Dark Matter Hierarchy and Hierarchy of EEGs

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Contents

Abstract

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 embedding 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 forces play a key role. 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 whereas for standard ground state classical Z^0 fields 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. It must be however emphasizef that there is also alternative model of Josephson junctions which seems to provide a better explanation for the role of protons in metabolism. 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 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.

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 at least 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 or theire generalizations associated with Josephson junctions assigned with cell membranes. If Josephson radiation modulates cyclogtron radiation also the frqequencies $mf_J \pm nf_c$ appear in the spectrum. Perhaps the most natural option is generalization of Josephson junction so that generalized Josephson frequencies are sums for differences of cyclotron frequencies for flux tubes in the interior resp. exterior of cell membrane and of Josephson frequency f_J . This implies that the information provided by cell membrane oscillations and nerve pulse patterns is coded to frequency modulations for differences of cyclotron frequencies defining EEG rhythms.
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 suggests two models for the cell membrane.
3. TGD inspires two views about cell membrane: the wiews need not be contradictory. For the first model cell is far from vacuum extremal, for the second model nearly vacuum extremal with classical Z^0 fields in key role.
   (a) There are several constraints on the first model coming from the TGD based identification of bio-photons as energy conserving decay products of dark photons and one ends up to a new view about metabolism and gneralization to of the notion of Josephson junction so that Josephson energy includes besides electrostatic energy also the difference of cyclotron energies at two sides of the membrane. It seem that that the first model might be enough when generalized along lines inspired by Pollack's findings about the fourth phase of water.
   (b) 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 at least some 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. Contrary to the original believe, this model does not require non-standard value of Weinberg angle and this model and first model allow a hybrid.

4. An important point is that the ions involved must behave like bosons or to form Cooper pairs. 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.
5. 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.
6. 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.
7. 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.

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 corresponds 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 embedding 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.

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 biophoton 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.

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 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.

1 Introduction

The emergence of zero energy ontology, the explanation of dark matter in terms of a hierarchy of Planck constants requiring a generalization of the notion of embedding 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 forces play a key role. 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 whereas for standard ground state classical Z^0 fields 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. It must be however emphasizef that there is also alternative model of Josephson junctions which seems to provide a better explanation for the role of protons in metabolism. 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 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: the recent view about the generalization of the notion of embedding space realizing this hierarchy is discussed in the Appendix. Cell membrane would represent only one level in this hierarchy. The analogs of EEG would exist 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.

1.1 Background Ideas

1.1.1 Zero energy ontology

Zero energy ontology meant a breakthrough in the understanding of TGD and TGD inspired theory of consciousness and biology.

In zero energy ontology the S-matrix is generalized to M-matrix defining entanglement coefficients between positive and negative energy parts of zero energy states [K6]. M-matrix has interpretation as a "complex square root" of density matrix and thus provides a unification of thermodynamics and quantum theory. S-matrix is analogous to the phase of Schrödinger amplitude multiplying positive and real square root of density matrix analogous to the modulus of Schrödinger amplitude.

The notion of finite measurement resolution realized in terms of inclusions of von Neumann algebras allows to demonstrate that the irreducible components of M-matrix are unique and possesses huge symmetries in the sense that the hermitian elements of included factor $\mathcal{N} \subset \mathcal{M}$ defining the measurement resolution act as symmetries of M-matrix, which suggests a connection with integrable quantum field theories.

Zero energy ontology is consistent with the ordinary positive energy ontology when the time scale T characterizing CD is long as compared to the time scale of observations. For shorter times scales however creation of matter from vacuum having in standard QFT framework interpretation as quantum fluctuations becomes possible and this process might occurs routinely in living matter unless the values of Planck constant assignable to CDs are very large. Also CDs can be created in quantum jump and a possible interpretation for a creation of CD is in terms of embedding space correlates of selves and of directed attention generating mental images. This interpretation leads to a model explaining how the arrow of psychological time emerges and why the contents of sensory experience are in so narrow time interval. The unexpected prediction is that zero energy ontology assigns to elementary particles macroscopic times scales. In particular, the time scales assignable to electron, d, and u quarks correspond to the frequencies 10 Hz (fundamental biorhythm), 1280 Hz (kHz cortical synchrony), and 160 Hz (cerebellar synchrony).

1.1.2 Systematic mistake in the identification of p-adic lengths scales above electron length scale

Before going to the topic it should be confessed that the identification of p-adic length scales and times above that defined by electron has been plagued by a systematic error appearing in all writings before 2014. This mistake deserves some comments.

1. The wrong identification was $L(151) \simeq 10$ nm implying wrong identification of other scales above $L(127)$ since I have calculated them by scaling $L(151)$ by an appropriate power of two. What I have denoted by $L(151)$ is actually obtained by scaling the Compton length $L_e(127) =$

$\hbar/m_e$ by $2^{(151-127)/2}$ and therefore electrons Compton scale if it would correspond to $k = 151$. Since the mass of electron from p-adic mass calculations is given by $m_e = \sqrt{5+X}\hbar/L(127)$, the correct identification of $L(151)$ would be

$$L(151) = 2^{(151-127)/2}L(127) = 2^{(151-127)/2}L_e(151)/\sqrt{5+X} = 10/\sqrt{5+X}\ \ nm\ \ ,\ \ 0 \leq X \leq 1\ \ .$$

Here X denotes the unknown second order contribution of form $X = n/M_{127}$, n integer, to the electron mass, and in the first approximation one can take $X = 0$ - the approximation is excellent unless n is very large. In the sequel I will try to use the shorthand $L_e(k) = \sqrt{5}L(k)$ but cannot guarantee that the subscript "e" is always present when needed: it is rather difficult to identify all places where the earlier erratic definition appears. I can only apologise for possible confusions.

2. This mistake has no fatal consequences for TGD inspired quantum biology. Its detection however provides a further support for the speculated central role of electron in living matter. Since the scales obtained by scaling the electron Compton scale seem to be important biologically (scaled up Comton scale $\sqrt{5}L(151)$ corresponds to cell membrane thickness), the conclusion is that electrons - or perhaps their Cooper pairs - play a fundamental role in living matter. The correct value of $L(151)$ is $L(151) = 4.5$ nm, which is slightly below the p-adic length scale $L_e(149) = 5$ nm assigned with the lipid layer of cell membrane.

3. I have also assigned to electron the time scale $T = .1$ seconds defining a fundamental biorhythm as a secondary p-adic time scale $T_2(127) = \sqrt{M_{127}}T(127)$. The correct assignment of $T = .1$ seconds is as the secondary Compton time $T_{2,e}(127) = \sqrt{M_{127}}T_e(127)$ of electron: secondary p-adic time scale is $T_2(127) = \sqrt{M_{127}}T(127)$ and corresponds to $T_{2,e}(127)/\sqrt{5} = .045$ seconds and to $f(127) = 22.4$ Hz.

1.1.3 p-Adic length scale hypothesis and biology

The basic implication of zero energy ontology is the formula $T_2(k) = T(k) \simeq 2^{k/2}L(k)/c = L(2,k)/c$ for the secondary p-adic time scale for $p \simeq 2^k$. This would be the analog of $E = hf$ in quantum mechanics and together hierarchy of Planck constants would imply a direct connection between elementary particle physics and macroscopic physics. Especially important this connection would be in macroscopic quantum systems, say for Bose Einstein condensates of Cooper pairs, whose signature the rhythms with $T(k)$ as period would be. The presence of this kind of rhythms might even allow to deduce the existence of Bose-Einstein condensates of hitherto unknown particles.

Unfortunately, the mistake in the identification of the p-adic length scales above electron scale forces to modify the definition of $T(k)$ by introducing a $\sqrt{5+X}$ factor so that it becomes the secondary Compton time scale of electron in the p-adic length scale considered. Writing this explicitly, one has $T_e(k) \equiv T_{2,e}(k) = 2^{k-127}T_{2,e}(127) \equiv 2^{k-127}T_e(127)$. Apologies for a loose notation replacing subscript "2, e" with "e".

1. For electron secondary Compton time equal to $T_e(k) = .1$ seconds defines the fundamental $f_e = 10$ Hz bio-rhythm appearing as a peak frequency in alpha band. This could be seen as a direct evidence for a Bose-Einstein condensate of Cooper pairs of high T_c super-conductivity. That transition to "creative" states of mind involving transition to resonance in alpha band might be seen as evidence for formation of large BE condensates of electron Cooper pairs.

2. TGD based model for atomic nucleus [K12] predicts that nucleons are connected by flux tubes having at their ends light quarks and anti-quarks with masses not too far from electron mass. The corresponding p-adic frequencies $f_q = 2^k f_e$ could serve as a biological signature of exotic quarks connecting nucleons to nuclear strings. $k_q = 118$ suggested by nuclear string model would give $f_q = 2^{18}f_e = 26.2$ Hz. Schumann resonances are around 7.8, 14.3, 20.8, 27.3 and 33.8 Hz and f_q is not too far from 27.3 Hz Schumann resonance and the cyclotron frequency $f_c(^{11}B^+) = 27.3$ Hz for $B = .2$ Gauss explaining the effects of ELF em fields on vertebrate brain.

3. For a given $T_e(k)$ the harmonics of the fundamental frequency $f = 1/T(k)$ are predicted as special time scales. Also resonance like phenomena might present. In the case of cyclotron frequencies they would favor values of magnetic field for which the resonance condition is achieved. The magnetic field which in case of electron gives cyclotron frequency equal to 10 Hz is $B_e \simeq 3.03$ nT. For ion with charge Z and mass number A the magnetic field would be $B_I = \frac{A}{Z}(m_p/m_e)B_e$. The $B = .2$ Gauss magnetic field explaining the findings about effects of ELF em fields on vertebrate brain is near to B_I for ions with f_c alpha band. Hence the value of B could be understood in terms of resonance with electronic B-E condensate.

4. The hierarchy of Planck constants predicts additional time scales $T_e(k)$. The prediction depends on the strength of the additional assumptions made. One could have scales of form $nT(k)$. Integers n could correspond to ruler and compass integers expressible as products of first powers of Fermat primes and power of 2. There are only four known Fermat primes so that one has $n = 2^n \prod_i F_i$, $F_i \in \{3, 5, 17, 257, 2^{16} + 1\}$. In the first approximation only 3- and 5- and 17-multiples of 2-adic length scales would result besides 2-adic length scales.

5. Mersenne primes are expected to define the most important fundamental p-adic time scales. The list of real and Gaussian (complex) Mersennes M_n possibly relevant for biology is given by n=89, 107, 113*, 127, 151*, 157*, 163*, 167* (* tells that Gaussian Mersenne is in question).

$$\begin{array}{llll} n & 89 & 107 & 113 & 127 \\ f_e/Hz & 2.7 \times 10^{12} & 1.0 \times 10^7 & 1.6 \times 10^5 & 10 \\ n & 151 & 157 & 163 & 167 \\ T & 19.4\ d & 3.40\ y & 218.0\ y & 3.49 \times 10^3\ y \end{array} \tag{1.1}$$

1.1.4 Mersenne hypothesis

The scale of the Josephson frequencies assignable to a given neuron is determined by the value of Planck constant. TGD inspired quantum biology and number theoretical considerations suggest preferred values for $r = \hbar/\hbar_0$. For the most general option the values of $\hbar$ are products and ratios of two integers n_a and n_b. Ruler and compass integers defined by the products of distinct Fermat primes and power of two are number theoretically favored values for these integers because the phases $exp(i2\pi/n_i)$, $i \in \{a, b\}$, in this case are number theoretically very simple and should have emerged first in the number theoretical evolution via algebraic extensions of p-adics and of rationals. p-Adic length scale hypothesis favors powers of two as values of r.

One can however ask whether a more precise characterization of preferred Mersennes could exist and whether there could exists a stronger correlation between hierarchies of p-adic length scales and Planck constants. Mersenne primes $M_k = 2^k - 1$, $k \in \{89, 107, 127\}$, and Gaussian Mersennes $M_{G,k} = (1 + i)k - 1$, $k \in \{113, 151, 157, 163, 167, 239, 241..\}$ are expected to be physically highly interesting and up to $k = 127$ indeed correspond to elementary particles. The number theoretical miracle is that all the four p-adic length scales $L_e(k)$ with $k \in \{151, 157, 163, 167\}$ are in the biologically highly interesting range 10 nm-2.5 μm). Of course, $L(k) = L_e(k)/\sqrt{5}$ also are in biologically interesting length scale range. The question has been whether these define scaled up copies of electro-weak and QCD type physics with ordinary value of $\hbar$. The proposal that this is the case and that these physics are in a well-defined sense induced by the dark scaled up variants of corresponding lower level physics leads to a prediction for the preferred values of $r = 2^{k_d}$, $k_d = k_i - k_j$.

This proposal will be referred to as Mersenne hypothesis and it leads to strong predictions about EEG since it predicts a spectrum of preferred Josephson frequencies for a given value of membrane potential and also assigns to given value of $\hbar$ a fixed size scale having interpretations as size scale of body part or magnetic body.

1.1.5 DNA and topological quantum computation

The model of DNA as topological quantum computer led to a dramatic progress in the understanding of how magnetic body interacts with the biological body. The model which looks the most plausible one relies on two specific ideas.

1. Sharing of labor means conjugate DNA would do TQC and DNA would "print" the outcome of TQC in terms of RNA yielding amino-acids in the case of exons. RNA could result in the case of introns. The experience about computers and the general vision provided by TGD suggests that introns could express the outcome of TQC also electromagnetically in terms of standardized field patterns. Also speech would be a form of gene expression. The quantum states braid would entangle with characteristic gene expressions.

2. The manipulation of braid strands transversal to DNA must take place at 2-D surface. The ends of the space-like braid are dancers whose dancing pattern defines the time-like braid, the running of classical TQC program. Space-like braid represents memory storage and TQC program is automatically written to memory during the TQC. The inner membrane of the nuclear envelope and cell membrane with entire endoplasmic reticulum included are good candidates for dancing halls. The 2-surfaces containing the ends of the hydrophobic ends of lipids could be the parquets and lipids the dancers. This picture seems to make sense.

One ends up to the model also in top-down way.

1. Darwinian selection for which 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.

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.

4. Fluid flow must 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.

5. The topology of the braid traversing cell membrane cannot not 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.

6. There are several problems related to the details of the realization. How nucleotides A,T,C,G are coded to strand color and what this color corresponds to? One can imagine several possibilities [K21] and the vision about DNA as topological quantum computer [K1] suggests that genetic code is indeed represented in several way. One of them predicts that wormhole contacts carrying quark and anti-quark at their ends appear in all length scales in TGD Universe. How to split the braid strands in a controlled way? High T_c super conductivity provides the 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. How magnetic flux tubes can be cut without breaking the conservation of the magnetic flux? The notion of wormhole magnetic field saves the situation now: after the splitting the flux returns back along the second space-time sheet of wormhole magnetic field. The model inspires several testable hypothesis about DNA itself: in particular, the notion of anomalous em charge of DNA leads to several predictions of this kind. Also new mechanisms of catalytic action based on phase transitions reducing the value of Planck constant emerge.

1.1.6 Summary of basic ideas leading to the model of EEG

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 [K1]. 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 could code for four DNA nucleotides in this model. 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 could code for four DNA nucleotides in this model. There are also other options. In particular, the states of dark proton are in one-one correspondence with DNA, RNA, amino-acids and possibly also tRNA, and vertebrate genetic code is realized as a natural mapping between DNA and amino-acid like states [K12, K10]. This coding would map entire dark DNA codons to dark amino-acids, and one cannot reduce the code words to separate letters since quarks are quantum entangled.

2. Zero energy ontology assigns to elementary particles so called causal diamonds (CDs). For u and d quarks and electron the Compton time time scales are (6.5,.78, 100) ms respectively, and correspond to fundamental biorhythms. As already noticed, secondary electron Compton time corresponds to 10 Hz fundamental biorhythm defining also the fundamental frequency of speech organs,.78 ms to kHz cortical synchrony [**?**]. and 160 Hz to cerebellar synchrony [**?**]. 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 [K16] remain to be disentangled.

3. The understanding of the Negentropy Maximization Principle [K11] 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.

1.1.7 The model of sensory receptor

One can think of two alternative models for sensory receptor. The first model for sensory receptor identifies cell membrane as almost vacuum extremal.

1. 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 [K16]. Also a model of photoreceptors explaining the frequencies of peak sensitivity as ionic Josephson frequencies and allowing the dual identifications Josephson radiation as bio-photons (energies) [I4] and EEG radiation (frequencies) emerge since the values of Planck constant can be very large.

2. 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 $sin^2(\theta_W) = .23$. This assumption of course might be criticized and is probably unrealistic. It can be given up if the effective cell membrane potential depends on the receptor of particular ion. Also the argument behind the conclusion about Weinberg angle is rather weak being based on rather ad hoc identification of the energies of photons with peak sensitivity as generalized Josephson energies assignable to specific dark ions.

Second model identifies cell membrane as far from vacuum extremal and is supported by the findings of Pollack about water as a fourth phase of water. This model forces generalization of Josephson junction so that Josephson energy as increment of Coulombic energy is replaced with its sum with the difference of cyclotron energies defining the TGD counterpart of the chemical potential in the thermodynamical model which in Zero Energy Ontology is replaced with its "square root". This model is also consistent with the TGD views about metabolism and bio-photons and also provides a mechanism for the generation of nerve pulse.

In microscopic description one must consider transmembrane proteins as Josephson junctions and one could argue that they can be either near to vacuum extremals or far from vacuum extremals but that both states are are not possible.

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. (Generalized) Josephson frequencies or assignable to biologically important ions are in one-one correspondence with the qualia and (generalized) Josephson radiation could re-generate the qualia or map them to different qualia in a one-one and synesthetic way 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 bio-photons 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 this analogy can be justified 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.

1.2 Vision About Eeg

The general model for EEG relies on the idea that EEG frequencies correspond to Josephson frequencies defined by membrane potentials and provide cognitive and one might also say emotional

representation of the sensory input at the magnetic body in terms of cyclotron transitions. The perturbations of the membrane potentials caused by spikes, neurotransmitters affecting alertness reducing the magnitude of the resting potential induced frequency modulations of the membrane potentials and one can say that the cell is like a singing whale with evoked potentials and nerve pulse patterns coded to the varying frequency. Song is expression of this singing but also speech involves frequency modulation as one learns by playing slowly recorded spoken language.

The scale of the frequency assignable to a given neuron is determined by the value of Planck constant. TGD inspired quantum biology and number theoretical considerations suggest preferred values for $r = \hbar/\hbar_0$. For the most general option the values of $\hbar$ are products and ratios of two integers n_a and n_b. Ruler and compass integers defined by the products of distinct Fermat primes and power of two are number theoretically favored values for these integers because the phases $exp(i2\pi/n_i)$, $i \in \{a, b\}$, in this case are number theoretically very simple and should have emerged first in the number theoretical evolution via algebraic extensions of p-adics and of rationals. p-Adic length scale hypothesis favors powers of two as values of r.

The hypothesis that Mersenne primes $M_k = 2^k - 1$, $k \in \{89, 107, 127\}$, and Gaussian Mersennes $M_{G,k} = (1+i)k - 1$, $k \in \{113, 151, 157, 163, 167, 239, 241..\}$ (the number theoretical miracle is that all the four p-adic length scales sith $k \in \{151, 157, 163, 167\}$ are in the biologically highly interesting range 10 nm-2.5 μm) define scaled up copies of electro-weak and QCD type physics with ordinary value of $\hbar$ and that these physics are induced by dark variants of corresponding lower level physics leads to a prediction for the preferred values of $r = 2^{k_d}$, $k_d = k_i - k_j$, and the resulting picture finds support from the ensuing models for biological evolution and for EEG.

An essential assumption is that cell membrane corresponds to almost vacuum extremal so that classical Z^0 field proportional to em field is present and leads to the replacement of ionic charges with effective charges much larger than ionic charges so that that membrane voltage corresponds to a photon energy in visible or UV range and the energies of biologically most important ions span half octave.

Armed with this picture one ends upd with a rather detailed quantitative model for EEG. In this chapter this model is applied in more detail. Features, synchronization, stochastic resonance, temporal codings, and what I have used to called scaling will be discussed.

1.3 Fractal Hierarchy Of Generalizations Of Eeg

EEG is replaced with a fractal hierarchy of generalizations of EEG corresponding to various values of Planck constants involved and to what kind of part of living system the magnetic body in question corresponds.

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 its $1/\hbar$ scaled counterparts, and to the Josephson frequencies f_J associated with Josephson junctions assigned with cell membranes. If Josephson radiation modulates cyclotron radiation also the frqequencies $mf_J \pm nf_c$ 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 bio-photons 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 [K12]. [K12].

4. For cyclotron frequencies the extremals are assumed to be far from vacuum extremals carrying very small classical Z^0 fields but non-vanishing 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 gene 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 allowed 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. Note that 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 almost vacuum extremals. For Ca^{++} ion r is very near to a power of 2.

1.4 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 corresponds 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 embedding 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.

1.5 The Effects Of ELFEM 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. These effects therefore serve as a killer test for the scenario and are still only partially understood.

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 frqeuencies 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 bio-photons 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/m follows 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 nearly that corresponding to 2 eV energy, which also corresponds to bio-photon energies assignable to 50 mV subcritical membrane potential. 1-10 V/m interval corresponds roughly to the range of bio-photon energies. 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.

1.6 Generalized EEG and Consciousness

If the Josephson radiation for a particular primary sensory organ and corresponding sensory pathway propagates to a specific part of the magnetic body along flux quanta it for sensory qualia. Similar interpretation applies to motor action interpreted formally as sensory perception in reversed time direction. Note that the resting potential for the cell membrane is considerably higher for motor neurons than for sensory receptor neurons. The assumption that Josephson radiation induces cyclotron transitions leads to a general interpretation of the generalized EEG in terms of spectroscopy of consciousness.

1. The primary qualia are coded by quantum numbers of quark pairs (or pairs of them) assignable to the ends of the flux tubes connecting DNA nucleotide and lipids. Sensory input generates the Josephson radiation and induces the primary qualia at the level of sensory receptor. Josephson radiation can also regenerate primary qualia or mental images in one-one correspondence with the primary qualia along the entire sensory pathway. Josephson radiation can transform to either bio-photons or EEG photons.

2. At the magnetic body Josephson radiation induces cyclotron transitions if resonance conditions are satisfied which implies that the communication of sensory data is optimal for special values of cell membrane resting potential for a fixed value of the magnetic field which of course can also vary. The value of resting potential critical for the generation of nerve pulse is the best candidate in this respect.

3. Also cyclotron transitions could correspond to some kind sensory qualia. "General feeling of existence" possibly accompanying all sensory qualia shared by the magnetic body is one possible identification for the quale involved. The quantum entanglement between this kind of mental image and the mental image representing the primary quale is natural candidate for the experience.

1.7 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 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.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. Pdf representation of same files serving as a kind of glossary can be found at `http://tgdtheory.fi/tgdglossary.pdf` [**?**].

2 What Is EEG Made Of?

The usual classification of EEG frequencies by EEG bands is more or less a convention and the definitions of various bands vary in frustratingly wide ranges. In a more ambitious approach bands should be replaced with some substructures identified on basis of their physical origin and function. In the proposed framework this is possible. This identification of substructures of course applies only to that part of EEG from which evoked potentials, noise, and possible other contributions are subtracted.

2.1 Basic Ingredients For Dark Hierarchy Of EEGs

The dark hierarchy of Josephson junctions with fixed size characterized by a p-adic length scale most naturally assignable to a member of twin prime pair defining a fractal hierarchy of EEG like spectra assignable to various parts of organism is the basic element of the model of generalized EEG. In the following only ordinary EEG is considered.

2.1.1 The path to recent view

The most obvious guess is that Josephson radiation is used for communications from cell membrane to magnetic body, its absorption induces cyclotron transitions, and the feedback to genome induces cyclotron transitions at the level of DNA inducing DNA expressions. This is of course only the simplest guess: one must start somewhere.

There are indeed objections against this view but the notions of magnetic body, dark matter has hierarchy of phases with non-standard value of Planck constant, and zero energy ontology solve these problems as the construction of a model for the findings of Pollack demonstrated [**?**].

1. If one assumes that bio-photons are outcome from transformations of dark EEG photons to visible photons, one encounters a problem since the energies of bio-photons are in visible and UV range unlikes the Josephson photons from cell membrane with energy $E_J = ZeV$ in the range.1-.16 eV for $Z = 2$.

The earlier proposal for the solution of this problem was that cell membranes can be near vacuum extremal so that classical Z^0 force gives dominating contribution to the membrane potential and increases it so that Coulombic energy has correct order of magnitude. This proposal emerged from a model for color qualia. The problem was that one had to assume for Weinberg angle a value about 1/10 from the standard model value.

2. The nominal value of metabolic quantum is about.5 eV and much larger than the Josephson energy $E_J = .1 - .16$ eV so that one cannot assume that mitochondrial membrane is battery unless there is large chemical potential or some additional contribution to single particle energy.

   In the case of proton Z^0 potential is negligible so that near vacuum extremal property does not solve the problem.

3. In the thermodynamical model of cell membrane and metabolism chemical potentials dominate over Coulomb energy.

   Zero energy ontology means that quantum theory in TGD sense is square root of thermodynamics. This leads to a modification of the thermodynamical model of cell membrane but chemical potential replaced with cyclotron energy of dark matter particle at magnetic flux tube. Also in the thermodynamical model the chemical potential would be replaced by cyclotron energy.

   This model gives hopes of resolving the listed problems. The model has as physical parameters bio-photon energy E_{bio} equal to energy of dark photon, $E_J = ZeV$ or equivalently membrane voltage V, and masses m_i and charges Z_i of charged particles involved, and magnetic field strengths at the portions of the magnetic flux tube at opposite sides of the cell membrane. The octaves of the endogenous magnetic field with value $B_{end} = .2$ Gauss are a good first guess for the values of B. Membrane potential is coded to the generalized Josephson frequency $f = f_{c,I} + f_{J,1}/n$ and the variations of membrane potential give rise to frequency modulation with $\Delta f/f \sim .1$ which would characterize the width of EEG bands. EEG bands correspond to cyclotron frequencies.

