Bio-Systems as Super-Conductors: Part II

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Abstract

The general model for quantum control and coordination relies crucially on the existence of a hierarchy of superconductors associated with the self hierarchy (self defined as a quantum system able to avoid bound state entanglement with environment) controlling the ionic densities at atomic space-time sheets via many-sheeted ionic flow equilibrium and being quantum controlled with the mediation of the fractal hierarchy of MEs.

1. General mechanisms for superconductivity

The many-sheeted space-time concept provides a very general mechanism of superconductivity based on the 'dropping' of charged particles from atomic space-time sheets to larger space-time sheets. The first guess was that larger space-time sheets are very dry, cool and silent so that the necessary conditions for the formation of high T_c macroscopic quantum phases are met.

The possibility of large hbar quantum coherent phases makes however the assumption about thermal isolation between space-time sheets un-necessary. At larger space-time sheet the interactions of the charged particles with classical em fields generated by various wormhole contacts feeding gauge fluxes to and from the space-time sheet in question give rise to the necessary gap energy. The simplest model for Cooper pair is space-time sheet containing charged particles having attractive Coulombic interaction with the quarks and antiquarks associated with the throats of the wormhole contacts.

A crucial element is quantum criticality predicting that superconductivity appears at the fluctuating boundaries of competing ordinary and large $\hbar$ phases for nuclei. This assumption predicts several anomalous phenomena such as cold fusion and nuclear transmutations. Also high T_c superfluidity of bosonic atoms dropped to space-time sheets of electronic Cooper pairs becomes possible besides ionic super conductivity. Even dark neutrino superconductivity can be considered below the weak length scale of scaled down weak bosons.

Magnetic and Z^0 magnetic flux tubes and walls are especially interesting candidates for supra current carries. In this case the Cooper pairs must have spin one and this is indeed possible for wormholy Cooper pairs. The fact that the critical magnetic (Z^0 magnetic) fields can be very weak or large values of $\hbar$ is in accordance with the idea that various almost topological quantum numbers characterizing induced magnetic fields provide a storage mechanism of bio-information.

This mechanism is extremely general and works for electrons, protons, ions, charged molecules and even exotic neutrinos so that an entire zoo of high T_c bio-superconductors, super-fluids and Bose-Einstein condensates is predicted. Of course, there are restrictions due to the

critical temperature and it seems that only electron, neutrino, and proton Cooper pairs are possible at room temperature.

a) The experimental data about the effects of ELF em fields at cyclotron frequencies of various ions in Earth's magnetic field on biosystems provide support for this scenario. Most remarkably, the cyclotron frequencies of biologically important ions correspond to the important frequencies of EEG and the time scale of nerve pulse corresponds to $n = 3$ multiple of proton cyclotron frequency so that a direct quantitative contact with brain consciousness results.

b) Electronic super conductors are of type II with defect regions being typically cylindrical: DNA sequences, proteins, microtubules,... could provide examples of the defect regions. One ends up also with a model of high T_c super conductors in which the interaction of the electrons with wormhole BE condensate gives rise to Cooper pairs. The model explains elegantly the basic peculiar features of the high T_c superconductors.

c) Long ranged Z^0 force due to anomalous weak isospin of nuclei and Z^0 charged wormholes make possible also Z^0 ionic superconductivity and even dark neutrino super conductivity. For instance, Z^0 ionic superconductivity is crucial in the model for the quantum correlate of hearing: audible frequencies are mapped to Z^0 cyclotron frequencies. Dark neutrino super conductors are of type I in the interesting length scale range and defect regions are stripe like. Besides cell and endoplasma membranes, epithelial sheets consisting of two cell layers and some larger structures in cortex could correspond to regions of this kind and the interpretation as a physical realization of cognitive hierarchy suggests itself.

2. Superconductivity at magnetic flux quanta in astrophysical length scales

Magnetic flux tubes of Earth's magnetic field are crucial for the TGD based model of superconductivity. Since the models of auroras assume that the magnetic flux lines act effectively as conducting wires, the natural hypothesis is that superconductivity is an astrophysical phenomenon. This leads to a model of auroras explaining the latest findings and providing further insights to the superconductivity and the manner how it breaks down. Critical temperature is the temperature at which the join along boundaries bonds making possible the leakage of the supra currents to the non-superconducting space-time sheets become possible and can be gigantic as compared to the temperature at the superconducting space-time sheets.

3. Fractal hierarchy of EEGs

There are three contributions to EEG besides neural noise: Schumann frequencies, cyclotron frequencies, and the frequencies associ-

ated with Josephson junctions determined by the sum of the constant voltage and voltage perturbation determined by the superposition of cyclotron frequencies. Cyclotron contribution can be interpreted as a control signal from a magnetic body in question labelled by k_d and affects both the ions at the flux sheets traversing DNA and the Josephson junction. The coherent state of photons generated by Josephson current corresponds to a reaction to this signal received by the magnetic body as a feedback. Schumann frequencies can be assigned to the control by magnetic body of Earth and correlate with the collective aspects of consciousness.

The analysis of the Josephson current leads to the conclusion that the frequencies in the coherent state of photons are in general sums and differences of Josephson frequency and harmonics of cyclotron frequencies. For small amplitudes 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. 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.

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. One explanation is that right *resp.* left brain hemisphere corresponds to $Z = 2$ *resp.* $Z = 1$ quantization condition $Z \int BdS = n\hbar$ for the magnetic flux. $Z = 2$ case allows only doubly charged bosonic ions at magnetic flux sheets. $Z = 1$ case also also singly charged ions be their bosons or fermions and for this option magnetic field is scaled down by a factor of 1/2. The alternative explanation is that during sleep only Bose-Einstein condensates of singly charged exotic ions resulting when color bond inside nucleus becomes charged are present. This reduces the scale of cyclotron frequencies by a factor 1/2 and leaves only theta and delta bands. 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. For $k_d = 3$ and magnetic field scaled up by λ and flux tube area scaled down by λ^{-2} DNA frequencies are scaled up to kHz for $Z = 2$ flux quantization and might define neuronal synchronization frequencies.

4. 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 provide a test bench for the fractal hierarchy of EEGs.

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 ZEGs.

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.

The temperature interval has interpretation in terms of quantum criticality of high T_c superconductivity (both interior and boundary super currents are possible in this interval). Amplitude windows correspond to resonant EEG bands if the voltage perturbations contribute to the voltages over Josephson junctions and are thus coded to EEG. That the effects occur only for cyclotron frequencies and in the amplitude windows can be understood if there is AND gate involved. The voltage signal affects the interior of the cell nucleus opening communication line to the magnetic body if a harmonic of cyclotron frequency is in question. The signal affects also the Josephson junction which sends a signal to magnetic body if the voltage of the perturbation is large enough and corresponds to a frequency in the resonance band of EEG. The response of the magnetic body affects nucleus only if the communication line is open. This AND gate eliminates very effectively the effects of neural noise.

1 Introduction

The general model for quantum control and coordination relies crucially on the existence of a hierarchy of superconductors associated with the self hierarchy (self defined as a quantum system able to avoid bound state entanglement with environment) controlling the ionic densities at atomic space-time sheets via many-sheeted ionic flow equilibrium and being quantum controlled with the mediation of the fractal hierarchy of MEs.

1.1 General mechanisms for superconductivity

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assumption about thermal isolation between space-time sheets un-necessary. At larger space-time sheet the interactions of the charged particles with classical em fields generated by various wormhole contacts feeding gauge fluxes to and from the space-time sheet in question give rise to the necessary gap energy. The simplest model for Cooper pair is space-time sheet containing charged particles having attractive Coulombic interaction with the quarks and antiquarks associated with the throats of the wormhole contacts.

A crucial element is quantum criticality predicting that superconductivity appears at the fluctuating boundaries of competing ordinary and large $\hbar$ phases for nuclei. This assumption predicts several anomalous phenomena such as cold fusion and nuclear transmutations. Also high T_c superfluidity of bosonic atoms dropped to space-time sheets of electronic Cooper pairs becomes possible besides ionic super conductivity. Even dark neutrino superconductivity can be considered below the weak length scale of scaled down weak bosons.

Magnetic and Z^0 magnetic flux tubes and walls are especially interesting candidates for supra current carries. In this case the Cooper pairs must have spin one and this is indeed possible for wormholy Cooper pairs. The fact that the critical magnetic (Z^0 magnetic) fields can be very weak or large values of $\hbar$ is in accordance with the idea that various almost topological quantum numbers characterizing induced magnetic fields provide a storage mechanism of bio-information.

This mechanism is extremely general and works for electrons, protons, ions and even charged molecules so that an entire zoo of high T_c bio-superconductors and super-fluids is predicted. All atoms and ions can be regarded as completely ionized Z^0 ions and also Z^0 superconductors (or super fluids) are predicted.

a) The experimental data about the effects of ELF em fields at cyclotron frequencies of various ions in Earth's magnetic field on bio-systems [17] provide support for this scenario. Most remarkably, the cyclotron frequencies of biologically important ions correspond to the important frequencies of EEG and the time scale of nerve pulse corresponds to $n = 3$ multiple of proton cyclotron frequency so that a direct quantitative contact with brain consciousness results.

b) Electronic super conductors are of type II with defect regions being typically cylindrical: DNA sequences, proteins, microtubules,... could provide examples of the defect regions. One ends up also with a model of high T_c super conductors in which the interaction of the electrons with wormhole BE condensate gives rise to Cooper pairs. The model explains elegantly the basic peculiar features of the high T_c superconductors.

c) Long ranged Z^0 force due to anomalous weak isospin of nuclei [F8, F9] and Z^0 charged wormholes make possible also Z^0 ionic superconductivity and even dark neutrino super conductivity. For instance, Z^0 ionic superconductivity is crucial in the model for the quantum correlate of hearing: audible frequencies are mapped to Z^0 cyclotron frequencies. Dark neutrino super conductors are of type I in the interesting length scale range and defect regions are stripe like. Besides cell and endoplasma membranes, epithelial sheets consisting of two cell layers and some larger structures in cortex could correspond to regions of this kind and the interpretation as a physical realization of cognitive hierarchy suggests itself.

1.2 Bio-structures as defect regions or large $\hbar$ regions of quantum critical superconductors

The original hypothesis was that defects of superconductors are represented as so called wormhole magnetic fields and serve as templates for the formation of various bio-structures is very attractive. Also fractal defects inside defects structures are possible. One can speculate that various linear structures common in bio-systems correspond to defects of electronic type II super conductors at various space-time sheets. There are also obvious candidates for structures identifiable as defect regions of super conductors of type I.

The identification of high T_c superconductors as quantum critical superconductors suggest a different interpretation in which the superconducting regions correspond to boundaries between phases having different values of $\hbar$. These regions would also consist of dynamical stripe like regions.

Besides cell membranes, epithelial sheets consisting of two cell layers and some larger structures in cortex could correspond to regions of this kind and the interpretation as a physical realization of cognitive hierarchy suggests itself. The critical temperatures of dark neutrino super conductors formed by join along boundaries condensates turn out to be smaller than room temperature but this is not a problem since the temperatures at non-atomic space-time sheets are extremely low.

1.3 Superconductivity at magnetic flux quanta in astrophysical length scales

Magnetic flux tubes of Earth's magnetic field are crucial for the TGD based model of superconductivity. Since the models of auroras assume that the magnetic flux lines act effectively as conducting wires, the natural hypothesis is that superconductivity is an astrophysical phenomenon. This leads

to a model of auroras explaining the latest findings and providing further insights to the superconductivity and the manner how it breaks down. Critical temperature can be identified as the temperature at which the join along boundaries bonds making possible the leakage of the supra currents to the non-superconducting space-time sheets become possible and can be gigantic as compared to the temperature at the superconducting space-time sheets if space-time sheets are thermally isolated. On the other hand, the possibility of large $\hbar$ phases in principle makes possible arbitrarily high critical temperatures in a given length scale.

p-Adic length scale hierarchy and the hierarchy of dark matters labelled by values of $\hbar$ suggest the existence of an entire hierarchy of super conducting space-time sheets giving rise to a hierarchy of cognitive representations (abstractions about abstractions about...). The possibility of complex conformal weights expressible in terms of zeros of Riemann Zeta such that the net conformal weight is real, and the hierarchy of algebraic extensions of p-adic number fields suggest the existence of additional hierarchies.

1.4 Fractal hierarchy of EEGs and ZEGs

There are three contributions to EEG besides neural noise: Schumann frequencies, cyclotron frequencies, and the frequencies associated with Josephson junctions determined by the sum of the constant voltage and voltage perturbation determined by the superposition of cyclotron frequencies. Cyclotron contribution can be interpreted as a control signal from a magnetic body in question labelled by k_d and affects both the ions at the flux sheets traversing DNA and the Josephson junction. The coherent state of photons generated by Josephson current corresponds to a reaction to this signal received by the magnetic body as a feedback. Schumann frequencies can be assigned to the control by magnetic body of Earth and correlate with the collective aspects of consciousness.

The analysis of the Josephson current [M3] leads to the conclusion that the frequencies in the coherent state of photons are in general sums and differences of Josephson frequency and harmonics of cyclotron frequencies. For small amplitudes 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. For large amplitudes EEG becomes chaotic which is indeed the property of beta band during say intense concentration or anxiety. The findings of Nunez [51] about narrow 1-2 Hz wide bands at 3,5,7 Hz and 13,15,17 Hz confirm with the prediction of satellite

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The generalization of the model for EEG hierarchy to the case of ZEG is straightforward and cyclotron frequency spectrum is essentially the same [M3]. Z^0 ions are obtained when nuclear color bonds become charged and the combination of ordinary and exotic ionization can produce also em neutral Z^0 ions. 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 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 provide a test bench for the fractal hierarchy of EEGs. 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 ZEGs.

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2 Models for ionic superconductivity and topological condensation at the magnetic flux quanta of endogenous magnetic field

In this section the model for ionic superconductivity is constructed as a straightforward generalization of the model of high T_c electronic superconductivity: the basic prediction is that only ions with $A < 4$ (in practice protons) can form stable Cooper pairs at room temperature. The new model for the topological condensation at magnetic flux quanta of mendogenousagnetic field differs radically from the earlier model and allows to understand that effects of ELF em fields on brain. Bose-Einstein condensates of bosonic ions are predicted to be of special importance for the functioning of living systems. Also a quantitative understanding of the effects of Schumann resonances and EEG emerges.

2.1 Model for ionic superconductivity

The model of ionic super-conductivity is a direct generalization of corresponding model for high T_c electronic super conductivity.

a) Electron is topologically condensed at a cylindrical space-time sheets of radius $L(k = 149) = 5$ nm and length $L(151) = 10$ nm and carrying magnetic monopole flux flowing through the wormhole throat at the upper end of the cylindrical sheet to the larger space-time sheet and returning back through the throat at the lower end of the sheet. Magnetic monopole flux

made possible by the topology of CP_2 is necessary in order to have spin 1 Cooper pairs.

b) The two causal horizons associated with each wormhole contact carry quantum numbers of quark and antiquark and the charges of quark and antiquark at electron space-time sheet sum up to the negative of electron charge. The two flux tubes of this kind are connected by color bonds such that the state does not reduce to a product of color singlets. Hence color confinement is responsible for the formation of Cooper pair.

c) The requirement that the binding energy is maximum as a function of p-adic length scale implies that $k = 151$ corresponds to the length of the electronic flux tube and $k = 149$ to its radius.

