TGD Inspired Quantum Model of Living Matter

M. Pitkänen
Email: matpitka@mappi.helsinki.fi.
http://www.helsinki.fi/∼matpitka/.

August 1, 2008

Contents

Abstract

Basic ideas of TGD inspired view about quantum biology are discussed. TGD inspired theory of consciousness provides the basic conceptual framework besides new view about space-time and quantum theory, in particular dark matter hierarchy whose levels are labelled by the increasing value of Planck constant so that macroscopic quantum systems are predicted to be present in all length scales. This gives a justification for the notion of field body having onion-like fractal structure with astrophysical size and using biological body as a sensory receptor and motor instrument. Great evolutionary leaps correspond naturally to the increases of Planck constant for the highest level in "personal" hierarchy of Planck constants implying a scaling up of time scales of long term memory and planned action. The notion of magnetic body leads to a generalization of the notion genome: one can assign coherently expressed super genome to single organ and hyper genome to an entire population. Important experimental input comes from high T_c superconductivity, from the strange findings related to cell membrane, and from the effects of ELF em fields on vertebrate brain. The model for EEG based on "dark" photons predicts correctly its band structure and also narrow resonances in theta and beta bands in terms of cyclotron resonance frequencies of biologically important ions.

Keywords: Topological Geometrodynamics, quantum theories of consciousness, quantum biology.

1 Introduction

One can make a long list of questions challenging the materialistic and reductionistic framework of standard biology.

1. Can one assume reductionism in its standard form? Can one reduce life to "standard" physics and chemistry or are macroscopic quantum phases needed? Is existing quantum physics enough?

2. Is locality assumption justified? Can one reduce the behavior of living matter to what happens in biological body? Can one reduce consciousness to brain alone?

3. What is the role of electromagnetic fields in living matter? What is the function of EEG: is it only a side product of the electrical activity of neural circuits?

4. Is the relation between experienced time and time of physicist really understood. Do we really understand the mechanisms of memory?

Taking seriously these questions one is led to consider the possibility that macroscopic and macro-temporal quantum effects might be crucial for living matter and consciousness. There is indeed some evidence for these effects.

1. The strange findings about ionic currents through cell membrane [40] suggest that these currents are quantal and universal in the sense that they do not depend on the structure of membrane involved, and that they do not appreciably dissipate energy. There is also some evidence for the flux quantization and Josephson tunnelling in physiological temperatures [35, 36].

2. High T_c super-conductivity [29, 31] is still a mystery and might represent something which goes outside the conceptual framework of standard physics.

3. Effects of very weak ELF em fields on vertebrate brain [63, 65] suggest quantal effects in thermal and amplitude windows in a frequency range in which quantal effects should be completely masked by thermal noise. This looks a complete mystery in the framework standard quantum mechanics. That the effects occur only for vertebrate brain is also puzzling.

4. EEG correlates with brain function and consciousness. The Compton wavelength of EEG photon about Earth size scale. If quantum effects are in question this would suggests that the visible part of the living matter might not be all that is important for the understanding of life. Also Libet's findings [56] about time delays of consciousness which are typically a fraction of second might be understood if brain communicates information to and receives control signals from structures of this size.

In TGD framework a possible explanation for these strange findings relies on dark matter matter hierarchy [C7, C8] whose levels are labeled by an increasing value of Planck constant. Dark matter would reside at dark field quanta (magnetic and electric flux quanta) responsible for the mysterious dark energy [D5]. Field bodies would act as intentional agents using biological body as a sensory receptor and motor instrument [M3]. Accepting this hypothesis the basic challenge is to understand how magnetic body controls and receives information from the biological body.

2 Basic ideas

2.1 The new view about time and energy

The new view about time and energy makes possible to distinguish even at elementary particle level between positive energy particles propagating to geometric future and negative energy particles propagating to geometric past and explains phase conjugate photons as a particular case of a completely general phenomenon. This distinction inspires a new view about realization of memory and of intentional action, and allows also the notion of remote metabolism. For all these mechanisms negative energy phase conjugate photons and possibly also other gauge bosons propagating to geometric past are essential.

Zero energy ontology gives justification for the notion of negative energies and propagation of signals to the geometric past. The distinction between two arrows of time could also mean dissipation in different direction of geometric time. Mathematically this distinction would relate to the imaginary parts of the complex eigenvalues of the modified Dirac operator [B4] analogous to mass (rest energy). The imaginary part defines inverse of a time scale T and in zero energy ontology a natural identification of T would be as a typical temporal distance between positive and negative energy parts of the zero energy state formed by positive energy particle at the boundary of future directed light-cone in geometric past ("not so big bang") and and negative energy particle at the boundary of past directed light-cone in geometric future ("not so big crunch"). This temporal distance does not relate to the decay rate of system be it particle or something more complex. It would however relate to the temporal span for the contents of conscious experience. For electron the time scale is .1 seconds and corresponds to the fundamental bio-rhythm.

2.2 p-Adic physics as physics of intentionality and cognition

p-Adic physics as physics of cognition and intentionality is an essential element in the understanding of living matter. The fusion of real and p-adic physics leads to a generalization of the notion of number obtained by gluing reals and p-adics together along common algebraic numbers and to a generalization of notions of imbedding space and space-time. p-Adic space-time sheets are identified as space-time correlates of intentions (bosons) and cognitions (fermions).

p-Adic fractality of real physics in long scales can be seen as a direct counterpart of smoothness and continuity of p-adic physics in short p length scales in p-adic sense. The effects of intentions and cognitions would be physically measurable albeit indirectly. p-Adic length scale hypothesis leads to quantitative predictions based on simple scaling arguments. What is fascinating that in the length scale range 10 nm-5 μm all p-adic length scales $p \simeq 2^k$, k prime, correspond to Gaussian Mersennes $(1+i)^k - 1$. The conjecture is that these Mersennes label fractal copies of electro-weak and or color physics relevant for how living matter is a macroscopic quantum system.

The origin of p-adic length scale hypothesis has been one of the basic open problems of TGD. The fundamental formulation of quantum TGD in zero energy ontology relates it to the Brownian motion assignable to light-like geodesic lines of light-like 3-surfaces defining the basic dynamical objects of quantum TGD. The standard formula $r^2 = Dt$ for diffusion generalizes and gives p-adic length scale hypothesis and assigns to elementary particles time scale as secondary p-adic time scale $T_p(2) = \sqrt{p}L_p$, $p \simeq 2^k$, characterizing the duration of zero energy space-time sheet having electron and its negative energy counterpart at its space-like boundaries. As noticed, for electron this time scale is .1 s and a fundamental biorhythm.

2.3 Hierarchy of Planck constants and dark matter hierarchy

The world of classical world is union over the configuration spaces associated with the imbedding spaces $H_\pm = M^4_\pm \times CP_2$ imbedded to M^4 ($M^4_\pm$ refers to future/past directed lightcone and the position of its tip varies over M^4). The generalization of imbedding space $H_\pm$ is obtained by gluing together along common sub-manifold an infinite number of almost copies with various values of $M^4_\pm$ and CP_2 Planck constants to get a book like structure. This generalization is discussed in detail in the Appendix of [L5] and of the first article of the series. Very roughly one can say that these almost copies of H correspond to products of singular factor spaces or covering spaces of $M^4_\pm$ and CP_2. The singular factor spaces have locally the bundle structure $M^4_\pm \to M^4_\pm/G_a$ and $CP_2 \to CP_2/G_b$. The singular covering spaces have the local structure $M^4_\pm \times G_a$ or $CP_2 \times G_b$. $G_a \times G_b \subset SU(2) \times SU(2) \subset SL(2,C) \times SU(3)$ (Cartesian product of Lorentz group and color group) with point which is invariant under subgroups of $G_a \times G_b$ representing orbifold points.

The pages of the big book have in general different values of Planck constant. Since the particles at different pages cannot appear in the same vertex of Feynman diagram, one can say that these particles are dark relative to each other. These particles can have classical interactions mediated by gauge fluxes tunneling between different pages and also interactions mediated by the tunneling of exchanged particles. The notion of relative darkness is consistent with that is known about dark matter in cosmological scales and explains several anomalies in the functioning of living cell.

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

in living matter [M3]. An especially important fractal hierarchy seems to correspond to $n = 2^{k11}$, $k = 0, 1, 2..$

One can imagine several kinds of new physics relevant for living matter. For instance, G_a should act as symmetries of visible matter controlled dark matter. This allows straightforward identification of candidates for this kind of systems. The free electron pairs associated with cyclic molecules containing 5- and 6-cycles and dominating biochemistry could be in dark phase corresponding $n = 5$ and $n = 6$ multiples of Planck constant. The delocalization of electron pairs of cycles of sugar basis of DNA would make possible phenomena like anomalous DNA conductivity [37, J3]. p-Adic length scale hypothesis allows these symmetries occur in even macroscopic length scales. For instance, the formation snow-flakes possessing 6-fold cyclic symmetry might involve quantum control by dark matter in a p-adic length scale of order of snowflake size.

Only the four amino-acids containing 5- and/or 6-cycles appear as neurotransmitters and neurotransmitters and various psychoactive substances in general contain these cycles [J3]. These findings suggest that the function of these substances is to make possible flow of electronic currents and perhaps super-conductivity in clusters of neurons which in turn would make possible quantum criticality of a particular kind allowing some magnetic body in the hierarchy of magnetic bodies to receive information from brain and also control it.

The hierarchy of Planck constants corresponds naturally to an evolutionary hierarchy, and great leaps in evolution would correspond to the increase of the value of Planck constant characterizing the highest level in the personal dark matter hierarchy. These leaps would involve scaling up of the time scale of long term memory and planned action. The model of EEG supports the view that the most important hierarchy corresponds to powers $n = 2^{k11}$, $k = 1, 2, ..$: precise predictions for the span of long term memories at particular level of the hierarchy as 2^{k11} multiples of basic time scale with .1 second corresponding to $k = 4$ follow from the model [M3]. The reason for the special role of power 2^{11} would be that it defines a fundamental dimensionless constant in TGD Universe [D6].

Large values of Planck constant could characterize collective levels of consciousness even for bacteria and the fact that the time scale of DNA-amino-acid translation is 20 amino-acids per second suggests that $k = 4$ level is present for bacteria (but not for viruses) and responsible for their social behavior. An interesting and testable working hypothesis is that social insects and even bacterial colonies could have magnetic body and collective "EEG" [M3].

At the level of biology there are now several concrete applications leading to a rich spectrum of predictions. Magnetic flux quanta would carry charged particles with large Planck constant.

1. The shortening of the flux tubes connecting biomolecules in a phase transition reducing Planck constant could be a basic mechanism of bio-catalysis and explain the mysterious ability of biomolecules to find each other. Similar process in time direction could explain basic aspects of symbolic memories as scaled down representations of actual events.

2. The strange behavior of cell membrane suggests that a dominating portion of important biological ions are actually dark ions at magnetic flux tubes so that ionic pumps and channels are needed only for visible ions. This leads to a model of nerve pulse explaining its unexpected thermodynamical properties with basic properties of Josephson currents making it un-necessary to use pumps to bring ions back after the pulse. The model predicts automatically EEG as Josephson radiation and explains the synchrony of both kHz radiation and of EEG.

3. The DC currents of Becker could be accompanied by Josephson currents running along flux tubes making possible dissipation free energy transfer and quantum control over long distances and meridians of chinese medicine could correspond to these flux tubes.

4. The model of DNA as topological quantum computer assumes that nucleotides and lipids are connected by ordinary or "wormhole" magnetic flux tubes acting as strands of braid and carrying dark matter with large Planck constant. The model leads to a new vision about TGD in which the assignment of nucleotides to quarks allows to understood basic regularities of DNA not understood from biochemistry.

2.4 Universal metabolic currencies

The dropping of particles to larger space-time sheets can liberate metabolic energy as zero point kinetic energy, and if Coulombic interaction energies can be neglected this leads to a spectrum of universal metabolic currencies. Hence one would get rid of the hen and egg problem whether metabolism preceded the chemical energy storage or vice versa [L4].

In particular, the $\sim$ .5 eV metabolic energy quantum associated with ADP-ATP cycle [K6] would correspond to the dropping of proton from $k = 137$ space-time sheet of atomic size scale to much larger space-time sheet. Also the dropping of electron from $k = 151$ space-time sheet with size of order thickness of cell membrane (and the Compton length of dark electron in the TGD based model of high T_c super-conductivity) could be in question. The prediction would be that also more refined metabolic energy quanta are present.

The existence of universal energy quanta should correspond to absorption and emission lines having no identification in terms of molecular transitions. It is indeed known that this kind of unidentified lines and bands exist in UV, visible and IR region [82, 78, 86] and can be associated with interstellar dust containing organic molecules. The identification of these structures is discussed in [J7].

It would not be surprising if irradiation of living matter with frequencies corresponding to universal energy quanta would have effect on living matter and there indeed exist support for this [50, 46]. This is discussed in [M2] where one also ends up with a model for DC currents involved with healing as shown by Becker [51]. The model assumes that metabolic energy is transferred as universal metabolic quanta via non-dissipating supra currents along magnetic flux tubes.

Also the phase transition reducing the value of Planck constant can induce emission of radiation at precise energies and serve as a source of metabolic energy. The hydrino atom introduced by Randell Mills [81] to explain his experimental findings is based on assumption that the binding energies of hydrogen atom in this state are scaled by k^2, $k = 2, ...$ This can be understood if Planck constant has value $\hbar = \hbar_0/k$ for these states [F9]. TGD suggests also an alternative explanation based on quantum group variant of Schrödinger equation for hydrogen atom [F9]. The model predicts the energy of $k = 2$ state correctly but for $k > 2$ the accuracy is 10-20 per cent. These states could appear as intermediate states in transitions to states with reduced Planck constant. These states could also be interpreted in terms of transition to chaos meaning that the orbits of electron are not exactly periodic anymore and close only after k turns.

