

Quantum Mind, Magnetic Body, and Biological Body

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Abstract

The chapter is devoted to some applications of TGD inspired view about Quantum Mind to biology. Magnetic body carrying dark matter and forming an onionlike structure with layers characterized by large values of Planck constant is the key concept. Magnetic body is identified as intentional agent using biological body as sensory receptor and motor instrument. EEG is identified as a communication and control tool of the magnetic body and a fractal hierarchy of analogs of EEG is predicted.

Living system is identified as a kind of Indra's net with biomolecules representing the nodes of the net and magnetic flux tubes connections between them. The reconnection of magnetic flux tubes and phase transitions changing Planck constant and therefore the lengths of the magnetic flux tubes are identified as basic mechanisms behind DNA replication and analogous processes and also behind the phase transitions associated with the gel phase in cell interior. The braiding of magnetic flux makes possible universal memory representation recording the motions of the basic units connected by flux tubes. Braiding also defines topological quantum computer programs updated continually by the flows of the basic units. The model of DNA as topological quantum computer is discussed as an application.

A vision about quantum metabolism in TGD Universe is proposed. The new element is the idea that the presence of ATP at magnetic flux tube is a necessary prerequisite for negentropic entanglement between its ends. ATP could be seen as a molecule of consciousness in this picture. Also a possible modification of second law to take into account negentropic entanglement is discussed. TGD approach to living matter was strongly motivated by the findings about strange behavior of cell membrane and of cellular water, and gel behavior of cytoplasm. These findings are briefly discussed in TGD framework by bringing in magnetic flux tubes as a new element. Water is in key role in living matter and TGD inspired view about water and its anomalies is discussed.

1 Introduction

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

The article is devoted to some applications of TGD inspired view about Quantum Mind to biology. Magnetic body carrying dark matter and forming an onion-like structure with layers characterized by large values of Planck constant is the key concept. Magnetic body is identified as intentional agent using biological body as sensory receptor and motor instrument. EEG and its fractal variants are identified as a communication and control tool of the magnetic body and a fractal hierarchy of analogs of EEG is predicted. Living system is identified as a kind of Indra's net with biomolecules representing the nodes of the net and magnetic flux tubes connections between them. The reconnection of magnetic flux tubes and phase transitions changing Planck constant and therefore the lengths of the magnetic flux tubes are identified as basic mechanisms behind DNA replication and analogous processes and also behind the phase transitions associated with the gel phase in cell interior. The braiding of magnetic flux makes possible universal memory representation recording the motions of the basic units connected by flux tubes. Braiding also defines topological quantum computer programs updated continually by the flows of the basic units. The model of DNA as topological quantum computer is discussed as an application.

In the following I briefly summarize some applications to quantum biology. I am of course forced to leave details to the books about TGD inspired theory of consciousness and quantum biology at my homepage [K60, K14, K41, K23, K13, K30, K32, K55].

1. A vision about relationship between information processing and metabolism in TGD Universe is represented.
 - (a) The already existing ideas include the notion of time mirror mechanism as a way to realized intentional action, memory recall, and remote metabolism by sending negative energy photons to geometric past where some system able to absorb them exists. The proposal is that the utilization of ATP is also possible in this way: this quantum credit

card would make living matter extremely flexible since instantaneous reaction to changing circumstances would become possible. Many-sheeted space-time inspires the idea that the dropping of particles, in particular electrons and protons, to larger space-time sheets liberates metabolic energy. This mechanism would provide universal metabolic currencies and also ATP-ADP might be based on it.

- (b) The new idea is that the presence of ATP at magnetic flux tube is a necessary prerequisite for negentropic entanglement between its ends. ATP could be seen as a molecule of consciousness in this picture and high energy phosphate bond would be replaced with a state involving negentropic entanglement. There is also a connection with the model of living matter as quantum computer.
 - (c) A possible modification of second law to take into account negentropic entanglement is discussed. The pessimistic modification states that genuine islands of negentropy can be generated rather than islands in which entropy is very small. The generation of negentropy is however always accompanied by compensating generation of entropy. A possible interpretation is that the eventual reduction of negentropic entanglement in state function reduction generates this entropy at ensemble level.
2. TGD approach to living matter was strongly motivated by the findings about strange behavior of cell membrane and of cellular water, and gel behavior of cytoplasm. These findings are briefly discussed in TGD framework by bringing in magnetic flux tubes as a new element.
 3. Water is in key role in living matter and TGD inspired view about water and various anomalies related to the physics of water are also discussed.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. Pdf representation of same files serving as a kind of glossary can be found at <http://tgdtheory.fi/tgdglossary.pdf> [L10].

2 Quantum Mind And Magnetic Body

The notion of magnetic/field body (see **Fig.** <http://tgdtheory.fi/appfigures/fluxquant.jpg> or **Fig. ??** in the appendix of this book) is probably the feature of TGD inspired theory of quantum biology which probably creates strongest irritation in standard model physicist. A ridicule as some kind of Mesmerism might be the probable reaction. The notion of magnetic/field body has however gradually gained more and more support and it is now an essential element of TGD based view about living matter. In the following I discuss the basic applications in the hope that the overall coherency of the picture might force some readers to take this notion seriously. The notion of magnetic body leads to a dramatic modification of the views about functions of brain and biological systems in general. I will talk mostly about magnetic body although it is clear that field body has also electric parts (electric flux quanta with cell membrane and various electrets populating living matter) as well as radiative parts realized in terms of “massless extremals” or topological light rays [K37] providing correlates for EEG and its fractal analogs.