2.1.2 Josephson current

Each junction has a background voltage over it. The basic hierarchy involves the p-adic length scales $L(k)$, $k = 151, 157, 163, 167$ corresponding to Gaussian Mersennes - or to be more precise - the scaled up variants of electron Compton scale for this p-adic scales, which seem to be biologically highly relevant. This suggests the importance of p-adic and dark scales coming in powers of 2. One could consider the possibility that not only $k = 151$ but all these length scales and also twin primes define their own Josephson junctions with their own values of Josephson potential.

Thee model for Josephson current relies on the model of cell membrane inspired by the findings of Pollack.

1. The generalized Josephson current for ion labelled by i can be written as

$$\begin{aligned} J_i &\propto R_{1,i}R_{2,i}sin[\omega_i t + \frac{Z_i e \int V_1 dt)}{\hbar_{eff}}] \ , \\ \omega_i &= \omega_{c,i,1} - \omega_{c,i,2} + \omega_{J,1} - \omega_{J,2} \ , \\ \omega_{J,i,k} = \frac{Z_i e V_k}{\hbar_k}, \ k = 1,2 \ , & \\ \omega_{c,i} &= \frac{Z_i e B_{end,i}}{m_i} \\ , R_{i,k} &= exp(\frac{nE_{c,i,k} + Z_i e V_k)}{2T}) \ , \ E_{c,i,k} = h_{eff,i}\omega_{c,i,k} \ , \ n_{i,k} = \frac{h_{eff,i,k}}{h} \end{aligned} \tag{2.1}$$

   Here V_k, $k = 1, 2$ denotes electromagnetic potential at the two sides of the membrane and $V = V_1 - V_2$ defines the resting potential. Gauge invariance demands that one can choose $V_2 = 0$ so that one has $V_1 = V$. $R_{i,k}$ denotes the square root of Boltzmann weight defined by cyclotron energy and Josephson energy. T is the physiological temperature.

2. If $n_{i,1} \neq n_{i,2}$ is allowed, the frequency of Josephson radiation is not unique: $\omega_{J,1}/n_{i,1}$ or $\omega_{J,1}/n_{i,2}$. Gauge invariance requires unique Josephson frequency and thus $n_{i,1} = n_{i,2}$ In this case the values of magnetic field B_{end} must differ at the two sides of the cell membrane in order to get radiation with energy scale in that for biophotons. Octave hypothesis for the strength of B_{end} is attractive so that difference of two octaves of $B_{end} = .2$ Gauss would determine E_{bio}.

3. If $E = \hbar_1\omega_1 - \hbar_2\omega_2$ corresponds to bio-photon energy E_{bio} in (possibly IR,) visible or UV range, then the proportionality $h_{eff,i}/h = n \propto A_i$ of h_{eff} to the mass number A_i characterizing the cyclotron frequency of the ion is natural first guess. It implies that

$$E_{bio,i} = h_{eff,i,1}f_1 - h_{eff,i,2}f_2 = h_{eff,i,1}(f_1 - f_2)$$

depends only weakly on ion (through the additive contribution coming from Josephson energy which is smaller by factor 1/50 roughly).

4. The first guess suggested by octave structure of EEG is that $B_{end,i}$ and cyclotron frequency spectrum becomes in octaves so that spectrum to the cyclotron part of bio-photon energy would come as differences of octaves in the general case. These discrete energy values would be widened to bands with width $\Delta f/f$. The basic prediction is that bio-photon spectrum should reflect rather directly EEG spectrum.

5. There are additional complicacies due to the fact that also the harmonics of ω_i are allowed and the membrane potential is time dependent. EEG spectrum becomes effectively continuous and this reflects itself also in bio-photon spectrum. The membrane potential receives also feedback contribution from magnetic body coming through DNA in the simplest model assuming that magnetic flux tubes in the interior of cell connect it with DNA nucleotides [K1].

Some general comments are in order.

1. Generalized Josephson frequency ω_i would define a kind of drum beat whereas the frequencies associated with V_1 would represent modulation of this drum beat frequency so that the outcome would be like Chopin's piano piece with tempo rubato. ω_i also defines a candidate for the time unit in which the time scale of memories and intentional action of the living system are measured.

2. The phase transitions leading to swelling or contraction of cell can be identified as phase transitions changing the value possible at both sides of the cell and implying that equilibrium concentrations of ions are changed in the manner implied by the generalization of the Boltzmann weight formulas. The modulations of Josephson frequency implied by nerve pulses occur in time scale of few milliseconds and are fast in the time scale defined by cyclotron frequencies and it is quite possible that they modulate electron cyclotron frequency rather than ionic or protonic cyclotron frequencies.

The model for nerve pulse [K16] supports strongly the view that in resting state V corresponds to a propagating soliton sequence associated with Sine-Gordon equation. As described in the section about EEG, the situation is mathematically equivalent to a linear array of gravitational penduli coupling with each other and soliton sequence corresponds to a rotation of penduli with constant phase difference between neighbors so that a propagating wave would result. The analog of EEG would be associated also with ordinary cell membranes but the smaller value of $\hbar$ would imply that the frequencies involved are higher. Non-propagating EEG would accompany neuronal soma and possible propagating EEG waves with axons.

2.1.3 Thermodynamical considerations

The replacement of thermodynamics by its square root required by ZEO has been already explained. The key idea is that the density matrix is replaced with its hermitian square root multiplied by unitary S-matrix. The model of cell membrane would be the first real world application of ZEO.

If cyclotron energies at the two sides of membrane are different and their energy scale is in the range of bio-photons energies or if the membrane is almost vacuum extremal, generalized Josephson energy for ions corresponds to that for a visible or UV photon so that the Josephson photons are well above the thermal energy. The identification of EEG and bio-photons as decay products of large h_{eff} Josephson photons is possible. If the cyclotron energies are different then the generalized Josephson energy is above thermal energy always and Josephson frequency represents only 10 per cent modulation.

Josephson energy should be above thermal energy at physiological temperatures if one allows also the situation in which cyclotron energies are same at the two sides of the cell membrane. The conservative option is that the cell membrane is far from vacuum extremal phase with very small Z^0 field. From the resting potential whose nominal value is often taken to be for.08 V, f_J corresponds roughly to the energy.16 eV whereas the energies allowed by thermal stability must be larger than the energy corresponding to the maximum of black-body radiation intensity distribution as function of frequency and given by $E \simeq 3T_{phys} \simeq .93$ eV at $T_{phys} = 37$ C.

Nerve pulse is generated when the potential drops to about.055 eV: the corresponding Josephson energy for far from vacuum extremal Josephson junction is .11 eV, which is slightly above thermal energy.093 eV so that it seems that metabolic costs are minimized. The energy $E = .1$ eV is the universal transition energy of Cooper pairs of high T_c electronic super conductor [K3].

The generation of nerve pulse should involve h_{eff} changing transitions at either or both sides of the membrane forcing the equilibrium concentrations to change. They might also accompany the transition of the cell from a resting state to active state, which involves folding of the parts of straight unfolded parts of proteins and partial melting of globular proteins due to the melting of ordered water surrounding them.

For organisms possessing no nervous systems, in particular bacteria, this constraint is not relevant.

ZEO thermodynamics should explain why the temperature of brain must be in the narrow range 36-37 C to guarantee optimal functionality of the organism- one of the fundamental mysteries related to living matter.

1. Quantum criticality in some form is expected to be involved. Phase transitions changing the value of Planck constant at the flux tube portions at two sides of cell membrane must be possible. This would induce flows of ions through membrane and swelling and contraction of the cell which are basic phenomena at cell length scale. Phase transitions changing the length of flux tubes would be also involved with bio-catalysis. The possibility of wide spectrum of length scales is indeed key property of critical system. Temperature appears as a parameter in single particle wave functions in ZEO so that there are good changes to understand the thermodynamical aspects of the criticality at the level of first principles.

2. That the ordinary Josephson frequency is very just above the thermal energy should relate to the quantum criticality. If the temperature has too low, the value of h_{eff} is fixed to single value and bio-control - for instance that needed in basic bio-reactions - does not work. Hence h_{eff} changing phase transitions must be possible, and this requires high enough temperature. The temperature cannot be however too high since Josephson energy should be above thermal energy even in the case that cyclotron energies at two sides of the cell membrane are same. Thus biolocical activity and communications to magnetic body are competing factors and lead to a critical range of temperatures.

3. One could say that above critical temperature magnetic body becomes partially blind because communications with ordinary Josephson frequency are not present. Below the critical temperature the biological body becomes lame.

2.1.4 Classification of cyclotron frequencies

Consider now the classification of cyclotron frequencies ($B_{end} = .2$ Gauss will be assumed).

1. Cyclotron frequencies can be classified according to whether they are associated with atomic or molecular ions. For biologically important atomic ions most frequencies are above 7.5 Hz. For molecular ions frequencies are lower and for DNA sequences the frequencies are in delta

band rather near 1 Hz irrespective of the length of DNA because the charge is 2 negative charge units per nucleotide.

Thermal stability condition suggest a lower bound of ~ 1 Hz for significant frequencies of this kind. Thus one can ask whether delta band dominating during deep sleep could correspond to DNA and possibly other bio-molecules and EEG during wake-up state corresponds to atomic ions. For $B_{end} = .2$ Gauss this would require that DNA strands are at magnetic flux tubes and by previous argument at rather large distance from Earth. Interestingly, the large negative charge of DNA makes possible for it to levitate in the Earth's electric field of $E_2 \sim 100$ V/m at the surface of Earth up to heights about 30-50 km and $r \simeq 1.3R_E$. At higher heights this field becomes small or reverses sign.

O^{2-} is bosonic ion and of special interest because cyclotron frequency is about 37 Hz and near to the thalamo-cortical resonance frequency. O^{2-} also associated with bio-photon emissions so that a connection with EEG is suggestive.

2. Atomic ions can be classified into bosonic and fermionic ions. Practically all biologically important bosonic ions have $Z = 2$ and in alpha band: $f(^6Li^+) = 50$ Hz and $f(Mg^{2+}) = 25$ Hz are the only frequencies above alpha band (see Appendix). Situation is essentially the same for biologically interesting ions. $^7Li^+$ is exception and corresponds to 42.9 Hz. Thus the frequency range $7.5 - 15$ Hz is very strongly represented and expected to be fundamental.

3. The integer n characterizing the harmonics of the cyclotron frequency is an additional classificational criterion and n could correlate with the character of neural processing. The harmonics of Josephson frequency are present in Josephson radiationandinduce resonant cyclotron transitions with arbitrary high values of n if the ratio of Josephson frequency and cyclotron frequency is rational number. Note that the sensory representations at magnetic body are generated only at at critical values of the membrane potential. In case of hearing the values of n would characterize the harmonics of the fundamental and determine the character of the pitch.

4. Also the position in the periodic table of elements provides a classificational criterion (see Appendix) but this criterion does not seem to be so useful as thought originally.

What about electron? The mass ratio m_p/m_e is roughly 2^{-11} so that the cyclotron frequency is by factor about 2^{11} higher. Thus proton and various ions correspond to $h_{eff} = 2^{k+11}A$ and electron to $h_{eff} = 2^k$. This would give some motivation for the original quite too strong hypothesis that the values of h_{eff} come as powers of 2^{11}.

2.1.5 Basic contributions to EEG

The following general overview about quantum communication and control emerges in this framework.

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 and Josephson frequencies f_J.

1. Schumann resonances do not depend on magnetic field strengths assignable with the magnetic flux sheets and would characterize Earth's magnetic field and collective aspects of consciousness. According to the model for sensory receptor and magnetic body [K9, K15] the inner rotating part of the Earth's magnetosphere could correspond to the third person aspect of sensory perception whereas the personal magnetic body would be anchored to body and move with it. Both inner and outer magnetosphere (which does not rotate with Earth) could receive sensory input from biosphere.

2. Cyclotron frequencies correspond to magnetic field $B_{end} = .2$ Gauss for the ordinary value of Planck constant and its $1/\hbar$ scaled down counterparts. The extremals are assumed to be far from vacuum extremals carrying very small classical Z^0 fields but non-vanishing classical W fields and color fields (with $U(1)$ holonomy). The corresponding flux quanta would naturally correspond to flux sheets traversing through DNA strands.

3. Josephson frequencies f_J are associated with Josephson junctions assigned with transmembrane proteins. Far from vacuum extremals are assumed. Generalized Josephson frequency is given by $f_i = \Delta f_c + f_{J,1}/n$.

   (a) Bio-photons and EEG can be seen as manifestations of one and same thing: generalized Josephson radiation with a large value of Planck constant with energies of bio-photons and frequencies of EEG. Ordinary EEG photons result when dark visible photon decays into a bunch of ordinary ELF photons and bio-photons result when dark photon transforms to ordinary visible photon. Generalized Josephson radiation would propagate along flux tubes parallel to the cell membrane.

   (b) Generalized Josephson frequencies can be said to code for qualia if the generalized Josephson radiation is guided along magnetic flux tubes to a part of magnetic body specific to a given sensory receptor (or even neuron or cell in the case of cell level qualia). According to the model of sensory receptor [K9, K15] they do not however directly induce the sensory quale, which would be characterized by the net quantum numbers of quark pair (or two of them depending on the model).

   Generalized Josephson radiation can also regenerate the sensory quale along neural pathway. Therefore the original vision about spectroscopy of consciousness is realized in a limited sense. This implies that the precise value of the membrane resting potential could characterize both the parts of the organism and state of consciousness in the case of cortical neurons (say alertness) since depending on the value of membrane potential the neuron is in wake-up state or "sleeps". The value of the membrane potential would also directly correlate with the analog of EEG assignable to the body part. The fact that neuron types correspond to different membrane potentials conforms with this picture and suggest that they also correspond to different magnetic bodies with different field strengths.

4. Far from biological body one expects both kinds of flux quanta to fuse to form larger quanta so that one has parallel space-time sheets carrying cyclotron *resp.* generalized Josephson radiation, whose frequencies are rather near to each other so that flux tube with varying value of B can serve as receiver of the entire spectrum of Josephson radiation for a given ion. 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.

How these two kinds of radiations relate to the communication between magnetic and biological body and to the control of biological body by magnetic body is not quite clear.

1. One of the basic functions of the cell membrane is to monitor the chemical environment using various kinds of receptors as sensors. Neurons have specialized to receive symbolic representations of the sensory data of primary sensory organs about the situation in the external world. Receptor proteins would communicate cell level sensory input to the magnetic body via MEs parallel to magnetic flux tubes connecting them to the magnetic body. Josephson frequencies would code various fundamental qualia assignable to DNA nucleotide-lipid pairs so that a sensory map defined by the cell membrane would be communicated to the magnetic body.

2. A good guess is that cyclotron frequencies are assignable to the magnetic flux sheets going through DNA strands responsible for quantum control via gene expression. This guess might be too naïve. Josephson radiation would induce transitions between cyclotron states and generate in this manner sensory representations at magnetic body so that both frequencies would be involved with sensory representations. Furthermore, the identification of motor action as a time reversal of sensory perception allowed by zero energy ontology would mean that the mechanisms of sensory perception 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.

3. 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. Note that for 10 Hz cyclotron frequency the estimate for $\hbar$ in the case of 2 eV dark photon is $r \simeq 3 \times 2^{46}$.

Far from critical vacuum extremals allow also classical W fields and gluon fields and they might be relevant for the quantum control via DNA flux sheets.

1. In the length scales below the weak length scale L_w also charged dark weak bosons behave as massless particles and the exchange of virtual W bosons makes possible a non-local charge transfer. For instance, for $\hbar \sim 2^{89}$ W bosons behave like massless particles below the length scale 10^{-4} m and classical W fields and the exchange of W bosons might make possible charge entanglement. The hypothesis that Mersenne primes and Gaussian Mersennes correspond to a hierarchy of exotic weak physics leads to a highly unique vision for how life has evolved. In this model weak interactions play a key role in even macroscopic length scales.

2. Dark quark-antiquark pairs associated with the color bonds of the atomic nuclei could become charged via the emission of dark W boson and thus produce and exotic ion. The same can happen at the higher levels of dark matter hierarchy. This provides a non-local quantal mechanism inducing or changing electromagnetic polarization in turn inducing ordinary charge flows and thus making possible quantum control. Long range charge entanglement could be understood also in terms of classical W fields. Same applies to color entanglement which could be crucial element of topological quantum computation.

2.2 The Simplest Model For The Correspondence Between Generalized Josephson Frequencies And Cyclotron Frequencies

The vision is that generalized Josephson radiation is received resonantly at the magnetic flux tubes of the magnetic body and induces a phase transition like emission of cyclotron radiation defining the response of the magnetic body communicated to DNA and possibly activating DNA expression and topological quantum computation like activities in DNA-membrane system [K1, K14]. A natural requirement is that membrane potential coding for the neural events and coded to generalized Josephson frequency is in turn coded to a position coordinate at flux tube by the resonance condition. The thickness and thus the local magnetic field at the flux tube must be varying in order that position coding is obtained.

2.2.1 Resonance condition equates generalized Josephson frequency with cyclotron frequency

The challenge is to understand the correspondence between Josephson and cyclotron frequencies and the what happens in the absorption of generalized Josephson radiation and how the response of magnetic body is generated. The following discussion represents a dramatic simplification of the earlier model.

1. The simplest coding would correlate $h_{eff}/h = n$ and the mass number A of ion: $n \propto A$ so that carrier frequency for Josephson radiation would correspond to cyclotron frequency. One could have $n = 2^k A$ and generalized Josephson frequency would correspond to cyclotron frequency through resonance condition at magnetic flux tube carrying particular ion and corresponding to a particular value of $h_{eff} \propto A$. Since Josephson contribution is small the two frequencies are near to each other with difference being of order 10 per cent.

2. The sub-band structure of EEG would naturally correlate with the cyclotron frequencies assignable to the biologically important ions. Bands with width about $\Delta f/f \sim .1$ would itself could correspond to the variation from the nominal value $B_{end} \simeq .2$ Gauss along flux tube. Proton would define the frequency scale with $f_c(p) = 300$ Hz and ion with charge Z and mass number A would have cyclotron frequency $f_c = Zf_c(p)/A$.

3. The atomic weight A has rather small number of values for biologically important ions if only bosonic ions are assumed (Bose-Einstein condensate). If also Cooper pairs are allowed, or if one accepts the suggestion of TGD inspired nuclear physics that exotic bosonic nuclei with mass of fermionic nuclei exist [K12], the situation changes. Many nucleon states in large h_{eff} phase can also allow pseudo Bose-Einstein condensates since anti-symmetrization in discrete degrees of freedom corresponding to sheets of multi-sheeted covering allows Bose-Einstein condensation like process in translational degrees of freedom. The anti-symmetrization gives also rise to negentropic entanglement [K11].

4. The magnetic field along flux tube could vary in range which is 10 percent of its mean value. The nominal values are $B_{end} = .2$ Gauss and its octaves. The variation along flux tube length would gives rise to a map of Josephson frequency - and thus membrane potential - to the flux tube coordinate. The variation of V would correspond to back and forth motion of "sensation" along the flux tube. Evoked potentials and neural noise would modulate the frequency and would be coded to this motion.

5. Resonance loop magnetic body-biological body requires that the motor response of the magnetic flux tube communicated to DNA has the same frequency spectrum as sensory input and thus correspond to a radiation at frequencies which correspond to differences of octaves of B_{end}. This can be achieved in several ways.

   (a) The change of B by octave at flux tube traversing cell membrane could be translated to phase transition changing the thickness of flux tube and thus the value of B. Generalized Josephson radiation could induce phase transitions reducing h_{eff} by a power of 2. If p-adic prime increases by the same power, do not change the length of flux tube but changes the value of B_{end} temporarily by flux conservation since the thickness of the flux tube changes. This would induce coherent emission of radiation at frequency very near to a multiple of cyclotron frequency and induce a response at DNA level if flux sheets traverse DNA strands. This response would induce genetic expression and possibly further transfer of cyclotron transition to Josephson junction so that a resonant feedback would result. Also topological quantum computation like activities might be induced.

   (b) The magnetic field at the receiving portion of the magnetic flux tube receiving generalized Josephson radiation could have a value that corresponds to the difference of magnetic fields at the flux tube traversing cell membrane.

At the level of magnetic body the generalized Josephson radiation induces cyclotron phase transitions and in this manner communicate generalized sensory input to the magnetic body.

1. Chopin's piano pieces are highly emotional and half-jokingly one can ask whether tempo rubato due to the frequency modulation could code for the emotional content of the neural input. As a matter of fact, I have proposed that emotions correspond to the sensory experiences of the magnetic body. Frequency coding would provide the representation the information carried by nerve pulses and possible perturbations at cyclotron frequencies arriving from the magnetic body adding to the basic frequency.

2. The coherent photon state generated by J defines representation of evoked potentials V_1 as a generalized EEG interacting resonantly with magnetic body and providing feed back at harmonics of cyclotron frequency. This would create resonant feedback loops via DNA giving rise to biological representations as dark cyclotron photons interact with the living matter.

3. The scaling $h_{eff} \to n$ scales the time dependences of the Josephson current and Josephson radiation: $t \to t/n$. One obtains scaled variants of representations of the neural dynamics communicated to magnetic body. Different "stories" in various time scales is regarded as an essential element of intelligence and I have indeed proposed that they correspond to different values of h_{eff}. Different dark ions would correspond to these scaled variants of the representation.

To sum up, the model would realize the original idea about spectroscopy of consciousness rather concretely. The assumption that B_{end} has only the bands around preferred values differening by

octaves is of course vulnerable to criticism. The model for hearing indeed suggests that instead of only octaves something analogous to music scale is needed. This well be discussed in more detail below. The role of fermionic ions remains open but there are slight indications that Na^+ might be importance for beta band.

2.2.2 Satellites

The input from cell membrane to the magnetic body can have two effects.

1. It can induce ordinary cyclotron transitions generating cyclotron radiation propagating from the magnetic body to genome to cell membrane as a small perturbation. This feedback could be called perturbative.

2. The input can also induce phase transitions by scaling the value of B_{end} by power of 2 (the simplest assumption) for the entire flux tube from the magnetic body to genome to cell membrane. This would give rise to a biological response as the ionic equilibrium concentrations change in accordance with the model based on "square root of thermodynamics" suggested by ZEO. Nerve pulse might be one such a response.

The perturbative feedback from the magnetic body to the DNA and from DNA to cell membrane would be present in two ways.

1. The feedback could affect the magnetic fields at flux tubes. Besides small oscillations also phase transitions This feedback could serve as basic control mechanism.

2. Feedback could affect also $V_1(t)$ besides the neural input such as evoked frequencies and give rise to additional frequencies satisfying the resonance condition. Nerve pulses generating motor actions could be one form of this feedback.

The general form of the perturbative feedback is easy to deduce.

1. Generalized Josephson current generating generalized Josephson radiation is trigonometric function of its argument of form $\int \omega(t)dt = \omega_0 t + \int \Delta\omega(t)dt$. $\Delta omega(t)$ contains a contribution coming from the modification of magnetic fields at both sides of the cell membrane and from $V_1(t)$.

2. If the amplitude of the feedback is small, it makes sense to develop the generalized Josephson current - essentially sine of its argument $\int \omega_0 t + \int \Delta\omega(t)dt$ - by using trigonometric formulas first and then expressing the trigonometric functions of $\int \Delta\omega(t)dt$ as Taylor series.

3. If $\Delta\omega(t)$ is superposition of trigonometric functions, this gives rise to series of higher harmonics involving integer combinations of generalized Josephson frequencies associated with various charged particles.

4. The simplest - perhaps un-necessary restrictive - possibility is that the feedback uses same frequencies as sensory input to magnetic flux tubes: this poses conditions on the allowed phase transitions inducing a change of B at the magnetic body. In this case only linear combinations of the basic frequencies ω_i with integer coefficients appear.

5. A sinusoidally varying perturbation would contribute to the generalized Josephson radiation frequencies of form

$$\sum_i n_i f_i \ ,$$

and give rise to what might be called satellites in EEG. These can contribute to conscious experience at magnetic body if the linear combination of the frequencies is cyclotron frequency. For instance, 5 Hz theta frequency could result as $f_c(Ca^{++}) - f_c(Co^{2+})$.

6. Simplest satellites are of form $f_i \pm f_j$ and thus appear as mirror pairs. In 10 per cent accuracy these frequencies are cyclotron frequencies and the first guess is that only bosonic ions contribute. The existence of the mirror satellites might be regarded as a killer prediction.

Amazingly, narrow EEG bands which are mirror images of each other with respect to alpha band have been reported [**?**]. Besides alpha band at 11 Hz, Nunez mentions also narrow sub-bands at 3, 5 and 7 Hz at delta and theta range, as well as the bands at 13, 15 and 17 Hz in beta band [**?**]. All these frequencies are expressible in the form $f_c \pm f$, $f = 5$ Hz. $f = 5$ Hz would correspond to cyclotron frequency in alpha band during first stage sleep if the transition $B_{end} \to B_{end}/2$ occurs during this stage of sleep. Of course, several octavess of B_{end} are in principle possible during wake-up state too.

The cyclotron frequencies associated with the bands are 8, 10, and 12 Hz. The cyclotron frequencies of bosonic ions $^{80}Se^{2-}$, $^{64}Zn^{2+}$, and $^{55}Mn^{2+}$ for a magnetic field strength $B_{end} = .2$ Gauss are 8.00, 9.90, and 12.00 Hz. The cyclotron frequencies of bosonic ions $^{59}Co^{2+}$ and $^{56}Fe^{2+}$ would be 10.52 Hz and 11.36 Hz and the satellites are at frequencies 5.52 Hz and 6.36 Hz and 15.52 and 16.36 Hz. All these frequencies belong to the bands reported by Nunez since their widths are 1-2 Hz. Thus the frequencies of all bosonic ions in alpha band and in their satellites belong to the bands reported by Nunez for values of f_J and B_{end} very near to their nominal values used in calculations!