Exactly the same mechanism works also in the case of ions and the only differences come from the different mass and charge of ion.

a) The weak length scale $L_w = .2$ μm associated with doubly dark $k = 113$ weak bosons gives an upper bound for the size of the Cooper pair. The requirement that the binding energy is minimum forces this length for the Cooper pair if one assumes that the diameter of ionic flux tube equals to its length.

b) For proton regarded as a particle in 1-D box the scale of excitation energy inside flux tube is $\Delta E \sim 3\pi^2\hbar^2/2m_pL_w^2 = .31$ eV for $\hbar = 2^{11}\hbar_0$ and safely above the maximum photon energy $E_{th} = 2.882T = .086$ eV of black body radiation at room temperature $T = 300$ K. For $A \geq 4$ nuclei this energy scale is below E_{th} ($A = 4$ gives $E = .078$ eV). Thus it would seem that only protonic Cooper pairs are relevant for living systems at $k_d = 1$ level of dark matter hierarchy. For $^7Li_+$ ion this energy corresponds to .04 eV. One cannot exclude the possibility that for effectively 2- or 1-D systems lithium Cooper pairs might be marginally stable. In the case of electronic Cooper pairs one has $\Delta E \sim 3 = .06$ eV ($E_{th} = \Delta E$ corresponds to $T = 219$ K) so that thermal stability criterion is marginally satisfied at room temperature.

2.2 Model for Bose-Einstein condensation in endogenous magnetic field

The effects of ELF em fields on living matter suggest that quantal cyclotron transitions are involved. This does not conform with intuitive expectations since cyclotron energy scale is ridiculously as compared to the thermal energy at room temperature.

The earlier model based on ordinary $\hbar$ assumed thermal isolation between space-time sheets and that large space-time sheets are cold so that BE condensates are possible. Thermal stability in fractal sense requires

that temperature scales like cyclotron energy as a function of p-adic length scale. Flux quantization implies that T scales like zero point kinetic energy: $T(k) \propto 1/L^2(k)$.

One can criticize the assumption about thermal isolation. Second criticism concerns the assumed flux quantization. The flux tubes of the endogenous magnetic field have radius which is at most $5L(167) = 8$ μm. This however suggests that ions and atoms can be in two states depending on whether they are condensed at magnetic flux tubes or not. In the absence of topological condensation to magnetic flux tubes no cyclotron transitions or spin flips should occur. The states in which ions do not respond to magnetic field have not been however observed. Usually it is assumed that no flux quantization occurs in macroscopic length scales but this assumption is in conflict with the idea that there are no preferred length scales. The scaling up of flux quantum by scaling of $\hbar$ could resolve this problem.

2.2.1 A model for the condensation of ordinary ion to dark magnetic flux tube

One particular set of preferred values of $\hbar_{eff} = n_a/n_b$ suggested by the model of living matter is as powers of $\lambda = 2^{11}$. Dark ions at space-time sheets having $(n_a = \lambda^k, n_b = 1)$, $k > 1$, are thermally unstable at room temperature since the atomic energy scale would be $\lambda^{-k} E_0$. The only possibility is that ion itself has small enough a value of n_a/n_b. The simplest possibility is $(n_a = 1, n_b = 1)$.

The next question concerns the magnetic interaction between ion and dark magnetic flux tube. The magnetic flux from the dark flux quantum must be feeded to the space-time sheet of ion and return back. This is indeed possible since it is M^4_+ projection which is zero-dimensional and corresponds to the tip of M^4_+ at the 2-surface which corresponds to parton just intermediate between two sectors. The 2-dimensionality of CP_2 projection allows non-vanishing magnetic flux. That magnetic flux cannot flow between sectors with different value of n_b might relate to Meissner effect. If so, the values of n_b for super-conductor and its environment would be different.

Since n_a sheets fuse to single one at the leakage point, the magnetic flux feeded to the ordinary space-time sheet of ion is n_a-fold so that cyclotron energy is n_a-fold too. One can equally well consider the situation also by assuming that the magnetic flux of ion is shared by the $N(G_a)$ flux sheets of the dark magnetic field and returns back to ion. The total magnetic interaction energy summed over the $N(G_a)$ identical G_a-related sheets is scaled up by n_a since the value of Planck constant is n_a time larger.

If the dark magnetic flux sheets with $k > 1$ contain nuclei, they form a fully ionized plasma at room temperature, and have cyclotron energies which are Z/A times the cyclotron energy of proton. For $B = .2$ Gauss this gives $f_c = (2Z/A)(f_p/2) = (2Z/A) \times 150$ Hz.

2.2.2 Why the endogenous magnetic field corresponds to .2 Gauss?

For years I erratically believed that the magnitude of the magnetic field assignable to the biological body is $B_E = .5$ Gauss, the nominal value of the Earth's magnetic field. Probably I had made the calculational error at very early stage when taking Ca^{++} cyclotron frequency as a standard. I am grateful for Bulgarian physicist Rossen Kolarov for pointing to me that the precise magnitude of the magnetic field implying the observed 15 Hz cyclotron frequency for Ca^{++} is .2 Gauss and thus slightly smaller than the minimum value .3 Gauss of B_E. This value must be assigned to the magnetic body carrying dark matter rather than to the flux quanta of the Earth's magnetic field. This field value corresponds roughly to the magnitude of B_E at distance 1.4R, R the radius of Earth.

Dark matter hierarchy leads to a detailed quantitative view about quantum biology with several testable predictions. The applications to living matter suggests that the basic hierarchy corresponds to a hierarchy of Planck constants coming as $\hbar_{eff}(k) = \lambda^k(p)\hbar_0$, $\lambda = 2^{11}$ for $p = 2^{127-1}$, $k = 0, 1, 2, ...$ Each p-adic length scale corresponds to this kind of hierarchy. Number theoretical arguments suggest a general formula for the allowed values of λ [C7] as $\lambda = n$ where n characterizes the quantum phase $q = exp(i\pi/n)$ characterizing Jones inclusion [C6]. The values of n for which quantum phase is expressible in terms of squared roots are number theoretically preferred and correspond to integers n expressible as $n = 2^k \prod_n F_{s_n}$, where $F_s = 2^{2^s} + 1$ is Fermat prime and each of them can appear only once. $n = 2^{11}$ obviously satisfies this condition. The lowest Fermat primes are $F_0 = 3, F_1 = 5, F_2 = 17$. The prediction is that also n-multiples of p-adic length scales are possible as preferred length scales. The unit of magnetic flux scales up as $h_0 \to h = nh_0$ in the transition increasing Planck constant: this is achieved by scalings $L(k) \to nL(k)$ and $B \to B/n$.

$B_{end} = .2 = 2B_E/5$ with $k = 169$, $\hbar = 5\hbar_0$, with flux tubes of radius 25 μm carrying flux $2h_5$ is the most natural option since gives a direct connection with the Earth's magnetic field. Furthermore, the model for EEG forces to assume that also the presence of the magnetic field $B_{end}/2$ and this gives the minimal flux h_5. Note that $n = 5$ is the minimal value of n making possible universal topological quantum computation with Beraha

number $B_n = 4cos^2(\pi/n)$ equal to Golden Mean [E9].

2.2.3 How to identify the personal magnetic body?

The notion of magnetic body is central in the TGD inspired theory of living matter. Every system possesses magnetic body. If EEG corresponds to the purely personal aspects of consciousness, the magnetic body associated with human body should be of order Earth size. This however raises the question about how to distinguish between the magnetic bodies of Earth and of human body. As a matter fact, this problem turned out to be a pseudo problem due to calculational error. The value of the endogenous magnetic field is $B = .2$ Gauss from experiments of Blackman and others and corresponds to p-adic length scale $L(169)$ and $\hbar = 5\hbar_0$ level in dark matter hierarchy carrying two flux quanta h_5 whereas Earth's magnetic field would correspond to $L(169)$ and $n = 1$. What is nice is that $n = 5$ is the minimal value of n making universal topological quantum computation possible [E9].

One can argue that it is the neuronal time scale of millisecond rather than EEG time scale which serves as a correlate for the conscious experiences assignable solely to our biological body and that EEG is associated with the social aspects of our behavior. The problem with this argument is that our conscious experience contains contributions from much longer time scales than millisecond. The following argument based on a simple model for magnetic flux quanta allows to discuss this problem more quantitatively.

There are several manners to achieve quantization of magnetic flux with dynamical $\hbar$.

a) One possibility is that the area S of flux quantum scales as $\hbar^2$. In this case flux quantization implies that B and cyclotron frequency scale as $1/\hbar$ whereas cyclotron energy is invariant under the scaling of $\hbar$.

b) Second possibility is that the value of magnetic field remains invariant and S scales as $\hbar$. This is especially natural when flux quanta are magnetic flux walls. In this case cyclotron frequencies remain invariant but cyclotron energy scales as $\hbar$. The considerations of this chapter provide support for both quantizations in living matter.

For the latter option one can consider both tubular and sheet like flux quanta.

a) For tubular flux quanta $k_d = 4$ level of dark matter hierarchy the radii of tubular flux quanta would be about $2^{22} \times L(169) = L(169+44 = 213) = 20$ m for the Earth's magnetic field B_E. For the endogenous magnetic field $B_{end} = .2$ Gauss the radii of fundamental flux tubes would be $5L(169)$, the size of a large neuron. Using the above described identifications the radii of

flux tubes would be scaled up by a factor 5 to about $2^{22} \times 5 \times L(169) = 100$ m. This length scale would define the size scale for the quantum coherence regions of the Bose-Einstein condensates of bosonic ions. This scale is enough to guarantee that the behavior of ions in B_{end} is consistent with the model based on single-sheeted space-time.

b) For $B_{end} = .2$ Gauss one can consider flux sheets with a total transversal length $5 \times L(169 + 4 \times 22) = 5L(257) = 4 \times 10^5$ km, which corresponds to about 62 Earth radii. Strongly folded flux sheets of this thickness might be associated with living matter and connect their DNAs to single coherent structure. The photon frequency corresponding to the wavelength $5L(257)$ is 1 Hz and characterizes delta band. One can however argue that DNA thickness which happens to be $\simeq 5L(169)/\lambda \simeq 12.5$ nm, slightly above cell membrane thickness of 10 nm, defines a more natural thickness of the flux sheet. In this case the width of the flux sheet would be scaled up by a factor λ to 8.9×10^8 km about 1.4×10^5 Earth radii: note that the length scale of the plasma sheet at night side extending to about 1000 Earth radii. Let us refer to these alternatives as option I and II respectively.

The question is whether one can assign a convoluted flux sheet of this width to a single human body or brain. Suppose that the magnetic flux flows in head to tail direction so that the magnetic flux sheet arrives to the human body through a string of cortical neurons. This means that the flux quantum traverses neuronal nuclei such that they are arranged like text lines of a book page along the flux sheet. This structure could closely correlate with the organization of central nervous system and give rise to what might be called super genes.

The total length of DNA in single human cell is about one meter. The DNA of about 8×10^7 neurons (1.6×10^{10}) neutrons would be required for option I (II) *if the contribution of DNA length dominates the width.* The italics are absolutely essential here! If the number of cortical neurons in single layer is about 8×10^7 which corresponds roughly to an average neuron radius of 10^{-5} meters then the flux sheet should go through all neurons in the uppermost neuron layer for option I. This cannot be the case and $k_d = 4$ flux sheets must traverse through several organisms so that they necessarily correspond to collective aspects of consciousness: the mind of Mother Gaia. Also the estimate $\lambda^4 L(151) < L < \lambda^4 L(169)$ for the over all size L of scaled up dark variant of cell nucleus suggests that single magnetic flux sheet traverses cells of organisms in an area of size $L > 180$ km.

If one assumes that the text lines on flux sheet are fully written, a more realistic candidate for the personal magnetic body would correspond to $k_d = 3$ with $B = \lambda B_{end}$ to achieve thermal stability. 1 Hz DNA cyclotron band

would for $Z = 2$ flux quantization scale up to kHz band possibly involved with neuronal synchrony and defining the time scale of the nerve pulse. Flux quantization requires flux sheets with width scaled down by λ^{-2} to 40 km. This requires neuronal strings traversing at least 4×10^4 neuronal nuclei which the highly convoluted cortex can easily accommodate. If the personal magnetic body can be regarded as a fractally scaled up cell nucleus, the estimate 80 m $< L <$ 176 km for the size of the personal magnetic body emerges for $\lambda = 2^{11}$.

The fact is however that our consciousness involves contributions from much longer time scales than millisecond. This raises difficult questions about our identity. Do I correspond to a single flux quantum of B_{end} after all: could it be that only a small fraction of these flux sheets corresponds to neuronal DNA and the empty parts of text lines are waiting for the evolution of larger brain to be fully written? How much of the contents of my conscious experience is from my own biological body? Why my sensory experience is dictated by my this particular biological body and why I possess intentional control only over it.

2.2.4 The definition of the model

The new model for the topological condensation at magnetic flux quanta of endogenous magnetic field $B_{end} = .2$ Gauss is based on the dark matter hierarchy with levels characterized by the value of $\hbar(k) = \lambda^{k_d}\hbar_0$, $\lambda = 2^{11}$.

a) There are several levels of dynamics. In topological condensation the internal dynamics of ions is unaffected and $\hbar$ has the ordinary value. The formation of Cooper pairs involves dynamics at $k_d = 1$ level of dark matter hierarchy. Also the dynamics of ionic Cooper pairs remains unaffected in the topological condensation to magnetic flux quanta obeying $k > 1$ dynamics.

b) Cyclotron energies scale as as λ^{k_d} so that for a sufficiently high value of k thermal stability of cyclotron states at room temperature is achieved. Spin interaction energy $\mu \cdot B \propto S \cdot B$ scales as $1/\hbar$ since four-momentum and angular momentum are by Poincare symmetry invariant under the scaling of $\hbar$ (the highly non-trivial implications of the invariance of angular momentum are discussed in [C6]). Hence spin interaction energy has the ordinary value. Unless thermal isolation is assumed, spin degrees of freedom are thermalized, and only cyclotron degrees of freedom can be quantum coherent. This is a testable prediction distinguishing between the new and old model.

c) If the flux quanta of B_{end} correspond to $k_d = 4$ level of dark matter hierarchy, cyclotron energies $E = (\hbar/2\pi) \times ZeB/Am_p$ are scaled up by a factor $\lambda^4 = 2^{44}$ from their ordinary values and are above thermal energy at

room temperature for $A \leq 233Z$, where Z is the charge of the ion. Even for $Z = 1$ this includes all stable nuclei. Bose-Einstein condensates of bosonic ions are thus possible at room temperatures at Earth's surface. Cooper pairs of fermionic ions are possible only for $A \leq 4$ leaving in practice only protons into consideration. Also bosonic molecular ions can suffer BE condensation.

2.2.5 Schumann resonances, EEG and large $k_d = 4$ level of dark matter hierarchy

The photon frequency corresponding to the wavelength $5 \times L(256)$ (size scale of magnetic flux quanta assignable to living matter) is 1.5 Hz and defines delta band. The corresponding energy is $E = .238$ eV which is above than the maximum photon energy $E_{th} = .085$ eV of black body radiation at T=300 K. The frequency $f = 10$ Hz, which corresponds to secondary p-adic length scale associated with Mersenne prime M_{127} characterizing electron, and defines fundamental biological rhythm, corresponds to $E = .67$ eV.

The nominal value 7.8 Hz of the lowest Schumann resonance frequency [32] corresponds to .52 eV which is in the range of energies assignable to the metabolic energy quantum. $A \leq 233Z$ corresponds to $f_{min} = 1.29$ Hz which corresponds to delta band. The higher Schumann frequencies 14, 20, 26, 33, 39, and 45 Hz correspond to energies .9, 1.3, 1.7, 2.2, 2.6, and 3.0 eV. The corresponding photon energies belong to infrared and visible range in the case of ordinary photons. The Schumann frequencies 26, 33, and 39 Hz correspond to red, green, and blue light.