2.1 Living Matter As Ordinary Matter Controlled By Dark Matter At Magnetic Bodies

The notions of many-sheeted space-time, topological field quantization, and magnetic body were in a key role in the model of living matter as a macroscopic quantum system. It was assumed that space-time sheets are not at thermal equilibrium and that the space-time sheets responsible for the macroscopic quantum coherence are at very low temperature. See the article “Biosystems as macroscopic quantum systems” [L1] and **Figs. ??, ??, ??, ??, and ??** in the appendix of this book.

1. Libet’s findings and the model of memory based on time mirror hypothesis suggests that magnetic body is indeed needed. What is the real function of magnetic body? Is it just a sensory canvas? The previous considerations suggest that it is also the seat of geometric qualia, in particular the pitch of sound should be coded by it. It would be relatively easy

to understand magnetic body as a relatively passive sensory perceiver defining sensory map. If one assumes that motor action is like time reversed sensory perception then sensory and motor pathways would be just sensory pathways proceeding in opposite time directions from receptors to the various layers of the magnetic body. Brain would perform the information processing.

Certainly there must exist a region in which the motor and sensory parts of the magnetic body interact. What comes in mind is that these space-time sheets (or actually pairs of space-time sheets) are parallel and generate wormhole contacts between them. This interaction would be assignable to the region of the magnetic body could receive positive energy signals from associative sensory areas and send negative energy signals to motor neurons at the ends of motor pathways wherefrom they would propagate to premotor cortex, supplementary motor cortex and to frontal lobes where the abstract plans about motor actions are generated.

2. The hierarchy of Planck constants and identification of dark matter as phases with non-standard value of Planck constant makes it possible to give up the assumption about low temperatures at flux quanta. Dark matter becomes the key notion in the quantum controller of ordinary matter in living matter. The large value of Planck constant - integer multiple of standard value- scales up quantum lengths since typically they are proportional to \hbar and scales the quantum coherence lengths and times. This also scales the energy $E = hf$ associated with a photon with given frequency. This allows to understand the quantal effects of ELF em fields to vertebrate brain.
3. Large Planck constant means that quantum length scales such as Compton length are scaled up. This makes possible macroscopic quantum coherence and non-locality. Magnetic flux tubes are identified as carriers of dark matter with non-standard value of Planck constant.
4. The ideas about the role of magnetic flux quanta have evolved considerably. It is natural to assume that magnetic flux tubes carry macroscopic quantum phases of dark matter. The phase transitions changing Planck constant reduce or increase the length of the flux tube and could be responsible for the dramatic volume changes of cytoplasm. The reconnections of magnetic flux tubes make possible dynamics for the topology of the web formed by magnetic flux tubes. ATP-ADP process can be associated with this kind of reconnection process. The braiding of magnetic flux tubes makes possible topological quantum computations and DNA and lipid layers of cell membrane form an ideal hardware for topological quantum computer with braiding of flux tubes connecting lipid layers with DNA nucleotides defining the TQC programs. Braiding provides also a universal memory storage mechanism since liquid flow induces braiding of the particle in the flow. Lipid layers of cell membrane are indeed liquid crystals so that their flows update quantum computer programs coded by space-like braiding.
5. Living matter would be ordinary matter controlled by the dark manner at the “magnetic body” of the system and magnetic flux tubes and sheets act as carriers of dark matter. Phase transitions changing the value of Planck constant induce contractions or lengthenings of the flux tubes and would be key mechanism in the volume changing phase transitions in living matter. Reconnection process for the flux tubes is second mechanism and ATP-ADP mechanism would involve basically the reconnection which would in quantum computer inspired picture mean formation of a link to and address in memory. Braiding of flux tubes makes possible topological quantum computation. For details see the chapters

Macroscopic quantum coherence and metabolism as different sides of the same coin (see <http://tinyurl.com/yd7j9f5j>) [K28].

DNA as topological quantum computer (see <http://tinyurl.com/ybyscdpt>) [K3].

Dark Matter Hierarchy and Hierarchy of EEGs (see <http://tinyurl.com/y9y87z84>) [K19].

TGD Based View about Classical Fields in Relation to Consciousness Theory and Quantum Biology (see <http://tinyurl.com/y9exp84r>) [K58].

Quantum model for bio-superconductivity:part I (see <http://tinyurl.com/yahrlysf>) [K44].

Quantum model for bio-superconductivity:part II (see <http://tinyurl.com/y7fbb4hm>) [K45].

Quantum model for nervepulse (see <http://tinyurl.com/y8e5oqkm>) [K47].

2.2 Magnetic Body As Intentional Agent And Experienter

In TGD Universe brain would be basically a builder of symbolic representations assigning a meaning to the sensory input by decomposing sensory field to objects and making possible effective motor control by magnetic body containing dark matter. A concrete model for how magnetic controls biological body and receives information from it is discussed in the model for the nerve pulse [K47] and for the hierarchy of EEGs [K19, K48].

Also magnetic body could have sensory qualia, which should be in a well-defined sense more refined than ordinary sensory qualia [K22]. The quantum number increments associated with cyclotron phase transitions of dark ion cyclotron condensates at magnetic body could relate to the cognitive and possibly also emotional content of sensory input and would indeed have interpretation as higher level sensory qualia. On the other hand, the positive/negative emotional coloring itself might be the core of what it is to be emotion and most naturally relates to the sign of negentropy increment in quantum jump so that it would not be a quale in the sense that visual colors are.

