various ions in Earth's magnetic field on vertebrate brains were crucial for the development of the model of EEG. As a matter fact, it was the attempt to explain these effects, which eventually led to the discovery of the fractal hierarchy of EEGs and its generalizations.

The reported effects occur for harmonics of cyclotron frequencies of biologically important ions in Earth's magnetic field. They occur only in amplitude windows. The first one is around 10^{-7} V/m and second corresponds to the range $1 - 10$ V/m: the amplitudes of EEG waves are in the range 5-10 V/m. The effects are present only in the temperature interval 36-37 C.

1. Cyclotron frequencies led to the vision about cyclotron condensates of biologically important ions and their Cooper pairs at the flux quanta of dark magnetic field with so large Planck constant that the energies of cyclotron photons are above thermal threshold. The model for EEG and biophotons in terms of Josephson radiation from cell membrane which is almost vacuum extremal allows to make this model more quantitative.

2. The temperature window has one interpretation in terms of a competion of almost vacuum extremal property of cell membrane possible above some critical temperature and high T_c super-conductivity possible below some critical temperature.

3. The amplitude window 10^{-7} V/mfollows from a quantized form of Faraday law whose existence is supported by the fact that space-time sheets are analogs of Bohr orbits in exact sene. The quantisation condition relates the amplitude of electric field to Planck constant and frequency. For the value $r = \hbar/\hbar_0 = 2^{47}$ of Planck constant required by 5 Hz Josephson frequency the 10^{-7} V/m amplitude is predicted correctly.

4. The amplitude window around 1-10 V/m (EEG amplitudes are in the range 5-10 V/m) follows if the values of Planck constant in the range $10^7 r - 10^8 r$ can be justified. A possible justification is based on the observation that for $r_1 = 10^8 r$ the Compton wave length of intermediate gauge bosons corresponds to $k = 163$ defining Gaussian Mersenne and wavelength corresponding to 2 eV energy for photon which also corresponds to bio-photon energies assignable to 70 mV resting potential of neuron membrane. Electron's Compton length corresponds for $r_1 = 10^8 r$ to 28 cm, which defines the size scale of brain. One might hope that these findings could allow to build an internally consistent story about what happens.

6.4   Vision about biological evolution and evolution of brain

The proposed model for EEG, the idea that Gaussian Mersennes (four of them are in the range 10 nm-2.5 micrometers) define p-adic length scales allowing exotic variants of color and electro-weak physics with light intermediate gauge bosons at space-time sheets near vacuum extremals, and the assumption that the preferred values of Planck constant are such that they relate these p-adic scales to each other leads to a detailed quantitative vision about evolution of life as emergence of longer scales belonging to this hierarchy and as special case also to a vision about evolution of cell, nervous system, EEG, and long term memory. The incrase of the largest Planck constant in the hierarchy of Planck constants associated with the organism would mean increase of the time scales of planned action and memory and therefore evolutionary leap. The model predicts a hierarchy of preferred size scales for various sub-systems of organisms and corresponding time scales identifiable in terms of bio-rhythms and memory span. Also cells and neurons could be classified according the their evolutionary level characterized by the largest Planck constant involved.

   The evolution at our level of hierarchy would most naturally correspond to cultural evolution taking mainly place at the level of magnetic bodies responsible for higher levels of collective consciousness. This would explain why we differ so dramatically from our cousins although genomes are virtually identical. Evolution of quantum computer programs associated with DNA would be one aspect of this evolution.

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