These observations suggest that EEG corresponds to $k_d = 4$ space-time sheets and that EEG frequencies correspond to dark photon energies above the thermal energy at body temperature. The dominance of theta and delta bands during sleep state could be due to the fact that the EEG photons at these energies are not able to induce metabolic effects. The reported strong effects of the lowest Schumann resonance frequency on human brain could be interpreted in terms of a metabolic resonance. Lowest Schumann resonance could also serve as a biological clock synchronizing the behavior of living matter in Earth length scale. Higher Schumann resonance frequencies could define a global reference for the representation of visible colors.

2.2.6 Bose-Einstein condensates of bosonic ionized atoms

The number of elements for which ions are bosons is not very large. The following table lists the cyclotron frequencies of bosonic ions which are biologically important for $B_{end} = .2 \times 10^{-4}$ Tesla.

Ion	f_1/Hz	E_1/eV
$^6Li^+$	50.1	3.3
$^{24}Mg^{2+}$	25.0	1.65
$^{16}O^{2-}$	37.6	2.48
$^{32}S^{2-}$	18.8	1.24
$^{40}Ca^{2+}$	15.0	.99
$^{55}Mn^{2+}$	11.4	.75
$^{56}Fe^{2+}$	10.8	.71
$^{59}Co^{2+}$	10.0	.66
$^{64}Zn^{2+}$	9.4	.62
$^{80}Se^{2-}$	7.6	.5

Table 1. The first columns give the cyclotron frequencies and cyclotron energies for biologically relevant bosonic ions in $B_{end} = .2 \times 10^{-4}$ Tesla. The third column gives cyclotron energy.

The table inspires some comments.

a) For Li^+ the dominating isotope $^7Li^+$ is fermion. $^6Li^+$ is boson and its abundance is 5 per cent. Li^+ ions are used as medications in mania and represents mood stabilizer [30]. A possible explanation is that the cyclotron oscillations of Bose-Einstein condensate of $^6Li^+$ ions serve as a biological clock helping to stabilize the mood. The cyclotron frequency is however 50 Hz and higher than thalamocortical resonance frequency having nominal value 40 Hz.

An alternative explanation for the effect of Li^+ is based on the observation that $^7Li_+$ has cyclotron frequency equal to 42.9 Hz for $B_{end} = .2 \times 10^{-4}$ Tesla, which is at the upper limit of the 40 Hz resonance band. The presence of lithium ions or their Cooper pairs could enhance thalamocortical resonance.

These hypothesis could be tested by looking whether the use of pure $A = 6$ ($A = 7$) isotope of Li^+ amplifies the beneficial effect and the use of $A = 7$ ($A = 6$) isotope nullifies it.

b) For Mg^{2+} cyclotron energy corresponds to the energy of photon of green light. Chlorophyll is not able to convert nutrients to sugar without magnesium, which suggests that cyclotron transitions of Mg BE condensate are at least partially responsible for the green color of plants. Mg BE condensate could control the coherent occurrence of photosynthesis in the size scale of plant.

c) For oxygen ion the cyclotron frequency is 37.6 Hz and rather near

to $\sim$ 40 Hz thalamocortical resonance frequency, which suggests that the cyclotron transitions of oxygen ions might play key role in inducing coherent firing of neurons at this frequency. This would mean that oxygen would be much more than a mere provider of metabolic energy. Note also that $\Delta n = 3$ cyclotron transition of Na^+ ion corresponds to frequency 39 Hz and might be involved with the synchronous firing.

d) Ca^{2+} ions play a unique role in the functioning of living matter. In particular, calcium waves appearing in a wide range of time scales are known to serve a crucial role in nervous system [33]. Ca^{2+} corresponds to .99 eV cyclotron energy scale, which is twice the energy of metabolic energy quantum. Hence one can ask whether the cyclotron transitions of Ca^{2+} BE condensate could induce a collective emission of metabolic energy quanta and in this manner induce coherent metabolic activity in the scale of entire body.

e) The cyclotron frequencies Mn, Fe, Co, Cu, and Zn are in alpha band and corresponding cyclotron energies are somewhat above metabolic energy quantum. These energy quanta could drive protons from larger space-time sheet to $k = 137$ atomic space-time sheet. 10 Hz frequency is known to define an important biological clock and Co ions could be essential for the functioning of this clock. $n = 3$ multiple of Co^{2+} cyclotron frequency corresponds to the 30 Hz threshold of gamma band known to be important for cognition. Also $3f_c(Fe^{2+}) = 32.2$ Hz and $3f_c(Mn^{2+}) = 34.2$ belong to gamma band. The presence of Bose-Einstein condensates of these ions in length scale of $5L(212) = 141$ km could mean that these bio-rhythms are shared by different organisms inside regions of this size.

f) The fact that the cyclotron frequency of Se^{2-} ion, which is known to be a biologically important trace element, corresponds to the nominal value of the metabolic energy quantum, raises the question whether Selenium BE condensate might act as a metabolic synchronizer.

2.2.7 Cyclotron frequencies and Schumann frequencies

Even in the case that Cooper pairs of fermionic ions are not thermally stable, the cyclotron transitions of fermionic ions like K^+, Cl^-, and Na^+ are expected to be important. In the following table cyclotron frequencies and energies of some fermionic ions are given. Notice that the cyclotron energy of K^+ ion corresponds to metabolic energy quantum. Quite generally fermionic ions cannot be involved with the generation of Josephson part of EEG.

Ion	f/Hz	E_c/eV
$^7Li_+$	42.9	
F^-	15.8	1.04
Na^+	13	.86
Al^+	11.1	.73
Cl^-	8.5	.56
K^+	7.5	.50
Cu^+	4.8	333.9
Ag^+	2.8	.18
I^+	2.4	.16
Au^+	1.5	.10

Table 2. The first columns give cyclotron frequencies and corresponding cyclotron energies for some ions in $B_{end} = .2 \times 10^{-4}$ Tesla for some fermionic ions.

The first thing to notice is the close relationship of cyclotron frequencies with the lowest resonance frequencies in the spectrum of geo-electromagnetic field starting from 5 Hz, so called Schumann frequencies [32], are $7.8, 14$, $20, 26, 33, 39$ and 45 Hz. 5 Hz corresponds roughly to the threshold 4 Hz of theta frequency range below which EEG spectrum lies during sleep which suggests that wake-up state involves the coupling of brain with geo-electromagnetic activity. 7.8 Hz corresponds to the threshold for alpha waves associated with wake-up state without cognition; 14 Hz corresponds to threshold of 13 Hz for beta waves accompanying cognitive activities, and 33 Hz is quite near to the threshold 30 Hz for gamma waves known to be important in the temporal coding of sensory data.

Consider now examples of cyclotron frequencies keeping in mind that Schumann frequencies vary typically within 1 Hz interval around their mean values [32].

a) As already noticed, the frequencies, which are multiples of 15 Hz can be assigned to Ca^{2+} ion. The excitations $n = 3, 5, 7, ..$ correspond to the frequencies $45, 75, 105, ...$ Hz. All these frequencies have been observed. The two lowest frequencies correspond to Schumann frequencies 14 and 45 Hz with accuracy of 1 Hz.

b) Na_+ has $A = 23$ and gives $f = 13$ Hz. This is the lower bound for the frequency of beta EEG waves which are associated with conscious cognition. This would suggest that the presence of em field of 13 Hz frequency correlates with large fluxes of Na_+ ions through the axonal cell membrane during nerve pulse generation. This could result from increased amplitude of Na_+

Josephson current facilitating the emission of nerve pulses at the second half of the EEG cycle. Silencing of mind by meditation or closing eyes reduces amplitudes associated with EEG frequencies below 13 Hz and conscious cognition disappears.

$n = 3$ excitation of Na_+ corresponds to 39 Hz, which is one of the Schumann frequencies and quite near to the 40 Hz resonant frequency associated with the thalamocortical circuit. This could correspond to jumping of Na_+ ions from ground state to $n = 3$ state or vice versa. $n = 5$ quantum jumps correspond to 65 Hz which is average EEG frequency during REM sleep! Thus 13, 39 and 65 Hz frequencies correspond to the basic signatures of conscious cognition. The two lowest transition frequencies correspond to Schumann frequencies 14 and 45 Hz within accuracy of 1 Hz.

c) K_+ has $A = 39$ and gives $f = 7.5$ Hz, which is theta frequency rather near to the lowest Schumann resonance frequency 7.8 Hz. K_+ ion flux could correlate with em fields in the range of the alpha frequencies creating cyclotron resonance. Theta activity dominates during sleep and Adey's observations [17] demonstrate that 7 Hz ELF field increases reaction times. Second and third transition frequencies are within 1.5 Hz Schumann frequencies 20 and 37.5 Hz.

d) Cl_- ion has $A = 35$ and gives $f = 8.5$ Hz. Chloride ion has inhibitory effect. $n = 3, 7, ..$ excitations correspond to 25.5, 42.5 Hz,... Rather interestingly, frequencies rather near to 40 Hz associated with thalamo-cortical loops appear as excitations for all ions relevant to nerve pulse activity. Note that 39 Hz is also Schumann frequency. Two lowest transition frequencies of Cl_- are quite near to Schumann frequencies 7.8 and 25 Hz.

e) Fe^{2+} has $A = 56$ and corresponds to 10.7 Hz. $3f_c(Fe^{2+}) = 32.2$ Hz is rather near to Schumann frequency 33 Hz whereas Co^{2+} corresponds to 10 Hz in excellent accuracy. Co has especially large nuclear magnetic moment and serves as a natural magnet. Fe^{2+} and/or Co^{2+} could be present in magnetic sensory organ possessed also by humans making it possible to navigate using magnetic fields. Yarrow suggests that Co makes B_{12} magnetic vitamin [17] so that it can serve as fundamental biological clock at frequency very precisely equal to 10 Hz. Co is carried by B_{12} vitamin and is known to be important for normal consciousness: among other things the lack of B_{12} causes fatigue, blurred vision and cognitive problems.

f) Mg^{2+} has A=24 and $f = 25$ Hz which is near to Schumann frequency: $n = 3$ corresponds 75 Hz. Charged polypeptides could also form BE condensates and be involved with cyclotron mechanism: they are rather heavy and their cyclotron frequencies are in Hz range. Negatively charged organic molecules are indeed known to be present in neurons.

To sum up, surprisingly many magnetic transition frequencies are near to Schumann frequencies which suggests strong resonant interaction between brain and geo-electromagnetic fields.

2.2.8 What about proton's cyclotron frequency?

There are good reasons to expect that the cyclotron frequency of proton and its odd harmonics play an important role in brain functioning. The cyclotron frequency of proton in $B_{end} = .2$ Gauss is $f(p) = 300$ Hz. The frequency associated with $n = 3$ transition would be $3f(p) = 900$ Hz. Third harmonics of cyclotron frequencies of many ions with f_c in alpha band belong to gamma band known to relate to cognition. Perhaps this is true also in the case of proton.

The duration of single bit of the memetic codeword consisting of 127 bits and having total duration defined by the p-adic timescale $T^{(2)}_{M_{127}} = .1$ seconds corresponds to the frequency $f_m = 1027$ Hz. This frequency is by 10 per cent higher than the cyclotron frequency of proton for $B_{end} = .2$ Gauss. If magnetic homeostasis is realized, as will be discussed later, and if it allows 10 per cent variation of the strength of magnetic field as the width 1 Hz of alpha band suggests, it is possible to realize this frequency as proton's cyclotron transition frequency.

The frequency of neuronal synchronization, which is obviously associated with cognitive processing, is $\simeq 1$ kHz and might well be identifiable with f_m. The maximum rate of neuronal firing is slightly below kHz: this rate however corresponds to the rate of quantum jumps rather than oscillation frequency at space-time level.

2.2.9 Bose-Einstein condensates of bosonic molecular ions

Also biologically relevant bosonic molecular ions such SO_4^{2-}, CO_3^{2-}, NO_3^-, NO_2^- could form Bose-Einstein condensates. The cyclotron frequencies for bosonic molecular ions satisfying the thermal stability condition $A \leq 233 \times Z$ at room temperature are typically in theta and delta band and above $f_{min} =$ 1.29 Hz.

DNA is negatively charged and an interesting question is whether DNA satisfies the stability condition. The molecular weights of DNA nucleotides A,T,C,G are 132,126,96,149. The molecular weight of deoxyribose sugar attached to the nucleotide is 100 and that of phosphate group PO_4^{2-} is 95. Altogether this makes molecular weights 327, 321, 291, 344. Since phosphate group is doubly charged this structure has cyclotron energy which is higher

than thermal energy. Also DNA sequences satisfy the thermal stability condition. The presence of DNA Bose-Einstein condensates at magnetic flux quanta could mean that DNA can be transferred between different organisms along these space-time sheets and that DNAs of different organisms of same species could form quantum coherent systems inside regions where magnetic field can be regarded as a constant.

3 Magnetic genome, magnetic homeostasis, and magnetic circulation?

The view about the interaction of magnetic flux sheets with DNA leads to a rather far reaching vision about what genetic code really is. The notions of magnetic homeostasis and magnetic circulation are also highly suggestive.

3.1 The new view about genetic code

The concrete realization of the personal magnetic body or actually hierarchy of them labelled by $k_d = 0, 1, ..., 7$ was already discussed in section discussing the difference between personal magnetic body and that of Earth. The cautious proposal was that the personal magnetic body consists at $k = 169$ level of flux tubes of Earth's magnetic field with thickness $L(169)$ and width which scales as λ^{k_d}, $\lambda \simeq 2^{11}$. $k_d = 7$ would give total length of about 1.28×10^{12} km, which could correspond to the size of magnetosphere of Sun. If the flux tube have thickness $L(169)/\lambda = 2.5$ nm, which would naturally correspond to the thickness of DNA, $k = 7$ would correspond to about 136 light years and the assignment of cosmic consciousness with crown chakra would be really well justified. This length of flux tube would require that it traverses through about 10^{15} cell nuclei and cells of human body might be enough.

For $k_d < 4$ level the cyclotron frequencies in Earth's magnetic field do not correspond to cyclotron energies above thermal threshold so that stronger magnetic fields associated with $k < 169$ are necessary if cyclotron energies are to be of biological significance. It would seem that $k_d = 3$ defines upper bound in this respect: in this case $L(151)$ corresponds to cyclotron energies above thermal threshold for $A \leq 55Z$.

Those for whom pictures about mitosis are familiar might have had the feeling that the chromosomes are indeed bound to threads and that division of a dipole magnetic field to two occurs during cell division. This encourages to speculate about the possible implications of the proposed realization of

magnetic bodies corresponding to $k_d \geq 3$ levels of dark matter hierarchy.

a) The flux tube with given value of k_d need not go through every gene. It is also possible that same gene topologically condenses at flux sheets characterized by several values of k_d. These assignments are in principle dynamical. The flux sheets would obviously define a functional hierarchy such that at each level quite different structures or functions are coded. A natural guess would be that dark genes at level k_d code structure and functions related to dark matter at level k_d. This increases dramatically the representative power of genome and would explain why the amount of human genome differs only little from that of much more primitive organisms such as wheat or fishes.

The emergence of dark matter hierarchy would be the manner to make genes multi-functional and bring in a hierarchy of increasingly refined abstraction hierarchy. In vertebrates the really significant evolution would take place at this level. This also allows a new perspective to the mysterious introns, the 95 per cent portion of DNA christened as "junk DNA" by materialistic biologists, as a part of genome codes mostly for functions associated with dark matter levels.

b) For $k_d \geq 2$ single human genome with a total length ~ 1 m of DNA cannot correspond to entire width of the magnetic flux sheet which is about 40 km for $k_d = 3$. This means that the flux sheet must traverse through a large number of genes and bind them to single super gene (this would occur even in the case that the flux sheet is branched). For $k = 7$ the number of genomes traversed could be $\sim 10^{15}$ if they have thickness of 1.28 nm. The number of neurons in human brain is estimated to be $\sim 10^{12}$ so that also other cells must be added to the necklace.