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

These qualia could be seen as somatosensory qualia at the level of magnetic body. One must be however cautious with interpretations. It is not all obvious whether the qualia should be assigned with body alone or magnetic body alone or both. Out of body experiences and various illusions such as train illusion and the disgusting sensation about falling when one is near the edge of cliff could be virtual world experiences resulting from the relative motion of the magnetic body with respect to the biological body: the sensory sensation would correspond to the interference effects for dark photon radiation between the biological body and magnetic body [K57].

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

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

2.3 Time Mirror Mechanism Can Be Seen As The Basic Mechanism Of Memory, Intentional Action, And Metabolism

It means sending negative energy signal propagating backwards in time and ZEO gives precise meaning for this notion.

1. Memory recall in the case of symbolic memories would correspond to sending of negative energy signal to geometric past. The signal would be reflected as positive energy signal. An alternative possibility is that time-like entanglement is generated. This mechanism would make it un-necessary to store memories again and again. The proposed model for the recent finding that memory code with six bits might make sense suggests that metabolism is necessarily involved. The negative energy quantum absorbed in geometric past transforms ATP to ADP and deletes the conscious memory item but creates it again in the geometric now. This would conform with no-cloning theorem.
2. Sending of negative energy signals to a system serving as energy storage to generate metabolic energy as a recoil makes possible an extremely flexible quantum credit card in living matter. This kind of flexibility is extremely useful in circumstances requiring very rapid reactions.
3. Motor actions could be regarded as realizations of intentions using negative energy signals propagating to the direction of geometric past. This hypothesis would explain the strange

finding of Libet that conscious decision in volitional action seems to occur later than the neural activity initiating the motor action. One could argue that the free will aspect of motor actions does not conform with the interpretation as sensory perception in reversed direction of time. On the other hand, also percepts are selected -say in binocular rivalry [J9]. Only single alternative percept need to be realized in a given branch of the multiverse. This makes possible metabolic economy: for instance, the synchronous firing at kHz frequency serving as a correlate for the conscious percept requires a lot of energy since dark photons at kHz frequency have energies above thermal threshold. Similar selection of percepts could occur also at the level of sensory receptors but quantum statistical determinism would guarantee reliable perception. The passivity of sensory perception and activity of motor activity would reflect the breaking of the arrow of time if this interpretation is correct.

2.4 Biosystems As Conscious Holograms

The notion of conscious hologram is TGD based generalization of the idea about brain as a hologram. In nutshell, the notion of conscious hologram follows from the topological field quantization. Classical fields and matter form a Feynman diagram like structure consisting of lines representing matter (say charged particles) and bosons (say photons). The matter lines are replaced by space-time sheets representing matter (elementary particles, atoms, molecules, ...), and virtual bosons are replaced by topological light rays ("massless extremals", MEs). Also magnetic flux tubes appear and together with MEs they serve as correlates for bound state quantum entanglement.

The internal lines of the Feynman diagram are analogous to wave guides and the classical fields and coherent light propagating along these wave guides interfere at the space-time sheets representing the vertices of the Feynman diagram and the "points" of the conscious hologram. The formation of the hologram corresponds to the self-organization induced by the leakage of supra currents to smaller (say atomic) space-time sheets. This leakage is induced by the high frequency MEs propagating along low frequency MEs serving as correlates for quantum entanglement. The 3-D stereovision associated with ordinary hologram is generalized to stereo consciousness resulting, when the mental images associated with different "points" of conscious hologram fuse to single mental image. Central nervous system can be regarded as a conscious hologram of this kind.

Time mirror mechanism (see **Fig.** <http://tgdtheory.fi/appfigures/timemirror.jpg> or **Fig. ??** in the appendix of this book) is a key element of intentional action. The notion of four-wave interaction generalizes: the interference pattern of oppositely moving reference waves forming an archetypal standing wave (possibly moving as in case of nerve pulse) can be replaced by any synchronously oscillating periodic spatial pattern. Plasma waves for which the frequency does not depend on wave vector are ideal candidates for holograms in the generalized sense. Living matter is full of this kind of holograms: besides plasma oscillations associated with biologically important ions, also Z^0 plasma oscillations associated with atoms and molecules can define holograms. p-Adic length scale hypothesis predicts a hierarchy of plasma frequencies related by powers $2^{3k/4}$ so that even so called "non-living matter" could build this kind of sensory representations based on plasma oscillations.

p-Adic length scale hypothesis and dark matter hierarchy allow to quantify the notion of conscious hologram. The hierarchy of generalized EEGs associated with the dark matter hierarchy allows to propose concrete mechanism of remote mental interactions playing a key role also in the interaction of magnetic bodies with the biological body. Experimental findings related to anomalous pre-cognition support the view that even galactic magnetosphere acts as a conscious entity receiving sensory input from bio-sphere and controlling it.

Bio-photons provide an application of the general theory. Simple mathematical facts about the delayed luminescence induced by an external perturbation combined with the model for a hierarchy of dark EEGs assignable to that of Josephson junctions, lead to a model in which positive and negative energy MEs transversal to DNA strand and representing dark photons generate coherent bio-photons via de-coherence. Rather detailed quantitative models for how MEs and supra current circuits interact and how bio-photons are generated during the gene expression emerge.