2.5 Topological light rays, communication, and control

So called topological light or massless extremals (MEs)[J4, K4] rays define extremely general solution type of classical field equations of TGD depending on two arbitrary functions. One can assign to these solutions local light-like wave vector and polarization vector and the interpretation in terms of radiation propagating with light velocity is appropriate. The nonlinearity of the theory allows the shape of pulse pattern to be preserved and the signal propagates in a precisely targeted manner like laser pulse. MEs and their dark variants would be ideal for communication and control purposes.

Both neutral MEs representing combination of classical em and Z^0 gauge fields and charged MEs representing classical W boson fields are possible as well as classical color gauge fields, which always has $U(1)$ holonomy, a possible signal for color confinement at space-time level. A possible

interpretation is that neutral MEs are responsible for coordination and communication and charged W MEs serve as correlates for remote charge entanglement and represent exchange of charge W bosons in arbitrary long length scales. This would make possible remote quantum control by inducing charge density gradients at dark space-time sheets in turn inducing changes of voltage also at space-time sheets containing visible matter (many-sheeted Faraday law). Nerve pulse generation could involve exchange of W MEs between cell interior and exterior inducing charge non-equilibrium reducing resting potential below the threshold [M2]: the pulse could also be initiated by magnetic body by a similar mechanism.

Also dark MEs are possible. Bio-photons [44] might have explanation in terms of ordinary photons resulting via a de-coherence of dark bio-photons having originally much longer wave length and perhaps related to the control of biological body by magnetic body. The finding of Gariaev that visible laser photons induce bio-active radio emission from DNA [46] might be understood in terms of dark radio waves produced by DNA, whereas phantom DNA effect [46] could be produced by the dark matter associated with DNA and remaining in the chamber after the removal of DNA. Also bio-holograms [45] might involve dark photons.

2.6 Classical color and electro-weak fields in macroscopic length scales

One can say that the basic physics of standard model without symmetry breaking and color magnetic confinement is realized at classical level on cellular space-time sheets. Classical Z^0 fields, W fields and gluon fields unavoidably accompany non-orthogonal electric and magnetic fields. The proper interpretation of this prediction is in terms of a p-adic and dark fractal hierarchies of standard model physics with scaled down mass scales making possible long range weak and color interactions in arbitrarily long length scales.

This prediction forces to modify even the model of nuclei [F8]. Nucleons carry exotic color and form nuclear strings consisting of color bonds with exotic quark q and antiquark $\overline{q}$ at their ends. These exotic quarks correspond to $k = 127$ level of dark matter hierarchy. Also dark variants of ordinary quarks with size of about atom are possible. It is also possible to have $u\overline{d}$ and $\overline{u}d$ type color bonds which carry em and weak charge and this means exotic nuclear ionization. Tetraneutron [75, 73] would represent one particular example of this kind of exotically ionized nucleus [F8]. Exotic nuclear physics would have also implications for the ordinary condensed matter physics and could be involved with the very low compressibility of liquid phase and the anomalous behavior of water [F9].

Exotic ionization is the key element in the quantum model for the control action of the magnetic body on biological body. Exotic ionization induces dark plasma oscillations which in turn generate via classical em fields ordinary ohmic currents at the level of the ordinary matter. Nerve pulse patterns [M2] and Ca^{2+} waves [K6, K5] would represent examples of physiological correlates of this quantum control.

2.7 High T_c super-conductivity in living matter

The model for high T_c super-conductivity realized as quantum critical phenomenon predicts the basic scales of cell membrane [J1] from energy minimization and p-adic length scale hypothesis. This leads to the vision that cell membrane and possibly also its scaled up dark fractal variants define Josephson junctions generating Josephson radiation communicating information about the nearby environment to the magnetic body.

Any model of high T_c superconductivity should explain various strange features of high T_c superconductors. One should understand the high value of T_c, the ambivalent character of high T_c super conductors suggesting both BCS type Cooper pairs and exotic Cooper pairs with non-vanishing spin, the existence of pseudogap temperature $T_{c_1} > T_c$ and scaling law for resistance

for $T_c \leq T < T_{c_1}$, the role of fluctuating charged stripes which are anti-ferromagnetic defects of a Mott insulator, the existence of a critical doping, etc...[31, 32].

There are reasons to believe that high T_c super-conductors correspond to quantum criticality in which at least two (cusp catastrophe as in van der Waals model), or possibly three or even more (more complex catastrophes [83]), phases are competing. A possible analogy is provided by the triple critical point for water vapor, liquid phase and ice coexist. Instead of long range thermal fluctuations long range quantum fluctuations manifesting themselves as fluctuating stripes are present [31].

The TGD based model for high T_c super-conductivity [J1] relies on the notions of quantum criticality, general ideas of catastrophe theory, dynamical Planck constant, and many-sheeted space-time. The 4-dimensional spin glass character of space-time dynamics deriving from the vacuum degeneracy of the Kähler action defining the basic variational principle would realize space-time correlates for quantum fluctuations.

1. Two kinds of super-conductivities and ordinary non-super-conducting phase would be competing at quantum criticality at T_c and above it only one super-conducting phase and ordinary conducting phase located at stripes representing ferromagnetic defects making possible formation of $S = 1$ Cooper pairs.

2. The first super-conductivity would be based on exotic Cooper pairs of large $\hbar$ dark electrons with $\hbar = 2^{11}\hbar_0$ and able to have spin $S = 1$, angular momentum $L = 2$, and total angular momentum $J = 2$. Second type of super-conductivity would be based on BCS type Cooper pairs having vanishing spin and bound by phonon interaction. Also they have large $\hbar$ so that gap energy and critical temperature are scaled up in the same proportion. The exotic Cooper pairs are possible below the pseudo gap temperature $T_{c_1} > T_c$ but are unstable against decay to BCS type Cooper pairs which above T_c are unstable against a further decay to conduction electrons flowing along stripes. This would reduce the exotic super-conductivity to finite conductivity obeying the observed scaling law for resistance.

3. The mere assumption that electrons of exotic Cooper pairs feed their electric flux to larger space-time sheet via *two* elementary particle sized wormhole contacts rather than only *one* wormhole contacts implies that the throats of wormhole contacts defining analogs of Higgs field must carry quantum numbers of quark and anti-quark. This inspires the idea that cylindrical space-time sheets, the radius of which turns out to be about about 5 nm, representing zoomed up dark electrons of Cooper pair with Planck constant $\hbar = 2^{11}\hbar_0$ are colored and bound by a scaled up variant of color force to form a color confined state. Formation of Cooper pairs would have nothing to do with direct interactions between electrons. Thus high T_c super-conductivity could be seen as a first indication for the presence of scaled up variant of QCD in mesoscopic length scales.

This picture leads to a concrete model for high T_c superconductors as quantum critical superconductors [J1]. p-Adic length scale hypothesis stating that preferred p-adic primes $p \simeq 2^k$, k integer, with primes (in particular Mersenne primes) preferred, makes the model quantitative.

1. An unexpected prediction is that coherence length ξ is actually $\hbar_{eff}/\hbar_0 = 2^{11}$ times longer than the coherence length 5-10 Angstroms deduced theoretically from gap energy using conventional theory and varies in the range $1 - 5$ μm, the cell nucleus length scale. Hence type I super-conductor would be in question with stripes as defects of anti-ferromagnetic Mott insulator serving as duals for the magnetic defects of type I super-conductor in nearly critical magnetic field.

2. At quantitative level the model reproduces correctly the four poorly understood photon absorption lines and allows to understand the critical doping ratio from basic principles.

3. The current carrying structures have structure locally similar to that of axon including the double layered structure of cell membrane and also the size scales are predicted to be same. One of the characteristic absorption lines has energy of .05 eV which corresponds to the Josephson energy for neuronal membrane for activation potential $V = 50$ mV. Hence the idea that axons are high T_c superconductors is highly suggestive. Dark matter hierarchy coming in powers $\hbar/\hbar_0 = 2^{k11}$ suggests hierarchy of Josephson junctions needed in TGD based model of EEG [M3].

2.8 Magnetic body as a sensory perceiver and intentional agent

The hypothesis that dark magnetic body serves as an intentional agent using biological body as a motor instrument and sensory receptor is consistent with Libet's findings about strange time delays of consciousness. Magnetic body would carry cyclotron Bose-Einstein condensates of various ions. Magnetic body must be able to perform motor control and receive sensory input from biological body.

Cell membrane would be a natural sensor providing information about cell interior and exterior to the magnetic body and dark photons at appropriate frequency range would naturally communicate this information. The strange quantitative co-incidences with the physics of cell membrane and high T_c super-conductivity support the idea that Josephson radiation generated by Josephson currents of dark electrons through cell membrane is responsible for this communication [M3].

Also fractally scaled up versions of cell membrane at higher levels of dark matter hierarchy (in particular those corresponding to powers $n = 2^{k11}$) are possible and the model for EEG indeed relies on this hypothesis. The thickness for the fractal counterpart of cell membrane thickness would be 2^{44} fold and of order of depth of ionosphere! Although this looks weird it is completely consistent with the notion of magnetic body as an intentional agent.

Motor control would be most naturally performed via genome: this is achieved if flux sheets traverse through DNA strands. Flux quantization for large values of Planck constant requires rather large widths for the flux sheets. If flux sheet contains sequences of genomes like the page of book contains lines of text, a coherent gene expression becomes possible at level of organs and even populations and one can speak about super- and hyper-genomes. Introns might relate to the collective gene expression possibly realized electromagnetically rather than only chemically [M3, L2].

Dark cyclotron radiation with photon energy above thermal energy could be used for coordination purposes at least. The predicted hierarchy of copies of standard model physics leads to ask whether also dark copies of electro-weak gauge bosons and gluons could be important in living matter. As already mentioned, dark W bosons could make possible charge entanglement and non-local quantum bio-control by inducing voltage differences and thus ionic currents in living matter.

The identification of plasmoids as rotating magnetic flux structures carrying dark ions and electrons as primitive life forms is natural in this framework. There exists experimental support for this identification [80] but the main objection is the high temperature involved: this objection could be circumvented if large $\hbar$ phase is involved. A model for the pre-biotic evolution relying also on this idea is discussed in [L4].

2.9 Electric flux quanta and capacitor model for sensory receptor

The assumption that sensory qualia are realized at the level of sensory receptors, when combined with the requirement that the average increments are non-vanishing, and perhaps even same from quantum jump to quantum jump, poses strong constraints on the model of the sensory receptor [K3].

These constraints suggest what might be called the capacitor model of the sensory receptor.

1. There are two reservoirs of quantum charges having total charges of equal magnitude but of opposite sign. The charges are macroscopic in order to guarantee robustness. These reservoirs are analogous to capacitor plates, and only the second one corresponds to the sensory experienced quale unless both the quale and its conjugate are experienced simultaneously. Capacitors plates can carry several kinds of charges (em charge, color charges, etc...)

2. When the sensory quale is generated, there is a flow of charge quanta between the quantum capacitor plates. The charge quanta are more or less constant. This requirement could be relaxed to the condition that only the average increment is constant. Note that the charge flow could mean also exchange of virtual W bosons.

Cell membrane, or rather the pair formed by cell interior and exterior, and synaptic junction are excellent candidates for quantum capacitors.

1. During nerve pulse various ions flow between cell interior and exterior, which suggests that sub-neuronal sensory qualia are generated in a time scale of a millisecond. Also membrane oscillations might give rise to some kind of sensory qualia. In particular, super-conducting Cooper pairs and bosonic ions enter or leave the Bose-Einstein condensates at the magnetic flux tubes and this should give rise to a chemical experience defined by the quantum numbers of the carrier particle. Not only the increment of electric charge but increments of magnetic quantum numbers characterize the qualia in question. Various information molecules transferred through the cell membrane could also give rise to sensory qualia.

2. In the synaptic contact the vesicles containing neurotransmitter are transmitted, and the net quantum numbers for the vesicles should determine the neuronal chemical qualia associated with the process.

This model does not apply to all qualia. Qualia can be also associated with the quantum phase transitions at dark magnetic flux quanta. A typical example is a coherently occurring cyclotron transition for a macroscopic phase of Cooper pairs. It would seem that quantum phase transitions at the magnetic flux quanta and particle flows between the quantum electrodes associated with electret type structures could define two basic types of qualia. Note that electret structures are dual to magnetic flux quanta as solutions of field equations. Vision and hearing would be basic examples of these two types of qualia.

2.10 DNA as topological quantum computer

I ended up with the recent model of tqc in bottom-up manner and this representation is followed also in the text. The model which looks the most plausible one relies on two specific ideas.

1. Sharing of labor means conjugate DNA would do tqc and DNA would "print" the outcome of tqc in terms of mRNA yielding amino-acids in the case of exons. RNA could result also in the case of introns but not always. The experience about computers and the general vision provided by TGD suggests that introns could express the outcome of tqc also electromagnetically in terms of standardized field patterns as Gariaev's findings suggest [48]. Also speech would be a form of gene expression. The quantum states braid (in zero energy ontology) would entangle with characteristic gene expressions. This argument turned out to be based on a slightly wrong belief about DNA: later I learned that both strand and its conjugate are transcribed but in different directions. The symmetry breaking in the case of transcription is only local which is also visible in DNA replication as symmetry breaking between leading and lagging strand. Thus the idea about *entire* leading strand devoted to printing and second strand to tqc must be weakened appropriately.

2. The manipulation of braid strands transversal to DNA must take place at 2-D surface. Here dancing metaphor for topological quantum computation [76] generalizes. The ends of the space-like braid are like dancers whose feet are connected by thin threads to a wall so that the dancing pattern entangles the threads. Dancing pattern defines both the time-like braid, the running of classical tqc program and its representation as a dynamical pattern. The space-like braid defined by the entangled threads represents memory storage so that tqc program is automatically written to memory as the braiding of the threads during the tqc. The inner membrane of the nuclear envelope and cell membrane with entire endoplasmic reticulum included are good candidates for dancing halls. The 2-surfaces containing the ends of the hydrophobic ends of lipids could be the parquets and lipids the dancers. This picture seems to make sense.