These super genes would be very literally light highly convoluted pages of book containing sequences of nucleons as text lines. The pages of this book would be dynamical and the evolution of individual would presumably be like writing this enormous body book and expressing it in various manners. They would provide an exponentially explosive representational power and the relation of genome itself to super-genome would be like that of bit to a large collection of computer programs. This would also mean that brain would have use quantum computational capacity (for TGD based model for topological quantum computation see [E9]).

c) Even more dramatic generalization of genome can be considered. There is in principle no reason why magnetic flux sheets could not pass through several organisms so that kind of hyper-genes would result. These hyper-genes could make possible the emergence of complex social structures with individuals obeying rules making possible complex behavioral patterns.

In this case there is practically no upper bound for k_d.

3.2 Magnetic homeostasis and magnetic circulation?

The possible importance of the precise value of the local magnetic field for say memetic code [L1] suggests that living matter has learned to control local magnetic field inside magnetic flux tubes just as it controls salt level of biological water.

In particular, B_E could have slightly different values at different levels k_d of dark hierarchy (cyclotron energies can be above thermal threshold only for $k_d \geq 4$). Cell differentiation could lead to the differentiation of the local value of B_E and the value could vary even inside single cell nucleus, and be slightly different for genes characterized by different value of k_d (that is, topologically condensed at flux sheet with this value of k_d).

There is rather precise analogy with blood flow since both incompressible velocity field of blood and magnetic field are divergenceless: one can imagine magnetic flux to flow along 'B-veins' (magnetic flux tubes) along organism or at least CNS. Variation of the magnetic field strength would be forced by the variation of the thickness of the flux tube since magnetic flux is conserved just as the variation of the thickness of blood veins affects blood flow. Artificial small alteration of local magnetic from outside would only interfere with this control.

For instance, alpha peak drifts in Hz range and this could be due the variation of the value of local magnetic field varies as much as 10 per cent. If this variation is due to the homeostatic variation of the local magnetic field, absolute variation should increase for higher frequencies: at the upper end of gamma band it would be 9 Hz. An alternative explanation for drifting is in terms of amplitude modulation: amplitude modulation of frequency f_1 by frequency f implies that original frequency is split to frequencies $f_1 \pm f$. In this case the amplitude of drifting does not depend on frequency.

3.2.1 Magnetic circulation

The analogy with blood flow suggests that one could speak about B-circulation completely analogous to blood circulation: B-circulation could be crucial for bio-system to act as macroscopic quantum system. B-circulation would naturally accompany neural circuitry. It could be also accompany ordinary blood circulation physically or could form an independent system. The association with blood circulation would provide prerequisites for quantum control of also blood circulation and metabolism. The control could be based

on MW frequency Josephson currents associated with ELF em fields inducing conformational changes of proteins coherently in large regions in turn giving rise to needed synchronous biochemical self-organization processes. Also Z^0 magnetic circulation system is plausible.

3.2.2 Temperature dependence of the local magnetic field strength

EEG frequencies are known to change with temperature [37]. The assumption that the thickness of magnetic flux tubes depends on temperature implies that EEG frequency scale varies with temperature. One might think that this kind of mechanism could partially explain why a serious hibernation leads to a lower level of arousal. The results of Blackman [25] suggesting that ELF effects with given frequency disappear when body temperature is not in the range $36 - 37$ C inspires the hypothesis that quantum critical high T_c superconductivity is possible only in the range 36-37 C. This obviously provides a more plausible explanation for the effect of hibernation. In this picture the extreme importance of temperature regulation for the functioning of organism could be seen as a prerequisite for continual quantum control by magnetic transition frequencies from $k = 4$ magnetic body.

Circadial temperature variation can be something like 20 Kelvins , which means relative variation about 10 per cent for poikilotherms, which is of same order as alpha frequency drifting. The relative width of the cyclotron resonance would be from this about 7 per cent ($\Delta f/f = \Delta B/B \propto \Delta T/T$).

The observation that widely separated brain regions tend to fluctuate in unisono [36] is not easy to understand if one imagines brain as consisting of independent oscillators. If important EEG frequencies correspond to magnetic transition frequencies, the fluctuations can be understood as induced from fluctuations of the local magnetic field possibly induced by the organism itself.

3.2.3 Why the increase of the local magnetic field strength by factor of ten does not raise alpha band to heaven?

The increase of the local magnetic field strength by a factor $10-20$ is known to induce stress [17] and confuse biological timekeeper mechanisms but it certainly cannot raise alpha band above 100 Hz. Resolution of the this objection is simple. The size of the volume in which artificially generated magnetic field prevails determines the value of k_d and p-adic length scale $L(k)$ in question. k_d is definitely smaller than $k_d = 4$ associated with the flux sheets corresponding to the Earth's magnetic field. Secondly, the ability

to perturb the magnetic field at $k_d = 4$ flux sheets associated with DNA would presumably require a refined technology. If organism has developed magnetic homeostasis, it tends to keep the magnetic field constant inside the flux sheets just as cell tends to keep salt concentration constant.

Assuming that k_d is fixed, p-adic length scale hypothesis suggests that the increase of local field strength of flux quantum by a factor four would cause change of p-adic scale since $p \simeq 2^k$, $k = 167$ is the next p-adic length scale below $k = 169$: this scale is by a factor 2 shorter so that magnetic field scales up by a factor of 4. Of course, it could be also that the increase of the local magnetic field with strength defined macroscopically by flux per area might only tend to thicken the flux tubes or increase their volume density rather than increasing the value of the magnetic field inside flux tube.

3.3 Some remarks and questions

3.3.1 Synchronizing effect of Earth's magnetic field

Earth's magnetic field acts as grand synchronizer of biorhythms of even separate organisms. Magnetic homeostasis does not prevent the effects due to the variation of Earth's magnetic field on human consciousness.

The close correlation of various cycles of biological and brain activity, in particular sleep-wake cycle, with periodic circadial variations of the geomagnetic field [17], is consistent with this. Magnetic storms change temporarily the value of the local magnetic field and also this should have effects on consciousness. The statistics about mental hospitals supports this view [17]. Also Persinger has proposed that the modulations of Earth's magnetic field caused by geomagnetic perturbations have effect on human consciousness [52, 17]. Michael Persinger has studied extensively the effects of Schumann resonances on brain and has even explained religious and UFO experiences as correlates of this interaction [53, 54, 55].

Also the diurnal changes of magnetic field caused by Moon having period of 25 hours are known and this variation seems to provide fundamental biological clock which sets on in absence of the normal 24 rhythm regulated by sunlight. The diurnal variations of the geomagnetic field are also responsible for sleep-awake rhythm: the increased melatonin secretion during dark hours correlate with the variation of Earth's magnetic field.

It is also known that that the exposure to magnetic fields 10-20 times geomagnetic field induces stress in rabbits and slowed reaction time in humans; that the absence of geomagnetic field leads to a complete de-syncronization of biorhytms and that the synchorization of ELF biorhytms is coupled to

ELF geomagnetic pulsations [17]. In particular, pineal gland serves as biological timekeeper with cyclotron frequency of Co^{2+} ion defining the basic time unit of .1 seconds.

Dr. Phil Callahan [50] claims on basis of intensive experimental work that there is a tendency of political strifes and wars to concentrate on regions where Schumann resonances are weak. This would not be surprising since Schumann resonances act as collective bio-rhytms if vertebrate brains are connected to the magnetic body of Earth.

3. What happens to astronaut's magnetic body

There is an old objection against the notion of magnetic body. If the local value of Earth's magnetic field is crucial for the brain functioning, astronauts should experience grave difficulties or at least dramatic changes in the character of consciousness. A possible estimate for the weakening of the local magnetic field is based on the scaling law $B \propto 1/r^3$ for dipole field. In this case a rough estimate for the relative change of the EEG frequency scale is $\Delta f/f = 3\Delta R/R \sim 6$ per cent for satellites moving below the ionosphere. This should affect the state of consciousness.

As a matter fact, there is reported evidence [47, 56] that cosmonauts spending months in MIR had strange altered states of consciousness involving among other things precognition of the difficulties to be countered by MIR and receiving advices and identification experiences with other people and life forms, even dinosaurs of ancient Earth!

In the many-sheeted space-time the situation looks like following.

a) Astronauts draw the magnetic flux sheets connecting them to the magnetic body of Earth and higher level magnetic bodies with them. Only $k_d = 4$ level might be affected since for $k_d > 4$ the length scale involved, which corresponds to height of ionosphere, is shorter the than the distance travelled.

b) At the level of cell nuclei nothing dramatic need happen. Energetically the stretching magnetic flux sheets associated with DNA is not a problem since the energy densities involved are rather tiny. Furthermore, if the flux sheets carry homological monopole flux, they could highly stable against increase of length since they would have magnetic monopole wormhole contacts at their ends.

c) The question is what happens for the $k_d = 4$ Josephson junction associated with 180 km thick layer composed of litosphere and connecting brain to magnetic body of Earth? Could the Josephson current run still now but from litosphere to the magnetic sheets to the brain of astronaut and back to the ionosphere? A long period in space might change the situation and

this could relate to the strange experiences of astronauts. If the contribution of $k_d = 4$ level weakens it might happen that $k_d > 4$ levels with longer time scale begin to dominate the consciousness.

d) The experiences are also consistent with TGD based view about geometric time and possibility of geometric memories extending beyond the duration of individual life cycle. If one takes seriously the report about dinosaurs, which lived for $\sim 10^8$ years ago, $k_d = 9$ level which corresponds to Josephson period of 5.44×10^9 years, could have contributed to the conscious experience of astronauts.

5. What the reduction of Earth's magnetic field means?

The strength of Earth's magnetic field has reduced 50 per cent during last 1.000 years. The fact that an exponential evolution of civilization has occurred during this period, is perhaps not an accident. Surprisingly many magnetic transition frequencies happen to be near to Schumann resonance frequencies. During this period the weakening of Earth's magnetic field has reduced cyclotron frequency spectrum of heavy ions from $3 - 8$ Hz range to the range $1.5 - 4$ Hz. Rather remarkably, delta frequencies near 3 Hz correspond to a peak in the frequency spectrum of so called sferics associated with lightning activity [34].

These observations suggest the emergence of strong interaction between brain and higher levels of the self hierarchy based on spherics and Schumann resonances. Assuming temporal linearity, the reduction of Earth's magnetic field has been 25 per cent after Newton and 5 per cent during last 100 years. Perhaps an exponential development of mathematical consciousness made possible by the activation of cyclotron frequencies of heavy ions with high nuclear and electronic angular momenta and allowing large number of conscious-to-us magnetic transitions, and possibly also involving some kind of fine tuning is taking place.

The weakening of Earth's magnetic field probably relates to a forthcoming change in the polarity of Earth's magnetic field. One might guess that the personal magnetic bodies are not affected appreciably during this period but that the violent change of Earth's magnetic field induces dramatic effects on collective aspects of consciousness at $k_d = 4$ level as the findings of Callahan suggest.

3.3.2 What about spin flips?

The natural question is whether also spin flips to which Larmor frequencies are associated could be important. 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 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.

Spin flip frequencies are in general of order few hundred Hz for $B = .2$ Gauss. The eight ions listed in the table below 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-canonical 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.

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 3. 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.

3.3.3 What about Z^0 magnetic transitions?

The idea that Z^0 magnetic magnetic transitions might be relevant for biomatter have been discussed already earlier. The identification of the sources of long ranged classical weak fields as dark matter forces however a profound modification of the earlier picture.

The TGD based models for atomic nuclei [F8] and condensed matter [F9] suggest strongly that the dark variant of $k = 113$ copy of $k = 89$ electro-weak physics is essential for understanding of not only the anomalies of water but also the basic properties of condensed matter. Also other copies of electro-weak physics with arbitrarily small weak mass scale are implied by the fact that long ranged classical weak fields are unavoidable in TGD Universe. Also the scaled down copies of color physics with arbitrarily low mass scales for quarks are a basic prediction of TGD.

If classical Z^0 magnetic field is present and if nuclei possess anomalous weak charges due to the presence of color bonds with quark and antiquark at their ends carrying non-vanishing net weak charges coupling to $k = 113$ dark weak bosons, one must consider also Z^0 cyclotron frequencies given by

$$\begin{aligned} \Omega &= \frac{N(u\bar{d})}{A} \times Q_Z(u\bar{d}) \times \frac{g_Z B_Z}{eB} \times \Omega_p \ , \quad \Omega_p = \frac{eB}{m_p} \ , \\ Q_Z(u\bar{d}) &= \frac{1}{2} - sin^2(\theta_W) \ . \end{aligned} \tag{1}$$

Here $N(u\bar{d})$ is anomalous Z^0 charge of the nucleus due to weakly charged color bonds connecting nucleons with quark and antiquark at their ends using $u\bar{d}$ Z^0 charge $Q(u\bar{d})$ as unit. Ω_p is proton cyclotron frequency, which is about 300 Hz for $B = B_E = .5$ Gauss. The dependence on the Z^0 magnetic transition frequencies on the mass of nucleus is same as in the electromagnetic case.

The doubly dark weak bosons with weak length scale $L_w = 2^{22} L_w(113) = .2$ μm should be key actors in TGD based model of living matter. Since the quantization of magnetic flux uses $\hbar$ as unit the quantum of Z^0 flux over a given area is multiplied by a factor 2^{22} for doubly dark weak bosons. Also the energy $\hbar\omega_c$ associated with the cyclotron frequency is multiplied by a factor 2^{22} so that energies are by a factor 2^{44} higher for cyclotron transitions in flux quantized Z^0 magnetic field than one might expect. In the case of dark quarks it would be natural to use $2(Q_Z(u\bar{d})$ as unit of charge in the quantization of magnetic flux so that the flux quantization reads $2Q_Z(u\bar{d}) \int B_Z dA = n2^{22}\hbar 2\pi$.

Z^0 flux quanta with radius $L_w = .2$ μm are expected to be of special interest. Consider the field corresponding to single flux quantum in this case. Using the fact that Earth's magnetic field taken to have nominal value .4742 Tesla corresponds to a single quantum of flux through a disk of radius $L(k = 169)$, one obtains that the Z^0 cyclotron frequency and energy in this case are given by

$$\begin{aligned} \Omega_c(2^{22}\hbar) &= 2^{22}\Omega_c(\hbar)2^{22}\frac{N(u\bar{d})}{A} \times Q_Z(u\bar{d}) \times (\frac{L(169)}{L_w})^2\omega_p(B_E) \\ &\simeq \frac{N(u\bar{d})}{A} \times 750 \ GHz \ , \\ E_c(2^{22}\hbar) &= 2^{44}E_c(\hbar) \simeq \frac{N(u\bar{d})}{A} \times 10^4 \ eV \ . \end{aligned} \tag{2}$$

Note that Ω_c and E_c do not depend on the unit of flux quantization. Cyclotron frequencies are in 10^{12} GHz range but energies in 10^4 eV range and corresponds to ordinary photon wavelength of about atomic length scale. In the earlier picture frequencies were in 10 Hz range. The energies involved are well above the thermal energy in room temperature. For the first level of dark matter hierarchy the frequency scale would be .375 GHz and energy scale 25 meV which is below thermal energy at room temperature.