Peter Gariaev and his group have discovered a radio wave emission from DNA induced by laser light. The model explaining delayed luminescence covers also this phenomenon: now the decay of dark photons with energies above thermal threshold to radio-wave photons rather than de-coherence would be the mechanism. The findings allow an explanation in terms of a many-sheeted

laser action, and a rather detailed view about how bio-system acts as a many-sheeted laser at a wide wave-length range emerges.

William Tiller in Stanford University has carried out impressive experimental work with what he calls intention imprinted electronic devices (IIED), and his results challenge that standard assumption that the intentions of experimenter do not affect the experimental apparatus. The analysis of the work of Tiller in the conceptual framework of TGD leads to the conclusion that four-wave interaction, which is a basic mechanism to produce phase conjugate waves (negative energy topological light rays), serves also as a basic mechanism of intentional action. This leads to a unified view allowing to see EEG and nerve pulse as a particular realization of four-wave interaction.

2.5 High T_c Superconductivity In Living Matter

The TGD inspired model for high T_c super-conductivity as quantum critical phenomenon is developed. The relies on the notions of quantum criticality, dynamical quantized Planck constant requiring a generalization of the 8-D embedding space to a book like structure, and many-sheeted space-time. In particular, the notion of magnetic flux tube as a carrier of supra current of central concept.

2.5.1 The model of super-conductivity

The model for generalized EEG relates very closely to the general model of high T_c superconductivity. This motivates a separate discussion of the vision about bio-super-conductivity in TGD Universe.

1. General mechanisms of bio-superconductivity

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

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

Wormhole contacts can be interpreted as Higgs type fields and photon massivation could be understood in terms of a coherent state of charged wormhole contacts. The coherent states of charged wormhole contacts and of Cooper pairs do not imply non-conservation of energy, charge, and fermion number in zero energy ontology.

A crucial element is quantum criticality predicting a new kind of superconductivity explaining the strange features of high T_c super-conductivity. There are two kinds of Cooper pairs, exotic Cooper pairs and counterparts of ordinary BCS type Cooper pairs. Both correspond to a large value of Planck constant. Exotic Cooper pairs are quantum critical meaning that they can decay to ordinary electrons. Below temperature $T_{c_1} > T_c$ only exotic Cooper pairs with spin are present and their finite lifetime implies that super-conductivity is broken to ordinary conductivity satisfying scaling laws characteristic for criticality. At T_c spinless BCS type Cooper pairs become stable and exotic Cooper pairs can decay to them and vice versa. An open question is whether the BCS type Cooper pairs can be present also in the interior of cell.

These two superconducting phases compete in certain narrow interval around critical temperature for which body temperature of endotherms is a good candidate in the case of living matter. Also high T_c superfluidity of bosonic atoms dropped to space-time sheets of electronic Cooper pairs becomes possible besides ionic super conductivity. Even dark neutrino superconductivity can be considered below the weak length scale of scaled down weak bosons.

Magnetic magnetic flux tubes and sheets are especially interesting candidates for supra current carries. In this case the Cooper pairs must have spin one and this is indeed possible for exotic

Cooper pairs. The fact that the critical magnetic fields can be very weak or large values of \hbar is in accordance with the idea that various almost topological quantum numbers characterizing induced magnetic fields provide a storage mechanism of bio-information.

This mechanism is extremely general and in principle works for electrons, protons, ions, charged molecules and even exotic neutrinos and an entire zoo of high T_c bio-superconductors, super-fluids and Bose-Einstein condensates is predicted. Of course, there are restrictions due to the thermal stability at room temperature and it seems that only electron, neutrino, and proton Cooper pairs are possible at room temperature besides Bose-Einstein condensates of all bosonic ions and their exotic counterparts resulting when some nuclear color bonds become charged.

2. Hierarchies of preferred p -adic length scales and values of Planck constant

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

The hypothesis that Mersenne primes $M_k = 2^k - 1$, $k \in \{89, 107, 127\}$, and Gaussian Mersennes $M_{G,k} = (1+i)k - 1$, $k \in \{113, 151, 157, 163, 167, 239, 241.. \}$ (the number theoretical miracle is that all the four p -adic length scales with $k \in \{151, 157, 163, 167\}$ are in the biologically highly interesting range 10 nm-2.5 μ m) define scaled up copies of electro-weak and QCD type physics with ordinary value of \hbar and that these physics are induced by dark variants of corresponding lower level physics leads to a prediction for the preferred values of $r = 2^{k_d}$, $k_d = k_i - k_j$, and the resulting picture finds support from the ensuing models for biological evolution and for EEG [?] This hypothesis - to be referred to as Mersenne hypothesis - replaces the earlier rather ad hoc proposal $r = \hbar/\hbar_0 = 2^{11k}$ for the preferred values of Planck constant.

2.5.2 The role of Josephson currents

The general vision is that Josephson currents of various ions generate Josephson photons having dual interpretations as bio-photons and EEG photons. Josephson photons can in principle regenerate the quale in the neurons of the sensory pathway. In the case of motor pathways the function would be different and the transfer of metabolic energy by quantum credit card mechanism using phase conjugate photons is suggested by the observation that basic metabolic quanta 2 eV *resp.* 4 eV are associated with smooth muscle cells *resp.* skeletal muscle cells.

As already found in the previous section, the energies of Josephson photons associated with the biologically important ions are in general in visible or UV range except when resting potential has the value of -40 mV which it has for photoreceptors. In this case also IR photons are present. Also the turning point value of membrane potential is +40 mV so that one expects the emission of IR photons.