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

1. Darwinian selection for which standard theory of self-organization [85] provides a model, should apply also to tqc programs. Tqc programs should correspond to asymptotic self-organization patterns selected by dissipation in the presence of metabolic energy feed. The spatial and temporal pattern of the metabolic energy feed characterizes the tqc program - or equivalently - sub-program call.

2. Since braiding characterizes the tqc program, the self-organization pattern should correspond to a hydrodynamical flow or a pattern of magnetic field inducing the braiding. Braid strands must correspond to magnetic flux tubes of the magnetic body of DNA. If each nucleotide is transversal magnetic dipole it gives rise to transversal flux tubes, which can also connect to the genome of another cell.

3. The output of tqc sub-program is probability distribution for the outcomes of state function reduction so that the sub-program must be repeated very many times. It is represented as four-dimensional patterns for various rates (chemical rates, nerve pulse patterns, EEG power distributions,...) having also identification as temporal densities of zero energy states in various scales. By the fractality of TGD Universe there is a hierarchy of tqc's corresponding to p-adic and dark matter hierarchies. Programs (space-time sheets defining coherence regions) call programs in shorter scale. If the self-organizing system has a periodic behavior each tqc module defines a large number of almost copies of itself asymptotically. Generalized EEG could naturally define this periodic pattern and each period of EEG would correspond to an initiation and halting of tqc. This brings in mind the periodically occurring sol-gel phase transition inside cell near the cell membrane.

4. Fluid flow must induce the braiding which requires that the ends of braid strands must be anchored to the fluid flow. Recalling that lipid mono-layers of the cell membrane are liquid crystals and lipids of interior mono-layer have hydrophilic ends pointing towards cell interior, it is easy to guess that DNA nucleotides are connected to lipids by magnetic flux tubes and hydrophilic lipid ends are stuck to the flow.

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

6. There are several problems related to the details of the realization. How nucleotides A,T,C,G are coded to strand color and what this color corresponds to? The prediction that wormhole contacts carrying quark and anti-quark at their ends appear in all length scales in TGD Universe resolves the problem. How to split the braid strands in a controlled manner? High

T_c super conductivity provides a partial understanding of the situation: braid strand can be split only if the supra current flowing through it vanishes. From the proportionality of Josephson current to the quantity $sin(\int 2eVdt)$ it follows that a suitable voltage pulse V induces DC supra-current and its negative cancels it. The conformation of the lipid controls whether it it can follow the flow or not. How magnetic flux tubes can be cut without breaking the conservation of the magnetic flux? The notion of wormhole magnetic field saves the situation now: after the splitting the flux returns back along the second space-time sheet of wormhole magnetic field.

To sum up, it seems that essentially all new physics involved with TGD based view about quantum biology enter to the model in crucial manner.

2.11 Possible implications of zero energy ontology for biology

A rather strong argument in favor of zero energy ontology comes from superconductivity. The models super-conductivity utilize formally the notion of coherent state of Cooper pairs involving quantum superposition of arbitrary numbers of Cooper pairs. This is in conflict with various conservation laws in standard ontology but in zero ontology it is quite possible to consider quantum superposition of zero energy states with various values of quantum numbers for positive energy states.

This opens the gates for rather fascinating speculations. Time-like charge entanglement would allow to imagine a time-like variant of the capacitor model of sensory receptor. For instance, sensory qualia could result in the reduction of coherent state of Cooper pairs to a state with a well defined charge. Also different DNA sequences with different masses and charges could appear in quantum superpositions for time like entanglement and this might be relevant for evolution of genetic code. As a matter fact, the proposed identification of S-matrix, or rather M-matrix, as time-like entanglement coefficients assumes the presence of all pairs of initial and final states appearing in the M-matrix in the superposition so that this possibility could be seen as a prediction.

The construction of M-matrix leads to a long looked for first principle justification of the p-adic length scale hypothesis stating that p-adic length scales correspond to primes $p \simeq 2^k$, k integer. A further result is that elementary particles are characterized by the secondary p-adic time scale $T_p(2) = T(2,k) = \sqrt{k}T_p$ characterizing the geometro-temporal size of the zero energy space-time sheet associated with the zero energy state having particle and its negative energy variant at past and future ends. For electron one has $T(2,127) \simeq .1$ seconds, which defines fundamental bio-rhythm (alpha peak in EEG for instance). Thus a direct connection between elementary particle physics and biology suggests itself.

3 Some anomalies of biology

The evolution of TGD inspired ideas about biology have involved a strong interaction of anomalies of recent day biology which have remained unknown to the average biologist and physicist too.

3.1 Strange findings about the behavior of cell membrane

In standard approach, which emerged around 1940, one can understand the properties of cell membrane by assuming that there are cell membrane pumps pumping ions from cell interior to exterior or vice versa and channels through which the ions can leak back. Quite a many candidates for proteins which seem to function like pump and channel proteins have been identified: even a pump protein for water [40]! This does not however prove that pumping and channeling are the main functions of these proteins or that they have anything to do with how ionic and molecular

concentrations in the interior and exterior of the cell are determined. It could quite well be that pump and channel proteins are receptors involved with the transfer of information rather than charges and only effectively act as pumps and channels. There are several serious objections of principle against the vision of cell as a bag of water containing a mixture of chemicals. Even worse, the hypothesis seems to be in conflict with experimental data.

3.1.1 Why pumping does not stop when metabolism stops?

One can wonder how metabolism is able to provide the needed energy to the continual construction of pumps and channels and also do the pumping. For instance, sodium pump alone is estimated to take 45-50 per cent of the cell's metabolic energy supply. Ling has studied the viability of the notion of the ionic pump experimentally [38] by exposing cell to a cocktail of metabolic poisons and depriving it from oxygen: this should stop the metabolic activities of the cell and stop also the pumping. Rather remarkably, nothing happened to the concentration gradients. Presumably this is the case also for the membrane potential so that also the notion of metabolically driven electrostatic pumps seems to fail. Of course, some metabolism is needed to keep the equilibrium but the mechanism does not seem to be a molecular mechanism and somehow it manages to use extremely small amount of metabolic energy.

The TGD based explanation would be based on dark matter hierarchy based on hierarchy of Planck constants. A considerable fraction of biologically important ions would be dark matter at magnetic or wormhole magnetic flux tubes connecting cell nucleus and interior, and more generally two biomolecules to each other. The large value of Planck constant alone implies slow dissipation and makes also possible macroscopic quantum phases. Therefore only ordinary ionic currents would dissipate. Pumps and channels would be needed only for ions with ordinary value of $\hbar$.

3.1.2 Universality of ionic membrane currents

A crucial verification of the channel concept was thought to come in the experiment of Neher and Sakmann [39] (which led to a Nobel prize). The ingenious experimental arrangement was following. A patch of membrane is sucked from the cell and remains stuck on the micropipet orifice. A steady voltage is applied over the patch of the membrane and the resulting current is measured. It was found that the current consists of discrete pulses in consistency with the assumption that a genuine quantum level current is in question. The observation was taken as a direct evidence for the postulate that the ionic currents through the cell membrane flow through ionic channels.

The later experiments of Fred Sachs [41] however yielded a complete surprise. Sachs found that when the patch of the cell membrane was replaced by a patch of silicon rubber, the discrete currents did not disappear: they remained essentially indistinguishable from cell membrane currents! Even more surprisingly, the silicon rubber membrane showed ion-selectivity features, which were essentially same as those of the cell membrane! Also the currents through synthetic polymer filters [42] were found to have essentially similar properties: as if ion selectivity, reversal potential, and ionic gating would not depend at all on the structure of the membrane and were more or less universal properties. Also experiments with pure lipid-layer membranes [43] containing no channel proteins demonstrated that the basic features – including step conductance changes, flickering, ion selectivity, and in-activation– characterized also cell membranes containing no ionic channels.

The in-escapable conclusion forced by these results seems to be that the existing 60-year old paradigm is somehow wrong. Ionic currents and the their properties seem to be universal and depend only very weakly on the properties of the membrane.

The TGD based solution of the problem would be that charged particles in living matter are dominantly dark variants of ordinary charged particles having large value of Planck constant and residing at magnetic flux tubes. They are indeed predicted to have classical electromagnetic

interactions although they cannot appear in vertices of particle reactions together with ordinary particles. In the case of bosonic ions dissipation free oscillating Josephson currents would replace ionic currents and no pumping would be needed. Also the independence on the structural details of membrane could be understood. Pumps and channels would be still be needed for visible ions but their much smaller amount would dramatically reduce the metabolic costs and pumps and channels might be only used for purposes like taking samples about the chemical environment.

3.2 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 endogenous magnetic field of .2 Gauss on vertebrate brains [65] provide a test bench for the fractal hierarchy of EEGs. As a matter of 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 $B = .-2$ Gauss [65]. 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. This means following. 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 would very effectively eliminate the effects of neural noise.

This picture leads to a model of EEG in which EEG is generated by Josephson currents running along magnetic flux tubes through cell membrane as Josephson radiation. The model for EEG actually follows from the model of nerve pulse based on Josephson currents of ions.

3.3 Anomalies related to nerve pulse

Let us first briefly summarize the soliton model of nerve pulse proposed by Danish researchers [61, 53, 54, 55] since it served as inspiration for the recent developments.

1. The temperature of the axon is slightly above the critical temperature T_c for the phase transition leading from crystal like state of the lipid layers to a liquid crystal state. Near criticality the elastic constants and heat capacity of the membrane vary strongly and have maxima at criticality so that also sound velocity varies strongly near criticality. Also the relaxation times are long. There is also dispersion present meaning that the frequency of sound wave depends nonlinearly on wave vector. Non-linearity and dispersion are prerequisites for the presence of solitons which by definition do not dissipate energy.

2. Variations of temperature, volume, area, and thickness and also other mechanical effects are known to accompany nerve pulse propagation. It is also known that the heat density and temperature of the cell membrane increases slightly first and is then reduced. This suggests adiabaticity in average sense. These findings motivate the assumption that nerve pulse actually corresponds to acoustic soliton [53, 54].

3. Soliton model reproduces correctly the velocity of nerve pulse inside myelin sheaths but it is not clear to me how well the lower values of the conduction velocity and its proportionality to the axonal radius in non-myelinated regions can be understood. Intuitively it however seems obvious that the lower velocity is due to the feedback from the interactions of ions with the region exterior to cell membrane. In the case of myelin sheaths the conduction of nerve pulse is usually believed to take place via saltation [60]: the depolarization induced at Ranvier node is believed to be enough to take the membrane potential below critical value in the next node so that nerve pulse hops between the nodes. Insulation would improve the insulation and make this process possible. The reversible heat transfer process is however known to be present also in the myelinated portions of axon so that there must be a pulse propagating also in these regions [54]. It is not clear how the myelin sheet can increase the velocity in the soliton model but the reduction of the feedback inducing friction suggests itself.

4. Soliton property predicts adiabaticity. Ordinary ionic currents however dissipate so that adiabaticity assumption is questionable in standard physics context. The model does not predict the growth of entropy followed by its reduction. This behavior is consistent with adiabaticity in a time resolution of order millisecond.

5. The estimate for the capacitor energy density during the nerve pulse is considerably smaller than that of the acoustic wave. This might allow to demonstrate that Hodgkin-Huxley model is not a complete description of the situation.

6. Authors notice [53, 54] that the shapes of the curves representing solitonic energy density and the capacitor energy density as a function of time are essentially identical. The same applies to the experimentally deduced heat change release curve and capacitor energy density for garfish axon. Also heat release and the deviation of the membrane potential from its resting value are in exact phase. These similarities could reflect a control signal responsible for the nerve pulse originating somewhere else, perhaps at microtubules. This could explain why secondary nerve pulse is not generated immediately after the first one although the temperature is slightly lower after the pulse than before it. This could of course be also due to the exhaustion of the metabolic resources.

3.4 DC currents of Becker

The findings of Robert Becker (the book "Electromagnetism and Life" by Becker and Marino can be found from web [52]) meant a breakthrough in the development of bioelectromagnetics. One aspect of bioelectromagnetic phenomena was the discovery of Becker that DC currents and voltages play a pivotal role in various regeneration processes. Why this is the case is still poorly understood and Becker's book is a treasure trove for anyone ready to challenge existing dogmas. The general vision guiding Becker can be summarized by a citation from the introduction of the book [52]. Details will be discussed later.

Growth effects include the alteration of bone growth by electromagnetic energy, the restoration of partial limb regeneration in mammals by small direct currents, the inhibition of growth of implanted tumors by currents and fields, the effect upon cephalocaudal axis development in the regenerating flatworm in a polarity-dependent fashion by applied direct currents, and the production of morphological alterations in embryonic development by manipulation of the electrochemical species present in the environment. This partial list illustrates the great variety of known bioelectromagnetic phenomena.

The reported biological effects involve basic functions of living material that are under remarkably precise control by mechanisms which have, to date, escaped description in terms of solution biochemistry. This suggests that bioelectromagnetic phenomena are fundamental attributes of living

matter that must have been possessed already by the first life forms. The traditional approach to biogenesis postulates that life began in an aqueous environment, with the development of complex molecules and their subsequent sequestration from the environment by membranous structures. The solid-state approach proposes an origin in complex crystalline structures that possess such properties as semiconductivity, photoconductivity, and piezoelectricity. All of the reported effects of electromagnetic forces seem to lend support to the latter hypothesis.

3.5 From dust to dust

The article *From Plasma crystals and helical structures towards inorganic living matter* of Tsytovich *et al* in August 2007 issue of New Journal of Physics provides [77] new empirical support for plasmoids as living life forms. The results of article suggest that interstellar dust could behave like living matter in some respects: it could even have variant of genetic code. This is really a shattering finding and with single blow might destroy the standard dogma about life as something purely chemical. It should also give some headaches for those influential colleagues who have decided that it is necessary to accept the anthropic principle. Here is little popularization of the result.