Also ordinary nuclei containing charged color bonds would couple to dark weak bosons with weak length scale having nominal value $L_w = 2^{11}L_w(113) =$ 1 Angstrom. In this case Z^0 magnetic fields would have 2^{11} stronger strength that in previous case and cyclotron energies would be same.

4 Fractal hierarchy of Josephson junctions and hierarchy of generalized EEGs

The idea about p-adic fractal hierarchy of Josephson junctions is not new in TGD framework. The development of quantitative models based on this notion has been however plagued by the absence of concrete idea about what these Josephson junctions look like. The dark matter hierarchy based on hierarchy of scaled up values of Planck constant when combined with the p-adic length scale hierarchy allows to circumvent the problem.

An essential boost for the development of ideas have been the effects of ELF em fields in living matter explainable in terms of quantum cyclotron transitions in Earth's magnetic field. Especially the fact that these effects appear only in narrow temperature and amplitude windows has provided

the key hints concerning the model for the hierarchy of Josephson junctions and EEGs. The discussion of these effects is left to a separate section.

4.1 Fractal hierarchy of Josephson junctions

The hierarchy of Josephson junctions involves actually two hierarchies, dark matter hierarchy and p-adic hierarchy, which can be said to be in resonance for living matter systems.

4.1.1 Fractal hierarchy of dark copies of cell nucleus as a fundamental structure in living matter

There are actually two hierarchies. The first hierarchy correspond to the p-adic length scales for given value of $\hbar$. Second hierarchy corresponds to dark matter hierarchy for which length scales come in powers $\lambda^{k_d} L(k))$ the basic p-adic length scales, $\lambda = 2^{11}$. The general prediction is that λ is power of two and $k = 11$ is favored value because it corresponds to a fundamental constant in TGD. There are also other arguments supporting the exactness of this value. Since 11 p-adic length scales combine naturally to form single block in this hierarchy, there is strong temptation to assume that p-adic length scales $k = 151, 147, 163, 167, 169$ form the fundamental block. Same length scale can have interpretation as several different p-adic length scales belonging to different levels of dark hierarchy. This is expected to induce an interaction between various levels of dark matter hierarchy.

The size of cell nucleus varies in the range ($L(169) = 5\ \mu m, 2L(169) = 10\ \mu m$). This is consistent with the assumption that cell nucleus provides the fundamental representation for this block. This would mean that at least the multiply coiled magnetic flux quantum structures associated with DNA appear as fractally scaled up copies.

Each dark matter level corresponds to a block of p-adic length scales $L(k)$, $k = 151, ..., 169$. Also new length scales emerge at given level k_d and correspond to $L(k)$, $k > 169$. The dark copies of all these length scales are also present. Hence something genuinely new emerges at each level.

The emergence of a genuinely new structure or function in evolution would correspond to the emergence of new level in this fractal hierarchy. Quantum criticality would be essential: phases corresponding k_d and $k_d + 1$ levels would compete at quantum criticality. A good guess is that for all levels flux sheets traverse partially the DNA of possibly several cell nuclei and that they are part of Josephson junctions.

a) $k_D = 0$ would correspond to cell nucleus since electronic and neutrino superconductivity correspond to ordinary $\hbar$.

b) $k_d = 1$ would correspond to emergence of organs with sizes below 4 cm and bounded by epithelial sheets (double cell layers) of thickness about 10+10 μm.

c)$k_d = 2$ would correspond to layers of thickness 2+2 cm and structures with size smaller than 80 m. Obviously genuinely dark level is in question now. The layers of this Josephson junction could be assignable to left and right halves of central nervous system. The interpretation in terms of dark matter around the magnetic body of organs suggests also itself. $k_d = 3$ corresponds to the emergence of double layered dark matter structures of thickness 40+40 m and size scale below 160 km. Now dark matter condensed around magnetic bodies of magnetic bodies of organs could be in question.

d) $k_d = 4$ could correspond to the emergence of EEG assignable to flux sheets of personal magnetic body. The bilayered structure has thickness of 80+80 km and the analog of cell nucleus has minimum $512 \times 160 = 8$ Mm and corresponds to Earth size scale (Earth radius is 6.96 Mm).

It must be emphasized that also other values of k besides $k = 168$ with $n = 5$ can be considered. In particular, the values $k = 151, 157, 163, 167$ corresponding to Gaussian Mersennes are especially promising candidates for characterizing endogenous magnetic fields. The model of EEG in turn leads to the conclusion that also $k = 169$ with $n = 5$ must be present. The relevant length scales vary accordingly.

4.1.2 Fractal hierarchy of Josephson junctions and EEGs

The fractal hierarchy of Josephson junctions defining a fractal hierarchy of EEGs is the basic element of the model.

1. Josephson junctions provide a representation of electric field as biological action induced by generalized EEG

Each junction has a background voltage over it and this voltage is independent of the p-adic length scale $L(k)$, $k = 151, ..., 169$ inside block. Josephson current can be written as

$$J \propto sin(2eVt + 2e \int V_1 dt) \ ,$$

where V corresponds to the background voltage analogous to resting potential of cell membrane and varies in rather narrow limits. $V_1(t)$ represents external perturbation.

The frequency of V_1 is represented as a period of periodic multiplicative modulation of the V_0. J itself is not periodic. There is however a periodicity with a period $T = n/f$, where f is frequency of V_1 for $f_J = mf/n$. There are two interesting limits. For $f_J^1 = 2eV_1/2\pi\hbar \gg f_J$ amplitude V_1 is represented as frequency since in reasonable approximation frequencies $f_\pm = f_J \pm f_J^1$ dominate. Second limit corresponds to $f_J^1 \ll f_J$. In this case the dominating frequencies are $f_\pm = f_J \pm f$

Josephson frequency would define a kind of drum beat whereas the frequencies associated with V_1 would represent the rest of the music. Josephson frequency $f_J = eV/2\pi\hbar$ indeed turns out to belong to the scaled up variant of delta band of EEG and thus defines the analog of drum beat and corresponds to a resonance frequency in delta band for the scaled up variants of EEG. Josephson frequency defines a candidate for the time unit in which the time scale of memories and intentional action of the living system are measured.

The coherent photon state generated by J defines representation of V_1 as a generalized EEG and biological representations result when the photons interact with the living matter.

The reactions of the Josephson junctions corresponding to different p-adic length scales $k = 151, ..., 169$ (if really present!) to external electric field are different due to $V_1 \propto L(k) \propto 2^{(k-151)/2}$ proportionality and independence of V on k.

2. Thermodynamical considerations

Josephson energy does not depend on the level of dark matter hierarchy and is thus above thermal energy since this holds true in the case of cell membrane. From the resting potential whose nominal value is often taken to be for .08 V, f_J corresponds roughly to the energy 1.6 eV roughly twice the energy allowed by thermal stability. Thermal stability of drum beat would allow 140 °C temperature. The growth temperatures of thermophilic bacteria can be even higher than 100 °C.

Nerve pulse is generated when the potential drops to .05 eV: the corresponding Josephson energy is .01 eV which is above thermal threshold for $T \leq 70$ C. For organisms possessing no nervous systems, in particular bacteria, this constraint is not relevant. The energy $E = 1$ eV is twice the energy $E = .05$ eV, which is a universal transition energy of Cooper pairs of high T_c electronic super conductor [J1]. The generation of nerve pulse might involve these transitions.

3. Josephson frequencies

Resting potential corresponds to the Josephson frequency $f_J = 5.95 \times 10^{13}$ Hz. Infrared radiation with intensity spectrum having characteristics of coherent state of photons would be a signature of this current. The Josephson frequency corresponding to threshold potential is $f_J = 3.36 \times 10^{13}$ Hz.

f_J scales like $f_J \simeq \lambda^{-k_d}$ as a function of the level of the dark matter hierarchy. For $k_d = 4$ one obtains $f_J = 3.38$ Hz using $\lambda = 2^{11}$. This frequency belongs to delta band (defined as the the frequency range .25-5 Hz).

4.1.3 Levels of dark matter hierarchy as a physical counterpart of chakras

The model identifying generalized EEG as coherent photons emitted by Josephson junction suggest that $k_d = 7$ corresponds to the highest level of dark matter hierarchy for humans. This brings in mind the seven chakras central for Eastern mystic traditions. The magnetic flux quanta would enter the body through organs which are assignable to a particular value of k_d and chakras could be identified as groups of organs with a given value of k_d. An alternative possibility is that the space-time sheets at level k_d are joined to the level $k_d + 1$ by Josephson junctions. In this case it is not necessary to have connections directly from the level of DNA.

The magnetic bodies involved include the magnetic body associated with biological body, presumably that associated with $k_{em} = 2$, magnetic body of Earth for $k_{em} = 4$, magnetic body associated with plasma sheet at night side of Earth's magnetosphere, the magnetic body of Sun for $k_{em} = 6$ and that of solar system for $k_{em} = 7$. Note however that the endogenous magnetic field is $B_{end} = .2$ Gauss and relates to $B_E = .5$ Gauss by a scaling factor. This suggests that personal magnetic bodies in the hierarchy interact with the astrophysical magnetic bodies but are not identical with them.

Josephson period associated with the largest chakra would would correlate with the time scales of intentional action and memories and would give a criterion making possible to estimate which levels are present for a given kind of organism or part of organism.

Of course, detailed one-to-one map between chakra picture and dark matter hierarchy is not possible. There are however common elements, most importantly the hierarchical structure of conscious experience leading from animal consciousness (root chakra) to cosmic consciousness (crown chakra). Chakra hierarchy should also have direct counterpart at the level of evolution of living organisms.

Hence it seems that two ideas, chakras and the idea about delicate interaction between astrophysical objects and human consciousness, hated bitterly by skeptics, find a natural place in dark matter hierarchy.

4.1.4 What is the precise value of λ?

The precise value of λ is important if one wants to assign the amplitude windows to resonance bands of EEG.

a) By the general model for quantization of Planck constant already discussed λ can correspond to a power of 2 and hence $\lambda = 2^{11}$ is strongly favored.

b) $\lambda = 2^{11}$ implies a precise resonance between dark length scales and ordinary p-adic length scales. If λ is integer and if it equals to 2^{11} then also lower powers of 2 can in principle appear in the dark matter hierarchy as sub-harmonics $\lambda/2^k$ (this is indeed predicted by integer quantization of Planck constant).

c) The interpretation of the Josephson period associated with the highest level of dark matter as the time scale for intentional action and memory allows to estimate the value of largest k relevant for humans and it turns out that the scaled up Josephson frequency corresponds to a period of 80 years for this option meaning that $k_d = 7$ naturally corresponds to the highest level in the dark matter hierarchy associated with humans.

d) $\lambda = 2^{11}$ option predicts for the length scale associated with $k_d = 4$ Josephson junctions a value having direct physical interpretation.

e) $\lambda = 2^{11}$ option provides a plausible interpretation for amplitude windows in terms of EEG resonance bands.

4.1.5 Josephson frequencies for various levels of dark matter hierarchy

The following tables list the Josephson frequencies for doubly charged current carriers for the levels of dark matter hierarchy corresponding to $k_d = 0, ..., 7$ using the value .08 V/m for the resting potential for $\lambda = 2^{11}$.

The powers of $\lambda = 2^{11}$ are allowed by the requirement that the scaling $\hbar = n\hbar_0$ of Planck constant corresponds to a quantum phase $q = exp(i\pi/n)$ assignable to an n-polygon constructible using only ruler and compass. In this case one has $n = n_F = 2^k \times \prod_k F_{n_k}$, where each Fermat prime $F_n = 2^{2^n} + 1$, $n = 0, 1..., 4$ can appear only once. The quantum phase $exp(i\pi/n_F)$ is expressible using using only iterated square root operation [C6] and same

applies to the algebraic extension of p-adic numbers is needed for $p \; mod \; 4 = 3$. This is not true for $\lambda = 2176$ so that $v_0 = 2^{-11}$ remains the only candidate.

For $\lambda = 2^{11}$ the Josephson period for $k_d = 7$ is $\simeq$ 80 years, which roughly corresponds to the duration of human life cycle. $k_d = 6$ corresponds to $\simeq 14.3$ days and $k_d = 5$ to $\simeq 10.1$ minutes.

Note that there is no dependence on the p-adic length scale $k = 151, ..., 169$. Also the frequencies corresponding to the .05 V corresponding to the potential at which nerve pulse is generated are listed. For singly charged bosonic ions the frequency would be $f_J/2$. For fermionic ions Josephson currents are not of course possible.

k_d	0	1	2	3
$f_J(80\ mV)/Hz$	5.95e+13	2.91e+10	1.42e+07	6.93e+03
$f_J(50\ mV)/Hz$	3.72e+13	1.82e+10	8.87e+06	4.33e+03
k_d	4	5	6	7
$f_J(80\ mV)/Hz$	3.38	6.18e-4	2.85e-7	1.31e-10
$f_J(50\ mV)/Hz$	2.11	1.0e-3	5.04e-07	2.46e-10

Table 4. The Josephson frequencies $f_J = 2eV/2\pi\hbar$ of doubly charged particles for $\lambda = 2^{11}$ corresponding to the resting potential .08 V and threshold potential .05 V for nerve pulse generation for $\lambda = 2^{11}$.

4.1.6 Objection

The electric field involved with the higher levels of Josephson junction hierarchy is very weak: something like 10^{-7} V/m for lito-ionospheric Josephson junctions (of thickness about 176 km from the scaling of the cell membrane thickness by $\lambda^4 = 2^{44}$) which might be responsible for EEG. The electric field of the Earth at space-time sheets corresponding to ordinary matter is much stronger: about $10^2 - 10^4$ V/m at the surface of Earth but decreasing rapidly as ionosphere is approached being about .3 V/m at 30 km height. The estimate for the voltage between ionosphere and Earth surface is about 200 kV [75].

The many-sheeted variant of Faraday law implies that on order to have a voltage of order .08 V over lito-ionospheric Josephson junction at dark matter space-time sheet, the voltage over ionospheric cavity must be almost completely compensated by an opposite voltage over litosphere so that lito-ionospheric double layer could be seen as a pair of capacitor plates in a radial electric field of order 10^{-7} V/m generated by the charge density in sub-litospheric part of Earth.

A natural distance scale in which the electric field is reduced would correspond to 10-20 km thick layer in which whether phenomena are present. The mirror image of this layer would be Earth's crust. The cell membrane counterpart would be a dipole layer like charge density between the lipid layers of the cell membrane. Note that the electric field at dark matter space-time can be constant. However, as far as Josephson junction is considered, it is only the net voltage what matters.

4.2 A possible identification of Josephson junctions

By fractally scaling up from the case of cell membrane one can assign to the Josephson junctions at a given level of dark matter hierarchy the p-adic length scales $L(k)$, $k = 151, ..., 169$, and neuron serves at least as a convenient visual guideline.

4.2.1 $k_d = 0$ level

At the lowest level of dark matter hierarchy cell membrane is a natural candidate for the Josephson junction. Electronic and exotic neutrino superconductivities indeed correspond to the ordinary value of $\hbar$. The Josephson frequency is now 29.8 THz and corresponds to infrared photons. The observation of photons with spectrum having characteristics of coherent photon state generated by Josephson current is a testable experimental prediction.

An interesting question is whether membrane proteins acting as receptors and possibly also as channels and pumps correspond to a concrete realization of Josephson junctions and could be seen as being analogous to living organisms populating the cell membrane. Josephson junction would correspond to the protein magnetic body connecting cell interior to the magnetic body of cell. Second question is where the magnetic flux tube of the personal magnetic body flows in the cell interior and exterior. As a matter fact, the radius 18 μm of flux quanta for $B_{end} = .2$ Gauss resolves this question and suggests that large neurons of vertebrate brain are essential concerning the effects of ELF fields on brain.