With these assumptions the frequencies $3f_c(Mn^{2+}) \pm f_J$ are 40.97 Hz and 30.97 Hz corresponding to 40 Hz band and the threshold of gamma band. That $f_c(O^{2-}) = 39.6$ Hz is also in this band suggests additional reason for why oxygen is so important for consciousness. $f_c(Mg^{2+}) = 26.3$ Hz is very near to Schumann resonance 26 Hz and its upper satellite corresponds to the threshold of gamma band.

What is also very remarkable that the 10 Hz magic frequency of the memetic code corresponding to the secondary p-adic length scale $L(2, 127)$ associated with Mersenne prime M_{127} characterizing electron and emerging as the basic prediction of the zero energy ontology appears. It should be also noticed that $f_J = 5$ Hz frequency corresponds to cognitive theta appearing during tasks requiring mathematical skills. Note that the scaling of ordinary value of h_{eff} by a factor of 2 scales 10 Hz frequency to 5 Hz.

2.2.3 Harmonics

As a special case about satellites one obtains harmonics $f = nf_i$ and these can induce both ordinary cyclotron transitions.

1. For alpha band the third harmonics of most bosonic ions are in the range 28.2-34.2 Hz and roughly in gamma band above 30 Hz assignable with the control of cognitive activities from a flux quantum of Earth's magnetic field.

2. Fifth harmonics of alpha band would are in the range 37.5-57 Hz. The fermionic ion Na^+ would correspond to 65 Hz. During REM sleep EEG very similar to awake but 65 Hz resonance is present. One can ask whether fifth harmonics are present during REM sleep and serve as correlates for conscious visual imagery.

3. The fourth harmonic of 40 Hz thalamo-cortical resonance band is very important EEG band. The upper satellite of the third harmonic of Mn^{2+} is 37.9 Hz. The third harmonics of fermionic ions $^7Li^+$ and Na^+ correspond to 42.9 Hz and 39 Hz (Schumann resonance) respectively.

   As will be discussed, a more natural interpretation for thalamo-cortical resonance frequency and also the observed 20 Hz and 80 Hz resonance frequencies is in terms of p-adically scaled values of both h_{eff} and B_{end}.

2.3 Music Metaphor

I have proposed music metaphor as a useful heuristic guideline in attempts to understand brain functioning and music metaphor can be also used in attempts to understand EEG.

2.3.1 Right brain sings, left brain talks

I have proposed that right brain sings and left brain talks metaphor could apply quite generally to the frequency modulated communications to the magnetic body. That it could distinguish between hemispheres is also an interesting hypothesis to study.

1. Right brain sings

Right brain sings would in the first approximation (forgetting glissandos!) mean that Josephson frequency and thus membrane potential is a piecewise constant function of time.

"Singing" would represent a special case of frequency modulation for Josephson radiation and would require that various perturbations from neural activity and from feedback from magnetic body are small corrections possibly contributing to the emotional content of the signal (vibrato).

2. The metaphor would suggest that generalized Josephson frequencies have a set of discrete values analogous to the notes of the music scale which naturally spans one octave. This would reflect in the spectrum of bio-photons.

3. The variation range for the resting potential V is not a full octave so that the model involving only resting potential does not allow to realize the scale. The addition of the dominating cyclotron contribution saves the situation, and - just as in the case of hearing [K15] - the realization of scale in terms of the values of B_{end} becomes possible.

4. The resonance condition for cell membrane-magnetic body system requires that B_{end} has a spectrum of discrete values analogous to notes of the scale. If one takes 10 percent rule seriously and requires that the "note bands" do not overlap, one obtains $f_{n+1} = f_n + k_f n$, $k = .1$, giving $f_n = (1+k)^{n-1} f_0$. $f_{n_{max}}/f_0 = 2$ gives that the number of "notes" is 7.3 suggesting that 8-note scale could relate directly to the spectrum of generalized cyclotron frequencies.

5. If this picture is correct, the existence of minor and major scales means that emotional content of major and minor scales could reduce to that for the membrane potential scales so that the spectrum of B_{end} would code for the emotional content of the scale.

2. Left brain talks

Left brain talks metaphor suggests that there is in some sense discrete carrier frequency which is frequency modulated in such a manner that the outcome is analogs for the phonemes of language.

1. Binary code for phonemes is suggestive and I have considered the possibility that genetic code might define the six bits of code words represented as phonemes with duration of about.1 seconds corresponding to the fundamental time scale identifiable as secondary p-adic time scale of electron in zero energy ontology. The occurrence/non-occurrence of nerve pulse having duration somewhat longer than millisecond is an obvious candidate for defining the values of the bit.

2. The coding of nerve pulse patterns to cyclotron frequencies suggest that the carrier frequency f_J is higher than kHz. This requires reduction of h_{eff} by a suitable power 2^{-k} and scaling of B_{end} by 2^k. Also flux tubes contain cyclotron condensate of electric Cooper pairs with cyclotron frequency of order 5.6×10^5 Hz suggest themselves.

   "No nerve pulse" situation would correspond to a situation in which generalized Josephson radiation with frequency f is generated and magnetic flux tube detects it: continual "beee...p" would characterize the "sensation" at the flux tube would definite bit "0". As the nerve pulse passes by the frequency of beep changes about.1 for a time of order millisecond and returns to a value differing slightly from the original value due to hyperpolarization increasing the value of the resting potential. Thus bit "1" would have just the obvious representation.

4. This form of proposal does not assume any time discretization as the earlier proposals and the code would thus be very flexible. The duration of phoneme would be however about.1 seconds. The capacity to code six bits would require allow 1.5 ms minimal duration for nerve pulse. If the duration of "beep" does not matter at all then only the number of pulses during.1 second interval matters, and one obtains the familiar rate coding and 6 bit reduce to 7 possible values for the number of nerve pulses. This cannot represent all phonemes of spoken language.

The situation changes if there is background oscillation of the f with period of order nerve pulse duration of order.1/64 seconds $\simeq$ 1.6 ms. In this case it is possible to tell whether given period contains beep or nerve pulse. This would give rise to 6 binary digits able to code for 64 analogs of phonemes and one can consider also the analog of genetic code giving rise to redundancy. This kind of redundancy might be necessary since it can happe that given nerve pulse is present during two subsequent periods.

If this picture is on correct track, language would appear already at the level of communications to magnetic body and spoken and written languages would represent only its "externalizations". The first basic difference between speech and singing (and left and right brain) could be due to the fact that speech uses electronic Cooper pair condensates whereas singing uses ionic B-E condensates. Speech would also involve nerve pulse time scale in an essential manner an carry information about phase transitions changing the value of B_{end}.

2.3.2 Could the analogs of music scales appear in the communications to the magnetic body

The basic questions concern the allowed values of magnetic field B_{end} and the values of membrane voltage defining the scale of generalized Josephson frequencies.

Consider first hints concerning the spectrum of B_{end}.

1. Position coding suggests a band of about $\Delta B_{end}/B_{end} \simeq 10$ percent related to the position coding. This range would correspond to the frequency variation coming from the additive contributions to the resting potential from neural activity and magnetic body.

2. The model for the various stages of sleep relying on p-adic length scale hypothesis suggest that the scale of B_{end} comes as at least three powers 2^{-k}, $k = 1, 2, 3$ corresponding to alpha, theta, and delta bands. $h_{eff}/h = 2^k n$ would come as three powers in the same manner. It is also known that the frequencies 20, 40, and 80 Hz are resonance frequencies of EEG. 80 Hz is also resonance frequency in ERG.

3. This suggests that at least 6 octaves are involved. The next two powers of two correspond to 160 Hz and 320 Hz quite near to proton's cyclotron frequency 300 Hz for the nominal value of B_{end}.

These observations suggest that music metaphor is realized in rather concrete form. EEG would decompose to octaves just as music scale does. Each ion would define with its own scale scale and thus serve as an analog of instrument (note that the energy spectra of dark photons could be nearly identical for ions) corresponding a spectrum of values of B_{end}. The fundamental octave would correspond to scale with fundamental defined by $B_{end} = .2$ Gauss. In particular, 10-20 Hz interval would be associated with alpha band as the basic octave.

The attempt to identify different notes of the scale in terms of different bosonic ions does not look like an attractive idea. The region 10-20 Hz contains only 4 bosonic cyclotron frequencies: that of corresponding to Co, Fe, Mn in alpha band and Ca at 15 Hz and they need not correspond to notes of the same scale but fundamental frequencies of different keys. EEG could represents same piece in different keys labelled by bosonic ions. If this is the case, one could disentangle information from EEG by separating these contributions from each other by using the fact that they correspond to same function of time but with differently scaled argument.

2.4 An Attempt To Understand EEG In Terms Of The Resonance Model

In the following an attempt to understand the basic structure of EEG (`http://tinyurl.com/2mapqg`) and its relationship to state of consciousness is made.

2.4.1 Basic tests

The identification of EEG bands in terms of cyclotron frequencies identified as generalized Josephson frequencies is quite powerful prediction and deserves sensibility check.

1. The value of the endogenous magnetic field is $B_{end} = .2$ Gauss is 2/5: th of the nominal value of the Earth's magnetic field. B_{end} could be assigned to the magnetic field at flux tubes going through cell membrane (note however that also other values perhaps realizing the analogy of music scale with octaves is suggested by above considerations). The value of B at magnetic body, whose flux tubes would presumably be transversal to those connecting cell DNA and cell membrane, would be slightly different since Josephson frequency does not contribute to cyclotron frequency and have relative variation $\Delta B/B \simeq .1$.

   (a) If the variation $\Delta B/B$ corresponds to the variation of the Earth's magnetic field B_E scaling roughly like $(R_E/r)^3$ with the distance from the Earth's center, one would have $\Delta R/R_E \simeq .033$. This corresponds to $\Delta R \simeq 210.5$ km. Note that the F-layer of ionosphere - its densest layer - begins at about 200 km.

   (b) It could also be that B corresponds to the magnetic field of Earth. For Earth's magnetic field the distance at which its magnitude is about $2/5B_E$, $B_E = .5$ Gauss, would be roughly $r = 1.4R_E$. B_E defines the cyclotron frequencies of various ions and resonance condition must hold true for the resonant absorption of generalized Josephson radiation. The value of B_E should vary in some limits at flux tubes in order to achieve coding of generalized Josephson frequency by distance along flux tube: this gives rise to the EEG band.

2. If one assumes that only bosonic ions are relevant then for $B_{end} = .2$ Gauss, the values of relevant ionic cyclotron frequencies would be $f_c/Hz \in \{50, 27.4, 37.4, 25.0, 15.0, 11.4, 10.8, 9.5, 7.6\}$ Hz corresponding to ${}^6Li^+, Mg^{++}, Ca^{++}, Mn^{2+}, Fe^{2+}, Co^{2+}, Xn^{2+}, Se2-$ and 37.4 Hz near 40 Hz thalamo-cortical resonance frequency for molecular ion O^{2-} related to the bio-photon emissions in turn having interpretation as transformation of dark EEG photons to ordinary ones [K5]. There are three cyclotron frequencies in alpha band which makes it rather special.

3. The model could explain why wake-up consciousness is effectively lost when EEG frequencies are below 7.6 Hz: there would be no cyclotron condensates receiving input as generalized Josephson radiation and no consciousness assignable to the magnetic body.

   An alternative possibility is that consciousness changes its character during sleep. If magnetic flux tubes with B_{end} scaled down most naturally by factor 1/2 or 1/4 suggested earlier to explain the stages of sleep and h_{eff} is scaled up by factor 2 or 4 respectively, cyclotron frequencies are reduced by factor 1/2 or 1/4, and can be low enough for cyclotron resonance conditions to be satisfied. This scales various frequency bands down by factor 1/2 or 1/4. This consciousness would differ from wake-up consciousness, and this might explain why we do not have memories about sleeping period and conclude that sleeping period is non-conscious.

   If B correspond to the Earth's magnetic field at large enough distance so that the distance of the receiving flux tubes would increase roughly by a factor $2^{k/3}$, $k = 1, 2$, for theta and delta bands. The value of B_{end} could also change in a phase transition increasing p-adic prime approximately by a factor 2^k. This phase transition is proposed to be fundamental for metabolism [K14].

2.4.2 Theta and delta bands

Wikipedia article about EEG (`http://tinyurl.com/2mapqg`) summarizes the basic features of EEG bands.

1. Delta band is below 4 Hz and appears frontally in adults and posteriorly in children with high amplitude waves. It appears during adult slow wave sleep, in babies and during continuous attention tasks.

   Cyclotron frequency hypothesis and $h_{eff} \to 4h_{eff}$ hypothesis are consistent with these features. In particular, the model of slow wave sleep conforms with this picture. The satellite associated with Schumann resonance would be in alpha band and an interesting question is whether it appears in EEG during slow wave sleep.

2. Theta waves (4-7 Hz) appear in locations not related to task at hand, is higher in young children, correlates with drowsiness in adults and teens, is associated with "idling", and with inhibition of elicited responses.

   These features conform with the cyclotron frequency hypothesis and $h_{eff} \to 2h_{eff}$ hypothesis scaling alpha band to theta band corresponding to idling and also with the explanation of sensorimotor band 12-16 Hz in terms of satellites produced by input from magnetic body parts corresponding to alpha band. Also sleeping spindles can be understood. There would be no cyclotron frequency response at magnetic flux tubes responsible for wake-up sensory consciousness and motor activity. The performance of tasks would induce the transition $h_{eff} \to h_{eff}/2$ activating alpha band.

2.4.3 Alpha and Mu bands

Mu band is associated with sensorimotor motor cortex and is identified frequency range $8 - 12$ Hz and can be associated with rest-state motor neurons. Often one calls this band also alpha band.

Wikipedia definition identifies alpha band as $8 - 15$ Hz range. alpha band appears in posterior regions of at both sides and has higher amplitude on non-dominant sides. In a relaxed state beta band disappears and the spectral power in alpha band increases. alpha dominance correlates with relaxed/reflecting state of consciousness, appears when eyes are closed, and is also associated with inhibition control, seemingly with the purpose of timing inhibitory activity in different locations across the brain. alpha band appears also in coma.

A possible identification for Mu band is in terms of sub-bands associated with $f_J = f_c$ where f_c is cyclotron frequency for bosonic ions Se^{-2} (7.6 Hz), Zn^{2+} (9.4 Hz), Co^{2+} (10 Hz), Fe^{2+} (10.8 Hz), and Mn^{2+} (11.4 Hz). Depending on definition of alpha band it includes also Ca^{2+} (15 Hz). Also the sensorimotor rhythms belong to this band but in TGD framework it can be distinguished from genuine alpha band.

In a relaxed state beta band disappears and the spectral power in alpha band increases. The simplest explanation is that the value of h_{eff} corresponds to alpha band. An interesting question is whether the 10 Hz resonance frequency associated with the excitations of electric field in ionospheric cavity behaving like 2-dimensional waves on sphere is involved. Also the 10 Hz frequency assignable to electron's CD could be involved.

2.4.4 Sensorimotor rhythms in range 12-16 Hz

Sensorimotor rhythm corresponds the range 12-16 Hz and associated with physical stillness and body presence is a challenge for the model. For bosonic ions (Mn^{2+} and Ca^{2+} only the cyclotron frequencies 11.4 Hz and 15 Hz belong to this band. These are not enough if one is ready to losen the hypothesis $\Delta f_c/f_c \simeq 10$ per cent.

Two basis options can be considered.

1. If B_{end} indeed has spectrum of values analogous to music scale one could explain sensory motor rhythms in terms this spectrum for some ion. alpha band extended to a scale is the simplest possibility. The notes C, E_b, E, F G A_b, and A would correspond to $f/Hz \in \{10, 11.8, 12.6, 13.3, 14.9, 15.8, 16.8\}$. D would correspond 1.12 Hz still in alpha band.

2. The increase of h_{eff} by factor of two and satellite phenomenon provide an alternative identification of beta band. alpha band would be scaled down to about 5 Hz and would be fed by cyclotron frequencies in alpha band from magnetic body. Stillness would mean that order sensory input to the part of the magnetic body responsible for wake-up consciousness is absent since since 5 Hz does not correspond to any cyclotron frequency for the nominal value of B_{end}. The satellite frequencies for alpha band would be in the range 12.6-16.4 Hz. So called sleeping spindle during first stage of sleep for which also TGD model increase of h_{eff} by a factor of two, are also in this range. The interpretation would be as cyclotron communications from alpha part of magnetic body received by scaled down alpha part of neuronal membranes.

2.4.5 Beta band

beta band ranges from 16 to 31 Hz, appears in both sides, has symmetrical distribution, is most evident frontally, and waves have low amplitude. beta band is associated with active, busy or anxious thinking and active concentration and is chaotic and highly asynchronous.

Again one can consider several explanations.

1. The simplest explanation of beta band is in terms of octave wide scale associated with Ca^{++} ion with $f_c = 15$ Hz for $B_{end} = .2$ Gauss.

2. Second possibility is beta band involves in an essential manner the feedback from magnetic body and satellite frequencies which however need not induce cyclotron transitions unless one is willing to losen the basic criterion. If higher order effect is in question, the low beta amplitudes can be understood. Harmonics induce cyclotron transitions without further assumptions and one obtains a rich spectrum of sub-bands.

Besdes Ca^{++} octave beta band can contain resonances.

1. Mg^{++} is the only bosonic ion having cyclotron frequency in beta range at $f_c(Mg^{++})= 25$ Hz and could appear as resonance frequency in beta band. Alternatively it could correspond fundamental frequency assignable to gamma band.

2. If one accepts the hypothesis about octaves of B_{end} then gamma band should contain also resonance frequencies around 15.2 Hz, 20 Hz and 30 Hz corresponding to Se^{2^+}, alpha band and Ca^{2+}. The resonance at 20 Hz is known to exist.

3. As already noticed, in slow wave sleep Schumann resonance at $f_S = 27.3$ Hz could generate this frequency by satellite mechanism but the amplitude would be smaller than for direct generation. Also 10 Hz alpha frequency and Ca^{2+} frequency can add up via satellite mechanism rise to $f_c(Mg^{++}) = 25$ Hz.

2.4.6 Gamma band

Gamma band is associated with somatosensory cortex and displays during cross-modal sensory processing and also during short memory matching of recognized objects, sounds or tactile sensations. Clearly gamma band relates associative regions of cortex. Thalamo-cortical resonance frequency with nominal value of 40 Hz belongs to gamma band.

The simplest option is that gamma band contaings several octave scales associated with $f_c(Mg^{++}) = 25$ Hz, $f_c(O^{2-}) = 37.4$ Hz and $f_c(6Li^+) = 50.1$. One can criticize this assumption: 25 Hz is roughly 15 per cent lower than 31 Hz. One the other hand, the identification of the various frequency is far from unique.

Ten percent rule for $\Delta f/f$ suggests that thalamo-cortical resonance of 40 Hz could correspond to 37.4 Hz. This would predict a large amplitude in accordance with resonance interpretation. Note that fourth harmonics of alpha frequencies are around the thalamo-cortical resonance frequency.

An alternative explanation of 40 Hz resonance is that it corresponds to the p-adic scaling of h_{eff} and B_{end}. Ca^{2+} would give rise to 60 Hz resonance frequency and also other bosonic ions would give rise to resonances in gamma band. The octave of $f_J(Mg^{2+})$ would give 50 Hz resonance in gamma band.

The strong amplitude of the feedback contribution in the argument of generalized Josephson current $J = J_0 sin(\omega_0 t + X)$ also means that the higher terms in Taylor expansion with respect to X are important and large number of satellites $\omega_0 + nf_c)$ is important so that the amplitude becomes chaotic. The harmonics of bosonic cyclotron frequencies predict quite rich spectrum of sub-bands in beta and gamma banda and it would be highly interesting to test the prediction.

To sum up, according to the proposed picture the basic contribution to alpha, beta, and gamma bands correspond to octave scales associated with bosonic ions in alpha band around 10 Hz, Ca^{++} around 15 Hz, and Mg^{++} around 25 Hz. There are also resonance contributions and contributions from the octaves of the fundamental octaves. Besides the proposed picture many other options can be imagined. One must make working hypothesis and the basic challenge is to avoid too strong assumptions.

2.5 EEGDuring Sleep

The EEG during sleep [**?**, J1] provides a testing ground for the proposed anatomy of EEG. Sleep consists of 90 + 90 minute periods of NREM and REM sleep. This period is also the period of brain hemisphere dominances during wake up and day dreaming occurs with the same period as REM sleep. During REM sleep the EEG is essentially similar to that during wake-up. These observations inspire the hunch that brain hemisphere dominance dictates whether REM or NREM is in question.

The scalings of h_{eff} by factor 2 and 4 accompanied by corresponding compensating scalings of B_{end} so that generalized Josephson energies are almost invariant seem to explain the basic characteristics of these states but it is not completely clear whether the phase transitions occur for both cell membrane space-time sheets and flux quanta or only for the first ones.

2.5.1 EEG during stage 1

The stage 1 sleep is between wake-up state and full sleep involving sometimes hypnagogic hallucinations. During stage 1 of deep sleep [**?**] theta waves in frequency range 4-8 Hz beging to dominate and amplitudes increase as frequency is reduced. The transitiosn $h_{eff} \to 2h_{eff}$ and $B_{end} \to B_{end}/2$ should take place and would take place also in relaxed state and generates sensorimotor rhythms.

1. If $h_{eff} \to 2h_{eff}$ transition takes place alpha band is scaled down to the range 3.8-5.7 Hz. Ca^{++} frequency scales down to 7.5 Hz so that one indeed obtains theta band. The amplitudes associated with these frequencies are expected to be high. These amplitudes should dominate and EEG should look rhythmic rather than chaotic as indeed observed. The amplitudes behave as $1/f_c$ and thus increase with decreasing f_c. The fact that the amplitudes increase with decreasing EEG frequency suggests that the frequencies they correspond to different cyclotron frequencies.

2. The secondary amplitudes generated by satellite mechanism for alpha band give rise to sensorimotor rhythms appearing also in sleeping spindles. The mirror frequencies are in theta band below 5 Hz.

The most important range 7.5-15 Hz of cyclotron frequencies would be scaled down to 3.75-7.5 Hz which indeed corresponds to the theta band. If one excludes Ca^{2+}, the range for bosonic ion reduces from $7.5 - 11.4$ to $3.75 - 5.7$ Hz. The satellites correspond to the range $.05 - 8.7$ Hz and $7.45 - 9.4$ Hz plus Ca^{2+} satellites at 3.8 Hz and 11.2 Hz. With Ca^{2+} forming a possible exception, the resulting frequency ranges are consistent with empirical facts. Of course, it is quite possible that magnetic body does not generate cyclotron transitions at Ca^{++} cyclotron frequency.

One must consider two options.

1. If both cyclotron frequencies at magnetic body and generalized Josephson frequencies are scaled down, the communication-control loop between magnetic and biological body remains intact. This might be necessary for the survival. This raises the question whether sleep actually means a loss of consciousness. Could it be that only the character of consciousness is changed? Since the magnetic body moves to a different page of the "Big Book" having as pages various singular coverings of the embedding space, one could argue that consciousness is not lost but that it is difficult to remember anything about this period during wake-up period since the negative energy signals responsible for memory recall should leak to another page of Big Book and this process could take place with a low rate. The mental images appearing just at the border of falling asleep could give a glimpse about the character of conscious experience in this.

2. The phase transition changing Planck constant could take place for cell membrane space-time sheets only so that only generalized Josephson frequencies would be scaled down. For flux sheets traversing through DNA the value of Planck constant would not be changed. In this case resonance conditions satisfied in wake-up state would be satisfied for the even harmonics of Josephson frequencies during stage 1 of sleep. Therefore the sensory-motor loop involving magnetic body would not be so active in the relaxed state and in the first stage of sleep.

2.5.2 EEG during stage 2

The appearance of sleep spindles distinguishes stage 2 from stage 1. Sleeping spindles are sudden increases in EEG amplitude and frequency from theta band to 12-16 Hz [**?**]. The spindles last .5-.1.5 seconds and appear with a period of about minute. In some sources frequency range 7-16 Hz is given as sleeping spindle range. The so called K-complexes are sudden increases in EEG amplitude but no change in frequency.

The natural interpretation of sleep spindles is in terms of input from magnetic body in alpha band which generates by satellite mechanism sensorimotor rhythms assignable to a relaxed state. Sleep spindles would thus correspond to the satellites of alpha band identifiable as responses of the corresponding Josephson junctions to occasional strong control signals at cyclotron frequencies in alpha band. K complexes could be interpreted as signals from magnetic body but inducing no response. It might be that these sudden responses reflect the fact that the left brain is not fully asleep yet.

2.5.3 EEG during stages 3 and 4

Most of EEG power during deep sleep stages 3 and 4 is in the range .75-4.5 Hz [**?**]. The most straightforward interpretation is in terms of the scaling $\hbar \to 4\hbar$ so that alpha band would correspond to 2.5 Hz and beta frequency 15 Hz to 3.75 Hz.

Again one has two options corresponding to the scaling of $\hbar$ for all flux quanta and only for the cell membrane space-time sheets.

1. For the first option consciousness need not be lost during these phases of sleep if the above argument makes sense. The experiences just at the border of wake-up could give an idea about what this kind of consciousness is.

2. For the second option DNA cyclotron transitions could be important during deep sleep and it might be even possible to speak about DNA consciousness. For phosphorylated DNA sequences with charge of 2 units per single base-pair one would have $A \geq 300$. More precisely, the atomic weights for base pairs plus phosphate group and deoxyribose sugar are $327, 321, 291, 344$ corresponding to A, T, C, G. From the fact that proton's cyclotron frequency for $B_{end} = .2$ Gauss is 300 Hz one obtains that DNA cyclotron frequency is 1 Hz in good approximation. This would suggest that during deep sleep DNA cyclotron transitions are induced by Josephson frequencies and that DNA defines the sensory perceiver.