Scientists have discovered that inorganic material can take on the characteristics of living organisms in space, a development that could transform views of alien life.

An international panel from the Russian Academy of Sciences, the Max Planck institute in Germany and the University of Sydney found that galactic dust could form spontaneously into helixes and double helixes and that the inorganic creations had memory and the power to reproduce themselves.

A similar rethinking of prospective alien life is being undertaken by the National Research Council, an advisory body to the US government. It says Nasa should start a search for what it describes as weird life - organisms that lack DNA or other molecules found in life on Earth.

The new research, to be published this week in the New Journal of Physics [77], found nonorganic dust, when held in the form of plasma in zero gravity, formed the helical structures found in DNA. The particles are held together by electromagnetic forces that the scientists say could contain a code comparable to the genetic information held in organic matter. It appeared that this code could be transferred to the next generation.

Professor Greg Morfill, of the Max Planck institute of extra-terrestrial physics, said: Going by our current narrow definitions of what life is, it qualifies.

The question now is to see if it can evolve to become intelligent. Its a little bit like science fiction at the moment. The potential level of complexity we are looking at is of an amoeba or a plant.

I do not believe that the systems we are talking about are life as we know it. We need to define the criteria for what we think of as life much more clearly.

It may be that science is starting to study territory already explored by science fiction. The television series The X-Files, for example, has featured life in the form of a silicon-based parasitic spore.

The Max Planck experiments were conducted in zero gravity conditions in Germany and on the International Space Station 200 miles above earth.

The findings have provoked speculation that the helix could be a common structure that underpins all life, organic and nonorganic.

To sum up the essentials, plasma phase is involved and the dust life is able to construct analogs of DNA double helices and this has been achieved also in laboratory. "From dust to dust" seems to have a very deep side meaning!

Here is a more quantitative summary of the results reported in [77].

1. The scale of the dust balls seems to be few micrometers. It is essential that the system is open in the sense that there is both metabolic energy feed and continual feed of plasma to negatively charged dust particles to preserve their charges. Authors speak about effective "gravitational" instability as a mechanism leading to the formation of the helices and identify effective gravitational coupling (the formula contains a trivial typo) as a function of charge and mass of the particle plus dimensionless parameter characterizing the modification of Debye model implied by the fact that dust particles are not electrically closed systems. Authors give a long list of life-like properties possessed by the helical structures.

2. Helical structures are generated spontaneously and possess negative charges. The repulsion of the helical structures transforms to attraction at some critical distance interval due to the fact that the large electrostatic self energy depends on the distance between helices and this makes possible double helices (authors speak about over-screening in the formal model). Similar mechanism might work also in the case of ordinary DNA double helices whose stability is poorly understood since also in this case the large negative charge could be preserved by continual feed of charge.

3. The twist angle of the helix makes bifurcations as a function of radius of helix and the values of twist angle could define the letters of genetic code. Also a mechanism for how the twist angle is communicated to neighboring helix is proposed. Also dust vortices are observed and might be those which one can occasionally observe during hot summer days.

4. Authors do not mention magnetic fields but my guess is that the helical structures reflect directly the geometry of the helical magnetic flux tubes, and that dark electron pairs with large Planck constant at these tubes might be the quantal aspect of the system. These currents might relate closely to the plasma current, which charges the dust particles. Also DNA, which is an insulator, is known to be able to act as conductor, and here the free electron pairs associated with aromatic rings having $\hbar = n \times hbar_0$, $n = 5$ or 6, could make conduction possible since their Compton size would be n-fold.

4 Support for the notion of universal metabolic energy quanta

Universal energy quanta might have rather interesting implications. For instance, irradiation of cells could provide a direct metabolic mechanism when the normal metabolic machinery fails. The universal metabolic quanta should also have played a key role during pre-biotic evolution when chemical storage mechanism were absent or primitive so that energy metabolism relied on direct absorption of photons.

4.1 Astrophysical evidence for many-sheeted space-time and universal metabolic energy quanta

The dropping of particle to a larger space-time sheet liberates energy which is the difference of the energies of the particle at two space-time sheets. If the interaction energy of the particle with the matter at space-time sheet can be neglected the energy is just the difference of zero point kinetic energies. This energy depends on the details of the geometry of the space-time sheet. Assuming p-adic length scale hypothesis the general formula for the zero point kinetic energy can be written as

$$E(k) = x \times E_0(k) \quad , \quad E_0(k) = \frac{3}{2}\frac{\pi^2}{mL^2(k)} \quad .$$

Here x is a numerical factor taking into account the geometry of the space-time sheet and equals to $x = 1$ for cubic geometry.

The liberated zero point kinetic energy in the case that the particle drops to a space-time sheet labeled by $k_f = k + \Delta k$ with same value of x is

$$\Delta E(k, \Delta k) = x \times E_0(k) \times (1 - 2^{-\Delta k}) \ .$$

The transitions are seen as discrete lines for some resolution $\Delta k \leq \Delta k_{max}$. At the limit $k \to \infty$ transitions give rise to a quasi-continuous band. The photon energy for $k \to \infty$ transition is same as the energy from $k - 1 \to k$ transition, which brings in additional option to the model building.

For a proton dropping from the atomic space-time sheet $k = 137$ to very large space-time sheet ($\Delta k \to \infty$) one has $\Delta E(k) = E(k) \sim x \times .5$ eV. Since the ratio of electron and proton masses is $m_p/m_e \simeq .94 \times 2^{11}$, the dropping of electron from space-time sheet $k_e = k_p + 11$ liberates zero point kinetic energy which is by is by a factor .9196 smaller. For $k_p = 137$ one would have $k_e = 148$. This energy corresponds to the metabolic energy currency of living systems and the idea is that the differences of zero point kinetic energies define universal metabolic energy currencies present already in the metabolism of pre-biotic systems. In the following fit electron's zero point kinetic energy will be taken to be $E_0(148) = .5$ eV so that for proton the zero point kinetic energy would be $E_0(137) = .544$ eV.

The hypothesis predicts the existence of anomalous lines in the spectrum of infrared photons. Also fractally scaled up and scaled down variants of these lines obtained by scaling by powers of 2 are predicted. The wavelength corresponding to .5 eV photon would be $\lambda = 2.48$ μm. These lines should be detectable both in laboratory and astrophysical systems and might even serve as a signature for a primitive metabolism. One can also consider dropping of Cooper pairs in which case zero point kinetic energy is scaled down by a factor of 1/2.

Interestingly, the spectrum of diffuse interstellar medium exhibits three poorly understood structures [78]: Unidentified Infrared Bands (UIBs), Diffuse Interstellar Bands (DIBs) [86], and Extended Red Emission (ERE) [82] allowing an interpretation in terms of dropping of protons or electrons (or their Cooper pairs) to larger space-time sheets. The model also suggests the interpretation of bio-photons in terms of generalizes EREs.

4.1.1 Unidentified Infrared Bands

Unidentified infrared bands (UIBs) contain strong bands at $\lambda = 3.3, 6.2, 11.3$ microns [78]. The best fit for the values of k and Δk assuming dropping of either electron or proton are given by the following table. The last row of the table gives the ratio of predicted photon energy to the energy characterizing the band and assuming $x = 1$ and $E_0(148, e) = .5$ eV. Discrepancies are below 8 per cent. Also the dropping of protonic Cooper pair from $k = 137$ space-time sheet could reproduce the line $\Delta E = .2$ eV. The fit is quite satisfactory although there is of course the uncertainty related to the geometric parameter x.

λ/nm	$E/.5eV$	k	Δk	$\Delta E(k, \Delta k)/E$	p/e
3300	.7515	137	$\sim \infty$	1.002	e
6200	.4000	138	3	1.067	e
11300	.2195	139	3	0.878	p
11300	.2195	139+11=150	3	1.076	e

Table 2. Table gives the best fit for UIBs assuming that they result from dropping of proton or electron to a larger space-time sheet and one has $E_0(148, e) = .5$ eV. The fourth column the table gives the ratio of predicted photon energy to the energy characterizing the band and assuming $x = 1$. e/p tells whether electron or proton is in question.

According to [78], UIBs are detected along a large number of interstellar sight-lines covering a wide range of excitation conditions. Recent laboratory IR spectra of neutral and positively charged poly-cyclic aromatic hydrocarbons (PAHs) has been successfully used by Allamandola [72] to model the observed UIBs. It is believed that PAHs are produced in reactions involving photosynthesis and are regarded as predecessors of biotic life [79]. This would conform with the presence of metabolic energy quanta.

DNA sugar backbone, some amino-acids, and various hallucinogens involve 5- and 6-cycles and the proposal is that these cycles involve free electron pairs, which possess Planck constant $\hbar = n\hbar_0$, $n = 5, 6$. These free electron pairs would explain the anomalous conductivity of DNA and would be an essential characteristic of living matter. The emergence of $n = 5, 6$ levels could be seen as the first step in the pre-biotic evolution.

4.1.2 Diffuse Interstellar Bands

There are diffuse interstellar bands (DIBs) at wavelengths 578.0 and 579.7 nanometers and also at 628.4, 661.4 and 443.0 nm. The 443.0 nm DIB is particularly broad at about 1.2 nm across - typical intrinsic stellar absorption features are 0.1 nm [78]. The following table proposes a possible identification of these lines in terms of differences of zero point kinetic energies. Also now the best fit has errors below 7 per cent.

λ/nm	$E/.5eV$	k	Δk	$\Delta E(k, \Delta k)/E$	p/e
628.4	3.947	$135 = 3^3 \times 5$	$\sim \infty$	0.987	p
661.4	3.750	$135 + 11 = 2 \times 73$	3	0.985	e
443.0	5.598	$134 = 2 \times 67$	2	0.933	p
578.0	4.291	$135 + 11 = 2 \times 73$	$\sim \infty$	0.986	e
579.7	4.278	$135 + 11 = 2 \times 73$	$\sim \infty$	0.984	e

Table 2. Table gives the best fit for DIBs assuming that they result from dropping of proton or electron to a larger space-time sheet. Notations are same as in the previous table.

The peak wavelengths in chlorophyll and photosynthesis are around 650 nm and 450 nm and would correspond to second and third row of the table.

4.1.3 The Extended Red Emission

The Extended Red Emission (ERE) [78, 82] is a broad unstructured emission band with width about 80 nm and located between 540 and 900 nm. The large variety of peak wavelength of the band is its characteristic feature. In majority of cases the peak is observed in the range 650-750 nm but also the range 610-750 nm appears. ERE has been observed in a wide variety of dusty astronomical environments. The necessary conditions for its appearance is illumination by UV photons with energies $E \geq 7.25$ eV from source with $T \geq 10^4$ K. The position of the peak depends on the distance from the source [82].

According to [78] the current interpretation attributes ERE to a luminescence originating from some dust component of the ISM, powered by UV/visible photons. Various carbonaceous compounds seem to provide a good fit to the observational constraints. However, the real nature of ERE is still unknown since most candidates seem to be unable to simultaneously match the spectral distribution of ERE and the required photon conversion efficiency.

1. Consider first the band 650-750 nm appearing in the majority of cases. The most natural interpretation is that the lower end of the band corresponds to the zero point kinetic energy of electron at $k = 135 + 11 = 146 = 2 \times 73$ space-time sheet. This would mean that the lines would accumulate near 650 nm and obey the period doubling formula

$$\frac{\lambda(k)-\lambda(\infty)}{\lambda(\infty)} = \frac{2^{-k}}{1-2^{-k}} \quad .$$

By the estimate of Table 2 the lower end should correspond to $\lambda = 628.4$ nm with a correction factor $x < 1$ reducing the zero point kinetic energy. The reduction would be smaller than 4 per cent. $\Delta k = 3$ transition would correspond to 744 nm quite near to the upper end of the band. For $\Delta k = 2$ transition one has $\lambda = 867$ nm not to far from the upper end 900 nm. $\Delta k = 1$ corresponds to 1.3 μm.

2. For proton with $k = 135 = 146$ the energy band would shift by the factor $2^{11} m_e/m_p \simeq 1.0874$ giving the range (598,690) nm.

3. The variation for the position of the peak can be understood if the charged particles at the smaller space-time sheet can have excess energy liberated in the dropping to the larger space-time sheet. This excess energy would determine the position of the lower end of the band in the range $(540, 650)$ nm.

4. One should also understand the role of UV photons with energy larger than 7.25 eV. For proton the energy would be 8.76 eV. UV photon with energy $E \geq 8$ eV could kick electrons from large space-time sheets to $k = 144 = 146 - 4$ space-time sheet where they have zero point kinetic energy of 8 eV plus possible additional energy (for proton the energy would be 8.76 eV). One possibility is that these electrons drop first to $k = 145$ by the emission of ~ 4 eV UV photon and then to $k = 144$ by the emission ~ 2 eV photon corresponding to 650 nm line. The further dropping to larger space-time sheets would produce besides this line also the lines with longer wavelengths in the band.

   The energy of UV photons brings in mind the bond energy 7.36 eV of N_2 molecule and the possibility of metabolic mechanism using UV light as metabolic energy and based on the dissociation of N_2 followed by re-association liberating metabolic energy kicking protons or electrons to a smaller space-time sheet. For the $k \to k + 3$ transition of electron the energy would be 7 eV which suggests that this transition defines important metabolic energy quantum for living interstellar dust using dissociation and its reversal as basic metabolic mechanism.

4.2 Support for universal metabolic energy quanta from biology

There is direct support for the notion of universal energy quanta in living matter. The first support comes from the effect of low-power laser light on living matter. More than 30 years ago a method known with various names such as low-power laser therapy, biostimulation, or photobiomodulation emerged [50] and has now a wide range of applications. The treatment can apply both non-coherent (light emitting diodes) or coherent (laser light). In the case of of non-coherent light the method applies thin structures with thickness smaller than coherence length of light so that there is no difference between non-coherent and laser light. Laser light applies to situation when both the thickness of the surface layer and structure itself in range 1 mm- 1 cm and shorter than coherence length. Often the irradiation is applied to wounds and sites of injuries, acupuncture points, and muscle trigger points. The method involves several parameters such as wavelength in the range 400-900 nm (IR and near IR light), output power (10 100 mW), continuous wave and pulsed operation modes, and pulse parameters.