If topological magnetic monopole flux flowing to a larger space-time sheet through wormhole contacts and returning back at the other end of the junction in the similar manner is in question, this question is avoided. The Josephson junctions identifiable as protein magnetic bodies can be associated with also other membrane bounded structures, in particular organelles inside cell, say cell nucleus.

With inspiration coming from the experiments of Gariaev [58] I have

proposed that EEG has fractally scaled-up counterparts such that ordinary EEG would correspond to $k = 169$ level and scaled up variants to primes $k = 151, 157, 163, 167$ (at least). The model worked assuming that magnetic field scales like $B \propto 1/L(k)$: this is consistent with highly convoluted flux sheets. This scaling is just the reversal for the scaling of Josephson frequencies of external voltage perturbations as $f_J \propto L(k)$. These magnetic flux quanta can be associated with coiling hierarchy of DNA.

4.2.2 $k_d = 1$ level

In this case the membrane like structure is predicted to have thickness $L(173) = 20 + 20$ μm. The upper bound for the size of these structures would be $\lambda \times L(173) \simeq 4$ cm. Epithelial sheets consisting of double cell layer and surrounding organs would be an attractive identification for these structures.

Interesting question is whether the Josephson junctions have interpretation as particular kinds of cells at the epithelial sheet. Sensory receptors In the case of skin sensory receptors would be the counterpart for the proteins at cell membrane and would define the Josephson junctions.

Josephson frequency is 29 GHz and corresponds to the time scale for the conformational dynamics of proteins. Josephson junctions could define a pacemaker for this dynamics and perturbations of the "resting potential" would serve a control purpose.

4.2.3 $k_d = 2$ level

The thickness for the counterpart of cell membrane is for $\lambda = 2^{11}$ $L(195) = 2 + 2$ cm. The upper bound for the structures bounded by these membranes is 80 m and $L(169)$ corresponds now to 20 m length scale. This would require that magnetic flux sheets defining Josephson junctions traverse through cell nuclei of a large number of organisms and thus define hyper-genes responsible for the social aspects of the behavior. At least the interiors of these structures must correspond to dark matter. The proposal that the magnetic flux sheets of $k_d = 4$ magnetic body flow through DNA of neurons generalizes to the proposal that flux sheets of $k_d = 2$ magnetic body flow through the DNA of cells which are at a lower level in the differentiation hierarchy. Josephson frequency would be 14 MHz.

4.2.4 $k_d = 3$ level

In this case the membrane like structure would have thickness $L(217) = 40 + 40$ m. The Josephson frequency would be 6.9 kHz. The length of DNA needed to guarantee minimal flux quantum width would be $\lambda^3 L(169) \simeq 40$ km so that roughly 4×10^4 cell nuclei are needed if most of the width of flux sheet corresponds to DNA. Thus supergenes would necessarily emerge at this level and involve organisms in a region of size scale 176 km. $k_d = 3$ Josephson junction defined by the magnetic flux sheet going through cell nuclei could connect flux sheets associated with litosphere and ionspheric cavity: this pair becomes a Josephson junction at $k_d = 4$ level.

4.2.5 $k_d = 4$ level

As already proposed, $k_d = 4$ level could correspond to that level in the hierarchy of personal magnetic bodies which connects organism to the magnetic body of Earth.

The length scale $\lambda^4 L(151)$ equals to 176=88+88 km for $\lambda = 2^{11}$. The cavity between ionosphere and Earth surface is about 100 km thick whereas litosphere plate has thickness about 80 km [48]. The layer responsible for atmospheric phenomena is about 10 km thick. 180 km thickness is consistent with 176 km thickness predicted by $\lambda = 2^{11}$. Litosphere plate + atmosphere and ionosphere above atmosphere could thus form the counterpart of bilayered cell membrane. This hypothesis makes sense since its is dark matter which is involved with the Josephson junction in question. If this where the case living organisms would be analogous to the proteins defining receptors, ionic channels, and pumps at the cell membrane. For this option the convoluted magnetic flux tubes defining Josephson junctions could carry monopole flux which returns back at the larger space-time sheet. In this hyper-genes would involve organisms in the scale of entire Earth.

In this picture vertebrates would be like magnetic plants extending from the bottom of litosphere to the ionosphere. These Josephson junctions would presumably connect parts of the magnetic body of Earth to each other. Josephson frequency is 3.4 Hz and belongs to theta band in EEG. The frequency is somewhat higher than the 3 Hz frequency associated with absence seizures. 3-4 Hz posterior rhythm is established in EEG of 3 months old child in awake state. 5 Hz rhythm is established at the age of 6 months. A possible interpretation is that perturbing oscillatory voltage is superposed on the 3.4 Hz drum beat.

4.2.6 $k_d > 4$ levels

$k_d = 5$ corresponds to the length scale $L(151 + 5 \times 22 = 261) = .32$ Mkm to be compared with the solar radius $R = .7$ Mkm and Earth radius 6.3×10^3 km. Earth's rotating inner magnetosphere extends at night side to about 100 Earth radii which is of same order of magnitude as $L(261)$. The rather remarkable finding that equatorial plasma sheet is self-organizing system [49] which seems to represent in electron distributions patterns resembling "flowers", "eyes", etc... might have deeper meaning if plasma sheet corresponds to $k_d = 5$ level of dark matter hierarchy. I have indeed suggested the interpretation of these patterns as magnetospheric sensory representations [M1, N1].

Because of its size Sun could correspond to $k_d = 5$ level naturally. A possible interpretation is that all planets are accompanied by dark matter hierarchy involving also this size scale but that only in case of Sun there is considerable density of visible matter associated with this dark matter. In the case of Earth only plasma sheet would be associated to this level.

$k_d = 6$ corresponds to the length scale .64 Gkm and is of the same order of magnitude as the size of the planetary system (the distance to Sun about $AU = .146$ Gkm). $k_d = 7$ corresponds to the length scale 1.28 Tkm and could correspond to the size of solar magnetosphere. This size scale is .14 light years. The distance of nearest star is about 4 light years.

One can argue that a flux tube of thickness $L = 5L(169)/\sqrt{2}$ cannot follow every twist and turn of the highly convoluted DNA double strand. Many-sheeted space-time might save the situation. On the other hand, if the thickness of flux sheet is $L/\lambda = 8.8$ nm, it has almost the thickness of cell membrane and could adopt the shape of the convoluted DNA strand. The transversal dimension of base pair is indeed about 1.2 nm meaning that the thickness of the double strand is about 2.5 nm. Note that $k = 167$ could correspond to flux sheets traversing only single strand.

In this case the width of the flux sheet would be about 136 light years so that $k_d = 7$ level would indeed conform with the assignment of cosmic consciousness with the crown chakra. In this case the flux sheet should flow through $\sim 10^{15}$ neurons or cells and bind them to single string defining kind of super genome. The total number of cells in human body is estimated to be around 10^{14} so that hyper genes involving large number of different organisms should appear at this level if most of the flux sheet cross section contains DNA. As already noticed the estimate for the size of the scaled up version of nucleus implies that hyper-genes should appear already at $k_d = 2$ level.

4.3 Relation with the structure of CNS

Page of a book is rather precise metaphor for the magnetic flux sheet going through a linear array of strings of nuclei. This raises several questions. Do the lines of the text of this book correspond to axons in neural circuits? Do the pages correspond to larger structures formed by the axons? This might hold true for sufficiently large values of k_d, say $k_d \geq 2$.

Books are made for reading and one can thus ask whether the book metaphor extends. Could the observed moving brain waves scanning cortex relate to the "reading" of the information associated with these sheets of book by the magnetic body and does our internal speech correspond to this "reading"? One is also forced to ask whether these brain waves are induced by waves propagating along magnetic flux quanta of the magnetic body of Earth or personal magnetic body in the case that it has components other than magnetic flux sheets serving as Josephson junctions.

5 The effects of ELF fields on brain and high T_c ionic super conductivity

The article 'Spin the tale on the dragon' by David Jarron [17] 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 [18, 24]. The online review article of Cherry [29] 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.

5.1 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 [24] 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 [19, 21, 23].

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.

5.1.1 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 [29].

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 alternations. At the level of neuroendocrine 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 case of immune system an example is provided by the change of functioning of lymphosytes in turn reducing the competence of immune system making the subject more vulnerable to allergens, toxins and viruses.

5.1.2 Amplitude windows

Two main amplitude windows have been seen. 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 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 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 [34]. 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.

5.1.3 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 [22]: 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 [28] 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) [26]. 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 mul-

tiples of cyclotron frequencies give rise to stronger effects [24]. 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.

5.1.4 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.

a) 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.

b) 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 [35]. 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.

a) 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.

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

c) 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 $\hbar = \lambda^{k_d}\hbar_0$, $\lambda \simeq 2^{11}$.

5.1.5 A brief summary of the model

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.

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

$$E = E_c + E_L \ , \quad E_c = (n + \tfrac{1}{2})\hbar\omega_c \ , \quad E_L = S_z \tfrac{g\omega_c}{2} \ , \quad \omega_c = \tfrac{ZeB}{m} \ \ (c = 1) \ . \tag{3}$$

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.

b) The model for high T_c superconductivity involving competition of two superconductivities, one associated with cell interior and second with cell membrane is the starting point. These phases coexist in a narrow range around critical temperature and 36-37 C range where the effects are observed is a good candidate for this range.

c) 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. For $k_d = 4$ level of dark matter hierarchy cyclotron energy scale turns out to be above the thermal energy $2.88T$ of photons at maximum intensity of black body radiation at room temperature for $A \leq 223Z$. 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. The scale of cyclotron energies for $k_d = 4$ level of dark matter hierarchy is indeed turns out to be consistent with this assumption.

d) The ELF em field used in the experiments have electric fields strengths in two windows: one around 10^{-7} V/m and second corresponding to $1 - 10$ V/m. Even in the latter case the field is by a factor of order million weaker than membrane potential: the notion of many-sheeted space-time allows to understand why so weak fields can have effects on biomatter. Amplitude windows are a further mystery related with the interaction of ELF em fields with brain tissue: if ELF em field defines potential difference eV associated with a Josephson junction, one might understand this effect in terms of quantum jumps induced by Josephson current with frequency $f = ZeV/2\pi$.

e) 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 $\hbar$.

f) Josephson current is of form $J \propto sin(2eVt + 2e \int V_1 dt)$ and its amplitude does not depend on the strength of the perturbation V_1. V_1 is same for all values of $\hbar$ but scales like $L(k)$ as function of p-adic length scale for given value of $\hbar$. Perturbation is represent as EEG pattern commu-

nicated to the magnetic body of fractally scaled up variant of cell or cell nucleus, which reacts appropriately. At the limit when the Josephson frequency $f_J^1 = 2eV_1/2\pi\hbar$ of perturbation satisfies $f_J^1 \gg f_c$, the amplitude of perturbation is coded to frequencies $f_\pm = f_J^1 \pm f_J$ in the EEG in a good approximation.

g) The response of the system is that of AND gate. V_1 induces in the neuronal nucleus or its scaled up counterpart cyclotron transitions if the frequency is correct. If this the case, cell nucleus opens up communication line receiving possible control signals from the magnetic body at higher level of hierarchy. V_1 induces in Josephson junctions effects if the amplitude is in the amplitude window guaranteing that the frequencies $f_\pm$ belong to EEG resonance bands (or their scaled up variants. In this case magnetic body receives representation of V_1 as coherent photons and responds. If communication line is open the response induces in the cell nucleus gene translation and other activities necessary for the biological response. The model implies that cyclotron frequencies code for the biologically relevant information carried out by classical electric fields so that noise is eliminated very effectively.

5.2 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. 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 k_d in the dark matter hierarchy made possible by the external conditions allowing co-presence and competition of phases corresponding to $k_d - 1$ and k_d.

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.

5.3 Interpretation of amplitude windows in terms of resonance bands of generalized EEGs

5.3.1 Basic observations

The first amplitude window corresponds to $E \in [1, 10]$ V/m. Second window is around $E = 10^{-7}$ V/m. The following observations are crucial in attempt to understand what these windows correspond to.

a) The ratio of average electric fields for amplitude windows is $\sim 5 \times 10^7$. This is not too far from $\lambda^2 \simeq 4 \times 10^6$. This would suggest that the two windows correspond to levels k and $k + 2$ of dark matter hierarchy.

b) In Josephson junctions electric field is converted to voltage which in turn defines Josephson frequency. The voltage over junction is represented as a Josephson current generating coherent state of photons. The electric field is thus represented as biological actions induced by the absorption of coherent (dark photons) photons. Also the decoherence of these photons to ordinary photons would be involved.

These observations allow to construct a model for amplitude based on the idea that they correspond to resonance bands for generalized EEGs associated with p-adic and dark matter hierarchies.

5.3.2 Could amplitude windows correspond to the resonant EEG bands for the generalized EEGs?

In the proposed model of EEG the amplitude of oscillatory perturbation $V_1 sin(2\pi ft)$ of the voltage of Josephson junction is coded to Josephson frequency $f_J^1 = 2eV_1/2\pi\hbar$ and for $f_J^1 \gg f$, the frequencies $f_\pm = f_J \pm f_J^1$ appear in the generalized EEG spectrum as fundamental frequencies so that amplitude is coded to frequency. The frequency f itself defines the duration of the periodically occurring modulation of Josephson current. This

would suggest that the amplitude windows correspond to frequencies $f_J \pm f_J^1$ belonging to the resonant bands in the generalized EEG.

The requirement $f_J^1 > f_c$, the condition that f_J^1 and f_J are of same order of magnitude, and the condition that the scaled down counterpart of $f_\pm = f_J \pm f_J^1$ in ordinary EEG belongs to the range of EEG frequencies, fix uniquely the selection of k and k_d for both $E \in [1-10]$ V/m and $E = 10^{-7}$ V/m.

5.3.3 Josephson frequencies associated with amplitude windows

In the table below the Josephson frequencies associated with the perturbations $E = 1$ V/m, $E = 10$ V/m and $E = 10^{-7}$ V/m as a function of p-adic length scale. There is no dependence on the level of dark matter hierarchy.

k	151	157	163	167	169
$f_J^1/MHz(1\ V/m)$	3.72	29.8	238	952	1905
$f_J^1/MHz(10\ V/m)$	37.2	298	2380	9520	19050
$f_J^1/Hz(10^{-7}\ V/m)$	0.37	2.98	23.8	95.2	190.5

Table 5. Josephson frequencies f_J^1 having relevance for periodic perturbations satisfying $f_J^1/f \gg 1$ as a function of p-adic length scale. The frequencies are given for $E = 1V/m$, $E = 10$ V/m and $E = 10^{-7}$ V/m.

It is quite possible that also other values of k in the range $151, ..., 172$ are possible and this is indeed suggested with the experience with p-adic mass calculations which favor also other values of k besides integers.

5.3.4 Amplitude window $1-10$ V/m

In this case $f_J^1 \gg f_c$ condition is trivially satisfied. $k_d = 2$ is the only possible choice for dark matter level and corresponds to 2+2 cm Josephson junctions. $k = 151$ and $k = 157$ are the only possible candidates for the p-adic length scale in question. For $k = 157$ the upper limit for f_J^1 however corresponds to a frequency above the range 1-100 Hz of EEG frequencies so that this option looks implausible.

In order to utilize the intuition about ordinary EEG, one can translate scaled down the frequencies by a factor λ^{-2}. For $k = 151$ the scaled down frequencies satisfy

a) $f_+ \in [4.48, 12.85]$ Hz and $f_- \in [2.62, 5.75]$ Hz for $\lambda = 2^{11}$,

b) $f_+ \in [4.08, 12.45]$ Hz and $f_- \in [2.22, 6.15]$ Hz for $\lambda = 2.17 \times 10^3$.

f_+ and f_- cover delta, theta, and alpha bands and part of beta band. If the proposed interpretation is correct, the detailed dependence of the effect on V_1 should reflect the resonance band structure of EEG in this region.