2.6 Schumann Resonance And Consciousness

The lowest Schumann resonance frequency $f_S = 7.8$ Hz is conjectured to be important for consciousness.

1. One might imagine that the magnetic body of Earth as a conscious entity communicates to and controls brain using Schumann resonance. A possible mechanism is communication of Schumann radiation to DNA where it arrives along magnetic flux tubes to cell membrane as external perturbation superposing to membrane voltage as sinusoidal perturbation in the first approximation. One can decompose Josephson current as

$$J = J_0 sin(\omega_J t + X) = J_0[sin(\omega_J t)cos(X) + cos(\omega_J t)sin(X)] \ , \ X = \omega_0 t + \frac{Ze}{\hbar_{eff}} \int V dt \ ,$$

   and expand $sin(X)$, and $cos(X)$ in powers series of X. If X is sinusoidal, a perturbation with frequency f the series gives rise to the spectrum $f = f_0 + nf$ which should be equal to f_c for some ion at magnetic body. In the case of Schumann frequency this would give lowest frequency $f_0 \pm f_S$. If there is cyclotron frequency satisfying the resonance condition $f_c = f_0 + f_S$, Schumann frequency is perceived at magnetic body.

2. If sleep means formation of a kind of collective consciousness, then one expects that during first and second state of sleep when the scale f_J is reduced by $1/2$ *resp.* $1/4$ the resulting

frequency might correspond to cyclotron frequency. During second state of sleep alpha band is shifted to 2.5 Hz and $f_J + f_S = 10.3$ Hz is in alpha band so that Schumann resonance could contribute to alpha consciousness. For the first phase of sleep alpha band is at 5 Hz (theta band) and for $f_J = 10$ Hz one has $f_J + f_S = 12.8$ Hz in beta band - this is near to the scaled down cyclotron frequency of $f_c(Mg^{2+}) = 12.5$ Hz.

What about the interaction of higher Schumann resonances with consciousness? Schumann resonances are around 7.8, 14.3, 20.8, 27.3 and 33.8 Hz and could give rise to satellites, which for $f_J = 2.5$ Hz correspond to cyclotron frequencies. $f_c(Mg^{2+}) = 25.0$ Hz is not too far from $f_S = 27.3$ Hz Schumann resonance. During slow wave sleep the satellite $f_S - f_J = 27.3 - 2.5$ Hz equal to 24.8 Hz. For $f_S = 14.3$ Hz the satellite would be 11.8 Hz rather near $f_c(Mn^{2+}) = 11.4$ Hz.

2.7 What About Proton And Electron?

The model discussed has not said anything about proton and electron. with cyclotron frequencies of 300 Hz and 5.6×10^5 Hz for $B_{end} = .2$ Gauss. There are two hints about the role of these frequencies.

1. The spectrum of audible frequencies spans 10 octaves extending from 20 Hz to about 2×10^4 Hz. For bats the spectrum extends to MHz region. The frequency modulation of EEG frequencies by frequencies above 100 Hz produces a vanishing average effect analogous to small ripples much smaller than the wave-length of wave in water.

2. The durations associated with the nerve pulses are few milliseconds.

A natural manner to represent auditory information would be by using electron's cyclotron frequency as a carrier frequency. The proton cyclotron time 3.3 ms could be short enough to allow a representation of nerve pulse patterns as frequency modulation. This would require $f_J = f_c(p) =$ 300 Hz for the neuronal membranes involved. Also electronic cyclotron frequency would allow the representation of neuronal events as slow frequency modulations. The effects of VLF radiation at these cyclotron frequencies on living matter could serve as a test for this proposal.

3 The Effects Of ELFFields On Brain And High T_c Ionic Super Conductivity

The article "Spin the tale on the dragon" by David Jarron [**?**] gives excellent popular review about the history of the bio-electromagnetic research and about the frequencies for which electromagnetic fields have special effects on living matter and brain. The material from this article led to the realization of how brain manages to be a macroscopic quantum system in TGD Universe. A more technical view about the effects can be found from review articles of Adey and Blackman [**?**]. The online review article of Cherry [**?**] provides a good technical representation about various effects of weak ELF em fields and ELF modulated radiofrequency em fields on brain and an extensive list of references.

3.1 Summary About Effects Of ELF EM Fields On Brain

The work by pioneers of bio-electromagnetism (Wertheimer, Milham, Marino, Becker, Adey, Blackman and many others) which began already at sixties led to amazing discoveries about ELF fields on brain. The article of Blackman [**?**] provides a detailed summary of these developments. The results of the work of Bawin, Adey, Blackman and others can be summarized by saying that radio frequency em fields amplitude modulated by ELF frequencies affect in certain frequency and amplitude windows brain tissue [**?**, **?**, **?**]. The function of the radio frequency carrier wave is to facilitate the penetration of em field into tissue and its frequency is not essential for the occurrence of the effect. Presumably nonlinear effects give rise to a secondary wave with modulation frequency which is the primary source of effects.

3.1.1 Basic effects

The effects of ELF em fields on brain include chemical, physiological and behavioral changes within windows in frequency and field intensity. It is essential that the effects have been observed only in vertebrates which thus possess EEG. A good summary is the online review article of Cherry [**?**].

The well documented and established non-thermal biological effects of EMR include significant alteration of cellular calcium ion homeostasis, reduction of melatonin, and the detection of Schumann Resonances by human and avian brains. A key effect is change in Ca^{2+} homeostasis: Ca^{2+} it is involved with both pre- and postsynaptic steps of nerve pulse transmission and also with intracellular communication. For instance, Ca^{2+} is involved with gene expression, the development and plasticity of nervous system, modulation of synaptic strengths, and with $Ca^{2+} - c$AMP signal transduction process.

Change in Ca^{2+} homeostasis has harmful effects in central nervous system, endocrine system and immune system. At the level of CNS this means changes of reaction time and behavioral alterations. At the level of neuro-endocrine system a good example is the reduction of the melatonin production in pineal gland having wide variety of harmful effects since melatonin serves as effective scavenger of free radicals: among the effects are DNA strand breakage, chromosome aberrations and problems with gap junction communications. Melatonin is also crucial for healthy sleep and for the reduction of cholesterol and blood pressure. In the case of immune system an example is provided by the change of functioning of lymphocytes in turn reducing the competence of immune system making the subject more vulnerable to allergens, toxins and viruses.

3.1.2 Amplitude windows

There are several amplitude windows but here only the main amplitude windows will be discussed. For the first window ELF em fields have values of electric field in tissue around 10^{-7} V/m. The effects are high level effects and associated with navigation and prey detection in marine vertebrates and with the control of human biological rhythms. For ELF modulated radio frequency fields (RF) and microwaves (MW) the intensities are around $1 - 10$ V/m. In this case the effects are neurophysiological effects are lower level effects at the level of the brain tissue. In the case of brain tissue maximal sensitivity to electromagnetic fields occurs between 6 and 20 Hz.

In order to get grasp about orders of magnitude, it is good to notice that on some experiments cell membrane electric field has a strength about 10^7 V/m whereas EEG electric fields in the range $5 - 10$ V/m. The fact that the second intensity window corresponds to $1 - 10$ V/m suggests that the em field simulates the em field associated with EEG: a valuable guideline in attempts to understand what is involved. For Schumann resonances electric field is of order .6 mV/m. For sferics (em perturbations associated with lightnings) magnetic field strength is not above nTesla: this corresponds to electric field strength 10 V/m associated also with EEG waves [F1]. Field strength of V/m corresponds roughly to energy flux $\mu W/m^2$.

The presence of windows and weak intensities implies that the effects cannot be thermal. A good metaphor is the effect of radio noise on radio receiver: it occurs at definite frequency and destroys the information content of the original transmission.

3.1.3 The effects occur at harmonics of cyclotron resonance frequencies

Blackman also discovered that odd multiples 15, 45, 75, 105... of 15 Hz had much stronger effect on tissue than even multiples 30, 60, 90... Hz and realized a possible role of Earth's magnetic field [**?**]: it must be however emphasized that the value of magnetic field in question is $B_{end} = .2$ Gauss and smaller than $B_E = .5$ Gauss. A possible interpretation is that harmonics of cyclotron frequencies might be the information carrying frequencies in EEG.

In response to the results and speculations of Blackman, Liboff formulated ionic cyclotron resonance (ICR) model [**?**] based on the realization that the frequencies in question correspond to multiples of the cyclotron frequencies of Ca^{2+} ion in a magnetic field $B_{end} = .2$ Gauss. This model was classical. Later Blanchard and Blackman proposed so called ionic parametric resonance model (IPR) [**?**]. This phenomenological model combines ICR model with ideas about atomic physics. There are several objections against ICR model; classical orbits of ions in Earth's magnetic field have radius of order meters; dissipative effects and Brownian forces do not allow cyclotron orbits; charge-to mass ratios appearing in cyclotron frequencies correspond to vacuum rather than water

environment characterized by a large value of dielectric constant; it is difficult to understand why odd multiples of cyclotron frequencies give rise to stronger effects [**?**]. Some of these objections apply also to IPR model.

The pattern of data seems to suggest that the interaction occurs at quantum level. This is in dramatic conflict with the predictions of the standard quantum theory and with the standard view about space-time.

3.1.4 Are quantal effects in question?

The conclusion that the effect of ELF fields on brain represents quantum effects associated with the transitions of ions confined in magnetic field having same strength as Earth's magnetic field, is supported by the following observations.

1. The frequencies $15, 30, 45, 60, 75$ Hz having effect on primates are multiples of the same basic frequency $f = 15$ Hz, which turns out to be the cyclotron frequency of Ca^{2+} ion in magnetic field $B_{end} = .2$ Gauss. That these frequencies come in multiples is a direct signature of quantum: in classical world only basic frequency $f = 15$ Hz should have effects (forcing ions to rotational motion around field lines with this frequency.

2. Even multiples of 15 Hz have a weak but non-vanishing effect. Transitions are not possible at all in the lowest order of perturbation theory since the interaction Hamiltonian describing the transitions in question has non-vanishing matrix elements only between states of opposite parities in the dipole approximation applying when the wavelength of the radiation is much larger than the size of the radiating system [B1]. Odd and even values of n for cyclotron states have opposite parities so that Δn odd rule results. In higher orders of perturbation theory also transitions for which transition frequency is even multiple of the cyclotron frequency are possible. This observation provides additional strong support for the hypothesis that quantum transitions are involved.

There are however also objections.

1. The cyclotron energy scale is about 10^{-14} eV and ridiculously small as compared to the energy scale .086 eV defined by room temperature so that quantal effects should be masked completely by thermal noise.

2. Also ELF em fields at spin flip frequencies (Larmor frequencies) should induce transitions. To my best knowledge these have not been reported.

3. The wave functions of ions in magnetic field are confined in a region of size of order

$$r_n \sim \sqrt{2n/eB} \ ,$$

which is of the order of cell size: macroscopic quantum state is in question. In fact, the value $.5 \times 10^{-4}$ Tesla for Earth's magnetic fields corresponds to the p-adic length scale $L(169) = 5$ μm rather precisely for minimal value of the magnetic flux quantized as $ZeBS = n2\pi$ obtained for $n = 1$ (S denotes the area of the flux tube) and $Z = 2$. If one requires quantum classical correspondence, very large values of n are required and cyclotron radii would be much larger than flux tube radius.

A common resolution of all these objections is provided by large $\hbar$ phases and hierarchy of magnetic flux sheets with B scaling like $1/\hbar$ meaning that cyclotron frequencies scale down similarly and cyclotron energies remain invariant. Same applies to spin flip energies scaling in the same manner as cyclotron energies (for some time I thought that the scaling behaviors are different). By the quantization of the magnetic flux, predicted by TGD also classically, the minimal radius of the magnetic flux tube for the magnetic field of Earth of cell size for ordinary value of $\hbar$ but scales like $\hbar$ if magnetic field remains invariant and flux quantization $BS = n2\pi\hbar$ implying $S \propto \hbar$ holds true. This implies consistency with classical theory for large values of $\hbar$.

3.2 A Brief Summary Of The Model Explaining Cyclotron Frequencies

Some work is required to end up with the following interpretation based on a model for how the different levels of dark matter hierarchy communicate and control. This model already discussed at the general level relies on resonant cyclotron transitions induced by Josephson radiation from cell membrane Josephson junctions, which are almost vacuum extremals.

1. Ions with charge Z, mass m and spin S in the external magnetic field behave quantum mechanically like harmonic oscillator with energies quantized as

$$E = E_c + E_L \quad , \quad E_c = (n + \tfrac{1}{2})\hbar\omega_c \quad , \quad E_L = S_z \tfrac{g\omega_c}{2} \quad , \quad \omega_c = \tfrac{ZeB}{m} \quad (c = 1) \quad . \tag{3.1}$$

   The first contribution corresponds to cyclotron contribution. For a given value of n the component of angular momentum in the direction of B has $n+1$ values $n, n-2, ..., -n$. E_L denotes spin (Larmor) contribution. g is so called Lande factor which for free elementary fermions equals to $g = 2$. Since S_z is invariant under the scalings of $\hbar$, Larmor contribution is negligible as compared to cyclotron contribution for large values of $\hbar$. The contribution to energy coming from the free motion in the direction of magnetic field has not been written.

2. Experimental findings suggests strongly that external em field induces resonant transitions between cyclotron states: these transitions are identified as transitions inside the cell/nucleus or its fractally scaled up variant. Cyclotron radiation can drive charged particles to smaller space-time sheets and this is essential for the metabolism and this process is expected to be part of the interaction of ELF em fields with cell nucleus. This in turn induces a response of magnetic body affecting the state of brain.

3. Dark matter hierarchy leads to the hypothesis that there is entire hierarchy of EEGs generated as coherent photon states by Josephson currents associated with the Josephson junctions whose thickness scales as $\hbar$ and frequency scales as $1/\hbar$ so that cyclotron energy remains invariant and is above the thermal threshold. For each value of $\hbar$ there is also p-adic hierarchy corresponding to $k = 151, ..., 169$ with same Josephson frequency: these levels combine to form single block for dark matter hierarchy formed from the scaled up variants of this block. At least the magnetic flux tube structure of DNA and membrane structure appear as scaled up copies. The lowest level corresponds to cellular or nuclear membrane and ordinary value of $\hbar$.

3.3 Interpretation Of The Temperature Window

The effects of ELF em fields on matter have been observed only in a temperature window 36-37 C around body temperature. I have already proposed that this interval is due to competition of two effects.

1. High T_c super-conductivity and cyclotron condensates are possible below 37 C whereas near vacuum extremal property is possible above 36 C so that only a narrow temperature range remains making possible communications and control of the biological body by magnetic body.

2. Also the model of high T_c super-conductivity as a quantum critical phenomenon predicts that there is a narrow interval around T_c around which two competing phases corresponding to ordinary value and scaled up value of $\hbar$ compete.

More generally, dark matter hierarchy should correspond to a hierarchy of quantum criticalities. A fractal hierarchy of cusp catastrophes such that the next cusp is inside the critical line of the previous cusp would be a convenient manner to visualize the situation. Each big leap in the evolution corresponds to the emergence of a new level in the dark matter hierarchy made possible by the external conditions allowing co-presence and competition of phases corresponding to different Planck constants.

Quantum critical high T_c super-conductivity for electrons and protons (at least) is the essential prerequisite for the existence of Josephson currents through the cell membrane and its scaled up variants, and thus the hierarchy of generalized EEGs. Electronic super-conductivity is expected to be possible in a very limited temperature range usually idealized with single critical temperature.

Quantum critical phase is analogous spin glass phase possible in a finite interval around critical temperature, and one can indeed speak of quantum spin glass phase for which the analogs of regions with fixed direction of magnetization are 4-dimensional rather than 3-dimensional and static. This relates to the breaking of the strict classical determinism of the basic variational principle of TGD having interpretation in terms of space-time correlate for quantum non-determinism in long time and length scales. Quantum coherence and quantum nondeterminism in long scales is obviously what makes system living. An educated guess is that the critical range of temperatures allowing quantum criticality and high T_c super-conductivity is just 36-37 C: this in turn implies that the effects of ELF em fields occur only in this temperature range.

3.4 How Could One Understand The Amplitude Windows?

The attempts to understand the mysterious looking amplitude windows for electric field have not been fruitful hitherto. The intuitive expectation is that the explanation could be in terms of the new physics provided by zero energy ontology and causal diamonds, hierarchy of Planck constants, and cyclotron frequencies of ions, proton, and electron and even quarks and maybe even Z^0 cyclotron frequency of neutrino. The following argument represents the latex trial based on the model for the DC currents of Becker as quantum currents discussed in [K16].

3.4.1 Can one take into account the complications due to modulation?

Before representing any arguments it must be emphasized that the actual signal is either ELF signal or ELF modulated signal -say microwave signal (frequency in the range is.3 GHz-300 GHz) modulated by cyclotron frequency. The effects are very similar in the two cases. The assumption is therefore that the eventual interaction of the tissue is with ELF frequency signal. This requires demodulation in the tissue. In the case of modulated signal one has to be careful with the experimental definitions of field amplitudes. It will be assumed that the reported amplitude windows correspond in the case of ELF modulated signals to the ELF amplitudes measured in the tissue after de-modulation.

Not that even the question how linear superposition of fields takes place in TGD Universe is non-trivial. For given massless extremal linear superposition is possible only for signals propagating to fixed direction but need not correspond to that for fields since they are not the primary dynamical variables. In fact, the basic argument against TGD is that linear superposition for fields does not hold in TGD Universe in general since classical gauge fields and gravitational field are not primary fields but expressible in terms of embedding space coordinates and their gradients. The solution of the problem is provided by many-sheeted space-time concept (see **Fig.** `http://tgdtheory.fi/appfigures/manysheeted.jpg` or **Fig.** 9 in the appendix of this book). It is not field but their effects which superposed. In classical case the effects are the forces caused by the classical fields. This indeed happens if the fields involved correspond to different space-time sheets and particle suffers simultaneous topological condensation to the space-time sheets in question and experiences the sum of the forces caused by them. In quantum case the sum of gauge potentials and deviations of metric from Minkowski metric is what is experienced by the particle. This is discussed in detail in [K19].

Massless extremals represent the most promising classical description for the radiation fields. They allow arbitrary pulse shapes so that the modulation at the level of massless extremals is not a problem. This kind of modulation is indeed in question. Demodulation requires a highly non-linear mechanism leaving from the rapidly oscillating amplitude only the envelope. In TGD framework it is not difficult to imagine non-linear mechanisms since the dynamics of Kähler action is extremely non-linear. For MEs the time profile of the induced gauge field at given point is essentially arbitrary and one can easily imagine a process leading from ELF modulated field to a pure ELF field at given point. Energy conservation and effective 2-dimensionality of the signal (polarization direction and direction of 4-D wave vector) certainly puts bounds on the change of the amplitude and the simplest guess is that the amplitude squared for pure ELF corresponds to

the average of the amplitude squared over the cycle of the carrier wave for the modulated radiation so that amplitude is reduced by $1/\sqrt{2}$ factor.

3.4.2 Direct quantum currents of Becker and explanation for the amplitude windows

The quantum model for the DC currents of Becker suggests a new approach to the problem. Since ELF em fields are in question they can be practically constant in the time scale of the dynamics involved. Suppose that the massless extremal representing ELF em field is orthogonal to the flux tube so that the ions flowing along flux tube experience an electric force parallel to flux tube. What would happen that the ions at the flux tube would topologically condensed at both the flux tube and massless extremal simultaneously and experience the sum of two forces.

This situation is very much analogous to that defined by magnetic flux tube with longitudinal electric field and also now quantum currents could set on. Suppose that semiconductor property means that ions must gain large enough energy in the electric field so that they can leak to a smaller space-time sheet and gain one metabolic quantum characterized by the p-adic length scale in question. If the electric field is above the critical value, the quantum current does not however reach the second capacitor plate as already found: classically this is of course very weird. If the electric field is too weak, the energy gain is too small to allow the transfer of ions to smaller space-time sheet and no effect takes place. Hence one would have an amplitude window.

3.4.3 Explanation for the observed amplitude windows

The amplitude window occur in widely separate ranges 1-10 V/m and around 10^{-7} V/m. Of course, also other frequency ranges might be possible. Fractality and the notion of magnetic suggests a possible explanation for the widely different frequency ranges. Both p-adic length scale hypothesis and the hierarchy of Planck constants suggest that some basic structures associated with the cell membrane have fractal counterparts in a wide length scale range and correspond to binary structures. Magnetic flux tubes carrying quantal DC currents of Becker would be the most natural candidate in this respect since these currents appear in several length scales inside organism. Also the counterparts of lipid layers of cell membrane could be involved. If so, one must include to the hierarchy of amplitude windows also fields in the range corresponding to the cell membrane resting potential of about 6×10^6 V/m. This is of course only a rough order of magnitude estimate since perturbations of these field are in order.

By fractality the most natural guess is that the voltage along the flux tube is invariant under the scale of Planck constant. This would mean that the electric field would behave as $1/L^2 \propto 1/\hbar^2$ as a function of the length scale characterizing the scale variant of the structure. If so the range $E = 1 - 10$ V/m assignable also to EEG would correspond to a length scale of $7.7 - 24$ μm corresponding to cell length scale. Perhaps the direct currents run between cells layers. $E = 10^{-7}$ V/m would in turn correspond to 7.8 cm which corresponds to size scale of human brain hemisphere (experiments were carried out for vertebrates). Could the direct quantum currents in question run between brain hemispheres along corpus callosum?

4 How Does Generalized EEG Relate To Conscious Experience?

In this section possible interpretation of cyclotron phase transitions and EEG from the point of view of conscious experience are discussed.

4.1 Sensory Canvas Hypothesis

Sensory canvas hypothesis assumes that magnetic transition frequencies code for the temporal and possibly also spatial positions of the objects of the 4-D perceptive field at the personal magnetic body characterized by field strength B_{end}.2 Gauss at the surface of Earth. Magnetic transition frequencies are associated with MEs serving as sensory projectors to which various sub-selves representing features are entangled.

The view about evolution of consciousness as a gradual emergence of increasingly lower EEG frequency scales suggests a general paradigm concerning the assignment of the frequency bands with various cyclotron frequencies and possibly spin flip frequencies. 40 Hz band could naturally correspond to MEs projecting symbolic representations associated with the sensory input to the magnetic sensory canvas. The range 20-40 Hz could be associated with some simple cognitive features or emotions (say associated with odor discrimination) whereas 13-20 Hz interval could correspond to more refined cognitive features. alpha and theta bands could relate to the features representing memories. The possibility of communications at theta, delta and alpha frequencies to higher level many-brained magnetic selves representing collective levels of consciousness must be considered seriously in TGD framework.

The processing of the sensory input involves where-what division. The fact that "where" aspect has developed earlier encourages to think that it is more primitive aspect of perception so that the EEG frequencies associated with the simplest "where" aspects might be higher. This is supported also by the fact that the EEG rhythms associated with brain stem and cerebellum correspond to 80 Hz and 200 Hz respectively.

The narrow highly coherent frequency bands with width of order 1-2 Hz reported by Nunez at 3, 5 and 7 Hz, the alpha band at 11 Hz, and the narrow bands at 13, 15 and 17 Hz [**?**] plus the 8 Hz width band around 40 Hz provide empirical support for the basic assumptions and a good starting point for possible more detailed identifications.

4.2 Magnetic Quantum Phase Transitions And EEG

The original attempt to assign our qualia to magnetic and Z^0 magnetic transitions need not be correct. The following scenario looks a more realistic working hypothesis.

1. The EEG MEs associated with magnetic transitions serve as quantum entanglers of the bodily mental images to the personal magnetic body. If sensory representations are realized at the personal magnetic body, the magnetic quantum phase transitions at the personal magnetic body contribute to our conscious experience by the fusion of "simple feeling of existence" mental images with much more complex bodily mental images.

2. The field patterns associated with negative energy EEG MEs code for declarative long term memories perhaps using the hierarchy of p-adic cognitive codes discussed above. The model of long term declarative memories suggests that bodily magnetic qualia need not be conscious-to-us. The magnetic quantum phase transitions would represent a step in the transformation of the field patterns of EEG MEs representing declarative memories to conscious experiences.

The overall conclusion would be that, as far as primary sensory qualia are considered, magnetic transitions are not very interesting. On the other hand, the hypothesis that magnetic fields are such that magnetic transition frequencies tend to coincide with various universal frequencies (say those assignable toCDs), makes them very interesting concerning the practical models for what might be happening at the magnetic flux tubes of body and brain.

4.2.1 Sensory maps by magnetic frequency scale coding

There is a large temptation to assume that the great variety magnetic magnetic transitions in EEG frequency range make possible hierarchy of living maps. A varying magneti frequency scale would code for a position of neuron or some larger unit of brain and to which input from a point of perceptive field is mapped by entanglement (sharing of mental images) and/or by classical communications. Personal magnetic body would essentially remember what happens at material body by sending entanglement inducing negative energy ME to brain along magnetic flux tube and receiving positive energy MEs inducing self-organization and generation of mental images. The classical communication would be like communicating selectively by broadcasting radio waves to receivers each having their own narrow radio wave band.

The working hypothesis is that various mental images in the cortex are projected outside the cortex and CNS at the canvases formed by the magnetic flux quanta associated with various body parts. There are good reasons to believe that these maps are realized in the length scales of EEG wavelengths. The resulting 3-dimensionality of the map is a strong argument in favor of these

maps as also the complete decoupling between representation and information processing yielding the representation.

Quantum maps could be realized by place coding using cyclotron frequencies associated with ELF MEs emerging radially from various parts of CNS, also from sensory organs even. If the time mirror mechanism (see **Fig.** `http://tgdtheory.fi/appfigures/timemirror.jpg` or **Fig. ??** in the appendix of this book) is a general mechanism of sensory perception, motor action, and memory applied by the magnetic body, the length along the magnetic flux tube codes for the temporal distance to the geometric past. This coding would rely on resonance mechanism involving also resonant interaction of MEs with Alfven waves associated with magnetic flux tubes (much like oscillations of string). The very slow dependence of these frequencies on distance would be determined by the strengths of the classical magnetic fields for which these flux tubes provide a representation as topological field quanta.