1. What is known?

The article of Karu [50] gives a good summary about what is known.

1. The action spectrum characterizes the maxima of the biological response as a function of wavelength. Action spectrum is essentially universal. For near IR and IR light the maxima of spectra are at 620, 680, 760, 820-830 nm. The spectrum continues also to visible light [50] but I do not have access to these data.

2. The action can induce both physiological and morphological changes in non-pigmental cells via absorption in mitochondria. HeNe laser ($\lambda = 632.8$ nm) can alter the firing pattern of nerves and can mimic the effect of peripheral stimulation of a behavioral reflex.

2. Biochemical approach

In [50] the biochemical approach to the situation is discussed.

1. In standard biochemistry based approach the natural hypothesis is that the maxima correspond to some molecular absorption lines and the task is to identify the photo acceptor. The primary acceptor in IR-to red spectral region is believed to be the terminal enzyme of the respiratory chain cytochrome c oxidase located in mitochondrion but this is just an assumption. In the violet-to-blue spectral region flavoproteins (e.g. NADH-dehydrogenase in the beginning of respiratory chain) are among the photo acceptors as terminal oxidases. It is known that also non-mitochondrial enhancement of cellular metabolism exist, which does not fit well with the vision about mitochondria as power plants of cell. It is believed that electronic excitation occurs and somehow leads to the biological effect.

2. The natural assumption in biochemistry framework is that the stimulation increases the effectiveness of cellular metabolism by making the utilization of oxygen more effective. The effect of the light would occur at the control level and induce secondary reactions (cellular signaling cascades or photo signal transduction and amplification) affecting eventually the gene expression.

3. Three different regulation pathways have been suggested [50]. Since small changes in ATP level can alter cellular metabolism significantly, the obvious idea is that photoacceptor controls the level of intracellular ATP. In starving cells this looks especially attractive hypothesis. In many cases the role of redox homeostasis is however believed to be more important than that of ATP. The second and third pathways would indeed affect cellular redox potential shifting it to more oxidized direction. The mechanism of regulation is however not understood. Hence one can say that there is no experimental proof or disproof for the standard approach.

3. TGD inspired approach

In TGD framework the first guess is that irradiation pumps directly metabolic energy to the system by kicking particles to smaller space-time sheets. This kind of direct energy feed would be natural when the cell is starving or injured so that its control mechanisms responsible for the utilization of oxygen are not working properly. For Bose-Einstein condensate of photons this effect would be especially strong being proportional to N^2 rather than N, where N is photon number. The effect would also appear coherently in a region whose size is dictated by coherence length when the target is thick enough.

There is a simple killer test for the proposal. The predicted energies are universal in the approximation that the interactions of protons (or electrons) kicked to the smaller space-time sheets with other particles can be neglected. The precise scale of metabolic energy quanta can be fixed by using the nominal value of metabolic energy quantum .5 eV in the case of proton. This predicts the following spectrum of universal energy quanta for proton and electron

$$\Delta E_{k,n}(p) = E_0(k,p) \times (1-2^{-n}) \ ,$$
$$E_0(k,p) = E_0(137,p)2^{137-k} \simeq 2^{137-k} \times .5 \ \ eV \ \ .$$

$$\Delta E_{k,n}(e) = E_0(k,e) \times (1-2^{-n}) \ ,$$
$$E_0(k,e) = \frac{m_p}{2^{11}m_e} E_0(137,p)2^{148-k} \simeq 2^{148-k} \times .4 \ \ eV \ \ .$$

k characterizes the p-adic length scale and the transition corresponds to the kicking of charged particle from space-time sheet having $k_1 = k+n$ to $k = n$.

The shortest wavelength 630 nm is rather close to the wavelength of HeNe laser and corresponds to red light with $E_0 = 2.00$ eV. Thus one would have $k = 135$ in the case of proton which corresponds to roughly one of atomic radius for ordinary value of $\hbar$. For electron one would have $k = 150$ which corresponds to $L(151)/\sqrt{2}$: $L(151) = 10$ nm corresponds to cell membrane thickness. The following table gives the energies of photons for action spectrum and predicted values in the case of proton, which provides a better fit to the data.

n	2	3	4	5
λ/nm	825	760	680	620
E_{exp}/eV	1.50	1.63	1.82	2.00
E_{pred}/eV	1.50	1.75	1.88	1.94
E_{pred}/E_{exp}	1.00	1.07	1.02	0.97

(1)

The largest error is 7 per cent and occurs for $n = 3$ transition. Other errors are below 3 per cent. Note that also in experiments of Gariaev [48, 66] laser light consisting of 2 eV photons was used: in this case the induced radio wave photons - possibly dark photons with energy 2 eV - had positive effect on growth of potatoes.

4.3 Possible explanation for the effect of IR light on brain

The exposure of brain to IR light at wavelength of 1072 nm is known to improve learning performance and give kick start to cognitive function [71]. The simplest explanation is that this light reloads the metabolic energy batteries of neurons by kicking electrons or protons or their Cooper pairs to larger space-time sheets. The wavelength in question is roughly one half of the wavelength associated with metabolic energy quantum with average energy .5 eV (2480 μm) assignable to the dropping of proton to a very large space-time sheet from k=137 space-time sheet or of electron from k=137+11= 148 space-time sheet. This if the electron and proton are approximated to be free particles. Energy band is in question since both the particles can have additional interaction energy.

For the kicking of electron from very large space-time sheet to $k = 147$ space-time sheet the wave length would be below 1240 nm which is more than 10 per cent longer than 1072 nm. This would suggest that the final state electron is in excited state. The surplus energy is consistent with the width about 100 nm for the UIBs. This identification - if correct - would support the view that metabolic energy quanta are universal and have preceded the evolution of the biochemical machinery associated with metabolism and that the loading of metabolic energy batteries at the fundamental level correspond to the kicking of charged particles to smaller space-time sheets.

4.4 TGD based model for the findings of Becker

TGD suggests a close connections between DC currents, the effects of IR light on brain, and acupuncture.

4.4.1 Observations relating to CNS

The following more quantitative findings, many of them due to Becker, are of special interest as one tries to understand the role of DC currents in TGD framework.

1. CNS and the rest of perineural tissue (tissue surrounding neurons including also glial cells) form a dipole like structure with neural system in positive potential and perineural tissue in negative potential. There is also an electric field along neuron in the direction of nerve pulse propagation (dendrites correspond to - and axon to +) (note that motor nerves and sensory nerves form a closed loop). Also micro-tubules within axon carry electric field and these fields are probably closely related by the many-sheeted variants of Gauss's and Faraday's laws implying that voltages along two different space-time sheets in contact at two points are same in a static situation.

2. A longitudinal potential along front to back in brain with frontal lobes in negative potential with respect to occipital lobes and with magnitude of few mV was discovered. The strength of the electric field correlates with the level of consciousness. As the potential becomes weaker and changes sign, consciousness is lost. Libet and Gerard observed traveling waves of potentials across the cortical layers (with speeds of about 6 m/s: TGD inspired model of nerve pulse predicts this kind of waves). Propagating potentials were discovered also in glial cells. The interpretation was in terms of electrical currents.

3. It was found that brain injury generated positive polarization so that the neurons ceased to function in an area much larger than the area of injury. Negative shifts of neuronal potentials were associated with incoming sensory stimuli and motor activity whereas sleep was associated with a positive shift. Very small voltages and currents could modulate the firing of neurons without affecting the resting potential. The "generating" potentials in sensory receptors inducing nerve pulse were found to be graded and non-propagating and the sign of the generating potential correlated with sensory input (say increase/reduction of pressure). Standard wisdom about cell membrane has difficulties in explaining these findings.

4. The natural hypothesis was that these electric fields are accompanied by DC currents. There are several experimental demonstrations for this. For instance, the deflection of assumed DC currents by external magnetic field (Hall effect) was shown to lead to a loss of consciousness.

4.4.2 Observations relating to regeneration

The second class of experiments used artificial electrical currents to enhance regeneration of body parts. These currents are nowadays used in clinical practice to induce healing or retard tumor growth. Note that tissue regeneration is a genuine regeneration of an entire part of organism rather than mere simple cell replication. Salamander limb generation is one of the most studied examples. Spontaneous regeneration becomes rare at higher evolutionary levels and for humans it occurs spontaneously only in the fractures of long bones.

1. An interesting series of experiments on Planaria, a species of simple flatworm with a primitive nervous system and simple head-to-tail axis of organization, was carried out. Electrical measurements indicated a simple head-tail dipole field. The animal had remarkable regenerative powers; it could be cut transversely into a number of segments, all of which would regenerate a new total organism. The original head-tail axis was preserved in each regenerate, with that portion nearest the original head end becoming the head of the new organism. The hypothesis was that the original head-tail electrical vector persisted in the cut segments and provided the morphological information for the regenerate. The prediction was that the reversal of the electrical gradient by exposing the cut surface to an external current source of

proper orientation should produce some reversal of the head-tail gradient in the regenerate. While performing the experiment it was found found that as the current levels were increased the first response was to form a head at each end of the regenerating segment. With still further increases in the current the expected reversal of the head-tail gradient did occur, indicating that the electrical gradient which naturally existed in these animals was capable of transmitting morphological information.

2. Tissue regeneration occurs only if some minimum amount of neural tissue is present suggesting that CNS plays a role in the process although the usual neural activity is absent. The repeated needling of the stump had positive effect on regeneration and the DC current was found to be proportional to innervation. Hence needling seems to stimulate innervation or at least inducing formation of DC currents. Something like this might occur also in the case of acupuncture.

3. Regeneration involves de-differentiation of cells to form a blastema from which the regenerated tissue is formed. Quite early it was learned that carcinogens induce de-differentiation of cells because of their steric properties and by making electron transfer possible and that denervation induces tumor formation. From these findings Becker concluded that the formation of blastema could be a relatively simple process analogous to tumor growth whereas the regeneration proper is a complex self-organization process during which the control by signals from CNS are necessary and possibly realized in terms of potential waves.

4. Regeneration is possible in salamander but not in frog. This motivated Becker and collaborators to compare these situations. In an amputated leg of both salamander and frog the original negative potential of or order -1 mV went first positive value of order +10 mV. In frog it returned smoothly to its original value without regeneration. In salamander it returned during three days to the original base line and then went to a much higher negative value around -20 mV (resting potential is around -70 mV) followed by a return to the original value as regeneration had occurred. Thus the large negative potential is necessary for the regeneration and responsible for the formation of blastema. Furthermore, artificial electron current induced regeneration also in the case of frog and in even in the denervated situation. Thus the flow of electrons to the stump is necessary for the formation of blastema and the difference between salamander and frog is that frog is not able to provide the needed electronic current although positive potential is present.

5. It was also learned that a so called neural epidermic junction (NEJ) formed in the healing process of salamander stump was responsible for the regeneration in the presence of nervation. The conclusion was that the DC voltage and electronic current relevant for regeneration can be assigned the interface between CNS and tissue rather than with the entire nerve and regeneration seems to be a local process, perhaps a feed of metabolic energy driving self-organization. Furthermore, NEJ seems to make possible the flow of electrons from CNS to the stump.

6. The red blood cells of animals other than mammals are complete and possess thus nuclei.

   Becker and collaborators observed that also red blood cells dedifferentiated to form blastema. Being normally in a quiescent state, they are ideal for studying de-differentiation. It was found that electric current acted as a trigger at the level of cell membrane inducing de-differentiation reflected as an increased amount of mRNA serving as signal for gene expression. Also pulsed magnetic field was found to trigger the de-differentiation, perhaps via induced electric field. By the way, the role of the cell membrane fits nicely with the view about DNA-cell membrane system as topological quantum computer with magnetic flux tubes connecting DNA and cell membrane serving as braids.

7. The experiments of Becker and collaborators support the identification of the charge carriers of DC currents responsible for the formation of large negative potential of stump as electrons. The test was based on the different temperature dependence of electronic and protonic conductivities. Electronic conductivity increases with temperature and protonic conductivity decreases and an increase was observed. In TGD based model also super-conducting charge carriers are possible and this finding does not tell anything about them.

4.4.3 A TGD based model for the findings of Becker

On basis of the observations of Becker one can try to develop a unified view about the effects of laser light, acupuncture, and DC currents. It is perhaps appropriate to start with the following - somewhat leading - questions inspired by a strong background prejudice that the healing process - with control signals from CNS included - utilizes the loading of many-sheeted metabolic batteries by supra currents as a basic mechanism. In the case of control signals the energy would go to the "moving of the control knob".

1. Becker assigns to the system involved with DC currents an effective semiconductor property. Could the effective semiconductor property be due the fact that the transfer of charge carriers to a smaller space-time sheet by first accelerating them in electric field is analogous to the transfer of electrons between conduction bands in semiconductor junction? If so, semiconductor property would be a direct signature of the realization of the metabolic energy quanta as zero point kinetic energies and hence a very ancient property.

2. Supra currents flowing along magnetic flux tubes would make possible dissipation free loading of metabolic energy batteries. This even when oscillating Josephson currents are in question since the transformation to ohmic currents in semiconductor junction makes possible energy transfer only during second half of oscillation period. Could this be a completely general mechanism applying in various states of regeneration process. This might be the case. In quantal situation the metabolic energy quanta have very precise values as indeed required. For ohmic currents at room temperature the thermal energies are considerably higher than those corresponding to the voltage involved so that they seem to be excluded. The temperature at magnetic flux tubes should be however lower than the physiological temperature by a factor of order 10^{-2} at least for the voltage of -1 mV. This would suggest high T_c superconductivity is only effective at the magnetic flux tubes involved. The finding that nerve pulse involves a slight cooling of the axonal membrane proposed in the TGD based model of nerve pulse to be caused by a convective cooling due the return flow of ionic Josephson currents would conform with this picture.