Josephson photons could be used to communicate the qualia to the magnetic body.

1. If Josephson currents are present during the entire action potential, the entire range of Josephson photons down to frequencies of order 2 kHz range is emitted for the standard value of \hbar . The reason is that lower frequencies corresponds to cycles longer than the duration of the action potential. The continuum of Josephson frequencies during nerve pulse makes it possible to induce cyclotron transitions at the magnetic body of neuron or large structure. This would make possible to communicate information about spatial and temporal behavior of the nerve pulse pattern to the magnetic body and build by quantum entanglement a sensory map.
2. The frequencies below 2 kHz could be communicated as nerve pulse patterns. When the pulse rate is above $f = 28.57$ Hz the sequence of pulses is experienced as a continuous sound with pitch f . f defines the minimum frequency for which nerve pulses could represent the pitch and there remains a 9 Hz long range to be covered by some other communication method.
3. The cyclotron frequencies of quarks and possibly also of electron would make possible a selective reception of the frequencies emitted during nerve pulse. Same applies also to the

fermion	$f_c(e)/MHz$	$f_c(u)/MHz$	$f_c(d)/MHz$
standard	.564	.094	.019
nearly vacuum extremal	8.996	2.275	.947

Table 1: Cyclotron frequencies of quarks and electron in magnetic field $B_{end} = .2$ Gauss for standard vacuum with very small Z^0 field and nearly vacuum extremal.

Josephson frequencies of hair cell (, which does not fire). If the value of Planck constant is large this makes possible to communicate the entire range of audible frequencies to the magnetic body. Frequency would be coded by the magnetic field strength of the flux tube. Two options are available corresponding to the standard ground state for which Z^0 field is very weak and to almost vacuum extremals. For the first option one as ordinary cyclotron frequencies. The cyclotron frequency scales for them differ by a factor

$$r(q) = \frac{Q_{eff}(q)}{Q_{em}(q)} = \frac{\epsilon(q)}{2pQ_{em}(q)} + 1 \text{ per, } \epsilon(u) = -1, \epsilon(d) = 1$$

from the standard one. For $p = .0295$ one obtains $(r(u), r(d), r(e)) = (24.42, 49.85, 15.95)$. The cyclotron frequencies for quarks and electron with masses $m(u)=2$ MeV, $m(d)=5$ MeV, and $m(e)=.5$ MeV are given **Table 1** for the two options. If one assumes that B_{end} defines the upper bound for field strength then the standard option would require both d quark and electron. For dquark with kHz CD the upper bound for cyclotron frequencies would be 20 kHz which corresponds to the upper limit of audible frequencies.

4. Besides cyclotron frequencies also the harmonics of the fundamental frequencies assignable to quark and electron CDs could be used and in case of musical sounds this looks a highly attractive option. In this case it is now however possible to select single harmonics as in the case of cyclotron transitions so that only the rate of nerve pulses can communicate single frequency. Lorentz transform sub-CD scales up the frequency scale from the secondary p-adic time scale coming as octave of 10 Hz frequency. Also the scaling of \hbar scales this frequency scale.

4. What are the roles of Josephson and cyclotron photons?

The dual interpretation of Josephson radiation in terms of bio-photons and EEG photons seems to be very natural and also the role of Josephson radiation seems now relatively clear. The role of cyclotron radiation and its interaction with Josephson radiation are not so well understood.

1. At least cell membrane defines a Josephson junction (actually a collection of them idealizable as single junctions). DNA double strand could define a series of Josephson junctions possibly assignable with hydrogen bonds. This however requires that the strands carry some non-standard charge densities and currents- I do not know whether this possibility is excluded experimentally. Quarks and antiquarks assignable to the nucleotide and its conjugate have opposite charges at the two sheets of the wormhole flux tube connective nucleotide to a lipid. Hence one could consider the possibility that a connection generated between them by reconnection mechanism could create Josephson junction.
2. The model for the photoreceptors leads to the identification of bio-photons as Josephson radiation and suggests that Josephson radiation propagates along flux tubes assignable to the cell membranes along sensory pathways up to sensory cortex and from there to motor cortex and back to the muscles and regenerates induced neuronal sensory experiences.
3. Josephson radiation could be used quite generally to communicate sensory data to/along the magnetic body: this would occur in the case of cell membrane magnetic body at least. The different resting voltages for various kinds of cells would select specific Josephson frequencies as communication channels.

4. If motor action indeed involves negative energy signals backwards in geometric time as Libet's findings suggest, then motor action would be very much like sensory perception in time reversed direction. The membrane resting potentials are different for various types of neurons and cells so that one could speak about pathways characterized by Josephson frequencies determined by the membrane potential. Each ion would have its own Josephson frequency characterizing the sensory or motor pathway.

The basic questions concern the function of cyclotron radiation and whether Josephson radiation induces resonantly cyclotron radiation or vice versa.