Positive energy magnetic transitions could be used for the temporal coding of the sensory representations whereas negative energy magnetic transitions could be used for the temporal coding of generalized motor actions. This would obviously help to avoid overlap between signalling associated with sensory representations and motor actions.

Magnetic quantum phase transitions could give rise to chemical maps of parts of organ. By using an appropriate value of frequency, magnetic quantum phase transitions can be induced and the intensities of these transitions would provide conscious measure for the densities of Bose-Einstein condensates of ions (and perhaps even their Cooper pairs if they manage to be thermally stable) whose densities in turn relate to those at atomic space-time sheets by many-sheeted ionic equilibrium conditions. If the thickness of the magnetic flux tube varies different quantum phase transitions occur at different points of the flux tube and kind of conscious spectrogram results. This kind of generalization of NMR spectroscopy need not be conscious to us although chemical senses could relate to it.

4.2.2 Place coding for the geometric parameters characterizing simple geometric features

Place coding for various geometric parameters characterizing simple geometric "features" could be realized using the variation of the cyclotron frequency along a magnetic flux tube of varying thickness. The hierarchy of the sensory canvases allows a modular structure in which a geometric feature such as triangle, line, or ellipse represented at a lower level sensory canvas is projected to a *single* point of "our" sensory canvas. If one accepts that only negative energy MEs can serve as entanglers, the conclusion would be that place coding must utilize negative energy MEs to entangle brainy mental images with the "simple feelings of existence" at the magnetic body.

Becker tells in his book "Cross Currents" [**?**] about a technique discovered by Dr. Elizabeth Rauscher, a physicist, and William Van Bise, an engineer. The technique uses magnetic fields generated by two coils of wire, each oscillating at a slightly different frequency and directed so as to intersect at the head of the subject person. When two energy beams with different frequencies intersect at some point in space, a third frequency, so called beat frequency is formed as the difference of the frequencies. What Bise and Rauscher found that this ELF frequency (unfortunately, I do not know what the precise frequency range was) generates simple visual percepts like circles, ellipses and triangles and that the variation of the second frequency induces the variation of the shape of the percept.

The simplest interpretation is that the beat frequency is extracted by non-linear effects in brain and induces a magnetic quantum phase transition at magnetic tubes whose thickness varies and codes for a parameter (say scaling in some direction) characterizing the geometry of the primitive percept (or "feature"). The proposed general mechanism for how EEG MEs give rise to declarative memories should apply also now and would mean that EEG MEs induce cyclotron transitions giving in turn rise to neural activity. If primary sensory organs are seats of sensory qualia, back-projection to the eyes is involved with the process as also in the case of electric stimulus of cortex inducing visual sensations. The intersection of ELF waves would wake-up symbolic mental images representing triangle and back-projection would make this concept visual. The geometric parameters characterizing the triangle would be coded to frequency differences. An analogous phenomenon occurs also for auditory inputs with slightly different frequencies fed into ears and makes it possible to "hear" sounds below the audible range. The mechanism could be the same.

4.2.3 Flag-manifold qualia and magnetic fields

Recall that the flag-manifold representing various choices of quantization axes is a coset space associated with the zero modes. The association of the six-dimensional flag-manifold of color group $SU(3)$ to honeybee dance and geometric aspects of honeybee's sensory experience (described in the chapter [K9] inspired the hypothesis that the values of the flag manifold coordinates might be quite generally mapped to magnetic or Z^0 magnetic frequencies by mapping these coordinates to the parameters characterizing magnetic flux tubes. Thus there are two frequencies involved and the mappings projects everything to 2-dimensional space.

The flag-manifold defined by the choices of the quantization axes for the super-symplectic algebra of the WCW is infinite-dimensional. One can however consider finite-dimensional flag-manifolds as lowest order approximation. In the case of MEs of type $E^2 \times CP_2$, the minimal flag-manifold would be the one defined by the Cartan group of $SO(2) \times SU(3)$, which is just the flag-manifold $F_3 = SU(3)/U(1) \times U(1)$ of color group introduced by Barbara Shipman. For MEs of type $S^2 \times CP_2$ which correspond to spherical light fronts the flag manifold is $S^2 \times F_3$. A very natural identification of S^2 is as labelling orientations of a vector in 3-space. Thus one might consider the possibility that the increments S^2 coordinates could represent changes of orientation at the level of conscious experience. On the other hand, linear sequence of sub-selves inside self would represent experienced orientations very concretely.

One could try to generalize, and consider the possibility that the proper flag manifold is defined by $SO(3,1) \times SU(3)$ by the division by Cartan subgroup. Lorentz group would give 4-dimensional flag-manifold $SO(3,1)/R \times SO(2)$. Lorentz rotations can be decomposed to boosts followed by rotations in rest frame of the resulting system. This suggests that $SO(3,1)$ flag-manifold has a bundle structure with the sphere S^2 defined by boost directions serving as the base and the sphere S^2 defined by the possible directions for the axis of rotation in the rest frame serving as the fiber. Again sub-self moving inside self could represent the direction of boost naturally.

There must be some correlation between the values of zero modes (in particular, flag manifold coordinates) and classical em Z^0 magnetic fields. For instance, color rotation affects the em and classical Z^0 fields. In this sense flag-manifold coordinates can be coded to em and Z^0 magnetic frequencies but the image is 2-dimensional. The work of Barbara Shipman with the dance of honeybee indeed implied that flag-manifold coordinates are mapped to spatial positions in *2-dimensional* plane representing the dance stage. This suggests that $F_3 = SU(3)/U(1) \times U(1)$ coordinates have representational role: they represent concrete geometric information about spatial positions. This representational role could derive from more general assumptions. The positions of plane are represented as frequencies by the place coding by magnetic and Z^0 magnetic frequencies and $SU(3)$ rotations affect em and Z^0 magnetic frequencies so that plane points can be mapped to equivalence classes of $SU(3)$ rotations so that a 2-dimensional space associated with the flag-manifold F_3 emerges naturally.

4.2.4 Could magnetic phase transitions define sensory qualia?

If universality principle holds truemagnetic qualia can be divided to universal kinesthetic qualia and to generalized chemical qualia corresponding to the change of a number of particles in a state with given quantum numbers (say the integer n characterizing cyclotron state). The interpretation of these qualia is far from obvious.

1. Magnetic qualia could be "universal feelings of existence" associated with the place coding of the motor actions from the sensory canvas and also inside brain. This would mean a neat separation of sensory and motor representations from each other. Universal feeling of existence might also be the basic aspect of tactile senses and in fact, all sensations.

2. If the harmonic of the cyclotron frequency does not affect the character of the quale, the number of cyclotron qualia is finite. alpha band is expected to be the most interesting frequency range as far as qualia are considered. The five bosonic ions $Mn^{2+}, Fe^{2+}, Co^{2+}, Zn^{2+}$, and Se^{2-} have cyclotron frequencies 7.6, 9.4, 10.0, 10.8 and 11.4 Hz. The number of basic tastes is thought to be five, which could mean that magnetic cyclotron phase transitions code for the basic tastes. The number of odors is definitely larger than basic tastes as is also the

number of exotic Z^0 ions, which are almost always bosons. Thus the identification of Z^0 magnetic cyclotron transitions as correlates for odors can be considered.

This proposal can be criticized. Any bosonic molecule with $A/Z \leq 223$ (thermal stability of the BE condensate at room temperature) could as such directly define a cyclotron quale so that tastes and odors would correspond to cyclotron transitions of molecules themselves rather than those of bosonic ions in alpha band. One could also argue that the odors and tastes should have a natural ordering according to the value of cyclotron frequency and be continuously transformable to each other by changing the strength of the magnetic field. This doesn't seem to be the case.

4.2.5 What about Larmor frequencies?

Larmor frequency characterizes the nuclear contribution of this interaction to energy and is related to the cyclotron frequency of a singly ionized atom by

$$\omega_L = g\frac{S}{2}\omega_c \quad , \quad \omega_c = \frac{eB}{m} \quad .$$

where S denotes the maximal projection of spin in the direction of the magnetic field and g is Lande factor, which equals to $g = 1$ in the ideal classical case for which spin corresponds to angular momentum whereas $g = 2$ holds true for elementary fermions. Nuclear contribution is the dominant contribution for ions Na_+, K_+, Cl_- since electron shell is full for the ions in question. The magnetic moments of ions Cl_-, K_+, Na_+ reduce to their nuclear magnetic moments and are rather large:

$$\mu = x\frac{e}{2m_p}S \quad , \quad g \simeq 2xA \quad ,$$

where m_p denotes proton mass and x is a parameter of order one so that Lande factor is proportional to the mass number A of nucleus. The reason for large value of μ is that magnetic interaction energy of the nucleus is essentially the sum over the interaction energies of nucleons.

If anomalous magnetic moment vanishes Larmor frequency differs by a factor 1/2 from cyclotron frequency: $f_L = f_c/2$ so that spin flip frequency is same as cyclotron frequency. For atomic nuclei the Larmor frequency tends to be larger than cyclotron frequency as the table of Appendix demonstrates. The effects of em fields in living matter at Larmor frequencies have not been however reported.

The interaction of the nuclear spin with magnetic field dominates over the cyclotron interaction energy by a factor of order A and that the natural frequency scale for the ionic Larmor frequencies is hundreds of cycles per second. The values of the parameter x are $x(Na) = 2.214$, $x(Cl) = .82181$ and $x(K) = .3915$. For instance, for Na_+ spin flip transition frequency with $\Delta S = 1$ is $f \sim 222$ Hz. For Ca_{++} spin and magnetic moment vanishes. Note that for $J = 3/2$ ions there are in principle three kinds of transitions corresponding to $\Delta S = \pm 1, \pm 2, \pm 3$. If transition reduces to single nucleon level, $\Delta S = \pm 1$ is the only possibility. The conclusion is that Larmor frequencies probably correspond to different components of sensory modalities than cyclotron frequencies.

The transitions changing the direction of spin of the Cooper pair are induced by the frequencies

$$\omega = (2n+1)\omega_c + 2\Delta m\omega_L = (2n + 1 + g\frac{\Delta m}{2})\omega_c \quad .$$

Odd multiples of the cyclotron frequency are possible in the first order perturbation theory whereas even multiples are possible only in the second order.

The natural question is whether also spin flips to which Larmor frequencies are associated could be also important from the point of view of conscious experience. The natural expectation is that Larmor frequency behaves in the same manner as cyclotron frequency in the scaling of Planck constant and this is indeed the case since spin scales as $\hbar_{eff}$. This allows to consider the possibility that also spin flip transitions are of interest and perhaps define correlates for sensory qualia.

Consider now some examples.

1. For proton and neutron the Lande factors are $g(p) = 3.58$ and $g(n) = -3.82$ so that the spin flip transition frequencies in Earth's magnetic field would be $2\omega_L = 542$ cycles/second for proton and 570 cycles/second for neuron. The frequencies $2f_L$ and $2f_L + f_c = 842$ cycles/second could have something to do with the time scale of nerve pulse in case of

Ion	(Z, A, S)	f_1/Hz	f_{flip}/Hz	J
Cl	(17, 35, F)	8.5	82.2	3/2
K	(19, 39, F)	7.5	39.1	3/2
Rb	(37, 85, F)	3.5	81.0	5/2
Y	(39, 89, F)	3.4	41.2	1/2
Rh	(45, 103, F)	2.9	26.6	1/2
Ag	(47, 107, F)	2.8	34.2 (39.2)	1/2
Ir	(77, 193, F)	1.6	17.0	3/2
Au	(79, 197, F)	1.5	14.0	3/2

Table 1: The ions for which electronic spin vanishes in ground state and minimum spin flip frequency f_{flip} is below 90 Hz. f_{flip} is defined as $f_{min} = 2f_L/J$m, where J is nuclear spin. Ag allows two stable isotopes with almost same abundances and the values of f_{flip} are given for both.

proton. Note that $2f_L - f_c = 242$ cycles/second is of same order as f_c for proton so that corresponding qualia might resemble each other.

2. For electron $g = 2$ in excellent approximation and the Larmor frequency is very nearly identical with one half of cyclotron frequency. The deviation is

$$\frac{\Delta g}{g} = \frac{\alpha}{2\pi}$$

in the lowest order of perturbation theory ($\alpha \simeq 1/137$) and thus the frequency for the transition $(n+1, up) \leftrightarrow (n, down)$ changing the spin direction of the second electron of the Cooper pair is $\omega \simeq 902$ Hz. This time scale corresponds to the duration of memetic codon fixed by the fact that memetic code corresponds to Mersenne prime M_{127}, which happens to be the p-adic prime characterizing also electron.

3. Spin flip frequencies for atomic nuclei are in general of order few hundred Hz for $B = .2$ Gauss. For instance, the spin flip frequencies of Mn, Co, Cu, and Na are for $B = .2$ Gauss 228 Hz, 199 Hz, 223 Hz, and 222 Hz. What makes this interesting is that cerebellar resonance frequency is around 200 Hz.

The eight ions listed in **Table 1** have however exceptionally low Larmor frequencies and, very importantly, the singly ionized states have vanishing electronic spin for all ions except Rh and IR for which electronic configuration corresponds to $J - e = 2/2$ (non-vanishing electronic spin implies that the Larmor frequency of ion is of order $f_L = f_c(e)/2 \simeq 3 \times 10^5$ Hz). This suggests that electromagnetic spin flip transitions for these ions at least could be related to our consciousness. Note that K, Ag and Au have spin flip frequencies near to the harmonics of the fundamental frequencies of exotic super-symplectic representations important in EEG frequency range. Note that the spin flip frequency of K is 39.1 Hz which is in 40 Hz thalamocortical resonance band. The spin flip frequency 82.2 Hz for Cl might relate to the resonance frequency 80 Hz associated with retina.

Magnetic states have momentum in the direction of the magnetic field and a priori the transition frequency spectrum is continuous rather than discrete. Energy and momentum conservation however imply that the increment of longitudinal momentum is fixed in transition and in excellent approximation transition energies are equal to those obtained by neglecting longitudinal momenta altogether.

To get an idea about energy and momentum transfers involved with the transitions between magnetic states with longitudinal momenta k_1 and k_2, one one apply energy and momentum conservation by assuming that the classical field associated with ME, and thus propagating with light velocity, induces the transition. Let k_1 and k_2 denote the wave vectors of initial and final magnetic states in the direction magnetic field: the corresponding contributions to the energies of the magnetic states are $k_i^2/2m$, $i = 1, 2$. Let $k_{||} = kcos(\theta)$ denote the projection of the wave vector k of the ME em wave to the direction of the magnetic field satisfying $k = E$: momentum conservation gives $k_1 - k_2 = k_{||}$. Energy conservation in turn gives

$$\Delta E = \Delta E_B + \frac{k_1^2 - k_2^2}{2m} = E \ ,$$

where

$$\Delta E_B = n\omega_c + \omega_{flip}$$

denotes to the contribution of the cyclotron and spin flip components to the transition frequency. The condition

$$(k_1 + k_2)/m << 1$$

is certainly satisfied and this allows the approximations

$$k = \Delta E \simeq \Delta E_B$$

$$k_1 - k_2 \simeq \Delta E_B cos(\theta)$$

The result means that transition frequencies are not essentially affected by the energy transfer in longitudinal degrees of freedom and it is an excellent approximation to assume that the frequencies inducing magnetic transitions correspond to the transition frequencies associated with the transitions in cyclotron and spin-flip degrees of freedom.

4.3 Altered States Of Consciousness And EEG

The magnetic flux tubes in the length scale range determined by theta and delta band could quite well connect magnetic body to several different organisms and make possible sharing of experiences. Also magnetosphere and even larger magnetic structures could give rise to sensory and other representations receiving input from several organisms and sharing of mental images would allow to share these experiences.

If magnetic body is the experiencer applying time mirror mechanism and if positive energy EEG boundary MEs in delta and theta bands correspond to classical communications of declarative memories usually not conscious-to-us, the dominance of theta and delta waves during sleep suggests two alternatives.

1. During the sleep our attention is directed to transpersonal levels of consciousness but that we do not remember anything about this. The reason might be that no declarative memories are generated during this period.

2. We are entangled with transpersonal levels of consciousness and have lost our personal consciousness. A conscious contact with transpersonal levels requires sharing of mental images with these levels and this might occur during meditation. Theta and delta bands are also known to dominate during deep meditation.

One can consider two alternative interpretations corresponding to interior MEs (phase velocity equal to light velocity) and positive energy boundary MEs (phase velocity equal to EEG phase velocity) associated by scaling law with the negative energy MEs.

1. For positive energy interior MEs the frequencies would correspond to magnetic flux tube lengths up to about 10 Earth circumferences and contained within Earth's magnetotail at the night side. Time scale would be $T = 1/f$. These MEs could feed data using appropriate cognitive codes at p-adic resonances frequencies to the magnetospheric multi-brainy collective selves responsible for the transpersonal levels of consciousness.

2. The scaling law, assuming the alpha wave phase velocity to be the effective phase velocity v of boundary ME, would predict that the time $T_1 = \lambda/v$ needed by the boundary MEs to travel the distance $L = c/f$ defining the distance to the point of the magnetic body wherefrom the negative energy EEG ME was sent to the brain, is measured using decade as a natural unit. If magnetic body is the experiencer applying time mirror mechanism this would mean that delta band would correspond to memories with time span of about ten years. One might think that the magnetic body triggers boundary MEs using negative energy MEs in ULF range which automatically give rise to memories experienced after time T_1.

4.3.1 Transcendental states of consciousness and EEG

Transcendental states of consciousness are characterized by the presence of alpha and theta bands [**?**] (note that theta band is present also during childhood, youth and even early adolescence but usually disappears at older age). It is found that theta and alpha bands are preserved also during deep sleep [J2]. A possible interpretation is that the presence of alpha band signifies that left brain remains awake in a state of relaxed alertness involving weak signals from magnetic body. One could also argue that even deep sleep is a conscious state but that the presence of alpha band activity in left brain is necessary in order to have memories about this state.

4.3.2 Transpersonal levels of consciousness

Individual organisms or even larger structures could define the "pixel size" for higher level multi-brained selves realized as sensory, symbolic and cognitive representations at various magnetic structures like the magnetosphere of Earth. These levels could correspond to any p-adic length scale above brain size. These levels would obviously represent the consciousness of various kinds of groups and collectives.

1. Sleep and transpersonal states of consciousness

The simplest assumption is that one loses consciousness during sleep by entanglement with some higher level self, say magnetospheric multi-brained self. This would give rise to a fusion of mental images at this higher level and to a stereo consciousness representing "human condition".

One should not be however too hasty to make this kind of conclusion. If it is indeed biological body which sleeps, our field body could be full awake with attention directed to transpersonal levels of existence. If this is indeed the case, the basic question would be about how to have these experiences and simultaneously form long term declarative memories about them: some part of brain, probably including hippocampus, should be kept awake during these experiences. Perhaps meditative states, often characterized as transpersonal ego-free consciousness, are this kind of states.

2. Who am I?

These arguments raise the question "Who am I really?". What precise length scale my ME does corresponds size of Earth, of solar system, of galaxy? Or can my self size be literally infinite and correspond to some infinite p-adic prime and is only the localization for the contents of my conscious experience to this particular corner of this particular galaxy which creates the illusion that I am this biological body? During episodal memories and also ordinary memory recall parts of magnetic body and MEs having size $L = cT$, T the time span of the episodal memory are actively involved so that one can say that the size of "me" is measured in light years. But it is difficult to say whether the contents of my consciousness contains only personal memories even in ordinary states of consciousness. For instance, it is difficult to locate mathematical ideas in any particular portion of space-time and p-adic space-time sheets which are infinitesimally small p-adically are infinitely large in real sense.

Whatever the detailed answer to these questions is, this view allows to interpret physical death as a re-directed attention and giving rise to what might be called re-incarnation. What would differentiate between my and my dog's soul that our attentions are differently directed.

3. Examples of transpersonal experiences

Near-death experiences and out-of-body experiences could be examples of of almost transpersonal, "ego-free" consciousness. That these experiences often involve the experience of seeing one's own body from outside, is consistent with the transpersonal nature of the experience. As already noticed, delta band is peak frequency in the EEG of infant, which would suggest that children either direct their attention mostly to the transpersonal levels or that children are strongly entangled and almost unconscious as also we are when theta and delta bands of EEG dominate. That this would be the case would conform with the ideas about bicamerality. Otherwise our personal development would be gradual spiritual degeneration.

The experiences of what I call whole-body consciousness could also be example of consciousness involving transpersonal component. These states appear often at night time as dream like experiences and involve illusion of being in ordinary wake-up consciousness. The usual "noise" present

everywhere in body, possibly due to the averaging over proprioceptive experiences of sub-selves, disappears totally and peculiar silence falls down. Whole-body consciousness starts as a stir in spine (same as generated by good music sometimes) extending gradually to the entire body. Experiences of weightlessness and of "wavy" nature of physical body, flying into roof and falling down smoothly back into bed are typical aspects of these experiences. During this kind of experience it is sometimes also possible to leave the room. During my "great experience" I experienced of leaving the hospital and walking along street knowing that I was invisible. This experience ended to experience of being brought back to hospital by hospital personnel.

Short lasting form of whole-body consciousness is also possible after waking-up immediately after falling asleep in daytime: perhaps theta consciousness prevails for a short time after wake-up. My personal "great experience" involved besides whole body consciousness enhanced cognition: entire flux of ideas many of which have later developed to basic principles of quantum TGD.

4.3.3 Meditative states of consciousness and EEG

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The proposed general picture allows to build a rough model for the mechanism leading to meditative states. One can also understand how so called ORMUS elements [H2] might help to achieve these states.

The harmonics of cyclotron frequencies in delta band should represent even more deeper transpersonal qualia with time scale of about $t_1 = (c/V) \times T$, $T = 1/f$ light years for $f = 1.5$ Hz and $V = 3$ m/s. One could of course argue that the concentrations of heavy ions in brain are so low so that corresponding cyclotron transitions do not give rise to any experiences even if scaling law would not forbid them. This objection is not necessarily very convincing since the needed densities of ions in cellular space-time sheet might be by a fraction of order $[L_e(137)/L_e(167)]^3 \sim 10^{-13}$ smaller than density of water and because heavier ions are in gas form and presumably tend to be mostly in non-atomic space-time sheets. TGD predicts also new electro-weak physics would could dramatically change the isotope ratios at cellular space-time sheets.

Delta waves might relate to the interaction of brain with sferics which are atmospheric em perturbations [F1]. The spectrum of sferics at delta frequencies resembles EEG spectrum at same frequencies [F1]. The electric fields associated with sferics are of same order of magnitude as waves in delta band so that they are not amplified as much as alpha waves. This could explain why delta and theta consciousness is so weak.

One could also consider enhancing delta consciousness artificially: perhaps this could make enlightenment experience, if not more probable, at least more intense. This could perhaps be achieved by feeding in brain some heavy singly ionized ions with cyclotron frequencies in delta band and stimulating brain using ELF em field at corresponding cyclotron frequency in $B_{end} = 0.2$ Gauss. Some candidate ions are $Ag^+ : f_c = 2.8$ Hz; $I^+ : f_c = 2.4$ Hz and $Au^+ : f_c = 1.5$ Hz. Also heavy ions like Hg and Pb are in the same frequency range as Gold. For $Z = 1$ flux quantization these frequencies are halved since magnetic field strength is halved.

There are claims for so called ORMUS atoms which somehow differ from ordinary atoms [H2]. The persons involved take doses of what they call ORMUS elements, in particular so called White Gold, to induce spiritual experiences. In fact, Barry Carter who wanted to understand what is involved, contacted me about five years ago and told about these effects and I ended up the notion of wormhole Bose-Einstein condensate as a possible explanation of the claimed properties of White Gold. It might be that Gold ions and other heavy element ions enhance transpersonal sensory consciousness in delta band and lead therefore to spiritual experiences.

There is also a patented process developed by Robert Monroe and called Hemi-Synch [**?**] which might induce delta and theta consciousness. Feeding audible sounds to ears with carrier frequencies below kHz and frequency difference of say 10 Hz, which is as such not audible, generates binaural beat involving appearance of an EEG wave at difference frequency [**?**]. The difference frequency is not only "heard" but binaural beats in delta and theta range tend to induce relaxed, meditative and creative states [**?**]. This method might provide a test for the hypothesis that linear combinations or p-adic frequencies are crucial for consciousness by choosing beat frequencies equal to these frequencies. In a similar manner one could test the alternative hypothesis that cyclotron frequencies are fundamental for consciousness. One should know the precise value of local magnetic field and also take into account the possibility that brain could be able to regulate the value of the local

magnetic field to some extend. It could be also possible to apply EEG biofeedback and delta and theta frequencies.

4.3.4 Empirical evidence for transpersonal levels of consciousness

Recall that hyper-genes would correspond to flux sheets traversing through cell nuclei belonging to several organisms. Obviously this level would correspond to a transpersonal level of consciousness: kind of multi-brained conscious entities receiving sensory input from several organisms and performing intentional control over their behavior would be in question. Strong correlations between EEGs of individuals, in particular those having a close personal relationship, would be the obvious implication.

The experiments of Mark Germine [**?**] provide evidence for the notion of transpersonal conscious entities and associated collective memory perhaps realized in terms of flux sheets traversing the neuronal nuclei of several persons. What was studied was the evoked EEG response to a series of random quantum stimuli which consisted of series of identical sound stimuli with randomly located deviant stimulus. Two subject persons, A and B, were involved. In the case that A observed the differing stimulus 1 second before B, the evoked EEG response of B became incoherent. Since evoked stimulus was oscillation at EEG frequency of about 11 Hz in the case that A had not observed the stimulus, one could understand the mechanism as a direct evidence for transpersonal conscious entity interacting with brains of both A and B. When transpersonal conscious entity had hear the stimulus once, it did not react to it in similar manner.