3. What meridians are and what kind of currents flow along them? Could these currents be supra currents making possible dissipation-free energy transfer in the healthy situation? Does the negative potential of order -1 mV make possible flow of protonic supra currents and loading of metabolic batteries by kicking protons to smaller space-time sheets? Could electronic supra currents in opposite direct induce similar loading of metabolic batteries? Could these low miniature metabolisms realize control signals (protons) and feedback (electrons)?

The model answering these questions relies on following picture. Consider first meridians.

1. The direct feed of metabolic energy as universal metabolic currencies realized as a transfer of charge carriers to smaller space-time sheets is assumed to underly all the phenomena involving healing aspect. Meridian system would make possible a lossless metabolic energy feed - transfer of "Chi" - besides the transfer of chemically stored energy via blood flow. The metabolic energy currencies involved are very small as compared to .5 eV and might be

responsible only for "turning control knobs". The correlation of the level of consciousness with the overall strength of DC electric fields would reduce to the level of remote metabolic energy transfer.

2. The model should explain why meridians have not been observed. Dark currents along magnetic flux tubes are ideal for the energy transfer. If the length of the superconducting "wire" is long in the scale defined by the appropriate quantum scale proportional to $\hbar$, classical picture makes sense and charge carriers can be said to accelerate and gain energy ZeV. For large values of $\hbar$ an oscillating Josephson current would be in question. The semiconductor like structure at the end of meridian -possibly realized in terms of pair of space-time sheets with different sizes- makes possible a net transfer of metabolic energy even in this case as pulses at each half period of oscillation. The transfer of energy with minimal dissipation would thus explain why semiconductor like property is needed and why acupuncture points have high value of conductivity. The identification of meridians as invisible magnetic flux tubes carrying dark matter would explain the failure to observe them: one further direct demonstration for the presence of dark matter in biological systems.

3. In the case of regeneration process NEJs would be accompanied by a scaled down version of meridian with magnetic flux tubes mediating the electronic Josephson current during blastema generation and protonic supra current during the regeneration proper. Space-time sheets of proton *resp.* electron correspond to k_p and $k_e = k_p + 11$. In a static situation many-sheeted Gauss law in static situation would guarantee that voltages over NJE are same.

4. One can of course worry about the smallness of the electrostatic energies ZeV as compared to the thermal energy. Zero point kinetic energy could correspond also to the magnetic energy of the charged particle. For sufficiently large values of Planck constant magnetic energy scale is higher than the thermal energy and the function of voltage could be only to drive the charged particles along the flux tubes to the target: and perhaps act as a control knob with electrostatic energy compensating for the small lacking energy. Suppose for definiteness magnetic field strength of $B = .2$ Gauss explaining the effects of ELF em fields on brain and appearing in the model of EEG. Assume that charged particle is in minimum energy state with cyclotron quantum number $n = 1$ and spin direction giving negative interaction energy between spin and magnetic field so that the energy is $(g-2)\hbar eB/2m_p$. Assume that the favored values of hbar correspond to number theoretically simple ones expressible as a product of distinct Fermat primes and power of 2. In the case of proton with $g \simeq 2.7927$ the standard metabolic energy quantum $E_0 = .5$ eV would require roughly $\hbar/\hbar_0 = 17 \times 2^{34}$. For electron $g - 2 \simeq \alpha/\pi \simeq .002328$ gives $\hbar/\hbar_0 = 5 \times 17 \times 2^{30}$.

Consider next NEJs and semiconductor like behavior and charging of metabolic batteries.

1. Since NEJ seems to resemble cell membrane in some respects, the wisdom gained from the model of cell membrane and DNA as tqc can be used. The model for nerve pulse and the model for DNA as topological quantum computer suggest that dark ionic currents flowing along magnetic flux tubes characterized by a large value of Planck constant are involved with both meridians and NJEs and might even dominate. Magnetic flux tubes act as Josephson junctions generating oscillatory supra currents of ions and electrons. For large values of $\hbar$ also meridians are short in the relevant dark length scale and act as Josephson junctions carrying oscillatory Josephson currents.

2. The findings of Becker suggest that acu points correspond to sensory receptors which are normally in a negative potential. The model for the effects of laser light favors (but only

slightly) the assumption that in a healthy situation it is protons arriving along magnetic flux tubes which are kicked to the smaller space-time sheets and that negative charge density at acu point attracts protons to the acu point. Electrons could of course flow in reverse direction along their own magnetic flux tubes and be kicked to the smaller space-time sheets at the positive end of the circuit. In the case of brain, protonic end would correspond to the frontal lobes and electronic end to the occipital lobes. This kind of structure could appear as fractally scaled variants. For instance, glial cells and neurons could form this kind of pair with neurons in negative potential and glial cells in positive potential as suggested by the fact that neuronal damage generates positive local potential.

3. Classically the charge carriers would gain energy $E = ZeV$ as they travel along the magnetic flux tube to NJE. If this energy is higher than the metabolic energy quantum involved, it allows the transfer of charge carrier to a smaller space-time sheet so that metabolic resources are regenerated. Several metabolic quanta could be involved and the value of $V(t)$ would determine, which quantum is activated. The reduction of the V below critical value would lead to a starvation of the cell or at least to the failure of control signals to "turn the control knob". This should relate to various symptoms like pain at acupuncture points. In a situation requiring acupuncture the voltage along flux tubes would be so small that the transfer of protons to the smaller space-time sheets becomes impossible. As a consequence, the positive charge carriers would accumulate to the acu point and cause a further reduction of the voltage. Acupuncture needle would create a "wound" stimulating large positive potential and the situation would be very much like in regeneration process and de-differentiation induced by acupuncture could be understood.

Many questions remain to be answered.

1. What causes the de-differentiation of the cells? The mere charging of metabolic energy batteries perhaps? If so then the amount of metabolic energy- "chi"- possessed by cell would serve as a measure for the biological age of cell and meridian system feeding "chi" identified as dark metabolic energy would serve as a rejuvenating agent also with respect to gene expression. Or does the electric field define an external energy feed to a self-organizing system and create an electromagnetic environment similar to that prevailing during morphogenesis inducing a transition of cells to a dedifferentiated state? Or could DNA as tqc allow to understand the modification of gene expression as being due to the necessity to use tqc programs appropriate for regeneration? Or should cells and wounded body part be seen as intentional agents doing their best to survive rather than as passive parts of biochemical system?

2. Acupuncture and DC current generation are known to induce generation of endorphins. Do endorphins contribute to welfare by reducing the pain or do they give a conscious expression for the fact that situation has improved as a result of recharging of the metabolic energy batteries?

3. Could the continual charging of metabolic energy batteries by DC currents occur also in the case of cell membrane? The metabolic energy quantum would be around .07 eV in this case and correspond to p-adic length scale $k = 140$ for proton (the quantum is roughly a fraction $1/8$ of the fundamental metabolic energy quantum .5 eV corresponding to $k = 137$).

This picture suggests close connections between the effects of acupuncture, the effects of IR light on living matter, and the findings of Becker.

4.5 Could UV photons have some metabolic role?

The correlation between UV photons and ERE brings in mind the vision that high temperature plasmoids are primitive life-forms possibly having universal metabolic energy quanta in UV range. One can imagine that the development of chemical energy storage mechanisms has made it possible to use visible light from Sun as a source of metabolic energy and get rid of UV quanta having disastrous biological effects. Ozone layer shields out most of UV light and also air absorbs the UV light below wavelength 200 nm, which justifies the term vacuum UV (VUV) for this range.

Δk	1	2	≥ 3	∞
$\Delta E(144, \Delta k)/eV$	4	6	≥ 7	8
λ/nm	310(UVB)	207(UVB)	≤ 177 (VUV)	155 (VUV)

Table 3. The lines corresponding to the dropping of electron from $k = 144$ space time sheet defining a candidate for UV light inducing generation of ERE in the interstellar dust.

From Table 3 one finds that $\Delta k > 2$ electronic transitions cascading to 8 eV (155 nm) by period doubling) belong to vacuum UV (VUV) absorbed by air. The lines 310 nm and 207 nm corresponding to $\Delta k = 1$ and $\Delta k = 2$ could however define frequency windows since these lines need not correspond to any atomic or molecular electronic transitions.

In the solar photosphere the temperature is about 5800 K, roughly half of the minimum temperature 10^4 K needed to generate the UV radiation inducing ERE in interstellar dust. Solar corona however has temperature of about 10^6 K, which corresponds to a thermal energy of order 100 eV and the UV radiation from corona at above mentioned discrete frequencies resulting in dropping of electrons could serve as a metabolic energy source for pre-biotics in the interstellar space. This raises obvious questions. Should the stellar sources inducing ERE possess also corona? Could 4 eV and 6 eV UV photons from the solar corona serve as a source of metabolic energy for some primitive organisms like blue algae?

4.6 A simple model for the metabolism of plasmoids

Extended Red Emissions (EREs) are associated with the interstellar dust in presence of UV light with energies above 7.25 eV and source with temperature not below 10^4 K (maximum of wave length distribution of black body radiation corresponds to the energy 4.97 eV at this temperature). This suggests that plasmoids using UV photons as metabolic energy are involved.

1. Since the bond energies of molecules vary in few eV range and their formation typically liberates photons in UV range, the natural hypothesis is that the metabolic cycle is based on the formation of some molecule liberating UV photon kicking electron/proton to a smaller space-time sheet. UV photons from energy source would in turn induce dissociation of the molecule and thus drive the process. The process as a whole would involve several p-adic length scales and several metabolic currencies.

2. This situation is of course encountered also in the ordinary biology but with highly developed sharing of labor. Biosphere would burn hydrocarbons in animal cells with carbon dioxide as the eventual outcome. Carbon dioxide would in turn be used by plants to regenerate the hydrocarbons. Note that in the recent day technology the loop is open: hydrocarbons are burned but there is no process regenerating them: perhaps photons with large Planck constant might some day used to regenerate the fuel and give rise to "living" and perhaps tidier technology.

3. It is believed that complex organic molecules like amino-acids can form in the interstellar dust and the spontaneous formation of amino-acids is known to be possible in the interstellar ice under UV radiation. Hence at least N_2 and perhaps also CO can be expected to be present. The table below gives dissociation energies of some simple molecules.

Molecule	H_2	O_2	N_2	CO	NO
E_D/eV	4.48	5.08	7.37	11.11	5.2

   i) N_2 has bond energy 7.37 eV is slightly above the UV threshold 7.26 eV for ERE, which strongly suggests that N_2 is one of the molecules involved with the metabolism of interstellar plasmoids.

   ii) If ice is present then carbon monoxide CO would be an excellent candidate for a metabolic molecule since its bond energy is as high as 11.11 eV. The exceptionally large bond energy would naturally relate to the fact that carbon and oxygen are the key molecules of life.

4.7 Anomalous light phenomena as plasmoids

TGD suggests that anomalous light phenomena (ALPs, or light balls, or UFOs depending on one's tastes and assumptions) are identifiable as plasmoids behaving as primitive life forms. In the conference held in Röros Björn Gitle-Hauge told about the determination of the spectrum of visible light emitted by some light balls observed in Hessdalen [74] ("Hessdalen phenomenon" is the term used).

1. The spectrum is a band in the interval 500-600 nm whereas the typical ERE [82] is concentrated in the interval 650-750 nm. The peak is in the interval 540-900 nm, the width of the band is also now 100 nm, and there are no sharp peaks. Therefore the interpretation as ERE can be considered.

2. Because Hessdalen is an old mining district, authors propose that the light ball could consist of burning dust containing some metals. Author proposes that the burning of Titanium and Scandium (encountered only in Scandinavia) might provide the energy for the light ball. Sc reacts vigorously with acids and air (burning in oxygen gives Sc_2O_3 as end product). Ti burns in oxygen and is the only element that burns in nitrogen. Ti is used in fireworks since it produces spectacular fires.

   Author notices that the emission lines of N^+, Al^{++}, *resp.* Sc^+ at 528.02 nm, 528.2 nm, *resp.* 528.576 nm might contribute to the band. This might be the case but the explanation of the band solely in terms of molecular transitions is not favored by its smoothness.

3. The bond energies of TiO and TiN are 6.9 eV and 5.23 eV so that the radiation resulting in their formation is in UV range and could provide part of the metabolic energy. I do not know about bond energy of Scandium oxide.

4. TiO_2 is known to catalyze photolysis in the presence of UV light [59, 58], which in turn is basic step in photosynthesis [57], the basic step of which in TGD Universe would be the kicking of electrons/protons to smaller space-time sheets. Therefore the UV photons liberated in the formation of molecules containing Ti could catalyze photosynthesis like process.

5 Summary about the possible role of the magnetic body in living matter

The notion of magnetic/field body is probably the feature of TGD inspired theory of quantum biology which creates strongest irritation in standard model physicist. A ridicule as some kind of Mesmerism might be the probable reaction. The notion of magnetic/field body has however gradually gained more and more support and it is now an essential element of TGD based view about living matter. In the following I list the basic applications in the hope that the overall coherency of the picture might force some readers to take this notion seriously. I will talk only about magnetic body although it is clear that field body has also electric parts as well as radiative parts realized in terms of "massless extremals" or topological light rays.

5.1 Anatomy of magnetic body

Consider first the anatomy of the magnetic body.

1. Magnetic body has a fractal onion like structure with decreasing magnetic field strengths and the highest layers can have astrophysical sizes. Cyclotron wave length gives an estimate for the size of particular layer of magnetic body. $B = .2$ Gauss is the field strength associated with a particular layer of the magnetic body assignable to vertebrates and EEG. This value is not the same as the nominal value of the Earth's magnetic field equal to .5 Gauss. It is quite possible that the flux quanta of the magnetic body correspond to those of wormhole magnetic field and thus consist of two parallel flux quanta which have opposite time orientation. This is true for flux tubes assigned to DNA in the model of DNA as a topological quantum computer.