1. Cyclotron radiation would be naturally associated with the flux sheets and flux tubes. The simplest hypothesis is that at least the magnetic field $B_{end} = .2$ Gauss can be assigned with the some magnetic flux quanta at least. The model for hearing suggests that B_{end} is in this case quantized so that cyclotron frequencies provide a magnetic representation for audible frequencies. Flux quantization does not pose any conditions on the magnetic field strength if the above discussed general flux quantization condition involving charged currents at the boundary of the flux quantum are assumed. If these currents are not present, $1/\hbar$ scaling of B_{end} for flux tubes follows.
2. The assumption that cyclotron radiation is associated with the motor control via genome is not consistent with the vision that motor action is time reversed sensory perception. It would also create the unpleasant question about information processing of the magnetic body performed between the receipt of sensory data and motor action.
3. The notion of magnetic sensory canvas suggests a different picture. Josephson radiation induces resonant cyclotron transitions at the magnetic body and induces entanglement of the mental images in brain with the points of the magnetic body and in this manner creates sensory maps giving a third person perspective about the biological body. There would be two kind of sensory maps. Those assignable to the external world and those assignable to the body itself. The Josephson radiation would propagate along the flux tubes to the magnetic body.
4. There could be also flux tube connections to the outer magnetosphere of Earth. It would seem that the reconnections could be flux tubes traversing through inner magnetosphere to poles and from there to the outer magnetosphere. These could correspond to rather low cyclotron frequencies. Especially interesting structure in this respect is the magnetic flux sheet at the Equator.

2.6 Possible Roles Of The Magnetic Body In Living Matter

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

2.6.1 The anatomy of magnetic body

Consider first the anatomy of the magnetic body.

1. Magnetic body has a fractal onion like structure with decreasing magnetic field strengths and the highest layers can have astrophysical sizes. Cyclotron wave length gives an estimate for the size of particular layer of magnetic body. $B = .2$ Gauss is the field strength associated with a particular layer of the magnetic body assignable to vertebrates and EEG. This value is not the same as the nominal value of the Earth's magnetic field equal to .5 Gauss and follows from the TGD based explanation of the quantal effects of ELF em fields on vertebrate brain known for decades [J8]. 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 [K3, K64].

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 embedding space [K18].
3. In the case of wormhole magnetic fields it is natural to assign a definite temporal duration to the flux quanta and the time scales defined by EEG frequencies are natural. Encouragingly, the inherent time scale 1 seconds assignable to electron as a duration of zero energy space-time sheet in zero energy ontology having positive and negative energy electron at its ends would correspond to 10 Hz cyclotron frequency for ordinary value of Planck constant. For larger values of Planck constants the time scale scales as \hbar . Quite generally, a connection between p-adic time scales of EEG and those of electron and lightest quarks is highly suggestive since light quarks play key role in the model of DNA as topological quantum computer.
4. TGD predicts also a fractal hierarchy of scaled variants of electro-weak and color physics so that ZXG, QXG, and GXG corresponding to Z^0 boson, W boson, and gluons appearing effectively as massless dark particles below some biologically relevant length scale suggest themselves. In this phase quarks and gluons are unconfined and electroweak symmetries are unbroken so that gluons, weak bosons, quarks and even neutrinos might be relevant to the understanding of living matter. In particular, long ranged entanglement in charge and color degrees of freedom becomes possible. For instance, TGD based model of atomic nucleus as nuclear string suggests that biologically important fermionic could be actually chemically equivalent bosons and form cyclotron Bose-Einstein condensates.

This picture would mean that dark matter -usually believed to interact extremely weakly with the ordinary matter- would become a key player in biology. The failure to observe dark matter would be the completely wrong view about its nature. In TGD framework dark matter would make itself visible both via classical em fields and via the phase transitions transforming dark photons to ordinary ones. For instance, bunches of EEG photons and bio-photons could be interpreted as decay products dark photons [K19].

2.6.2 What magnetic body looks like?

What magnetic body looks like has been a question that I have intentionally avoided as a question making sense only when more general questions have been answered. This question seems how unavoidable now. Some of the related questions are following. The magnetic flux lines along various parts of magnetic body must close: how does this happen? Magnetic body must have parts of size at least that defined by EEG wavelengths: how do these parts form closed structures? How the magnetic bodies assignable to biomolecules relate to the Earth sized parts of the magnetic body? How the personal magnetic body relates to the magnetic body of Earth?

1. The vision about genome as the brain of cell would suggest that active and passive DNA strands are analogous to motor and sensor areas of brain. This would suggest that sensory data should be communicated from the cell membrane along the passive DNA strand. The simplest hypothesis is that there is a pair of flux sheet going through the DNA strands. The flux sheet through the passive strand would be specialized to communicate sensory information to the magnetic body and the flux sheet through the active strand would generate motor action as DNA expression with transcription of RNA defining only one particular aspect of gene expression. Topological quantum computation assignable to introns and also electromagnetic gene expression would be possible.
2. The model for sensory receptor in terms of Josephson radiation suggests however that flux tubes assignable to axonal membranes carry Josephson radiation. Maybe the flux tube structures assigned to DNA define the magnetic analog of motor areas and flux tubes assigned with the axons that of sensory areas.

3. A complex structure of flux tubes and sheets is suggestive at the cellular level. The flux tubes assignable to the axons would be parallel to the sensory and motor pathways. Also microtubules would be accompanied by magnetic flux tubes. DNA as topological quantum computer model assumes and the proposed model of sensory perception and cell membrane level suggests transversal flux tubes between lipids and nucleotides. The general vision about DNA as brain of cell suggest flux sheets through DNA strands.

During sensory perception of cell and nerve pulse the wormhole flux tube connecting the passive DNA strand of the first cell to the inner lipid layer would recombine with the flux tube connecting outer lipid layer to some other cell to form single flux tube connecting two cells. In the case of sensory organs these other cells would be naturally other sensory receptors. This would give rise to a dynamical network of flux tubes and sheets and axonal sequences of genomes would be like lines of text at the page of book. This structure could have a fractal generalization and would give rise to an integration of genome to super-genome at the level of organelles, organs and organism and even hypergenome at the level of population. This would make possible a coherent gene expression.