4.4 EEG And Golden Mean

Dan Winter has reported [H1] that in certain altered states of consciousness (described as experiences of bliss) the ratio of beta and alpha peaks approaches Golden Mean $\Phi \simeq 1.618...$ It is interesting to look what TGD based model for EEG could say about this finding.

1. For $f_J = 5$ Hz and $f_c = 10$ Hz (the p-adic frequency corresponding to the secondary p-adic time scale $T_2(127)$ associated with Mersenne prime M_{127}, and identifiable as a fundamental biorhythm) one has $\beta/\alpha = 3/2$ which is the lowest approximation to Golden Mean in terms of ratios of Fibonacci numbers. The higher approximations approach to Φ. The approximation sequence would be consistent with the 1 Hz width for the narrow beta bands.

2. This would suggest that beta/alpha ratio is maximal in this state and approaches to Φ in a discrete manner. The question is whether the resting potential is quantized in terms of ratios of Fibonacci numbers $F_{2n}/F_{2n-1} \in \{3/2, 8/5, 21/13, ..\}$. At the limit theta peak would approach to 3.92 Hz: note that shamanic drumming rhythm corresponds to 4 Hz frequency. This hypothesis is testable by comparing possible changes in the measured resting potentials with subjective reports of meditators.

3. The sequence of ratios of F_{n+1}/F_n approaches Golden Mean in an oscillatory manner, which suggests that states of hyper-polarization following generation of nerve pulse correspond to ratios $F_3/F_2 = 5/3$, $F_8/F_5 = 13/8$, ... above Golden Mean. In the sate of "full bliss" there would be no hyper-polarization after the generation of nerve pulse. A possible interpretation is that there is no "dead" time after nerve pulse and system is immediately in a state of maximal possible alertness. On the other hand, the state of pure bliss should be ideally a state of pure alertness without mental images. In the state in which cell membrane in resting state is maximally hyperpolarized, nerve pulse generation does not occur too easily and thus sensory or other mental are not easily generated.

4. The sequence of Fibonacci numbers could relate to a hierarchy of finite-dimensional approximations for Jones inclusions for quantum phase $q = exp(i\pi/5)$ represented in terms of braids. $n = 5$ is also the minimal value of n allowing universal topological quantum computation [K2]. The state of full bliss would correspond to the limit at which the number of strands of braid is infinite so that topological quantum computations resources are maximal.

5. Dan Winter has also emphasized the importance of tetrahedral and icosahedral symmetries for DNA. These symmetries correspond to the only genuinely 3-dimension finite subgroups of

rotation groups and are symmetries of water molecule clusters. Icosahedral group has $n = 5$ and would allow universal topological quantum computation.

4.5 Pineal Gland And EEG

Pineal gland is an unpaired structure and strictly speaking not part of brain being located outside the brain in primitive vertebrates. Pineal gland is known to play a role in the control of both central nervous system, endocrine system and immune system [**?**] . There is also strong evidence that pineal gland forms part of the magnetic navigation system in birds, and possibly also in humans who also have this system. Pineal gland is biological timekeeper and responsible for 24-hour circadian rhythms via a secretion of hormones, in particular melatonin. What pineal gland does is to inhibit secretion whereas pituitary gland facilitates it. Pineal melatonin level controls the hormone secretion and sleep wave cycle and magnetic exposure changes pineal melotonin secretion [**?**].

What makes pineal gland interesting is that it is accompanied by 10 Hz rhythms. This rhythm corresponds to the strongest resonance frequency in the alpha band for both EEG and ZEG.

4.5.1 Pineal gland as timekeeper

10 Hz corresponds to the p-adic frequency $f(2, 127)$ associated with the 126-bit memetic code, which is an especially important code in the hierarchy of the cognitive codes. The fact that tiny electric field at average alpha frequency of 10 Hz restores biorhythms in absence of local magnetic field [**?**], suggests that pineal gland has a coupling to some cavity resonances or some magnetic transition frequency equal to 10 Hz.

1. The lowest Schumann frequency 7.8 Hz is too low. On the other hand, the resonance frequency associated with effectively two-dimensional excitations of em fields inside Schumann cavity is exactly 10 Hz and could be involved with the realization of the memetic code.

2. Fe^{++} ion appears naturally and has cyclotron frequency of 10.74 Hz and provides a natural candidate for a biological clock, not necessarily associated with the pineal gland. A 3 per cent reduction of the Earth's magnetic field from the nominal value of.5 Gauss would reduce the cyclotron frequency to 10 Hz.

3. Co^{++} cyclotron frequency would be 10 Hz for $B = .5$ Gauss. Co^{++} has very high nuclear spin and is therefore a natural magnet: Yarrow has indeed suggested that vitamin B_{12} containing Co makes pineal gland magnetic hormone and fundamental biological clock at 10 Hz frequency [**?**]. Thus at least ELF ME with Co^{++} cyclotron frequency should go through pineal gland. In the case that they are singly ionized $n = 2$ multiples of corresponding cyclotron frequencies would be involved with the biological clocks in question: these transitions are possible in the second order of perturbation theory.

In darkness 24-hour circadian rhythm changes to 25-hour rhythm perhaps defined by the rotation of Moon and Earths's own rotation. The ratio of 24-hour period to 25-hour period is .96. The ratio of the average of Co^{++} and Fe^{++} frequencies to Fe^{++} frequency is .964 giving period of 24 hours 53 minutes if the average period is 24 hours. This observation suggests that circadian period is measured during daylight in time unit given by the period of Fe^{++} rhythm possibly associated with some visual pathway, perhaps even with eyes, and in darkness by the slightly slower Co^{++} rhythm associated with the pineal gland. Under this assumption the ordinary circadian rhythm f is weighted average of Fe^{++} and Co^{++} rhythms:

$$f = xf(C0^{++}) + (1 - x)f(Fe^{++}) \ ,$$

In ideal circumstances circadian rhythm is 24 hours: this gives $x = .44$ with roughly 13.5 day hours and 10.5 dark hours. In continual darkness the rhythm would transform to the slower Co^{++} rhythm of 25 hours with $f = f(Co^{++})$. These two rhythms would presumably distinguish between sleep and awake since pineal gland closely related to the regulation of sleep-wake cycle.

The deviation of x from ideal value $x = .44$ could be an important factor in some disorders. It is known that human melatonin levels do not depend very strongly on season except in arctic latitudes

(seasonal affective disorder) but that melatonin levels affect sleep-wake cycle. Abnormally high activity of pineal gland is associated with the hallucinatory periods of schizophrenia: perhaps visual hallucinations of schizophrenic are partially mediated by pineal gland. The manic (depressive) phase of bipolar disorder correlates also with over- (under-) activity of the pineal gland [**?**]. Keeping x by artificial lighting near its ideal value could be of help. The artificial modification of the strength of the local magnetic field should modify the unit of biological time: perhaps this could provide a manner to cure not only jet lag but even much more serious mental disorders.

4.5.2 Pineal gland as "third eye"

The question is whether the 25-hour rhythm equals to the rhythm defined by moon's rotation or is it a mere coincidence. If not, then the MEs going through through pineal gland might mediate unconscious-to-us information about the rotation of Moon. Could higher level self "see" moon in its orbit? Perhaps in some sense! The ability to restore circadian rhythms is based on the photosensitivity of the pineal gland. Pineal gland has been indeed regarded as "third eye" by mystics. As a matter fact, in some lower vertebrates pineal gland serves as a genuine eye [**?**]. For long it has been thought that in mammals pineal gland is not (or perhaps cannot be!) directly photosensitive. Indeed, there is a pathway from the retinas to the hypothalamus called the retinohypothalamic tract [**?**]. It brings information about light and dark cycles to a region of the hypothalamus called the suprachiasmatic nucleus (SCN). From the SCN, nerve impulses travel via the pineal nerve (sympathetic nervous system) to the pineal gland. These impulses inhibit the production of melatonin. When these impulses stop (at night, when light no longer stimulates the hypothalamus), pineal inhibition ceases and melatonin is released. The pineal gland is therefore a photosensitive organ and an important timekeeper for the human body.

The belief that pineal gland receives information about changes in the lighting from retinas only, has turned to be wrong: mammals lacking ordinary rods and cones genetically, can preserve they circadian rhythms [**?**] ! Thus pineal gland must perceive changes in lighting somehow. TGD based explanation for pineal vision is based on the many-sheeted space-time concept (see **Fig.** `http://tgdtheory.fi/appfigures/manysheeted.jpg` or **Fig.** 9 in the appendix of this book) and ELF selves: light reaches pineal gland via MEs associated with EEG frequencies. Why we do not then see with our third eye? Or do do we actually see?: perhaps visual dreaming involves also seeing with the third eye providing "spiritual input" ! This hypothesis can be tested by checking whether the dreams of people with pineal gland injury somehow change. This explanation also suggests that also eyes are foci of converging MEs so that eyes would be rather concretely mirror of the soul!

4.5.3 Perhaps Descartes was not so wrong after all!

Descartes has been ridiculed for his belief that pineal gland is the seat of soul. Perhaps this sentence has been precipitate as suggested by a clinical case in which over-activity of 5-year old child had led to premature adolescence. Here is a fragment from Frederic Tilney's book "The Pineal Gland":

Until a few decades ago scant attention was paid to the pineal gland. Then came the case, noted by Dr. Berman, in which a child was brought to a German clinic suffering from eye trouble and headaches. He was five years old and very mature, and apparently had reached the age of adolescence. He was abnormally bright mentally, discussing metaphysical and spiritual subjects. He was strongly group-conscious and only happy when sharing what he had with others. After his arrival at the clinic, he rapidly grew worse and died in a month. An autopsy showed a tumor of the pineal gland.

Pineal gland is one of so called chakras in mystic teachings and it is known that pineal gland is involved with altered states of consciousness [**?**]. Meditation practices assign to third-eye meditation development of "light in the original cavity or center of spirit" located in the center of the brain and "waking of Kundalini" is associated to pineal gland [**?**].

The fractal hierarchy of the magnetic flux tubes corresponds to a hierarchy of selves and pineal gland is known to contain magnetic crystals. These crystals create magnetic fields which are much weaker than Earth's magnetic field. Their flux tubes, with thickness measured in centimeters, could thus be carriers of super-conducting BE condensates with cyclotron time scale measured in the range year–thousand years. These higher level magnetic selves together with corresponding MEs

could be responsible for the higher levels of the self hierarchy. One could perhaps understand also the various characteristics of near death experiences in terms of higher level magnetic consciousness [K4]. Thus Descartes could have been right after all!

5 Great Vision About Biological Evolution And Evolution Of Brain

6 Great Vision About Biological Evolution And Evolution Of Brain

The following great vision about evolution and is not perhaps strictly about hierarchy of EEGs. The hierarchy of dark matter and EEGs however leads to this vision naturally. The first part of vision relates to biological evolution. Second part is about the evolution of brain. Here the key thread is evolution of two kinds of intelligences, the ordinary fast intelligence evolving via the emergence of fast computation type activities and emotional slow intelligence developing via the emergence of higher levels of dark matter hierarchy. The latter intelligence is what distinguishes us from animals.

6.1 Basic Assumptions

The great vision about evolution and brain relies on two several new notions and ideas.

1. Life as something in the intersection of real and p-adic worlds making possible negentropic entanglement- both space-like and time-like. This makes possible to understand what conscious intelligence is and NMP reduces evolution to a generation of negentropic entanglement (see **Fig.** `http://tgdtheory.fi/appfigures/cat.jpg` or **Fig. ??** in the appendix of this book). DNA as topological quantum computer hypothesis [K1] finds also a justification.

2. The notion of many-sheeted space-time (see **Fig.** `http://tgdtheory.fi/appfigures/manysheeted.jpg` or **Fig.** 9 in the appendix of this book) suggesting a universal hierarchy of metabolic energy quanta, and the notion of magnetic body.

3. Communication and control based on Josephson radiation and cyclotron transitions crucial for understanding bio-photons and EEG and its fractal generalization as a key element of bio-communications.

4. Zero energy ontology and the closely related notion of causal diamond (CD) assigning a hierarchy of macroscopic time scales to elementary particles coming as octaves of the basic time scale and justifying p-adic length scale hypothesis. Zero energy energy ontology also justifies the vision about memory and intentional action and the idea that motor action can be seen as time reversal of sensory perception.

5. The hierarchy of Planck constants and the identification of the fundamental evolutionary step as an increase of Planck constant. Evolutionary steps mean migration to the pages of the Big Book labeled by larger values of Planck constant and living system can be regarded as a collection of pages of the Big Book such that a transfer of matter and energy between the pages is taking place all the time. The change of the Planck constant implies either reduction or increase of the quantum scales-this leads to a model for biocatalysis and a model of cognitive representations as scaled down or scaled up "stories" mimicking the real time evolution.

6. A resonant like interaction between hierarchy of Planck constants and p-adic length scale hierarchy favoring the values of Planck constant proportional to powers of two, and idea that weak and color interactions are especially important in the length scales which correspond to Mersenne primes and Gaussian Mersennes. The simplest option is that weak bosons have their standard masses but appear as massless below their Compton length which scales up like $\hbar$ and preferred p-adic length scales correspond to Mersenne primes. Also copies of weak

bosons and gluons with ordinary value of Planck constant and reduced mass scale can (and will) be considered.

6.1.1 How to identify the preferred values of Planck constant?

The basic problem is to identify the preferred values of Planck constant and here one can only make theoretical experimentation and all what follows must be taken in this spirit. One can consider assumptions which become increasingly stronger.

1. If only singular coverings of CD and CP_2 are possible Planck constant is a product of integers. Algebraic simplicity of algebraic extensions of rationals favors ruler and compass integers (Appendix).

2. A resonant interaction between the dark length scales and p-adic length scales with ordinary value of Planck constant favors Planck constants coming as powers of two.

3. An even stronger assumption would be that p-adic length scales coming as Mersennes and Gaussian Mersennes are especially interesting.

   (a) If weak bosons can appear with the ordinary value of Planck constant only in the p-adic length scale $k = 89$, one obtains the condition

   $$k_d = k - 89 \quad , \quad k \in \{89, 107, 113, 127, 151, 157, 163, 167\} \tag{6.1}$$

   for the values of of $r = 2^{k_d}$ allowing dark weak bosons in p-adic length scales assignable to Mersennes. These values of k_d assign to electrons and quarks dark p-adic length scales $L(k_{eff}) = \sqrt{r}L(k)$, $r \equiv \hbar/\hbar_0 = 2^{k_d}$. The scales could correspond to size scales of basic units of living systems.

   (b) If weak bosons and possibily also gluons with ordinary value of Planck constant are possible in all p-adic length scales $L(k)$, $k \in \{89, 107, 113, 127, 151, 157, 163, 167\}$, one obtains much richer structure. This hierarchy defines defines secondary dark matter hierarchies from the condition that the scaling the p-adic length scale $L(k_1)$ in this set by $\sqrt{r}$, $r \equiv \hbar/\hbar_0 = 2^{k_d}$, gives a p-adic length scale equal to another p-adic length scale $L(k_2)$ in this set. This requires $k_d + k_1 = k_2$ so that the values

   $$k_d = k_2 - k_1 \tag{6.2}$$

   are favored for the scaling of $\hbar$. In this case the hierarchy of dark scales assignable to quarks and leptons is much richer. The tables below demonstrate that electron appears as its dark variant for all Mersennes and also in atomic length scales $k = 137, 139$ so that this option puts electron in a completely unique position.

4. Also other scales are possible. For instance, $r = 2^{47}$ required by 5 Hz Josephson frequency gives dark weak scale which corresponds $k = 136$ as a p-adic scale. The stages of sleep can be understood in terms of scaling of $\hbar$ by factor 2 and 4 so that also the atomic length scale $k = 137$ and the scale $k = 138$ are involved.

Since the experimental input is rather meager, one is forced to do theoretical experimentation with various hypothesis. The quantitative experimental tests are rather primitive but basically quantal.

1. The time scales assignable to CDs of leptons and quarks and their scaled up counterparts for the preferred values of Planck constant should define biologically important time scales. One might even speak about evolutionary level of electron. These time scales could define fundamental biorhythms and also time scales of long term memory and planned action.

k_d	p_1	p_2		k_d	p_1	p_2
4	163	167		38	**89**	127
6	107	113		38	113	151
6	151	157		40	127	167
6	157	163		44	107	151
10	157	167		44	113	157
12	151	163		50	107	157
14	113	127		50	113	163
16	151	167		54	113	167
18	**89**	107		56	107	163
20	107	127		60	107	167
24	**89**	113		62	**89**	151
24	127	151		68	**89**	157
30	127	157		74	**89**	163
36	127	163		78	**89**	167

Table 2: The integers k_d characterizing the preferred values of $r = \hbar/\hbar_0 = 2^{k_d}$ identified from the condition that the dark variant of p-adic length scale $L(p_1)$ corresponding to some ordinary p-adic length scale defined by Mersenne prime M_p or Gaussian Mersenne $M_{G,p}$, $p \in \{89, 107, 113, 127, 151, 157, 163, 167\}$ corresponds to similar p-adic length scale $L(p_2)$. If one assumes that weak bosons can appear with ordinary value of Planck constant only in the p-adic length scale $k = 89$, only the rows with $p_1 = 89$ of the table are possible: in these cases p_1 is in boldface and the row has double underline. The corresponding values of k_d are in the set $\{18, 24, 38, 62, 68, 74, 78\}$.

2. Josephson frequencies and cyclotron frequencies scaling like $1/\hbar$ (if magnetic field scales down like $1/\hbar$) charactering biologically important ions and elementary particles. In accordance with the quantum criticality of living matter it is assumed that cell membrane corresponds to almost vacuum extremal so that classical Z^0 force is an essential element of the model. Also these frequencies should define fundamental bio-rhythms and characterize the evolutionary level of cell. Experimentally of special importance are the cyclotron frequencies assignable to Ca^{++} ions.

3. The amplitude windows for electric field scaling like $\hbar$ for a particular cyclotron frequency define a basic prediction.

6.1.2 Tables about predicted time and length scales

The following tables summarize various predictions for time scales and length scales. They correspond to the most general assumption that exotic bosons with the ordinary value of Planck constant are possible in all length scales associated with Mersennes and Gaussian Mersennes.

Note that **Table 2** includes only the dark length scales associated with $k = 89$ gauge bosons.

6.1.3 Electron and u quark are different

Before continuing an important observation is in order. Electron is exceptional when compared to quarks. It appears as a dark particle in all p-adic length scales defined by biologically important Gaussian Mersennes and also in atomic length scales $k = 137$ and $k = 139$. The reason is trivial: by the basic assumptions electron must appear at same length scales as weak bosons above $k = 127$ since it corresponds to Mersenne prime. Also for the less general option (exotic intermediate gauge bosons are possible only as the dark variants of the standard ones) it appears at cell membrane length scale $k = 151$, which is due to the fact that one has $113 - 89 = 151 - 127 = 24$. Also u quark can appear with $k_{eff} = 137, 139, 163, 167$ and also this is an accident. The light invariants of intermediate gauge bosons appearing in long p-adic length scales would naturally correspond to almost vacuum extremals making possible the criticality as the basic aspect of life. One must of

Z, W	d	u	e	k_d
89	120	124	127	**0**
93	124	127	131	4
95	126	129	133	6
99	130	133	137	10
101	132	135	139	12
103	134	137	141	14
105	136	139	143	16
107	138	141	145	**18**
109	140	143	147	20
113	144	147	151	**24**
119	150	153	157	30
125	156	159	163	36
127	158	161	165	**38**
129	160	163	167	40
133	164	167	171	44
139	170	173	177	50
143	174	177	181	54
145	176	179	183	56
149	180	183	187	60
151	182	185	189	**62**
157	188	191	195	**68**
163	194	197	201	**74**
167	198	201	205	**78**

Table 3: The dark p-adic length scales $\sqrt{r}L(k) = L(k_{eff})$, $k_{eff} = k + k_d$, of intermediate gauge bosons Z, W, d and u quarks, and electron for the values $r = 2^{k_d}$ of Planck constant defined in **Table 2**. The uppermost row gives the integers characterizing the p-adic length scales of the particles for the standard value of Planck constant. k_{eff} characterizes also the CD times scale through the formula $T(CD, k_{eff}) = 2^{k_{eff}-127} \times .1$ seconds. The rows which correspond to the less general option for which only M_{89} corresponds to weak bosons with ordinary value of Planck constants have double underline and the corresponding values of k_d are in boldface.

k_1	k_M		k_1	k_M		k_1	k_M		k_1	k_M
113	89		113	107		163	127		163	157
127	89		119	107		167	127		169	157
151	89		123	107		133	127		173	157
157	89		113	107		139	127		163	157
163	89		117	107		143	127		167	157
167	89		111	107		133	127		161	157
95	89		175	113		137	127		169	163
109	89		181	113		131	127		183	163
133	89		187	113		225	151		207	163
139	89		191	113		229	151		213	163
145	89		119	113		157	151		219	163
149	89		133	113		171	151		223	163
103	89		157	113		195	151		177	163
127	89		163	113		201	151		201	163
133	89		169	113		207	151		207	163
139	89		173	113		211	151		213	163
143	89		127	113		165	151		217	163
113	89		151	113		189	151		187	163
119	89		157	113		195	151		193	163
125	89		163	113		201	151		199	163
129	89		167	113		205	151		203	163
95	89		137	113		175	151		169	163
101	89		143	113		181	151		175	163
105	89		149	113		187	151		179	163
95	89		153	113		191	151		169	163
99	89		119	113		157	151		173	163
93	89		125	113		163	151		167	163
145	107		129	113		167	151		187	167
169	107		119	113		157	151		211	167
175	107		123	113		161	151		217	167
181	107		117	113		155	151		223	167
185	107		195	127		235	157		227	167
113	107		201	127		163	157		181	167
127	107		205	127		177	157		205	167
151	107		133	127		201	157		211	167
157	107		147	127		207	157		217	167
163	107		171	127		213	157		221	167
167	107		177	127		217	157		191	167
121	107		183	127		171	157		197	167
145	107		187	127		195	157		203	167
151	107		141	127		201	157		207	167
157	107		165	127		207	157		173	167
161	107		171	127		211	157		179	167
131	107		177	127		181	157		183	167
137	107		181	127		187	157		173	167
143	107		151	127		193	157		177	167
147	107		157	127		197	157		171	167

Table 4: Table gives all weak boson length scales -both non-dark and dark implied by the assumption that all Mersennes primes and their Gaussian counterparts and their dark counterparts defined $k_d = k_i - k_j$ them are possible.

particle	Z, W	d	u	e
k	89	120	123	127
f(CD)/Hz	2.7488×10^{12}	1280	160	10

Table 5: The fundamental frequencies associated with the CDs of intermediate gauge bosons Z, W, d and u quarks, and electron. Note that for intermediate gauge bosons the frequency of CDs corresponds to energy $E = 1.13 \times 10^{-2}$ eV and wavelength $\lambda = 1.01 \times 10^{-4}$ m (size of a large neuron).

Z, W	d	u	e	k_d
3.64e-13	7.81e-04	6.25e-03	1.00e-01	**0**
5.821e-12	1.25e-02	1.00e-01	1.60e+00	4
2.31e-11	5.00e-02	4.00e-01	6.40e+00	6
3.73e-10	8.00e-01	6.40e+00	1.02e+02	10
1.49e-09	3.20e+00	2.56e+01	4.10e+02	12
5.97e-09	1.28e+01	1.02e+02	1.65e+03	14
2.38e-08	5.12e+01	4.10e+02	6.55e+03	16
9.54e-08	2.05e+02	1.64e+03	2.62e+04	**18**
3.81e-07	8.19e+02	6.55e+03	1.05e+05	20
6.10e-06	1.31e+04	1.05e+05	1.68e+06	**24**
3.91e-04	8.39e+05	6.71e+06	1.07e+08	30
2.50e-02	5.37e+07	4.30e+08	6.87e+09	36
1.00e-01	2.15e+08	1.72e+09	2.75e+10	**38**
4.00e-01	8.59e+08	6.87e+09	1.10e+11	40
6.40e+00	1.37e+10	1.10e+11	1.76e+12	44
4.10e+02	8.80e+11	7.04e+12	1.12e+14	50
6.55e+03	1.41e+13	1.13e+14	1.80e+15	54
2.62e+04	5.63e+13	4.50e+14	7.21e+15	56
4.19e+05	9.01e+14	7.21e+15	1.15e+17	60
1.68e+06	3.60e+15	2.88e+16	4.61e+17	**62**
1.07e+08	2.31e+17	1.84e+18	2.95e+19	**64**
6.87e+09	1.48e+19	1.18e+20	1.89e+21	**74**
1.10e+11	2.36e+20	1.89e+21	3.02e+22	**78**

Table 6: The $\hbar$-scaled fundamental time scales $T(CD, k_{eff}) = 2^{k_{eff}-127} \times .1$ seconds associated with the CDs of intermediate gauge bosons Z, W, d and u quarks, and electron for the values $\hbar/\hbar_0 = 2^{k_d}$ of Planck constant defined in **Table 2**. The scales are expressed in seconds. The uppermost row gives the time scales of CDs for the standard value of Planck constant. The rows which correspond to the less general option for which only M_{89} corresponds to weak bosons with ordinary value of Planck constants have double underline and the corresponding values of k_d are in boldface.

course be very cautious about the masses of exotic counterparts of u and d quark: one can also consider the possibility that masses are identical.

6.2 Dark Matter Hierarchy And Big Leaps In Evolution

Dark matter hierarchy leads to an amazingly concrete picture about evolutionary hierarchy allowing to identify the counterparts for concepts like mineral, plant, and animal kingdom that we learned during schooldays and ceased to take seriously as students of theoretical physics as we learned that other sciences are just taxonomy. Even more, a view about what distinguishes between prokaryotes, eukaryotes, animal cells, neurons, EEG, and even about what makes cultural evolution, becomes possible. This view is also very useful when one tries to understand the role of microtubules.