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

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

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

5.2 Functions of the magnetic body

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

1. Magnetic body controls biological body and receives sensory data from it. Together with zero energy ontology and new view about time explains Libet's strange findings about time lapses of consciousness. EEG, or actually fractal hierarchy of EXGs assignable to various body parts makes possible communications to and control by the various layers of the magnetic body. WXG could induce charge density gradients by the exchange of W boson.

2. The flux sheets of the magnetic body traverse through DNA strands. The hierarchy of Planck constants and quantization of magnetic flux predicts that the flux sheets can have arbitrarily large width. This leads to the idea that there is hierarchy of genomes corresponding to ordinary genome, supergenome consisting of genomes of several cell nuclei arranged along flux sheet like lines of text, and hypergenomes involving genomes of several organisms arranged in a similar manner. The prediction is coherent gene expression at the level of organ, and even of population. In this picture the big jumps in evolution, in particular, the emergence of EEG, could be seen as the emergence of a new larger layer of magnetic body characterized by a larger value of Planck constant. For instance, this would allow to understand why the quantal effects of ELF em fields requiring so large value of Planck constant that cyclotron energies are above thermal energy at body temperature are observed for vertebrates only.

3. Magnetic body makes possible information process in a manner highly analogous to topological quantum computation. The model of DNA as topological quantum computer assumes that flux tubes of wormhole magnetic field connect DNA nucleotides with the lipids of the lipid layer of nuclear or cell membrane. The flux tubes would continue through the membrane and split during tqc. The time-like braiding of flux tubes makes possible tqc via timelike braiding and space-like braiding makes possible the representation of memories. The model allows general vision about the deeper meaning of the structure of cell and makes testable predictions about DNA.

   One prediction is the coloring of braid strands realized by an association of quark or antiquark to nucleotide. Color and spin of quarks and antiquarks would thus correspond to the quantum numbers assignable to braid ends. Color isospin could replace ordinary spin as a representation of qubit and quarks would naturally give rise to qutrit, with third quark would have interpretation as unspecified truth value. Fractionization of these quantum numbers takes place which increases the number of degrees of freedom. This prediction would relate closely to the discovery of topologist Barbara Shipman that the model for the honeybee dance suggests that quarks are in some manner involved with cognition. Also microtubules associated with axons connected to a space-time sheet outside axonal membrane via lipids could be involved with topological quantum computation and actually define an analog of a higher level programming language.

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

5. These findings together with the discovery that also nerve pulse seems to involve only low dissipation lead to a model of nerve pulse in which dark ionic currents automatically return back as Josephson currents without any need for pumping. This does not exclude the possibility that ionic channels might be involved with the generation of nerve pulse so that the original view about quantal currents as controllers of the generation of nerve pulse would be turned upside down. Nerve pulse would result as a perturbation of kHz soliton sequence

mathematically equivalent to a situation in which a sequence of gravitational penduli rotates with constant phase difference between neighbors except for one pendulum which oscillates and oscillation moves along the sequence with same velocity as the kHz wave. The oscillation would be induced by a "kick" for which one can imagine several mechanisms.

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

The model predicts that the time taken to travel along any axon is a multiple of time dictated by the resting potential so that synchronization is an automatic prediction. Not only kHz waves but also a fractal hierarchy of EEG (and EXG) waves are induced as Josephson radiation by voltage waves along axons and microtubules and by standing waves assignable to neuronal (cell) soma. The value of Planck constant involved with flux tubes determines the frequency scale of EXG so that a fractal hierarchy results. A hierarchy of preferred values of Planck constant coming as powers of 2^{11} suggests itself and would correspond also a hierarchy of time scales of memory recall and of planned action. Ordinary EEG would correspond to 2^{k11}, $k = 4$, but also shorter and longer time scales are predicted.

6. Acupuncture points, meridians, and Chi are key notions of Chinese medicine and find a natural identification in terms of magnetic body lacking from the western medicine. Also a connection with well established notions of DC currents and potentials discovered by Becker and with TGD based view about universal metabolic currencies as differences of zero point energies for pairs of space-time sheets with different p-adic length scale emerges.

   Chi would correspond to these fundamental metabolic energy quanta to which ordinary chemically stored metabolic energy would be transformed. Meridians would most naturally correspond to flux tubes with large $\hbar$ along which dark supra currents flow without dissipation and transfer the metabolic energy between distant cells. Acupuncture points would correspond to points between which metabolic energy is transferred and their high conductivity and semiconductor like behavior would conform with the interpretation in terms of metabolic energy storages. The energy gained in the potential difference between the points would help to kick the charge carrier to a smaller space-time sheet. It is possible that the main contribution to the of charge at magnetic flux tube is magnetic energy and slightly below the metabolic energy quantum and that the voltage difference gives only the lacking small energy increment making the transfer possible. Also direct kicking of charge carriers to smaller space-time sheets by photons is possible and the observed action spectrum for IR and red photons corresponds to the predicted increments of zero point kinetic energies.

7. Magnetic flux tubes could also play key role in bio-catalysis and explain the magic ability of biomolecules to find each other. The model of DNA as tqc suggest that not only DNA and its conjugate but also some amino-acid sequences acting as catalysts could be connected to DNA and other amino-acids sequences or more general biomolecules by flux tubes acting as colored braid strands. The shortening of the flux tubes in a phase transition reducing the value of Planck constant would make possible extremely selective mechanisms of catalysis allowing precisely defined locations of reacting molecules to attach to each other. With recently discovered mechanism for programming sequences of biochemical reactions this would make possible to understand the miraculous looking feats of bio-catalysis.

8. The ability to construct "stories", temporally scaled down or possible also scaled up representations about the dynamical processes of external world, might be one of the key aspects of intelligence. There is direct empirical evidence for this activity in hippocampus. The phase

transitions reducing or increasing the value of Planck constant would indeed allow to achieve this by scaling the time duration of the zero energy space-time sheets providing cognitive representations.

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

The list of nice things made possible by the magnetic body is impressive and one can ask whether there is any experimental support for this notion. The findings of Peter Gariaev and collaborators give evidence for the representation of DNA sequences based on the coding of nucleotide to a rotation angle of the polarization direction as photon travels through the flux tube and for the decoding of this representation to gene activation [48], for the transformation of laser light to light at various radio-wave frequencies having interpretation in terms of phase transitions increasing $\hbar$ [46, 47], and even for the possibility to photograph magnetic flux tubes containing dark matter by using ordinary light in UV-IR range scattered from DNA [49].

Acknowledgements

I wish to thank the participants of the Unified Theories conference organized by the Institute for Strategic Research for very stimulating discussions and for the Institute for Strategic Research for a financial support.

References

Online books and articles about TGD, TGD inspired theory of consciousness and of quantum biology

[1] M. Pitkänen (2006), *Topological Geometrodynamics: Overview.* http://www.helsinki.fi/∼matpitka/tgdview/tgdview.html.

[2] M. Pitkänen (2006), *Quantum Physics as Infinite-Dimensional Geometry.* http://www.helsinki.fi/∼matpitka/tgdgeom/tgdgeom.html.

[3] M. Pitkänen (2006), *Physics in Many-Sheeted Space-Time.* http://www.helsinki.fi/∼matpitka/tgdclass/tgdclass.html.

[4] M. Pitkänen (2006), *Quantum TGD.* http://www.helsinki.fi/∼matpitka/tgdquant/tgdquant.html.

[5] M. Pitkänen (2006), *TGD as a Generalized Number Theory.* http://www.helsinki.fi/∼matpitka/tgdnumber/tgdnumber.html.

[6] M. Pitkänen (2006), *p-Adic length Scale Hypothesis and Dark Matter Hierarchy.* http://www.helsinki.fi/∼matpitka/paddark/paddark.html.

[7] M. Pitkänen (2006), *TGD and Fringe Physics.* http://www.helsinki.fi/∼matpitka/freenergy/freenergy.html.

[8] M. Pitkänen (2006), *Bio-Systems as Self-Organizing Quantum Systems.* http://www.helsinki.fi/∼matpitka/bioselforg/bioselforg.html.

[9] M. Pitkänen (2006), *Quantum Hardware of Living Matter*.
http://www.helsinki.fi/∼matpitka/bioware/bioware.html.

[10] M. Pitkänen (2006), *TGD Inspired Theory of Consciousness*.
http://www.helsinki.fi/∼matpitka/tgdconsc/tgdconsc.html.

[11] M. Pitkänen (2006), *Mathematical Aspects of Consciousness Theory*.
http://www.helsinki.fi/∼matpitka/genememe/genememe.html.

[12] M. Pitkänen (2006), *TGD and EEG*.
http://www.helsinki.fi/∼matpitka/tgdeeg/tgdeeg/tgdeeg.html.

[13] M. Pitkänen (2006), *Bio-Systems as Conscious Holograms*.
http://www.helsinki.fi/∼matpitka/hologram/hologram.html.

[14] M. Pitkänen (2006), *Magnetospheric Consciousness*.
http://www.helsinki.fi/∼matpitka/magnconsc/magnconsc.html.

[15] M. Pitkänen (2006), *Mathematical Aspects of Consciousness Theory*.
http://www.helsinki.fi/∼matpitka/magnconsc/mathconsc.html.

[16] M. Pitkänen (2008), *Topological Geometrodynamics: an Overall View*.
http://www.helsinki.fi/∼matpitka/articles/TGD2008.pdf.

[17] M. Pitkänen (2008), *TGD Inspired Theory of Consciousness*.
http://www.helsinki.fi/∼matpitka/articles/tgdconsc.pdf.

[18] M. Pitkänen (2008), *TGD Inspired Quantum Model of Living Matter*.

http://www.helsinki.fi/∼matpitka/articles/quantumbio.pdf.

[19] M. Pitkänen (2008), *DNA as Topological Quantum Computer*.
http://www.helsinki.fi/∼matpitka/articles/dnatqcart.pdf.

[20] M. Pitkänen (2008), *Quantum Model for Nerve Pulse and EEG*.
http://www.helsinki.fi/∼matpitka/articles/pulseeg.pdf.

[21] M. Pitkänen. *Evolution in Many-Sheeted Space-Time*.
http://www.helsinki.fi/∼matpitka/articles/prebiotic.pdf.

[22] M. Pitkänen (2008), *A Model for Protein Folding and Bio-catalysis*.
http://www.helsinki.fi/∼matpitka/articles/prebiotic.pdf.

[23] M. Pitkänen (2008), *The Notion of Wave-Genome and DNA as Topological Quantum Computer*.
http://www.helsinki.fi/∼matpitka/articles/gari.pdf.

References to the chapters of books

[B4] The chapter *Configuration Space Spinor Structure* of [2].
http://www.helsinki.fi/∼matpitka/tgdgeom/tgdgeom.html#cspin.

[C7] The chapter *Was von Neumann Right After All* of [4].
http://www.helsinki.fi/∼matpitka/tgdquant/tgdquant.html#vNeumann.

[C8] The chapter *Does TGD Predict the Spectrum of Planck Constants?* of [4].
http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html#Planck.

[D5] The chapter *TGD and Cosmology* of [3].
http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#cosmo.

[D6] The chapter *TGD and Astrophysics* of [3].
http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#astro.

[E9] The chapter *Topological Quantum Computation in TGD Universe* of [5].
http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html#tqc.

[F8] The chapter *TGD and Nuclear Physics* of [6].
http://www.helsinki.fi/~matpitka/paddark/paddark.html#padnucl.

[F9] The chapter *Dark Nuclear Physics and Condensed Matter* of [6].
http://www.helsinki.fi/~matpitka/paddark/paddark.html#exonuclear.

[H1] The chapter *Matter, Mind, Quantum* of [10].
http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#conscic.

[H6] The chapter *Quantum Model of Memory* of [10].
http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#memoryc.

[H8] The chapter *p-Adic Physics as Physics of Cognition and Intention* of [10].
http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#cognic.

[J1] The chapter *Bio-Systems as Super-Conductors: part I* of [9].
http://www.helsinki.fi/~matpitka/bioware/bioware.html#superc1.

[J3] The chapter *Bio-Systems as Super-Conductors: part III* of [9].
http://www.helsinki.fi/~matpitka/bioware/bioware.html#superc3.

[J4] The chapter *Quantum Antenna Hypothesis* of [9].
http://www.helsinki.fi/~matpitka/bioware/bioware.html#tubuc.

[J7] The chapter *About the New Physics Behind Qualia* of [9].
http://www.helsinki.fi/~matpitka/bioware/bioware.html#newphys.

[K3] The chapter *General Theory of Qualia* of [13].
http://www.helsinki.fi/~matpitka/hologram/hologram.html#qualia.

[K4] The chapter *Bio-Systems as Conscious Holograms* of [13].
http://www.helsinki.fi/~matpitka/hologram/hologram.html#hologram.

[K5] The chapter *Homeopathy in Many-Sheeted Space-Time* of [13].
http://www.helsinki.fi/~matpitka/hologram/hologram.html#homeoc.

[K6] The chapter *Macroscopic Quantum Coherence and Quantum Metabolism as Different Sides of the Same Coin* of [13].
http://www.helsinki.fi/~matpitka/hologram/hologram.html#metab.

[L2] The chapter *Many-Sheeted DNA* of [11].
http://www.helsinki.fi/~matpitka/genememe/genememe.html#genecodec.

[L4] The chapter *Pre-Biotic Evolution in Many-Sheeted Space-Time* of [11].
http://www.helsinki.fi/~matpitka/genememe/genememe.html#prebio.

[L5] The chapter *DNA as Topological Quantum Computer* of [11].
http://www.helsinki.fi/∼matpitka/genememe/genememe.html#dnatqc.

[M2] The chapter *Quantum Model for Nerve Pulse* of [12].
http://www.helsinki.fi/∼matpitka/tgdeeg/tgdeeg/tgdeeg.html#pulse.