5.3.5 Amplitude window around $E = 10^{-7}$ V/m

The condition $f_J^1 > f_c$ allows $f_\pm$ type EEG resonance only for $k = 163$ and $k_d = 4$ level of dark matter hierarchy.

a) For $\lambda = 2^{11}$ one has $f_+ = 27.1$ Hz and $f_- = f_J^1 - f_J = 20.4$ Hz. 27 Hz frequency corresponds to a resonance frequency in the EEG of dog induced by stimulation with monochromatic light [51]. $f_- = 20.4$ is very near to the second harmonic of the fundamental 10 Hz alpha peak and Schumann frequency 20 Hz.

b) $\lambda = 2.17 \times 10^3$ gives $f_+ = 26.4$ Hz and $f_- = 21.1$ Hz. f_+ is between Schumann resonance 26 Hz and 27 Hz resonance.

$\lambda = 2^{11}$ is favored by the following observation. $f \sim 3$ Hz peak in EEG correlates with spike activity accompanying absence seizures. For $k = 151$ one has $f_- = f_J(151) - f_J^1 = 3.38 - .37$ Hz $= 3.01$ Hz for $\lambda = 2^{11}$. Slowly varying perturbations with frequency $f < f_J^1(157)$, perhaps some cyclotron frequency, could induce resonant oscillation with frequency $\simeq 3$ Hz, which corresponds to A=100 (^{99}Ru).

5.4 Why it is necessary to have both cyclotron frequency and amplitude in the window?

The explanation of amplitude windows leaves for cyclotron frequencies a very passive role and there seems to be no special reason for why the frequency of V_1 should correspond to cyclotron frequency. What seems to be the simplest interpretation for the situation is that there is a kind of AND gate involved. A non-vanishing net effect requires too separate effects which can be assigned with the membrane and interior of the structure involved, most naturally cell nucleus or its scaled up counterpart. This makes sense if one assumes that the magnetic flux sheets have DNA strands or as fractality suggests, their scaled up variants as transversal sections.

This conforms with the general vision that high T_c superconductivity involves two different competing super conductivities at quantum criticality, which presumably corresponds to the temperature interval 36-37 C in the recent case. Quantum criticality is a necessary prerequisite that AND gate gives result 1. The supra currents flowing in the interior of cell or its nucleus correspond to large $\hbar$ variant of BCS superconductivity. Second

superconductivity corresponds to surface supra currents flowing along the membrane of cell or nucleus. For the surface super-conductivity the notion of Josephson junction makes sense only in synaptic contacts or gap junctions since the electrons of Cooper pair belong to different lipid layers. Josephson junctions between interior and exterior are a sensible concept if both are in large $\hbar$ phase. For cell nucleus inside cell this holds true. This kind of Josephson junctions could be also between two cells in synaptic contacts or gap junctions. This consideration generalizes straightforwardly to the scaled up version of cell and cell nucleus.

Consider now how the hierarchy of AND gates could be realized.

a) At cell membrane the perturbation V_1 affects Josephson junctions. For this effect the value of the frequency is not essential as long as the condition $\omega_J^1 \gg \omega$ is satisfied. V_1 affects generalized EEG. This means essentially a representation of V_1 in terms of EEG frequency and communication of this information to higher level magnetic body, which then reacts to situation by sending a control signal. The effects are therefore high level "behavioral" rather than direct "physiological" effects (this is of course relative concept due to the hierarchy). Indeed, in case of $E = 10^{-7}$ V/m perturbations the effects are high level effects affecting prey detection and navigation. Note that the size of the effect do not depend on the amplitude as long as $\omega_J^1 \gg \omega_c$ is satisfied since it is the phase of Josephson current rather than amplitude that is affected by V_1. This is absolutely essential for the universality of EEG amplitudes. If EEG wave indeed results it has amplitude in the range 5-10 V/m it it is expected to induce similar effect at $k_d = 2$ level of hierarchy if the proposed interpretation for $E \in [1 - 10]$ effects is correct. This means that also communication to lower levels occurs automatically. Here the amplitude window condition is guaranteed by the properties of Josephson current.

b) V_1 induces also cyclotron transitions in the cell nucleus or its fractally scaled up counterpart and in this manner affects the competing BCS type interior supra currents and BE condensates. Any controlled biological activity must involve the activation of genome inducing the translation of genes to amino-acid sequences needed to realize the needed action. Hence the AND gate could be realized in a simple manner: cyclotron transitions would simply turn the communication line from magnetic body to nucleus on. If the frequency is wrong, the higher level magnetic body receives the message and responds but since the nucleus does not experience the cyclotron transitions it is off-line and nothing happens. If amplitude is not in the window but frequency is correct, the communication lines is on but no signal goes to the magnetic body and no command for action is received.

6 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 noise is subtracted. The contribution of neural activity is one such source of noise, often regarded as the only contribution.

6.1 Basic contributions to EEG and ZEG

There are three fundamental contributions to EEG (or hierarchy of EEGs) besides the neuronal noise. This picture applies more or less as such also to ZEG.

a) Schumann resonances whose interpretation should be clear. These frequencies do not depend on magnetic field strengths assignable with magnetic flux sheets and characterize Earth's magnetic field and collective aspects of consciousness.

b) Cyclotron frequencies generated in cyclotron transitions of ions. An attractive guess is that cyclotron frequencies correspond directly to the control signals from the magnetic body or that they result as a consequence of the generalization actions of the magnetic body so that Josephson junctions and magnetic body would form a closed feedback loop. For instance, ions could drop during generalized motor actions to excited cyclotron states at dark magnetic flux quanta and their decay would produce dark cyclotron photons. Cyclotron frequencies can be classified to those associated with bosonic and fermionic ions respectively. The transitions of Bose-Einstein condensates of bosonic ions are of special interest. The scale of these frequencies could be be subject to homeostatic regulation which is local and can vary even inside genes of a given nucleus.

c) The frequencies generated by Josephson currents as coherent photons. Harmonics of cyclotron frequencies shifted upwards and downwards by Josephson frequency $f_J = 5$ Hz. If the amplitude of the perturbation at cyclotron frequency is strong the EEG looks locally like it would consists of amplitudes with frequencies $f_\pm = f_J^1 \pm f_J$ during most of the cyclotron period so that the visual inspection of time evolution of EEG can be rather misleading. Since these frequencies are involved with communications to the magnetic body of Earth, the natural guess would be that they correlate

with the neural processing.

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

a) Cyclotron frequencies relate to the control of the biological body by the magnetic body and could be assigned with the magnetic flux sheets going through DNA since it is genome where protein synthesis is initiated and is thus the optimal intermediate step in the cellular control.

b) One of the basic functions of cell membranes is to perceive 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. 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.

c) This picture would explain why the temperature of brain must be in the narrow range 36-37 K to guarantee optimal functionality of the organism. If interior superconductivity is lost, magnetic body receives sensory data but is paralyzed since its desires cannot be realized. If boundary superconductivity is lost, magnetic body can move but is blind.

d) In the length scales below the weak length scale L_w also charged weak bosons behave as massless particles and the exchange of virtual W bosons makes possible a nonlocal charge transfer. Dark quark-antiquark pairs associated with the color bonds of the atomic nuclei can 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 nonlocal quantal mechanism inducing or changing electromagnetic polarization in turn inducing ordinary charge flows and thus making possible quantum control.

e) Massless extremals (MEs, topological light rays) serve as correlates for dark bosons. Besides neutral massless extremals (em and Z^0 MEs) TGD predicts also charged massless extremals obtained from their neutral counterparts by a mere color rotation (color and weak quantum numbers are not totally independent in TGD framework). The interpretation of the charged MEs has remained open hitherto. Charged W MEs (hierarchy of WEGs!) could induce long length scale charge entanglement of Bose-Einstein condensates by inducing exotic ionization of ionic nuclei. State function reduction could lead to a state containing a Bose-Einstein condensate in exotically

ionized state.

In this manner the dark charge inside neuron and thus by Faraday's law also membrane potential could be affected by magnetic body. The generation of nerve pulse could rely on the reduction of the resting potential below the critical value by this kind of mechanism inducing charge transfer between cell interior and exterior. The mechanism might apply even in the scale of magnetic body and make possible the control of central nervous system. Also remote mental interactions, in particular telekinesis, might rely on this mechanism.

To sum up, charged massless extremals could be seen as correlates for nonlocal quantum control by affecting charge equilibria whereas neutral MEs would serve as correlates for coordination and communication. Color charged MEs could also induce color charge polarization and flows of color charges and thus generate visual color qualia by the capacitor mechanism discussed in [K3].

6.2 Classification of cyclotron frequencies

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

a) Cyclotron frequencies can be classified those associated with atomic and 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. Thermal stability condition suggest a lower bound of ~ 1 Hz for significant frequencies of this kind. Thus it would seem that delta band dominating during deep sleep corresponds to DNA and possibly other bio-molecules and EEG during wake-up state corresponds to atomic ions.

b) 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. Situation is essentially the same for biologically interesting ions too. $^7Li^+$ is exception and corresponds to 42.9 Hz: as a fermionic ion it does not possess satellites and does not contribute to Josephson part of EEG. Thus the frequency range $7.5 - 15$ Hz is very strongly represented and expected to be fundamental.

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

d) The integer n characterizing the harmonic of the cyclotron frequency

in question is an additional classificational criterion and n could correlate with the character of neural processing.

6.3 Wake-up EEG

The question is whether this classification is consistent with the conventional decomposition into various bands and whether it allows to gain some real insights EEG. Consider first wake-up EEG [39].

a) The first implication is that each cyclotron frequency f_c is accompanied by by two satellites $f_c \pm f_J$. For alpha band these satellites correspond to theta band and beta band identifiable as responses to control signals from magnetic body in alpha band. One can ask whether these bands as a whole correspond to the satellites of alpha band. This identification implies that both bands are present and makes sense for wake-up EEG but not as such for the EEG during first and second period of deep sleep during which theta band is present but higher bands are absent.

b) Sensorimotor rhythm in range (12-16) Hz is associated with physical stillness and body presence. The interpretation is as a low amplitude satellite of alpha rhythm with low amplitude control signals from the magnetic body so that rhythmicity is not lost and frequencies are clearly $f_c + f_J$.

c) Beta band is above 12 Hz and associated with active, busy or anxious thinking and active concentration and is chaotic and highly asynchronous. The natural interpretation is as large amplitude satellite of alpha band involving the activation of communications to the magnetic body and large control signals with $f_J^1 \gg f_c$. Hence the spectra would for a considerable part of period $1/f_c$ effectively consist of frequencies $f_\pm = f_J \pm f_J^1$, where f_J^1 varies in frequency range characterized by the amplitude of perturbation. There is no definite resonance frequency since ω_1^J can vary continuously. Globally the situation is different since the spectrum can in principle be decomposed to frequencies $f_J \pm nf_c$. These two descriptions correspond to time domain and genuine frequency domain.

For sufficiently high harmonics of f_c the chaoticity disappears and frequencies $f_J \pm nf_c$ become more manifest. The Josephson amplitudes of higher harmonics decrease as $1/nf_c$.

Beta band is predicted to have a mirror image in theta band during cognitive activity. The frequencies in theta band are assigned with cognitive activities and memory recall. Note that also alpha band due to cyclotron frequencies should be present as well as the basic "drum beat" defined by f_J for $f_J^1 \gg fc$.

d) Odd higher harmonics of cyclotron frequency are expected to be the

most important ones and would have interpretation as control signals from magnetic body. Satellites would correspond to responses to magnetic body involving entire 160 km thick Josephson junction but certainly correlating strongly with what happens in brain (recall the analog of biological body with a receptor at cell membrane).

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.

Fifth harmonics would be be 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.

e) 40 Hz thalamocortical 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) and have no satellites as fermionic ions.

6.4 Satellites exist as mirror pairs!

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 [51]. 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 [51]. All these frequencies are expressible in the form $f_c \pm f_J$, $f_J = 5$ Hz, which is one half of the frequency 10 Hz of the memetic code and by 14 per cent higher than 3.7 Hz predicted assuming $\lambda = 2^{11}$. The value of λ deduced from these frequencies would be $\lambda = 1902$ and about 7 per cent smaller than $\lambda = 2^{11}$. This estimate cannot be taken too seriously since it is quite possible that the thickness of Josephson junction is not scaled up completely exactly.

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 λ and B 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 appears. It should be also noticed that $f_J = 5$ Hz frequency corresponds to cognitive theta appearing during tasks requiring mathematical skills.

6.5 Alpha band dominance during relaxed state

In a relaxed state beta band disappears and the spectral power in alpha band increases. This seems to be in conflict with the idea that beta band is a mere satellite. There are two mutually non-inclusive manners to understand this.

a) The first possibility is that cyclotron frequencies in alpha band are not actually present and only Schumann frequency 7.8 Hz and 10 Hz resonance frequency associated with the excitations of electric field in ionospheric cavity behaving like 2-dimensional waves on sphere.

b) Second possibility is that ionospheric Josephson junction is somehow closed so that only the cyclotron contribution of various ions is present. This might be caused by DNA level mechanism which simply prevents the flow of the Josephson currents flowing along magnetic flux sheets through DNA strands. This mechanism would be completely analogous to the closing of ionic channel associated with cell membrane protein.

6.6 EEG during sleep

The EEG during sleep [40] 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. This turns out to be a correct guess.

6.6.1 EEG during stage 1

During stage 1 theta of deep sleep [40] waves in frequency range 4-8 Hz dominate and amplitudes increase when frequency is reduced. The control signals from magnetic body are expected to be weak so that $f_J^1 < f_J$ approximation should hold true implying that frequencies $f_J \pm f_c$ should dominate and EEG would look rhythmic rather than chaotic as indeed observed. The amplitudes behave as $1/\omega_c$ and thus increase with decreasing ω_c. The fact that amplitudes increase with decreasing EEG frequency suggests that the frequencies they correspond to different cyclotron frequencies.

These facts does not conform with the general picture as such. If theta and beta bands are mere satellites of alpha band, both of them should be present during stage 1 sleep but this is not the case. The idea that cyclotron frequencies of heavier ions in $B_{end} = .2$ Gauss could replace those appearing during wake-up does not work. Theta band simply does not contain the cyclotron frequencies of biologically important ions for $B_{end} = .2$ Gauss. One can imagine two manners to resolve the difficulty.

1. Two manners to quantize magnetic flux

One way out of difficulty seems to be that the value of the magnetic field associated with active flux sheets is reduced by a factor of 1/2. This would mean that 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 can image several manners to resolve the problem but the most natural resolution of the puzzle came with the frustrating realization that $B_{end} = .2$ Gauss explaining the observations of Blackman and others is not equal to the Earth's magnetic field $B_E = .5$ Gauss. Although B_{end} corresponds to $k = 169$, the value of Planck constant is $\hbar = 5\hbar_0$ and flux unit is $h_5 = 5h_0$. For B_{end} $k = 169$ flux tubes carry two units of flux and for $B_{end}/2$ single unit so that the halved value of B_{end} emerges very naturally.