4. This vision gives some idea about magnetic body in the scale of cell but does not say much about it in longer scales. The CDs of electrons and quarks could provide insights about the size scale for the most relevant parts of the magnetic body. Certainly the flux tubes should close even when they have the length scale defined by the size of Earth.

Additional ideas about the structure follow follow if one assumes that magnetic body acts a sensory canvas and that motor action can be regarded as time reversed sensory perception.

1. If the external world is represented at part of the magnetic body which is stationary, the rotation of head or body would not affect the sensory representation. This part of the magnetic body would be obviously analogous to the outer magnetosphere, which does not rotate with Earth.
2. The part of the magnetic body at which the sensory data about body (posture, head orientations and position, positions of body parts) is represented, should be fixed to body and change its orientation with it so that bodily motions would be represented as motions of the magnetic , which would be therefore analogous to the inner magnetosphere of rotating Earth.
3. The outer part of the personal magnetic body is fixed to the inner magnetosphere, which defines the reference frame. The outer part might be even identifiable as the inner magnetosphere receiving sensory input from the biosphere. This magnetic super-organism would have various life forms as its sensory receptors and muscle neurons. This would give quantitative ideas about cyclotron frequencies involved. The wavelengths assignable to the frequencies above 10 Hz would correspond to the size scale of the inner magnetosphere and those below to the outer magnetosphere. During sleep only the EEG communications with outer magnetic body would remain intact.
4. Flux quantization for large value of \hbar poses an additional constraint on the model.
 - (a) If Josephson photons are transformed to a bunch of ordinary small \hbar photons magnetic flux tubes can correspond to the ordinary value of Planck constant. If one assumes the quantization of the magnetic flux in the form

$$\int BdA = n\hbar$$

used in super-conductivity, the radius of the flux tube must increase as $\sqrt{\hbar}$ and if the Josephson frequency is reduced to the sound frequency, the value of \hbar codes for the sound frequency. This leads to problems since the transversal thickness of flux tubes becomes too large. This does not however mean that the condition might not make sense: for instance, in the case of flux sheets going through DNA strands the condition might apply.

- (b) The quantization of magnetic flux could be replaced by a more general condition

$$\oint (p - ZeA)dl = n\hbar , \quad (2.1)$$

where p represents momentum of particle of super-conducting phase at the boundary of flux tube. In this case also $n = 0$ is possible and poses no conditions on the thickness of the flux tube as a function of \hbar . This option looks reasonable since the charged particles at the boundary of flux tube would act as sources of the magnetic field.

- (c) Together with the Maxwell's equation giving $B = ZeNv$ in the case that there is only one kind of charge carrier this gives the expression

$$N = \frac{2m}{RZ^2e^2} \quad (2.2)$$

for the surface density N of charge carrier with charge Z . R denotes the radius of the flux tube. If several charge carriers are present one has $B = \sum_k N_k Z_k e v_k$, and the condition generalizes to

$$N_i = \frac{2m_i v_i}{RZ_i \sum_k Z_k v_k e^2} . \quad (2.3)$$

It seems that this condition is the most realistic one for the large \hbar flux sheets at which Josephson radiation induces cyclotron transitions.

2.6.3 Some functions of the magnetic body

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

1. Magnetic body controls biological body and receives sensory data from it. Together with zero energy ontology and new view about time explains Libet's strange findings about time lapses of consciousness [J12] in terms of time taken for the sensory signals from biological body to propagate to the appropriate layer of the magnetic body [K19]. EEG, or actually fractal hierarchy of EXGs assignable to various body parts makes possible communications to and control by the various layers of the magnetic body. WXG could induce charge density gradients by the exchange of W boson. Also the gluonic counterparts of EXG: s-QXG- are possible.
2. The flux sheets of the magnetic body traverse through DNA strands. The hierarchy of Planck constants and quantization of magnetic flux predicts that the flux sheets can have arbitrarily large width [K24]. This leads to the idea that there is hierarchy of genomes corresponding to ordinary genome, supergenome consisting of genomes of several cell nuclei arranged along flux sheet like lines of text, and hypergenomes involving genomes of several organisms arranged in a similar manner. The prediction is coherent gene expression at the level of organ, and even of population.

For instance, one could see the observed correlations between EEGs of two improvising musicians [J13], the findings of Germaine [J30] and also those of Persinger and colleagues about macro-entanglement [J32] as an experimental support for both macroscopic entanglement between brain and for the crucial role of magnetic body as a space-time correlate for this entanglement. In this picture the great leaps in evolution, in particular, the emergence of EEG, could be seen as the emergence of a new larger layer of magnetic body characterized by a larger value of Planck constant. For instance, this would allow to understand why the quantal effects of ELF em fields [J8] requiring so large a value of Planck constant that cyclotron energies are above thermal energy at body temperature are observed for vertebrates only.

3. Magnetic body makes possible information processing in a way highly analogous to topological quantum computation [K3]. The model of DNA as topological quantum computer [K3] assumes that flux tubes of wormhole magnetic field connect DNA nucleotides with the lipids of the lipid layer of nuclear or cell membrane. The flux tubes would continue through the membrane and split during topological quantum computation. The time-like braiding of flux tubes makes possible topological quantum computation via time-like braiding and the induced space-like braiding makes possible the representation of memories. The model allows general vision about the deeper meaning of the structure of cell and makes testable predictions about DNA. A good metaphor is dancers with feet connected to the walls of the dancing hall by threads. The dance representing quantum computation is coded to the braiding of the threads.