The appearance of CDs scaled up in size by $r = \hbar/\hbar_0$ and space-time sheets scaled up in size by $\sqrt{r}$ means the emergence of new levels of structure and it is natural to identify big leaps in evolution in terms of emergence of new larger matter carrying space-time sheet magnetic flux sheets and corresponding magnetic bodies. If magnetic flux quanta are scaled by r magnetic flux quantization conditions remain unaffected if magnetic field strengths scale down by $1/r$ so that the energies of cyclotron photons are not affected. The thickness of flux tubes can remain unchanged if the currents running at the boundaries of the flux quantum cancel the magnetic flux. As already found, this mechanism must be at work inside living organisms wheras in far away region flux quanta are scaled up in size.

The attractive hypothesis is that the leaps in evolution correspond to the emergence of dark variants of weak and possibly also color interactions in dark p-adic length scales which correspond to ordinary p-adic length scales characterized by Mersenne primes. These leaps would be quantum leaps but in different sense as thought usually. The emergence of higher dark matter levels would basically mean the integration of existing structures to larger structures. A good metaphor are text lines at the pages of book formed by magnetic flux sheets whose width is scaled up by r as the new level of dark matter hierarchy emerges. The big leaps can occur both at the level of organism and population and organisms with rather low individual dark matter level can form societies with high dark matter levels and high collective intelligence (honeybees and ants are good example in this respect).

Certainly also other scalings of Planck constant than those summarized in tables are possible but these scalings are of primary interest. This intuition is supported by the observation that electron is completely exceptional in this framework. Electron's dark p-adic length scales corresponds to p-adic length scales $L(k)$, $k = 167, 169$, assignable to atomic and molecular physics and to the Gaussian Mersennes $M_{G,k} = (1+i)^k - 1$, $k \in \{151, 157, 163, 167\}$, assignable to the length scale range between cell membrane thickness 10 nm and nucleus size 2.58 μm. The corresponding p-adic length scales or corresponding electronic Compton lengths, the number of which is 23, are excellent candidates for the scales of basic building brickes of living matter and vary from electron's p-adic length scale up to 1.25 m ($k = 167$ defining the largest Gaussian Mersenne in cell length scale range) and defining the size scale of human body. The corresponding p-adic time scales are also highly interesting and vary from.1 seconds for electron defining the fundamental biorhythm to 9.6×10^{14} years which is by 4-5 orders longer than the age of the observed Universe. For $k = 167$ the time scale is 1.1×10^{11} years and is by one order of magnitude longer than the age of the observed Universe estimated to be 1.37×10^{10} years [E1].

This conceptual framework gives rather strong guidelines for the identification of the levels of evolutionary hierarchy in terms of dark matter hierarchy. The outcome is a more detailed vision about big evolutionary leaps. Note that in the sequel only the general option is considered: the justification for this is that for this option electron appears as a dark particle for all length scales defined by Gaussian Mersennes as well as in atomic length scales. The basic vision in nutshell is that evolution means the emergence of dark weak and gluonic physics in both dark and ordinary length scales and that the size scales of the basic biostructures correspond to Mersenne primes and their Gaussian variants.

6.2.1 A sketch about basic steps in evolution

The vision about evolution depends on what one assumes about the initial state.

1. If one assumes that weak bosons with ordinary value of Planck constant were present in the begining, evolution would mean a steady growth of k_d. The problem is that small values of $k_d = k_1 - k_2$ correspond to the Gaussian Mersennes defining cellular length scales. If these exotic weak physics were present from the beginning, large parity breaking in cellular length scales would have been present all the time.

2. An alternative and perhaps more realistic view is that the evolution means the emergence of exotic weak physics corresponding almost vacuum extremals in increasingly longer length scales. A possible mechanism could have been the induction of exotic $\hbar_0$ variant of weak physics at the nearest Mersenne length scale k_{next} by the dark variant of weak physics at level k so that one would have $k_d = k_{next} - k$. The simplest induction sequence would have been $89 \to 107 \to 113 \to 127 \to 151 \to 157 \to 163 \to 167$ corresponding to $k_d \in \{18, 6, 14, 24, 6, 6, 4\}$. A possible interpretation of exotic $\hbar_0$ physics is in terms of almost vacuum extremals and non-standard value of Weinberg angle: also weak bosons of this physics would be light. This sequence defines the minimal values for k_d but also larger values of k_d are possible and would correspond to steps between neighbours which are not nearest ones.

The following sketch about the basic steps of evolution relies on the latter option.

1. Elementary particle level

Magnetic bodies with size scale defined by the sizes of CDs assignable to quarks and leptons and possibly also weak bosons (already now the size of big neuron emerges) corresponds to the lowest level of hierarchy with the sizes of the basic material structures corresponding to the Compton lengths of elementary particles. The fundamental bio-rhythms corresponding to frequencies 10, 160, and 1280 Hz appear already at this level in zero energy ontology which suggests that elementary particles play a central and hitherto unknown role in the functioning of living matter.

2. $89 \to 107$ *step with* $k_d = 18$

The first step would have been the emergence of $k_{eff} = 107$ weak bosons inducing $\hbar_0$ weak physics in $k = 107$ length scale characterizing also ordinary hadrons. This in turn would have led to the emergence of exotic nucleons possibly corresponding to almost vacuum extremals. The reduction of the model for the vertebrate genetic code to dark hadron physics [K21] is one of the most unexpected predictions of quantum TGD and assumes the existence of exotic- possibly dark- nucleons whose states with a given charge correspond to DNA, RNA, mRNA, and tRNA. The $\hbar_0$ variants of these nucleons would interact via weak bosons with hadronic mass scale. The exotic variants of the ordinary $k = 113$ nuclei would correspond to the nuclear strings consisting of exotic nucleons [K7, K21] and define nuclear counterparts for DNA sequences. Their dark counterparts could define counterparts of DNA sequences in atomic physics length scales. Therefore a justification for the previous observation that genetic code could be realized at the level of hadron physics and that chemical realization would be higher level realization finds justification. The anomalous properties of water could be also partly due to the presence of dark nucleons and the proposal was that the presence of exotic nuclei is involved with water memory [K10]. The possible existence of the analog of DNA-RNA transcription between ordinary DNA and its nuclear counterpart would have dramatic implications. For instance, one can imagine a mechanism of homeopathy based on this kind of transription process which would also allow a modification of genome by using dark nuclei to communicate the DNA sequences through the cell membrane to the target nuclei.

3. $107 \to 113$ *step with* $k_d = 6$

The next step would have been the emergence of $k_{eff} = 113$ weak bosons inducing $\hbar_0$ weak physics in $k = 113$ length scale characterizing also ordinary hadrons. Exotic variants of the ordinary nuclei possibly corresponding to almost vacuum extremals could have emerged interacting weakly (or actually relatively strongly!) via the exchange of weak bosons with mass scale of order 100 MeV. Also dark variants of the exotic $k = 107$ nucleons could have have emerged and formed exotic nuclei of size scale $k = 119$.

4. $113 \to 127$ *step with* $k_d = 14$

At this step weak bosons in electron mass scale would have emerged. Whether these weak bosons could have induced large parity breakings in atomic and molecular length scales is not clear. Viruses, which do not yet possess cell membrane could correspond to this level of hierarchy.

5. $127 \to 151$ *step with* $k_d = 24$

This step would have been fundamental since weak bosons in cell membrane length scale would have appeared. Note that by $113 - 89 = 24$ this step also leads from $k = 89$ weak bosons to $k = 113$ weak bosons. The weak bosons assignal to $k = 151$ could correspond to the weak interactions associated with almost vacuum extremals and $sin^2(\theta_W) = .0295$ could correspond to the weak physics in question.

$k_d = 24$ step for $k = 113$ $\hbar_0$ weak bosons would have produced them in $k_{eff} = 137$ atomic length scale with $L(137) \simeq .78$ Angstrom This could have naturally led to large parity breaking effects and chiral selection.

Dark $k_{eff} = 151$ electrons appearing in the TGD inspired model of high T_c super-conductivity would have been a by-product of this step. Whether dark electrons could have transformed to light $\hbar_0$ electrons (of mass.25 keV) with a common mass scale of order 10^2 eV with exotic weak bosons is an interesting question. The model of high T_c super-conductivity predicts the presence of structures analogous to cell membrane. This would suggest that cell membranes emerged and chiral selection emerged at this step so that one could not distinguish the emergence of molecular life as a precedessor for the emergence of cell membrane like structures. This would conform with the fact that DNA molecules are stable only inside cell nucleus. Note that for $k_{eff} = 151$ electron's CD has time scale $2^{24} \times .1$ seconds -that is 19.419 days (day=24 hours).

The smallest nanobes [I2] appearing in rocks have size 20 nm and could have emerged at this step. The size of the viruses [I3] is between 10-300 nm covers the entire range of length scales assignable to Gaussian Mersennes, which suggests that smallest viruses could have emerged at this step. Also the smallest [I1] [I1], which by definition have size smaller than 300 nm could have appeared at this stage.

6. The remaining steps

The remaining steps $k = 151 \to 157 \to 163 \to 167$ could relate to the emergence of coiling structure DNA and other structures inside cell nucleus. $k = 167$ would correspond to $k_d = 167 - 89 = 68$ to be compared with the value $k_d = 47$ required by 5 Hz Josephson frequency for the neuronal membrane for -70 mV resting potential. Note that $k_d = 48$ (state 1-2 of deep sleep) corresponds to $k = 163$.

By their smallness also double and triple steps defined by $k_d = k_{i+n} - k_i$, $n > 1$, are expected to be probable. As a consequence, electrons can appear as dark electrons at all the Gaussian Mersenne levels. At these steps the dark electrons corresponding to primes $k_{eff} = 137, 139$ would appear. For $k = 137$ dark electron appears with CD time scale equal to 128 seconds- rather precisely two minutes. The model for EEG suggests that the exotic weak bosons appear in the scales $k_{eff} = 136, 137, 138$.

Further multisteps from the lower levels of hierarchy would give structures with size scales above the size of cell nucleus possibly assignable to organs and structural units of brain. The dark levels assignable to electron are expected to be of special interest. It is encouraging that the longest scale assignable to electron in this manner corresponds to $k = 205$ and length scale of 1.28 m defining body size. As a consequence dark electrons are predicted at levels $k = 137, 139, 141, 143, 145, 147$ coming as octaves.

Prokaryotic cells (bacteria, archea) without cell nucleus for which cell membrane is responsible for metabolic functions and genome is scattered around the cell could have emerged at this step. This would mean that the emergence of the cell membrane thickness as a fundamental scale is not enough: also the size scale of membrane must appear as p-adic length scale. The sizes of most prokaryotes vary between 1 μm and 10 μm: the lower bound would require $k = 163$. There also prokaryotes with sizes between.2 μm ($k = 157$ corresponds to.08 μm) and 750 μm. Cell nuclei, mitochondria, and other membrane bounded cell nuclei would have evolved from prokaryotes in this framework. The sizes of eukaryote cells are above 10 μm and the fact that multicellular organisms are in question strongly suggests that the higher multisteps giving rise to weak bosons and dark electrons in length scales above $L(167)$ are responsible for multi-cellular structures.

This scenario leaves a lot of questions unanswered. In particular, one should understand in

more detail the weak physics at various length scales as well as various exotic nuclear physics defined by dark nucleons and dark variants of nuclei.

6.2.2 Division of the evolution to that of biological body and magnetic body

Electron's Mersenne prime M_{127} is the highest Mersenne prime, which does not correspond to a completely super-astrophysical p-adic length scale. In the case of Gaussian Mersennes $M_{G,k}$ one has besides those defined by k in $\{113, 151, 157, 163, 167, \}$ also the ones defined by k in $\{239, 241, 283, 353, 367, 379,\ 457, 997\}$ [A1]. The appropriately extended model for evolution allows to distinguish between three kinds of values of k_{eff}.

1. The values of k_{eff} for which electron can appear as dark particle and thus satisfying $k_{eff} \leq 205$ (Table 5). These levels would correspond to structures with size below 1.25 m defined roughly by human body size and it is natural to assign the evolution of super-nuclear structures to the levels $167 < k_{eff} \leq 205$.

2. The values of of k_{eff} for which dark gauge bosons are possible in the model. This gives the condition $k_{eff} \leq 235$. These levels correspond to structures in the range 1.25 m-40 km. The identification as parts of the magnetic body can be considered.

3. The values of k_{eff} obtained by adding to the system also the Gaussian Mersenne pair $k \in \{239, 241\}$ allowing also the dark electrons. The lower size scale for these structures is 640 km.

4. The higher levels corresponding to k_{eff} in $\{283, 353, 367, ...\}$. The lower size scale for these structures is 3 AU (AU is the distance from Earth to Sun).

$k_{eff} > 205$ levels would correspond to the emergence of structures having typically size larger than that of the biological body and not directly visible as biological evolution. This evolution could be hidden neuronal evolution meaning the emergence of extremely low Josephson frequencies of the neurons modulating higher frequency patterns and being also responsible for the communication of long term memories.

6.2.3 Biological evolution

In principle the proposed model allowing multisteps between hierarchy levels defined by Mersenne primes and their Gaussian counterparts could explain the size scales of the basic structures below the size scale 1.25 m identified in terms of the $k_{eff} \leq 205$ levels of the hierarchy.

1. The emergence of cells having organelles

The appearance of the structures with $k_{eff} > 167$ (possibly idetifiable as magnetic body parts) should correlate with the emergence of simple eukaryotic cells and organisms, in particular plant cells for which size is larger than 10 μm, which could correspond to $k_{eff} = 171$ for electron and dark variants of weak gauge bosons. $k_{eff} = 177$ is the next dark electron level and corresponds to 80 μm scale. It seems natural to assume that these dark weak bosons do not transform to their $\hbar_0$ counterparts at these space-time sheets.

Cell nucleus would be the brain of the cell, mitochondria would be the energy plant, and centrioles generating microtubules would define the logistic system. Also other organelles such as Golgi apparatus, ribosomes, lysosomes, endoplasmic reticulum, and vacuoles would be present. These organelles would live in symbiosis by topologically condensing to $k_{eff} \geq 171$ magnetic body controlling their collective behavior. Centrosomes associated with animal cells would not be present yet but microtubule organizing centers would already be there.

The recent observations show that centrioles are not always in the characteristic T shaped conformation. Daughter centrioles resulting during the replication of mother centriole use first ours of their lifetime to roam around the cell before becoming mature to replicate. A possible interpretation is that they are also life forms and that magnetic body utilizes daughter centrioles to perform some control functions crucial for the future development of the cell. For instance, centrioles visit the place where axonal growth in neurons starts.

Cytoskeleton would act as a counterpart of a central nervous system besides being responsible for various logistic functions such as transfer of proteins along microtobuli. Centrioles give also rise to basal bodies and corresponding cilia/flagella used by simple cells to move or control movement of air or liquid past them. Centriole pair would be also used by the magnetic body to control cell division.

The logistic functions are the most obvious functions of microtubules. Magnetic body would control cell membrane via signals sent through the cell nucleus and communicated to the cell membrane along microtubuli. Basal bodies below the cell membrane and corresponding cilia/flagella would serve as motor organs making possible cell motion. Tubulin conformations representing bits would allow microtubule surface to represent the instructions of the magnetic body communicated via via cell nucleus to various proteins moving along the microtubular surface so that they could perform their functions.

TGD based view about long memory recall as communication with geometric past allows also the realization of cellular declarative memories in terms of the conformational patterns. Memory recall corresponds to a communication with geometric past using phase conjugate bosons with negative energies reflected back as positive energy bosons and thus representing an "image" of microtubular conformation just like ordinary reflected light represents ordinary physical object. There would be no need for a static memory storage which in TGD framework would mean taking again and again a new copy of the same file.

Receptor proteins would communicate cell level sensory input to the magnetic body via MEs parallel to magnetic flux tubes connecting them to the magnetic body. We ourselves would be in an abstract sense fractally scaled up counterparts of receptor proteins and associated with dark matter iono-lito Josephson junction connecting the parts of magnetosphere below litosphere and above magnetosphere. The communication would be based on Josephson radiation consisting of photons, weak bosons, and gluons defining the counterpart of EEG associated with the level of the dark matter hierarchy in question.

3. The emergence of organs and animals

The emergence of magnetic bodies with k_{eff} in the range $(177, 181, 183, 187, 189, 195, 201, 205)$ allowing both dark electron and weak bosons could accompany the emergence of multicellular animals. Magnetic body at this level could give rise to super-genome making possible genetic coding of organs not yet possessed by plant cells separated by walls from each other. The super structures formed from centrosomes and corresponding microtubuli make possible complex patterns of motion requiring quantum coherence in the scale of organs as well as memories about them at the level of organs.

4. The emergence of nervous system

k_{eff} in the range $(187, 189, 195, 201, 205)$ allowing dark electrons and weak bosons gives size scales $(.25, .5, 4, 32, 128)$ cm, which could correspond to the scales of basic units of central nervous system. What would be of special interest would be the possibility of charged entanglement based on classical W fields in macroscopic length scales. The emergence of the new level means also the integration of axonal microtobuli to "text lines" at the magnetic flux sheets making possible logistic control at the multineuronal level. The conformational patterns of the microtubular surface would code nerve pulse patterns to bit patterns representing declarative long term memories. An interesting question is whether the reverse coding occurs during memory recall.

6.2.4 The evolution of magnetic body

For mammals with body size below 1.25 m the levels $k_{eff} > 205$ cannot correspond to biological body and the identification in terms of magnetic body is suggestive. The identification of EEG in terms of Josephson frequencies suggests the assignment of EEG with these levels.

1. The emergence of EEG

EEG in the standard sense of the word is possessed only by vertebrates and one should understand why this is the case. The value of Josephson frequency equal to 5 Hz requires only $k_d = 47$ so that something else must be involved. A possible explanation in the framework of the proposed model comes from the following observations.

1. Besides the maximal p-adic scale $k = 205$ for which electron and weak bosons appears as dark variants the model allows also levels at which only gauge bosons appear as dark particles. From **Table 6**one finds that levels $k \in \{207, 211, 213, 217, 219, 221, 223, 225, 229, 235\}$ are allowed. Could it be that these levels and possibly some highest levels containing both electrons and gauge bosons as dark particles are a prerequisite for EEG as we define it. Its variants at higher frequency scales would be present also for invertebrates. The lowest Josephson frequency coded by the largest value of $\hbar$ in the cell membrane system determines the Josephson frequency.

2. The membrane potentials -55 mV (criticality against firing) correspond to ionic Josephson energies somewhat above 2 eV energy ((2.20, 2.74, 3.07, 2.31) eV, see Table 1). For 2 eV the wavelength 620 nm is near to $L(163) = 640$ nm. Therefore the Josephson energies of ions can correspond to the $L_e(k = 163)$ if one assumes that a given p-adic mass scale corresponds to masses half octave above the p-adic mass scale so that the opposite would hold true at space-time level by Uncertainty Principle. Josephson frequencies $f_J \in \{5, 10, 20, 40, 80, 160\}$ Hz correspond to $k_d \in \{47, 46, 45, 44, 43, 42\}$ giving $k_{eff} \in \{210, 209, 208, 207, 206, 205\}$.

   (a) Cerebellar resonance frequency 160 Hz would correspond to $k = 205$ -the highest level for for which model allows dark electrons (also 200 Hz resonance frequency can be understood since several ions are involved and membrane potential can vary).

   (b) The 80 Hz resonance frequency of retina would correspond to $k_{eff} = 206$ -for this level dark electrons would not be present anymore.

   (c) 40 Hz thalamocortical frequency would correspond to $k_{eff} = 207$.

   (d) For EKG frequencies are EEG frequencies below 20 Hz 12.5 and heart beat corresponds to .6-1.2 second cycle (the average.8 s corresponds to $k_{eff} = 212$).

3. Even values of k_{eff} are not predicted by the model based on Mersenne primes allowing only odd values of k_{eff} so that the model does not seem to be the whole truth. The conclusion which however suggests itself strongly is that EEG and its variants identified as something in the range 1-100 Hz, are associated with the levels in at which only dark weak bosons are possible in the proposed model. Note that the size scales involved with EEG would be above the size scale of human body so that we would have some kind of continuation of the biological body to be distinguished from the magnetic body. The time scales assignable to the dark CDs would be huge: for instance, $k = 205$ would correspond to $T = 2^{42} \times .1$s making about 1395 years for electron.

2. Does magnetic body correspond to the space-time sheets carrying dark weak bosons?

The layers of the magnetic body relevant for EEG have have size of order Earth size. Natural time scale for the moment of sensory consciousness is measured as a fraction of second and the basic building blocks of our sensory experience corresponds to a fundamental period of.1 seconds. This scale appears already at $\hbar_0$ level for electron CD. The natural question concerns the relationship of the magnetic body to the $k > 205$ space-time sheets carrying only gauge bosons in the model and having size scale larger than that of biological body. Do they correspond to an extension of biological body or should they be regarded as parts of the magnetic body? The following observations suggest that they could correspond to layers of the magnetic body responsible for the fractal variant of EEG.

1. The primary p-adic time scales (Compton times) $T(239)$ and $T(241)$ correspond to frequencies, which are $2^{\pm 1/2}$ kHz. The geometric average $k = 240$ corresponds to kHz frequency. Is the appearance of kHz scale a mere accident or do the frequencies assignable to the quark CDs correspond to Compton times $\propto \sqrt{2^{k_{eff}/2}}$?

2. One can apply scalings by 2^{k_d} to the triplet $(239, 240, 241)$ to get a triplet $(239 + k_d, 240 + k_d, 241 + k_d)$. The results are summarized in **Table 7**. Clearly the frequencies in question cover also the EEG range. Note that these frequencies scale as $\sqrt{1/r}$ whereas Josephson frequencies scale as $1/r$.

k_d	f_1/Hz	f_2/Hz	f_3/Hz
0	707	1000	1412
4	177	250	354
6	89	1250	177
10	22.1	31.3	44.2
12	11.1	15.6	22.1
14	5.5	7.8	11.1
16	2.8	3.9	5.5
18	1.4	2.0	2.8
20	0.7	1.0	1.4
24	0.2	0.2	0.3

Table 7: The Compton frequencies obtained by scaling $2^{k_d/2}$ from the basic triplet $k_{eff} = (239, 240, 241)$. The values of k_d correspond to those predicted by the model based on Mersenne primes.

Also ZEG and WEG would appear but in much shorter scales dictated by k_{eff} and might accompany EEG. Somehow it seems that the effective masslessness of weak bosons below given scale is highly relevant for life. One can of course ask whether some larger Gaussian Mersenne could change the situation. There is a large gap in the distribution of Gaussian Mersennes after $k = 167$ and the next ones correspond to $M_{G,k}$, with k in $(239, 241, 283, 353, 367, 379, 457, 997)$ [A1]. The twin pair $k = (239, 241)$ corresponds to a length scales $(1.6, 3.2) \times 10^2$ km and the minimum value for k_d are (72, 74) ($167 \to (239, 241)$ transition).

3. Long term memory and ultralow Josephson frequencies

What determines the time scale associated with long term memory is a crucial question if one really wants to understand the basic aspects of consciousness.

1. Does the time scale correspond to the size scale of CD assignable to electron scaled by $r = \hbar/\hbar_0$? In this case relatively small values of r would be enough and $r = 2^{47}$ would give time scale of 10^{13} s for for electron's CD, which is about 3×10^5 years. This does not make sense.

2. Does Josephson frequency define the relevant time scale? In this case the long term memory would require the analog of EEG in the time scale of memory span. $k_{eff} = 205$ would give 6 ms time scale for memory from the assignment of $k_{eff} = 163$ to the Josephson photons at V=-50 mV implying $k_d = 42$. Minute scale would require $k_{eff} = 217$. The highest level $k_{eff} = 235$ allowed by the model involving only Gaussian Mersennes with $k \leq 167$ would correspond to a time scale of 77.67 days (day is 24 hours). For Gaussian Mersennes defined by $k_{eff} = (239, 241)$ the time scales become about (41.4, 82.8) months (3.4 and 6.8 years). These scales should also define important biorhythms. The claimed 7 years rhythm of human life could relate to the latter rhythm: note that the precise value of the period depends on the membrane potential and thus varies. The presence of the scaled up variants of the by $k_d \leq 78$ allows longer time spans of long term memory and the scaling defined by $k_d = 167 - 163 = 4$ scales up the span of long term memories to (54.4, 108.8) years.

4. Cultural evolution

Higher levels in the hierarchy would correspond mostly to the evolution of hyper-genome coding for culture and social structures. Introns are good candidate for the nucleotides involved. The development of speech faculty is certainly a necessary prerequisite for this breakthrough. Already EEG seems to correspond to dark layers of biological body larger than biological body so that one can cask whether the weak bosons and dark electrons in the length scales $k = 239, 241, 283, 353, 367, ...$ could be relevant for the collective aspect of consciousness and cultural evolution. Maybe the size scales $(175, 330)$ km and their scaled up variants by $k_d \leq 78$ might

have something to do with the spatial scale of some typical social structure (not city: the area of New York is only 790 km^2).

7 Appendix

7.1 Hierarchy Of Planck Constants And The Generalization Of The Notion Of Embedding Space

In the following the recent view about structure of embedding space forced by the quantization of Planck constant is summarized. The question is whether it might be possible in some sense to replace H or its Cartesian factors by their necessarily singular multiple coverings and factor spaces. One can consider two options: either M^4 or the causal diamond CD. The latter one is the more plausible option from the point of view of WCW geometry.

7.1.1 The evolution of physical ideas about hierarchy of Planck constants

The evolution of the physical ideas related to the hierarchy of Planck constants and dark matter as a hierarchy of phases of matter with non-standard value of Planck constants was much faster than the evolution of mathematical ideas and quite a number of applications have been developed during last five years [K17, K13, K8]

1. The starting point was the proposal of Nottale [E2] that the orbits of the 4 inner planets correspond to Bohr orbits with Planck constant $\hbar_{gr} = GMm/v_0$ and outer planets with Planck constant $\hbar_{gr} = 5GMm/v_0$, $v_0/c \simeq 2^{-11}$. The basic proposal [K17, K13] was that ordinary matter condenses around dark matter which is a phase of matter characterized by a non-standard value of Planck constant whose value is gigantic for the space-time sheets mediating gravitational interaction. The interpretation of these space-time sheets could be as magnetic flux quanta or as massless extremals assignable to gravitons.