The different values of field intensities might relate to the character of ions at the flux sheets in left and right hemisphere.

a) The quantization of magnetic flux reads as $Ze \int BdS = n\hbar$ and for Cooper pairs and bosonic ions with $Z = 2$ (Z refers to the absolute value

of charge) it gives magnetic field strength which is one half from that for fermionic singly charged ions. Both fermionic ions with $Z = 1$ and bosonic ions and Cooper pairs with $Z = 2$ are allowed in this case by the single valuedness of wave functions. For $Z = 2$ the quantization condition allows single valued wave functions for $Z = 2$ ions or Cooper pairs only.

b) Assume the quantization condition corresponds to $Z = 1$ for the left hemisphere and $Z = 2$ for the right hemisphere. The presence of fermionic ions implies additional cyclotron frequencies on left hemisphere and the presence of fermionic ions conforms with the old proposal that fermionic Fock states provide a realization of quantal version of Boolean algebra. This conforms with the view that left brain is more reductionistic and performs linear logic operations whereas right brain is more holistic.

c) As a consequence the cyclotron frequency scale in right hemisphere is reduced by a factor of 1/2 and during right hemisphere dominated NREM sleep alpha band would be scaled down to theta band.

d) The prediction is that, apart from the Schumann frequencies and neural noise, left hemisphere EEG spectrum consists of right hemisphere EEG specrum scaled up by a factor of 2 plus the contribution of fermionic ions and the Josephson satellites of these frequencies.

The assumption that the two quantization conditions correspond to just left and right hemispheres rather some other pair is of course un-necessarily strong and one can imagine also other correspondences.

2. Exotic ions as a resolution of the problem?

Second manner to achieve the scaling down of alpha band by a factor of 1/2 relies on the notion of exotic atomic nuclei. Z^0 ions coupling to $k = 113$ exotic weak bosons with $k_d = 2$ result if some color flux tubes bonding the nucleons of nuclei to nuclear string become weakly charged. This means that a color bond having quark and antiquark at its ends becomes $u\bar{d}$ type bond or its charge conjugate so that color bond becomes also em charged. There is evidence for this process. For instance, TGD explains the properties of tetraneuron assuming that alpha particle with two negatively charged color bonds is in question [F8].

Exotic ion is not chemically equivalent with an ion of same em charge since the valence of the system is anomalous. For instance, as far as electronic shell is considered, the ion could behave like noble gas atom. Electronic ionization could also compensate exotic ionization so that an electromagnetically neutral but weakly charged ion would result. For instance, doubly charged bosonic ions could have em neutral counterparts with two units of weak charge (unit defined as the weak charge of $u\bar{d}$ type color bond).

Since fermion number is not affected, singly charged exotic ion is boson for all nuclei with even neutron number, that is for the most stable nuclei. All biologically relevant ions might thus exist in bosonic states and form Bose-Einstein condensates. One can even wonder whether ions such as Na^+, K^+, and Cl^- associated with cell are actually exotic ions and appear as Bose-Einstein condensates. For doubly charged bosonic ions, most of which are in alpha band, cyclotron frequencies of singly charged exotic counterparts would be halved. Also the Josephson frequency would be halved. For the first option this is not the case.

6.6.2 EEG during stage 2

Sleep spindles appearing in the state 2 of deep sleep are sudden increases in EEG amplitude and frequency from theta band to 12-16 Hz [41]. The spindles .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.

One interpretation is that sleep spindles correspond to the occasional wake-ups of the left hemisphere. 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 to left hemisphere but inducing no response. It might be that these sudden responses reflect the fact that the left brain is not fully asleep yet.

6.6.3 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 [40]. This implies that control signals at cyclotron transition frequencies of ions from the magnetic body cannot be appreciably present and the control signals at cyclotron frequencies of molecular ions, such as DNA with cyclotron frequencies below 1 Hz, should be responsible for the EEG. The small amplitude of control signal implies $1/f_c$ behavior and large amplitude as compared to the corresponding amplitudes at higher bands at weak amplitude limit.

Taking into account the fact that magnetic field strength is scaled down by factor of 1/2 this means that mass numbers of the ions in question must satisfied $A/Z \geq 150$ for $f_c \leq 1$ Hz. For DNA sequences with charge of 2

units per single base-pair one would have $A \geq 300$. The atomic weights for base pairs plus phosphate group and deoxyribose sugar are $327, 321, 291, 344$ corresponding to A, T, C, G. Harmonics would be present also now but their contributions are small if the amplitudes of the control signals are small.

6.6.4 Transcendental states of consciousness and EEG

Transcendental states of consciousness are characterized by the presence of alpha and theta bands [42] (note that theta band is present also during childhood, youth and even early adolescence but usually disappears at older age). It is found that that theta and alpha bands are preserved also during deep sleep [43]. 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.

6.7 Scaled up EEG periods at levels $k_d = 5, 6, 7$

It of considerable interest to find the scaled up EEG periods corresponding to frequencies $8, 10, 12$ Hz in alpha band and their satellites for levels $k_d = 5, 6, 7$ levels in order to see whether they might correspond to some important bio-rhytms. For $\lambda = 1902$ Josephson periods are given by $T_J = 7.35$ minutes, 9.02 days, and 43.6 years.

T_c/min	4.59	3.66	3.06
$T_+(1)/min$	12.25	7.35	5.25
$T_+(3)/min$	1.93	1.47	1.19
$T_+(5)/min$	1.05	0.82	0.67
$T_-(1)/min$	2.83	2.45	2.16
$T_-(2)/min$	1.27	1.05	0.90
$T_-(3)/min$	0.82	0.67	0.57

Table 6. Periods T_c and $T_\pm(n)$ corresponding to f_c and $nf_c \pm f_J$, $n = 1, 3, 5$ for scaled up EEG at $k_d = 5$ level corresponding to alpha band frequencies 8, 10, 12 Hz of the ordinary EEG. The unit is one minute and Josephson period is 7.35 minutes.

T_c/day	5.6	4.5	3.8
$T_+(1)/day$	15.03	9.01	6.44
$T_+(3)/day$	2.37	1.80	1.45
$T_+(5)/day$	1.29	1.00	0.82
$T_-(1)/day$	3.47	3.01	2.65
$T_-(2)/day$	1.55	1.29	1.10
$T_-(3)/day$	1.00	0.82	0.69

Table 7. Periods T_c and $T_\pm(n)$ corresponding to f_c and $nf_c \pm f_J$, $n = 1, 3, 5$ for scaled up EEG at $k_D = 6$ level corresponding to alpha band frequencies 8, 10, 12 Hz of the ordinary EEG. The unit is one day and Josephson period is 9.02 days. Note that 1 day (24 hours) appears as period.

T_c/y	27.3	21.8	18.2
$T_+(1)/y$	72.7	43.6	31.2
$T_+(3)/y$	11.5	8.7	7.0
$T_+(5)/y$	6.2	4.8	4.0
$T_-(1)/y$	16.8	14.5	12.8
$T_-(2)/y$	7.5	6.2	5.3
$T_-(3)/y$	4.8	4.0	3.4

Table 8. Periods T_c and $T_\pm(n)$ corresponding to f_c and $nf_c \pm f_J$, $n = 1, 3, 5$ for scaled up EEG at $k_d = 7$ level corresponding to alpha band frequencies 8, 10, 12 Hz of the ordinary EEG. The unit is one year and Josephson period is 43.6 years.

6.8 Is $k_d = 3$ level responsible for kHz neuronal synchrony?

The time scale of nerve pulse emission is millisecond and synchronous emission of nerve pulses suggests the existence of a clock with frequency 1 kHz. Also memetic codeword for which single bit corresponds to 1027 Hz frequency requires a clock at ~ 1 kHz frequency.

The scaled up hierarchy of EEGs indeed predicts 1 kHz frequency band as a scaled up variant of 1 Hz cyclotron frequency associated with DNAs. Suppose that also magnetic flux tubes with area scaling as $S = \hbar^2$ and B scaling as $B \propto 1/\hbar$ are present, at least for sufficiently large values of k_d. For this hierarchy cyclotron frequencies would scale as $1/\hbar$ and for $k_d = 3$ 1 Hz DNA frequency in delta band would scale up to 2 kHz for $Z = 1$ magnetic flux quantization. For $Z = 2$ flux quantization scaled up

DNA cyclotron band would be around 1 kHz and could serve as a drum beat making possible synchronized neuronal firing. Similar situation would be obtained for the cyclotron frequencies of singly charged exotic ions for which color bond inside nucleus has become color charged so that cyclotron frequency is typically in or below alpha band scaled down to 5 Hz.

6.9 Generalization of EEG to ZEG

The generalization of the model of EEG to ZEG (E in the middle of EEG could be of course replaced with appropriate letter such as K) is rather straightforward.

Also now there are three contributions: Z^0 Schumann frequencies, cyclotron frequencies, and the frequencies associated with Josephson junctions. The most conservative approach assumes that also Z^0 flux sheets characterized by k_d traverse DNA (that is genes have wormhole contacts with these flux sheets). If these sheets possess the thickness of DNA double strand, the finite range $L_w(k_d)$ of $k = 113$ Z^0 quanta does not pose other restrictions than the requirement that the overall width of flux sheets is below $L_w(k_d)$.

For $k = 113$ weak bosons with $k_d = 2$ one has $L_w \simeq .2$ μm. For $k_d = 4$ which is thermally stable one would have $L_w \simeq .8$ m corresponding to the size scale of the human body, which is by a factor 2^{-22} smaller than the corresponding size in the electromagnetic case. Z^0 magnetic fields satisfy flux quantization condition implying that cyclotron frequency and energy are proportional to $Q_Z/Q_{Z,0}$, where a particle with charge $Q_{Z,0}$ defines flux quantization. Cyclotron frequencies would differ from their electromagnetic counterparts for $k_d = 2$ level only by factors $Q_Z/Q_{Z,0}$. The condition that Z^0 ions are em neutral would mean that Z^0 ions and bosonic ions are in one-one correspondence so that ZEG would be more or less identical with EEG as far as cyclotron frequencies are considered.

The model of Josephson junction hierarchy must be based on guesses. The simplest guess is that the cell membrane involves also a space-time sheet giving rise to Z^0 voltage, which is minimal in the sense that the energy of a singly charged Z^0 ion is at thermally marginally stable and thus also now $\simeq .08$ eV. The hierarchy of Z^0 Josephson junctions would result in an exactly the same manner as in the electromagnetic case and Josephson energies are same for all levels whereas frequencies scale down as $1/\hbar$.

Also the notion of Schumann resonance at same energy range as in em case could make sense. The finite range of weak force implies effectively the presence of conductive spherical surface analogous to ionosphere at radius L_w preventing the penetration of Z^0 electric field through. Hence the system

would possess effective Z^0 Schumann cavity and it could be possible to speak about cavity oscillations. Earth length scale would correspond to $k_d = 6$ level of dark matter hierarchy for Z^0 field which would mean that the Schumann energy would be very large in this length scale, about .64 MeV. $k_d = 4$ level ($L_w = .8$ m) would give Schumann energy which is of the same order of magnitude as in electromagnetic case.

With these assumptions the spectrum of ZEG for $k_d = 4$ level would be very much like the spectrum of EEG. An important difference would come from the fact that simplest exotic ions obtained by the generation of charged color bonds inside nuclei would be singly charged bosons and alpha band would be scaled down to 5 Hz for them. The mass number differs by one unit from that of ordinary ion and the resulting change of cyclotron frequency could be used as an experimental signature of exotic ion. Also Josephson energy would be one half from that of $Z = 2$ satellites so that alpha band its satellites would be suffer exact scaling by factor 1/2. For $k_d = 3$ and Z^0 magnetic field scaled up by λ, the 1 Hz lower bound dictated by thermal stability would correspond to kHz frequency for $Z = 2$ flux quantization. Scaled up delta band might be the "drum beat" making possible neuronal synchronization.

7 Appendix: Cyclotron frequencies and Larmor frequencies

The appendix emphasizes the difference between the endogenous magnetic field B_{end} explaining the effects of ELF em fields on vertebrate brain and Earth's magnetic field B_E and lists cyclotron and Larmor frequencies of some ions for B_{end}.

7.1 The relationship between the values of the endogenous magnetic field and the Earth's magnetic field

For years I erratically believed that the magnitude of the magnetic field assignable to the biological body is $B_E = .5$ Gauss, the nominal value of the Earth's magnetic field. Probably I had made the calculational error at very early stage when taking Ca^{++} cyclotron frequency as a standard. I am grateful for Bulgarian physicist Rossen Kolarov for pointing to me that the precise magnitude of the magnetic field implying the observed 15 Hz cyclotron frequency for Ca^{++} is .2 Gauss and thus slightly smaller than the minimum value .3 Gauss of B_E. This value must be assigned to the magnetic

body carrying dark matter rather than to the flux quanta of the Earth's magnetic field. This field value corresponds roughly to the magnitude of B_E at distance 1.4R, R the radius of Earth.

Dark matter hierarchy leads to a detailed quantitative view about quantum biology with several testable predictions [M3]. The applications to living matter suggests that the basic hierarchy corresponds to a hierarchy of Planck constants coming as $\hbar(k) = \lambda^k(p)\hbar_0$, $\lambda \simeq 2^{11}$ for $p = 2^{127-1}$, $k = 0, 1, 2, ...$ [M3]. Also integer valued sub-harmonics and integer valued sub-harmonics of λ might be possible. Each p-adic length scale corresponds to this kind of hierarchy. Number theoretical arguments suggest a general formula for the allowed values of λ [C7] as $\lambda = n$ where n characterizes the quantum phase $q = exp(i\pi/n)$ characterizing Jones inclusion [C6]. The values of n for which quantum phase is expressible using only iterated square root operation are number theoretically preferred and correspond to integers n expressible as $n = 2^k \prod_n F_{s_n}$, where $F_s = 2^{2^s} + 1$ is Fermat prime and each of them can appear only once. $n = 2^{11}$ obviously satisfies this condition. The lowest Fermat primes are $F_0 = 3, F_1 = 5, F_2 = 17$. The prediction is that also n-multiples of p-adic length scales are possible as preferred length scales. The unit of magnetic flux scales up as $h_0 \to h = nh_0$ in the transition increasing Planck constant: this is achieved by scalings $L(k) \to nL(k)$ and $B \to B/n$.

$B = .2$ Gauss would corresponds to a flux tube radius $L = \sqrt{5/2} \times L(169) \simeq 1.58L(169)$, which does not correspond to any p-adic length scale as such. $k = 168 = 2^3 \times 3 \times 7$ with $n = 5$ would predict the field strength correctly as $B_{end} = 2B_E/5$ and predict the radius of the flux tube to be $r = 18$ μm, size of a large neuron. However, $k = 169$ with flux $2h_5$ would be must more attractive option since it would give a direct connection with Earth's magnetic field. Furthermore, the model for EEG forces to assume that also a field $B_{end}/2$ must be assumed and this gives the minimal flux h_5. Note that $n = 5$ is the minimal value of n making possible universal topological quantum computation with Beraha number $B_n = 4cos^2(\pi/n)$ equal to Golden Mean [E9].

An interesting working hypothesis is that B_{end} is the dark companion of the the Earth's magnetic field and that the ratio $B_{end} = 2B_E/5$ holds true in the entire magnetosphere as a time average so that B_{end} would define what might be called the dark magnetosphere of Earth.

7.2 Table of cyclotron frequencies and magnetic frequencies

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

$$f = \frac{A}{20} \times f(Ca^{2+}) \qquad f(Ca^{2+}) \simeq 15\ Hz\ . \tag{4}$$

Here the strength of the endogenous magnetic field B_{end} is assumed to be .2 Gauss $= 2 \times 10^{-5}$ Tesla. The

The following table 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 9. The first column gives cyclotron frequency in cycles per second for some ions in the endogenous magnetic field $B_{end} = 2B_E/5 = .2$ Gauss explaining the effects of ELF em fields on vertebrate brain ($B_E = .5$ Gauss denotes the nominal of the Earth's magnetic field). The remaining columns give spin or nuclear spin and Larmor frequency f_L.

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