[M3] The chapter *Dark Matter Hierarchy and Hierarchy of EEGs* of [12].
http://www.helsinki.fi/∼matpitka/tgdeeg/tgdeeg/tgdeeg.html#eegdark.

Anyons and quantum Hall effect

[24] F. Wilzek (1990), *Fractional Statistics and Anyon Super-Conductivity*, World Scientific.
R. B. Laughlin (1990), Phys. Rev. Lett. 50, 1395.

[25] R. B. Laughlin (1983), Phys. Rev. Lett. 50, 1395.

[26] J.K. Jain(1989), Phys. Rev. Lett. 63, 199.

[27] J. B. Miller *et al*(2007), *Fractional Quantum Hall effect in a quantum point contact at filling fraction 5/2*, arXiv:cond-mat/0703161v2.

[28] *Fractional quantum Hall Effect*, http://en.wikipedia.org/wiki/Fractional_quantum_Hall_effect.
Fractional Quantum Hall Effect, http://www.warwick.ac.uk/∼phsbm/fqhe.htm.

High T_c super-conductivity and bio-superconductivity

[29] G. Burns (1993) *High Temperature Super Conductivity*, Academic Press, Inc.

[30] J. Zaanen (2005), *Why high Tc is exciting?*,
http://www.lorentz.leidenuniv.nl/research/jan_hitc.pdf.

[31] J. Zaanen (2006), *Superconductivity: Quantum Stripe Search*, Nature vol 440, 27 April.
http://www.lorentz.leidenuniv.nl/ jan/nature03/qustripes06.pdf.

[32] V. J. Emery, S. A. Kivelson,, and J. M. Tranquada (1999), *Stripe phases in high-temperature superconductors*, Perspective, Vol. 96, Issue 16, 8814-8817, August 3.
http://www.pnas.org/cgi/reprint/96/16/8814.pdf.

[33] *High temperature and other unconventional superconductors.*
http://www.fkf.mpg.de/metzner/research/hightc/hightc.html.

[34] S. Sachdev (1999) *Quantum phase transitions (summary)*, Physics World April pp. 33-38.

[35] E. Del Giudice, S. Doglia, M. Milani, C. W. Smith, G. Vitiello (1989), *Magnetic Flux Quantization and Josephson Behavior in Living Systems*, Physica Scripta,Vol. 40, pp. 786-791.

[36] Bio-chemistry laboratory U.S. Naval Air Development Center, Pennsylvania (1971), *Evidence from Activation Energies for Super-conductive Tunneling in Biological Systems at Physiological Temperatures*, Physiological Chemistry and Physics 3, pp. 403-410.

[37] A Kasumov *et al* (2001), *Proximity-induced superconductivity in DNA*, Science 291, 280.
See also *Electronic properties of DNA*, Physicsweb,
http://physicsweb.org/articles/world/14/8/8

Strange behavior of cell membrane

[38] G. N. Ling (1962) *A physical theory of the living state: the association-induction hypothesis; with considerations of the mechanics involved in ionic specificity.* New York: Blaisdell Pub. Co..
Ibid(1978):*Maintenance of low sodium and high potassium levels in resting muscle cells.* Journal of Physiology (Cambridge), July: 105-23.
Ibid(1992): *A revolution in the physiology of the living cell.* Malabar, FL: Krieger Pub. Co..
G. N. Ling *et al*: *Experimental confirmation, from model studies, of a key prediction of the polarized multilayer theory of cell water.* Physiological Chemistry and Physics, 10:1, 1978: 87-8.
G. N. Ling, *Three sets of independent disproofs against the membrane-pump theory* http://www.gilbertling.org/lp6a.htm .

[39] B. Sakmann and B. Neher (1983): *Single-channel recording.* Plenum Press, New York & London.

[40] G. Pollack (2000), *Cells, Gels and the Engines of Life.* Ebner and Sons.
http://www.cellsandgels.com/ .

[41] F. Sachs, F. Qin (1993), *Gated, ion-selective channels observed with patch pipettes in the absence of membranes: novel properties of a gigaseal.* Biophysical Journal, September: 1101-7.

[42] A.A. Lev *et al* (1993), *Rapid switching of ion current in narrow pores: implications for biological ion channels.* Proceedings of the Royal Society of London. Series B: Biological Sciences, June, 187-92. 134-2137.

[43] D. J. Woodbury (1989): *Pure lipid vesicles can induce channel-like conductances in planar bilayers.* Journal of Membrane Biology, July 1989: 145-50.

[44] F. A. Popp, B.Ruth, W.Bahr, J.Bhm, P.Grass (1981), G.Grolig, M.Rattemeyer, H.G.Schmidt and P.Wulle: *Emission of Visible and Ultraviolet Radiation by Active Biological Systems.* Collective Phenomena(Gordon and Breach), 3, 187-214.
F. A. Popp, K. H. Li, and Q. Gu (eds.) (1992): *Recent Advances in Bio-photon Research and its Applications.* World Scientific, Singapore-New Jersey.

[45] M. Shaduri. & G.Tshitshinadze (1999), *On the problem of application of Bioenergography in medicine.* Georgian Engineering News 2, 109-112.
See also http://www.biohолography.org/ .

[46] P. Gariaev *et al* (2000), *The DNA-wave-biocomputer*, CASYS'2000, Fourth International Conference on Computing Anticipatory Systems, Liege, 2000. Abstract Book, Ed. M. Dubois.

[47] P. Gariaev, *Brief introduction into WaveGenetics. Its scope and opporturnities..*
http://www.wavegenetics.jino-net.ru.

[48] P. P. Gariaev *et al*(2002), *The spectroscopy of bio-photons in non-local genetic regulation*, Journal of Non-Locality and Remote Mental Interactions, Vol 1, Nr 3.
http://www.emergentmind.org/gariaevI3.htm.

[49] P. P. Gariaev, G. G. Tertishni, A. V. Tovmash (2007), *Experimental investigation in vitro of holographic mapping and holographic transposition of DNA in conjuction with the information pool encircling DNA*, New Medical Tehcnologies, #9, pp. 42-53. The article is in Russian but Peter Gariaev kindly provided a translation of the article to English.

Biology and neuroscience

[50] T. I. Karu (1998), *The Science of Low-Power Laser Therapy*, Gordon and Breach, Sci. Publ., London.
T. I. Karu, *Cellular mechanisms of Low-power Laser Therapy (photobiomodulation)*, http://www.laserhealthsystems.com/Dr.%20Tiina%20Karu%20Presentation.htm.

[51] R. O. Becker and G. Selden (1990) *The Body Electric: Electromagnetism and the Foundation of Life*. William Morrow & Company, Inc., New York.

[52] R. O. Becker and A. A. Marino (1982), *Electromagnetism & Life*, State University of New York Press, Albany.
http://www.ortho.lsuhsc.edu/Faculty/Marino/EL/ELTOC.html.

[53] T. Heimburg and A. D. Jackson (2005),*On soliton propagation in biomembranes and nerves*, PNAS vol. 102, no. 28, p.9790-9795.

[54] T. Heimburg and A. D. Jackson (2005), *On the action potential as a propagating density pulse and the role of anesthetics*, arXiv : physics/0610117 [physics.bio-ph].

[55] K. Graesboll (2006), *Function of Nerves-Action of Anesthetics*, Gamma 143, An elementary Introduction. http://www.gamma.nbi.dk.

[56] B. Libet, E. W. Wright Jr., B. Feinstein, and D. K. Pearl (1979), *Subjective referral of the timing for a conscious sensory experience*, Brain, 102, 193-224.
S. Klein (2002), *Libet's Research on Timing of Conscious Intention to Act: A Commentary* of Stanley Klein, Consciousness and Cognition 11, 273-279.
http://cornea.berkeley.edu/pubs/ccog_2002_0580-Klein-Commentary.pdf.

[57] *Photosynthesis*, http://en.wikipedia.org/wiki/Photosynthesis.

[58] *Photolysis*, http://en.wikipedia.org/wiki/Photolysis.

[59] *Photocatalysis*, http://en.wikipedia.org/wiki/Photocatalysis.

[60] *Saltation*, http://en.wikipedia.org/wiki/Saltation.

[61] *Soliton model*, http://en.wikipedia.org/wiki/Soliton_model.

Effects of em fields on living matter

[62] S. M. Bawin and W. R. Adey (1975), *Interaction between nervous tissue and weak environmental electric fields*, Ann. N.Y. Acad. Sci. 247:323-330.

[63] C. F. Blackman, J. A. Elder, C. M. Weil, S. G. Benane (1979), *Induction of calsium-ion efflux from brain tissue by radio-frequency radiation: effects of modulation frequency and field strength*. Radio Sci. 14(6S): 93-98.
Blackman, C. F., Benane, S. G., Kinney, L. S., House, D. E., and Joines, W. T., (1982), *Effects of ELF fields on calcium-ion efflux from brain tissue, in vitro*, Radiat. Res. 92:510-520.
Blackman, C. F., Benane, S. G., Rabinowitz, J. R., House, D. E., and Joines, W. T., (1985), *A role for the magnetic field in the radiation-induced efflux of calcium ions from brain tissue, in vitro*, Bioelectromagnetics 6:327-337.
Blackman, C. F., Kinney, L. S., House, D. E., and Joines, W. T., (1989), *Multiple power*

density windows and their possible origin, Bioelectromagnetics 10(2):115-128.
C. F. Blackman (1994), "Effect of Electrical and Magnetic Fields on the Nervous System" in *The Vulnerable Brain and Enviromental Risks, Vol. 3, Toxins in Air and Water* (eds. R. L. Isaacson and K. F. Jensen). Plenum Press, New York, pp. 331-355.

[64] J. P. Blanchard and C. F. Blackman (1994), "A model of magnetic field effects on biological system with conforming data from a cell culture preparation" in *On the Nature of Electromagnetic Field Interactions with Biological Systems*, edited by Allan H. Frey. R. G. Landes Company. Medical Intelligence Unit.

[65] N. Cherry (2000), Conference report on effects of ELF fields on brain.
http://www.tassie.net.au/emfacts/icnirp.txt .

[66] P. Gariaev *et al* (2000), "The DNA-wave-biocomputer", CASYS'2000, Fourth International Conference on Computing Anticipatory Systems, Liege, 2000. Abstract Book, Ed. M. Dubois.

[67] A. R. Liboff (1985), "Cyclotron resonance in membrane transport", in *Interaction between Electromagnetic Fields and Cells* (a. Chiabrera, C. Nicolini, and H.P. Schwan, eds.), NATO ASI Series A97, Plenum Press. New York, pp. 281-296.

[68] P. L. Nunez (2000), *Toward a Quantitative Description of Large Scale Neocortical Dynamic Function and EEG*, Behavioral and Brain Sciences, 23,(3):XX.
http://www.bbsonline.org/documents/a/00/00/05/08/.

[69] A. Schienle, R. Stark, R. Kulzer, R. Klpper and D. Vaitl (1996) *Atmospheric electromagnetism: individual differences in brain electrical response to simulated sferics*. International Journal of Psychophysiology, 21, 177.

[70] Sentman, D., D. (1985), *Schumann Resonances*, in CRC Handbook of Atmospheric Electrodynamics, (Hans Volland, ed.), CRC Press, Boca Raton. http://sprite.gi.alaska.edu/schuchar.htm.

[71] *New research could help to reverse the biological clock for dementia patents*, University of Sunderland. Online abstract 2008.
http://www.biospace.com/news_story.aspx?NewsEntityId=83969.

Physics related references

[72] L. J. Allamandola, M. P. Bernstein, S.A. Sandford (1997), in *Astronomical and biochemical origins and the search for life in the universe*, Ed. CB Cosmovici, S. Bowyer, D. Wertheimer, pp. 23-47, Editrice Compositori, Bologna.

[73] C.A. Bertulani, V. Zelevinsky (2002), *Is the tetra-neutron a bound dineutron-dineutron molecule?*, J.Phys. G29, 2431-2437. arXiv:nucl-th/0212060.

[74] Björn Gitle-Hauge (2007), *Optical spectrum analysis of the Hessdalen phenomenon* in "The 7^{th} European SSE Meeting, August 17-19, 2007, Röros, Norway. Proceedings".

[75] F. M. Marquez *et al* (2003), Phys. Rev. C65, 044006.

[76] P. Parsons (2004), *Dancing the Quantum Dream*, New Scientist 24. January.
www.newscientist.com/hottopics.

[77] B. Tsytovich *et al* (2007), *From Plasma crystals and helical structures towards inorganic living matter*, New Journal of Physics, August issue.
http://www.iop.org/EJ/abstract/1367-2630/9/8/263.

[78] *Interstellar Dust as Agent and Subject of Galactic Evolution*,
http://www.ricercaitaliana.it/prin/dettaglio_completo_prin_en-2005022470.htm.

[79] *From the stars to the thought*,
http://www.brunonic.org/Nicolaus/fromthestarstot.htm.

[80] E. Lozneanu and M. Sanduloviciu (2003) *Minimal-cell system created in laboratory by self-organization*, Chaos, Solitons & Fractals, Volume 18, Issue 2, October, p. 335.
See also *Plasma blobs hint at new form of life*, New Scientist vol. 179 issue 2413 - 20 September 2003, page 16.

[81] R. Mills *et al* (2003), *Spectroscopic and NMR identification of novel hybrid ions in fractional quantum energy states formed by an exothermic reaction of atomic hydrogen with certain catalysts*.
http://www.blacklightpower.com/techpapers.html.

[82] Uma P. Vihj (2004), *Extended Red Emission*.
http://ardbeg.astro.utoledo.edu/∼karen/baglunch/vijh_abl_spr04.pdf.

[83] E. C. Zeeman (ed.)(1977), *Catastrophe Theory*, Addison-Wessley Publishing Company.

[84] *Liquid crystals on line*, http://www.lcionline.net/.

[85] *Self organization*, http://en.wikipedia.org/wiki/Self_organization.

[86] *Diffuse interstellar bands*,
http://en.wikipedia.org/wiki/Diffuse_interstellar_band.