2. Ordinary particles possibly residing at these space-time sheet have enormous value of Compton length meaning that the density of matter at these space-time sheets must be very slowly varying. The string tension of string like objects implies effective negative pressure characterizing dark energy so that the interpretation in terms of dark energy might make sense [K18]. TGD predicted a one-parameter family of Robertson-Walker cosmologies with critical or over-critical mass density and the "pressure" associated with these cosmologies is negative.

3. The quantization of Planck constant does not make sense unless one modifies the view about standard space-time is. Particles with different Planck constant must belong to different worlds in the sense local interactions of particles with different values of $\hbar$ are not possible. This inspires the idea about the book like structure of the embedding space obtained by gluing almost copies of H together along common "back" and partially labeled by different values of Planck constant.

4. Darkness is a relative notion in this framework and due to the fact that particles at different pages of the book like structure cannot appear in the same vertex of the generalized Feynman diagram. The phase transitions in which partonic 2-surface X^2 during its travel along X^3_l leaks to another page of book are however possible and change Planck constant. Particle (say photon -) exchanges of this kind allow particles at different pages to interact. The interactions are strongly constrained by charge fractionization and are essentially phase transitions involving many particles. Classical interactions are also possible. It might be that we are actually observing dark matter via classical fields all the time and perhaps have even photographed it [K20].

5. The realization that non-standard values of Planck constant give rise to charge and spin fractionization and anyonization led to the precise identification of the prerequisites of anyonic phase. If the partonic 2-surface, which can have even astrophysical size, surrounds the tip of CD, the matter at the surface is anyonic and particles are confined at this surface. Dark matter could be confined inside this kind of light-like 3-surfaces around which ordinary matter

condenses. If the radii of the basic pieces of these nearly spherical anyonic surfaces - glued to a connected structure by flux tubes mediating gravitational interaction - are given by Bohr rules, the findings of Nottale [E2] can be understood. Dark matter would resemble to a high degree matter in black holes replaced in TGD framework by light-like partonic 2-surfaces with a minimum size of order Schwartschild radius r_S of order scaled up Planck length $l_{Pl} = \sqrt{\hbar_{gr} G} = GM$. Black hole entropy is inversely proportional to $\hbar$ and predicted to be of order unity so that dramatic modification of the picture about black holes is implied.

6. Perhaps the most fascinating applications are in biology. The anomalous behavior ionic currents through cell membrane (low dissipation, quantal character, no change when the membrane is replaced with artificial one) has a natural explanation in terms of dark supra currents. This leads to a vision about how dark matter and phase transitions changing the value of Planck constant could relate to the basic functions of cell, functioning of DNA and amino-acids, and to the mysteries of bio-catalysis. This leads also a model for EEG interpreted as a communication and control tool of magnetic body containing dark matter and using biological body as motor instrument and sensory receptor. One especially amazing outcome is the emergence of genetic code of vertebrates from the model of dark nuclei as nuclear strings [K12, K20], [K12].

7.1.2 The most general option for the generalized embedding space

Simple physical arguments pose constraints on the choice of the most general form of the embedding space.

1. The fundamental group of the space for which one constructs a non-singular covering space or factor space should be non-trivial. This is certainly not possible for M^4, CD, CP_2, or H. One can however construct singular covering spaces. The fixing of the quantization axes implies a selection of the sub-space $H_4 = M^2 \times S^2 \subset M^4 \times CP_2$, where S^2 is geodesic sphere of CP_2. $\hat{M}^4 = M^4 \backslash M^2$ and $\hat{CP}_2 = CP_2 \backslash S^2$ have fundamental group Z since the codimension of the excluded sub-manifold is equal to two and homotopically the situation is like that for a punctured plane. The exclusion of these sub-manifolds defined by the choice of quantization axes could naturally give rise to the desired situation.

2. CP_2 allows two geodesic spheres which left invariant by $U(2$ *resp.* $SO(3)$. The first one is homologically non-trivial. For homologically non-trivial geodesic sphere $H_4 = M^2 \times S^2$ represents a straight cosmic string which is non-vacuum extremal of Kähler action (not necessarily preferred extremal). One can argue that the many-valuedness of $\hbar$ is un-acceptable for non-vacuum extremals so that only homologically trivial geodesic sphere S^2 would be acceptable. One could go even further. If the extremals in $M^2 \times CP_2$ can be preferred non-vacuum extremals, the singular coverings of M^4 are not possible. Therefore only the singular coverings and factor spaces of CP_2 over the homologically trivial geodesic sphere S^2 would be possible. This however looks a non-physical outcome.

   (a) The situation changes if the extremals of type $M^2 \times Y^2$, Y^2 a holomorphic surface of CP_3, fail to be hyperquaternionic. The tangent space M^2 represents hypercomplex sub-space and the product of the Kähler-Dirac gamma matrices associated with the tangent spaces of Y^2 should belong to M^2 algebra. This need not be the case in general.

   (b) The situation changes also if one reinterprets the gluing procedure by introducing scaled up coordinates for M^4 so that metric is continuous at $M^2 \times CP_2$ but CDs with different size have different sizes differing by the ratio of Planck constants and would thus have only piece of lower or upper boundary in common.

3. For the more general option one would have four different options corresponding to the Cartesian products of singular coverings and factor spaces. These options can be denoted by $C-C$, $C-F$, $F-C$, and $F-F$, where C (F) signifies for covering (factor space) and first (second) letter signifies for CD (CP_2) and correspond to the spaces $(\hat{CD} \hat{\times} G_a) \times (\hat{CP_2} \hat{\times} G_b)$, $(\hat{CD} \hat{\times} G_a) \times \hat{CP_2}/G_b$, $\hat{CD}/G_a \times (\hat{CP_2} \hat{\times} G_b)$, and $\hat{CD}/G_a \times \hat{CP_2}/G_b$.

4. The groups G_i could correspond to cyclic groups Z_n. One can also consider an extension by replacing M^2 and S^2 with its orbit under more general group G (say tetrahedral, octahedral, or icosahedral group). One expects that the discrete subgroups of $SU(2)$ emerge naturally in this framework if one allows the action of these groups on the singular sub-manifolds M^2 or S^2. This would replace the singular manifold with a set of its rotated copies in the case that the subgroups have genuinely 3-dimensional action (the subgroups which corresponds to exceptional groups in the ADE correspondence). For instance, in the case of M^2 the quantization axes for angular momentum would be replaced by the set of quantization axes going through the vertices of tetrahedron, octahedron, or icosahedron. This would bring non-commutative homotopy groups into the picture in a natural manner.

7.1.3 About the phase transitions changing Planck constant

There are several non-trivial questions related to the details of the gluing procedure and phase transition as motion of partonic 2-surface from one sector of the embedding space to another one.

1. How the gluing of copies of embedding space at $M^2 \times CP_2$ takes place? It would seem that the covariant metric of CD factor proportional to $\hbar^2$ must be discontinuous at the singular manifold since only in this manner the idea about different scaling factor of CD metric can make sense. On the other hand, one can always scale the M^4 coordinates so that the metric is continuous but the sizes of CDs with different Planck constants differ by the ratio of the Planck constants.

2. One might worry whether the phase transition changing Planck constant means an instantaneous change of the size of partonic 2-surface in M^4 degrees of freedom. This is not the case. Light-likeness in $M^2 \times S^2$ makes sense only for surfaces $X^1 \times D^2 \subset M^2 \times S^2$, where X^1 is light-like geodesic. The requirement that the partonic 2-surface X^2 moving from one sector of H to another one is light-like at $M^2 \times S^2$ irrespective of the value of Planck constant requires that X^2 has single point of M^2 as M^2 projection. Hence no sudden change of the size X^2 occurs.

3. A natural question is whether the phase transition changing the value of Planck constant can occur purely classically or whether it is analogous to quantum tunnelling. Classical non-vacuum extremals of Chern-Simons action have two-dimensional CP_2 projection to homologically non-trivial geodesic sphere S^2_I. The deformation of the entire S^2_I to homologically trivial geodesic sphere S^2_{II} is not possible so that only combinations of partonic 2-surfaces with vanishing total homology charge (Kähler magnetic charge) can in principle move from sector to another one, and this process involves fusion of these 2-surfaces such that CP_2 projection becomes single homologically trivial 2-surface. A piece of a non-trivial geodesic sphere S^2_I of CP_2 can be deformed to that of S^2_{II} using 2-dimensional homotopy flattening the piece of S^2 to curve. If this homotopy cannot be chosen to be light-like, the phase transitions changing Planck constant take place only via quantum tunnelling. Obviously the notions of light-like homotopies (cobordisms) are very relevant for the understanding of phase transitions changing Planck constant.

7.1.4 How could one fix the spectrum of Planck constants?

The question how the observed Planck constant relates to the integers n_a and n_b defining the covering and factors spaces, is far from trivial and I have considered several options. The basic physical inputs are the condition that scaling of Planck constant must correspond to the scaling of the metric of CD (that is Compton lengths) on one hand and the scaling of the gauge coupling strength $g^2/4\pi\hbar$ on the other hand.

1. One can assign to Planck constant to both CD and CP_2 by assuming that it appears in the commutation relations of corresponding symmetry algebras. Algebraist would argue that Planck constants $\hbar(CD)$ and $\hbar(CP_2)$ must define a homomorphism respecting multiplication and division (when possible) by G_i. This requires $r(X) = \hbar(X)\hbar_0 = n$ for covering and $r(X) = 1/n$ for factor space or vice versa.

2. If one assumes that $\hbar^2(X)$, $X = M^4$, CP_2 corresponds to the scaling of the covariant metric tensor g_{ij} and performs an over-all scaling of H-metric allowed by the Weyl invariance of Kähler action by dividing metric with $\hbar^2(CP_2)$, one obtains the scaling of M^4 covariant metric by $r^2 \equiv \hbar^2/\hbar_0^2 = \hbar^2(M^4)/\hbar^2(CP_2)$ whereas CP_2 metric is not scaled at all.

3. The condition that $\hbar$ scales as n_a is guaranteed if one has $\hbar(CD) = n_a\hbar_0$. This does not fix the dependence of $\hbar(CP_2)$ on n_b and one could have $\hbar(CP_2) = n_b\hbar_0$ or $\hbar(CP_2) = \hbar_0/n_b$. The intuitive picture is that n_b- fold covering gives in good approximation rise to n_an_b sheets and multiplies YM action action by n_an_b which is equivalent with the $\hbar = n_an_b\hbar_0$ if one effectively compresses the covering to $CD \times CP_2$. One would have $\hbar(CP_2) = \hbar_0/n_b$ and $\hbar = n_an_b\hbar_0$. Note that the descriptions using ordinary Planck constant and coverings and scaled Planck constant but contracting the covering would be alternative descriptions.

   This gives the following formulas $r \equiv \hbar/\hbar_0 = r(M^4)/r(CP_2)$ in various cases.

	$C-C$	$F-C$	$C-F$	$F-F$
r	n_an_b	$\frac{n_a}{n_b}$	$\frac{n_b}{n_a}$	$\frac{1}{n_an_b}$

7.1.5 Preferred values of Planck constants

Number theoretic considerations favor the hypothesis that the integers corresponding to Fermat polygons constructible using only ruler and compass and given as products $n_F = 2^k \prod_s F_s$, where $F_s = 2^{2^s} + 1$ are distinct Fermat primes, are favored. The reason would be that quantum phase $q = exp(i\pi/n)$ is in this case expressible using only iterated square root operation by starting from rationals. The known Fermat primes correspond to $s = 0, 1, 2, 3, 4$ so that the hypothesis is very strong and predicts that p-adic length scales have satellite length scales given as multiples of n_F of fundamental p-adic length scale. $n_F = 2^{11}$ corresponds in TGD framework to a fundamental constant expressible as a combination of Kähler coupling strength, CP_2 radius and Planck length appearing in the expression for the tension of cosmic strings, and I have considered the possibility that the powers of 2^{11} are favored as values of n_a in living matter.

7.1.6 How Planck constants are visible in Kähler action?

$\hbar(M^4)$ and $\hbar(CP_2)$ appear in the commutation and anti-commutation relations of various super-conformal algebras. Only the ratio of M^4 and CP_2 Planck constants appears in Kähler action and is due to the fact that the M^4 and CP_2 metrics of the embedding space sector with given values of Planck constants are proportional to the corresponding Planck constants [K8]. This implies that Kähler function codes for radiative corrections to the classical action, which makes possible to consider the possibility that higher order radiative corrections to functional integral vanish as one might expect at quantum criticality. For a given p-adic length scale space-time sheets with all allowed values of Planck constants are possible. Hence the spectrum of quantum critical fluctuations could in the ideal case correspond to the spectrum of $\hbar$ coding for the scaled up values of Compton lengths and other quantal lengths and times. If so, large $\hbar$ phases could be crucial for understanding of quantum critical superconductors, in particular high T_c superconductors.

7.1.7 Do factor spaces and coverings correspond to the two kinds of Jones inclusions?

What could be the interpretation of these two kinds of spaces?

1. Jones inclusions appear in two varieties corresponding to $\mathcal{M} : \mathcal{N} < 4$ and $\mathcal{M} : \mathcal{N} = 4$ and one can assign a hierarchy of subgroups of $SU(2)$ with both of them. In particular, their maximal Abelian subgroups Z_n label these inclusions. The interpretation of Z_n as invariance group is natural for $\mathcal{M} : \mathcal{N} < 4$ and it naturally corresponds to the coset spaces. For $\mathcal{M} : \mathcal{N} = 4$ the interpretation of Z_n has remained open. Obviously the interpretation of Z_n as the homology group defining covering would be natural.

2. $\mathcal{M} : \mathcal{N} = 4$ should correspond to the allowance of cosmic strings and other analogous objects. Does the introduction of the covering spaces bring in cosmic strings in some controlled manner? Formally the subgroup of $SU(2)$ defining the inclusion is $SU(2)$ would mean that

states are $SU(2)$ singlets which is something non-physical. For covering spaces one would however obtain the degrees of freedom associated with the discrete fiber and the degrees of freedom in question would not disappear completely and would be characterized by the discrete subgroup of $SU(2)$.

For anyons the non-trivial homotopy of plane brings in non-trivial connection with a flat curvature and the non-trivial dynamics of topological QFTs. Also now one might expect similar non-trivial contribution to appear in the spinor connection of $\hat{M}^2\hat{\times}G_a$ and $\hat{CP}_2\hat{\times}G_b$. In conformal field theory models non-trivial monodromy would correspond to the presence of punctures in plane.

3. For factor spaces the unit for quantum numbers like orbital angular momentum is multiplied by n_a *resp.* n_b and for coverings it is divided by this number. These two kind of spaces are in a well defined sense obtained by multiplying and dividing the factors of $\hat{H}$ by G_a *resp.* G_b and multiplication and division are expected to relate to Jones inclusions with $\mathcal{M} : \mathcal{N} < 4$ and $\mathcal{M} : \mathcal{N} = 4$, which both are labelled by a subset of discrete subgroups of SU(2).

4. The discrete subgroups of $SU(2)$ with fixed quantization axes possess a well defined multiplication with product defined as the group generated by forming all possible products of group elements as elements of $SU(2)$. This product is commutative and all elements are idempotent and thus analogous to projectors. Trivial group G_1, two-element group G_2 consisting of reflection and identity, the cyclic groups Z_p, p prime, and tetrahedral, octahedral, and icosahedral groups are the generators of this algebra.

   By commutativity one can regard this algebra as an 11-dimensional module having natural numbers as coefficients ("rig"). The trivial group G_1, two-element group G_2¡ generated by reflection, and tetrahedral, octahedral, and icosahedral groups define 5 generating elements for this algebra. The products of groups other than trivial group define 10 units for this algebra so that there are 11 units altogether. The groups Z_p generate a structure analogous to natural numbers acting as analog of coefficients of this structure. Clearly, one has effectively 11-dimensional commutative algebra in 1-1 correspondence with the 11-dimensional "half-lattice" N^{11} (N denotes natural numbers). Leaving away reflections, one obtains N^7. The projector representation suggests a connection with Jones inclusions. An interesting question concerns the possible Jones inclusions assignable to the subgroups containing infinitely manner elements. Reader has of course already asked whether dimensions 11, 7 and their difference 4 might relate somehow to the mathematical structures of M-theory with 7 compactified dimensions. One could introduce generalized WCW spinor fields in the WCW labelled by sectors of H with given quantization axes. By introducing Fourier transform in N^{11} one would formally obtain an infinite-component field in 11-D space.

5. How do the Planck constants associated with factors and coverings relate? One might argue that Planck constant defines a homomorphism respecting the multiplication and division (when possible) by G_i. If so, then Planck constant in units of $\hbar_0$ would be equal to n_a/n_b for $\hat{H}/G_a \times G_b$ option and n_b/n_a for $\hat{H}\hat{\times}(G_a \times G_b)$ with obvious formulas for hybrid cases. This option would put M^4 and CP_2 in a very symmetric role and allow much more flexibility in the identification of symmetries associated with large Planck constant phases.

7.2 Em Cyclotron Frequencies Of Biologically Important Ions

A detailed study of the cyclotron frequencies demonstrates that they indeed seem to correspond to important EEG frequencies. The cyclotron frequencies associated with other singly ionized atoms can be obtained by the formula

$$f = \frac{A}{20} \times f(Ca^{2+}) \qquad f(Ca^{2+}) \simeq 15\ Hz\ . \tag{7.1}$$

Here the strength of the magnetic field is assumed to be $B_{end} = .2$ Gauss $= 2 \times 10^{-5}$ Tesla. Note that published material there was an erratic identification $B = B_E = .5$ Gauss due to the calculational error.

Table 8 lists cyclotron frequencies and their lowest multiples for some of the most important ions.

Elementary particle	f_1/Hz	J	f_L/Hz
e	5.6×10^5	1/2	2.8×10^5
p	300	1/2	419
Bosonic ions			
^6Li	50.1	1	88.3
O^{2-}	37.4	0	0
Mg^{++}	25.0	0	0
Ca^{++}	15.0	0	0
Mn^{2+}	11.4	5/2	520
Fe^{2+}	10.8	0	0
Co^{2+}	10.0	7/2	695
Zn^{2+}	9.4	0	0
Se^{2-}	7.6	0	0
Fermionic ions			
$^7Li^+$	42.9	3/2	489
N^+	21.4	1	60.6
F^-	15.8	1/2	395
Na^+	13.0	3/2	333
Al^+	11.1	5/2	546
Si^+	10.7	0	0
P^+	9.7	1/2	170
S^-	9.4	0	0
Cl^-	8.5	3/2	130
K^+	7.5	3/2	58.5
Cr^-	5.7	3/2	71.1
Cu^+	4.8	3/2	333.9
Ag^+	2.8	1/2	17
I^+	2.4	5/2	420
Au^+	1.5	3/2	21

Table 8: The first column gives cyclotron frequency in cycles per second for some ions in Earth's magnetic field assumed to have strength $B_{end} = .2 \times 10^{-4}$ Tesla. The remaining columns give spin or nuclear spin and Larmor frequency f_L.

Ion	(Z, A, S)	f_1/Hz	Ion	(Z, A, S)	f_1/Hz
He	(2, 4, F)	75	C	(6, 12, F)	25.0
Li	(3, 7, F)	42.9	N	(7, 14, B)	21.4
Be	(4, 9, B)	33.3	O	(8, 16, F)	18.8
B	(5, 11, F)	27.3	F	(9, 19, F)	15.8

Table 9: Basic data for the ions in Helium period. Cyclotron frequency and nuclear spin for exotic ion with unit electric charge due to the charged color bond in nucleus. F or B tells the statistics of the electronically ionized atom (most atoms are bosons in ground state).

Ion	(Z, A, S)	f_1/Hz	Ion	(Z, A, S)	f_1/Hz
Ne	(10, 20, F)	15.0	Si	(14, 28, F)	10.7
Na	(11, 23, F)	13.0	P	(15, 31, F)	9.7
Mg	(12, 24, F)	12.5	S	(16, 32, F)	9.4
Al	(13, 27, F)	11.1	Cl	(17, 35, F)	8.5

Table 10: One can arrange the exotic ions in Neon period to one triplet of exotic ions allowing also spin flip qualia and to a quintet assigned with cyclotron qualia. For the meanings of various notations see previous table.

7.3 Cyclotron Frequencies Of Exotic Ions And Periodic Table

Exotic em and Z^0 ions result when some color bonds in atomic nucleus become charged and are simultaneously ordinary ions. By magnetic flux quantization Z^0 magnetic cyclotron frequencies differ from their electromagnetic counterparts for singly charged ions only by charge ratio factors $Q_Z/Q_{Z,0}$. Hence it is convenient to represent electromagnetic cyclotron frequencies instead. The ions in various periods correspond to bands of EEG: it seems however that satellites of the harmonics of cyclotron frequencies beta and theta bands and that harmonics of frequencies in alpha band provides a more natural explanation for gamma and higher bands. For completeness cyclotron frequencies for all periods are given although the biologically important heavy ions are rather scarce.

7.3.1 Ions in Helium period correspond to beta and gamma bands

Table 9 lists the relevant data about ions in He period. Cyclotron frequencies are in the range $(15.8 - 75)$ Hz for nuclear exotic ionization which respects statistics. Note that Be and N atoms are exceptional being fermions in ground state. Li ion has rather high cyclotron frequency 42.9 Hz.

7.3.2 Ions in Neon period correspond to alpha band

For Neon period nuclear exotic ionization the frequencies span the range $8.5 - 15.0$ Hz: only 15 Hz cyclotron frequency of Ne belongs to beta band.

7.3.3 Ions in Argon period correspond to theta band

Singly ionized exotic ions in Argon period have cyclotron frequencies in the range $(3.6\ Hz < f \leq 7.5\ Hz)$.

7.3.4 Ions in Krypton period correspond to delta band

Krypton period provides an almost identical copy of Argon period. The cyclotron frequencies of Krypton band are in the range $2.3 - 3.5$ Hz.

Ion	(Z, A, S)	f_1/Hz	Ion	(Z, A, S)	f_1/Hz
Ar	(18, 40, F)	7.5	Co	(27, 59, F)	5.0
K	(19, 39, F)	7.5	Ni	(28, 58, F)	5.2
Ca	(20, 40, F)	7.5	Cu	(29, 63, F)	4.8
Sc	(21, 45, F)	6.7	Zn	(30, 64, F)	4.7
Ti	(22, 48, F)	6.3	Ga	(31, 69, F)	4.3
V	(23, 51, F)	5.9	Ge	(32, 74, F)	4.1
Cr	(24, 52, F)	5.7	As	(33, 75, F)	4.0
Mn	(25, 55, F)	5.5	Se	(34, 80, F)	3.8
Fe	(26, 56, F)	5.4	Br	(35, 79, F)	3.8

Table 11: Basic data for singly charged exotic ions with frequencies in Argon period and having cyclotron frequencies in theta band.

Ion	(Z, A, S)	f_1/Hz	Ion	(Z, A, S)	f_1/Hz
Kr	(36, 84, F)	3.6	Rh	(45, 103, F)	2.9
Rb	(37, 85, F)	3.5	Pd	(46, 108, F)	2.8
Sr	(38, 86, F)	3.5	CD	(48, 114, F)	2.6
Y	(39, 89, F)	3.4	Ag	(47, 107, F)	2.8
Zr	(40, 90, F)	3.3	In	(49, 115, F)	2.6
Nb	(41, 93, F)	3.2	Sn	(50, 120, F)	2.5
Mo	(42, 98, F)	3.0	Sb	(51, 121, F)	2.5
Tc	(43, 99, F)	3.0	Te	(52, 130, F)	2.3
Ru	(44, 102, F)	2.9	I	(53, 127, F)	2.4

Table 12: Table 15. Basic data for singly charged exotic ions having [Kr] as ground state configuration. Tc does not allow stable isotopes but the lifetimes of two long-lived Tc isotopes are 1.5×10^6 years and 2.1×10^5 years.

Ion	(Z, A, S)	f_1/Hz	Ion	(Z, A, S)	f_1/Hz
Xe	(54, 132, F)	2.3	Yb	(70, 174, F)	1.7
Cs	(55, 133, F)	2.3	Lu	(71, 176, B)	1.7
Ba	(56, 138, F)	2.2	Hf	(72, 178, F)	1.7
La	(57, 139, F)	2.2	Ta	(73, 181, F)	1.7
Ce	(58, 140, F)	2.1	W	(74, 184, F)	1.6
Pr	(59, 141, F)	2.1	Re	(75, 187, F)	1.6
Nd	(60, 142, F)	2.1	Os	(76, 192, F)	1.6
Pm	(61, 147, F)	2.0	Ir	(77, 193, F)	1.6
Sm	(62, 152, F)	2.3	Pt	(78, 195, B)	1.5
Eu	(63, 154, B)	1.9	Au	(79, 197, F)	1.5
Gd	(64, 158, F)	2.0	Hg	(80, 202, F)	1.5
Tb	(65, 160, F)	1.9	Ti	(81, 205, F)	1.5
Dy	(66, 164, F)	1.8	Pb	(82, 206, F)	1.5
Ho	(67, 165, F)	1.8	Bi	(83, 209, F)	1.4
Er	(68, 166, F)	1.8	Po	(84, 209, F)	1.4
Tm	(69, ?, ?)	?	At	(85, 211, F)	1.4

Table 13: Basic data for ions with having [Xe] as ground state configuration.

7.3.5 Basic data for Xenon period

Table 13 lists ions with [Xe] ground state. Note that all ions in Xe band do not have stable isotopes and it is questionable whether any biologically interesting ions are in this period. Cyclotron frequencies of singly charged exotic ions in Xenon period vary in the range $1.5 - 2.2$ **Hz.**

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