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

This prediction would relate closely to the discovery of topologist Barbara Shipman [A4] that the model for the honeybee dance suggests that quarks are in some manner involved with cognition -something totally unimaginable unless one accepts the possibility of fractal hierarchies of electroweak and hadronic physics. Also microtubules associated with axons connected to a space-time sheet outside axonal membrane via lipids could be involved with topological quantum computation and actually define an analog of a higher level programming language.

4. The strange findings about the behavior of cell membrane are summarized in [I39] and discussed in TGD framework in [K47]. Mention only the finding that metabolic deprivation does not lead to the death of cell, the discovery that ionic currents through the cell membrane are quantal, and that these currents are essentially similar than those through an artificial membrane, suggest that the ionic currents are dark ionic Josephson currents along magnetic flux tubes. A high percent of biological ions would be dark and ionic channels and pumps would be responsible only for the control of the flow of ordinary ions through cell membrane. A further important finding is that the water in the cell interior in gel phase is ordered and nearer to ice than liquid [I39]. This explains nicely the stability of DNA and various biopolymers as being due to the fact that depolymerization by hydration is not possible in this phase. One could envisage the resting state of cell as a cellular winter during which proteins are folded or frozen to unfolded configurations by strong hydrogen bonds. External perturbation feeds energy to the system and induces periods during which the ice is frozen and proteins wake up and begin to unfold or fold and form aggregates as a response to the perturbation and return to the ground state after the energy of the signal is dissipated.
5. These findings together with the discovery that also nerve pulse seems to involve only low dissipation lead to a model of nerve pulse in which dark ionic currents automatically return back as Josephson currents without any need for pumping. This does not exclude the possibility that ionic channels might be involved with the generation of nerve pulse. In TGD inspired model [K47] nerve pulse would result as a perturbation of $f \simeq 1$ kHz frequency soliton sequence mathematically equivalent to a situation in which a sequence of gravitational penduli rotates with constant phase difference between neighbors except for one pendulum which oscillates and oscillation moves along the sequence with the same velocity as the kHz wave. The oscillation would be induced by a “kick” for which one can imagine several mechanisms. Nerve pulse would be like dissonance in background harmony. This view conforms with the general vision that any equilibrium in living matter is homeostasis rather than analog of equilibrium in mechanical system.

The model explains some features of nerve pulse not explained by Hodgkin-Huxley model. These include the mechanical changes associated with axon during nerve pulse, the outwards

force generated by nerve pulse with a correct prediction for its order of magnitude, the adiabatic character of nerve pulse, and the small rise of temperature of membrane during pulse followed by a reduction slightly below the original temperature.

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

The model forces to challenge the existing interpretation of nerve pulse patterns and the function of neural transmitters. Neural transmitters need not represent actual/only) signal but could be more analogous to links in quantum web. The transmitter would code the address of the receiver, which could be a gene inside neuronal nucleus. Nerve pulses would build a connection line between sender and receiver of nerve pulse along which actual signals would propagate. Also quantum entanglement between receiver and sender can be considered.

6. Acupuncture points, meridians, and Chi are key notions of Eastern medicine and find a natural identification in terms of magnetic body lacking from the western medicine. Also a connection with well established notions of DC currents and potentials discovered by Becker and with TGD based view about universal metabolic currencies as differences of zero point energies for pairs of space-time sheets with different p-adic length scale emerges [K28]. The spectrum for increments of zero point kinetic energies represents lines which cannot be explained in terms of molecule physics and the empirical evidence for them is discussed in [K12]

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

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

7. The notion of magnetic body implicates the notion of magnetic motor actions. Magnetic flux tubes and their motor actions could play key role in bio-catalysis and explain the magic ability of biomolecules to find each other. The model of DNA as topological quantum computer [K3] suggest that not only DNA and its conjugate but also some amino-acid sequences acting as catalysts could be connected to DNA and other amino-acids sequences or more general biomolecules by flux tubes acting as colored braid strands. The shortening of the flux tubes in a phase transition reducing the value of Planck constant would make possible extremely selective mechanisms of catalysis allowing precisely defined locations of reacting molecules to attach to each other. With recently discovered mechanism for programming sequences of biochemical reactions (based on idea that each step in the reaction sequence means key allowing to open the door to the room containing the next key) [I44] this would make possible to understand the miraculous looking feats of bio-catalysis. Second key mechanism would be the re-connection of the magnetic flux tubes changing the topology of the Indra's net formed by magnetic flux tubes having biomolecules at their nodes.
8. Water memory is one of the highly disputed notions and motivated by the claimed effects of homeopathy. Water memory for which the work of the group led by HIV Nobelist L.

Montagnier [I32] gives support would be naturally based on the coding of the biologically relevant properties of molecules to the cyclotron frequencies of its magnetic body. Water memory could rely on the copies of this magnetic body.

Quite surprisingly, the finding of the group suggest also that genetic code might have hitherto unknown realization. TGD indeed predicts several realizations, for instance those based on electromagnetic field patterns [K24]. The model of watermemory [K25] in turn led to a theoretical surprise [K64]. One could understand DNA, RNA, tRNA, and amino-acids in terms of states of dark nucleons constructed from three quarks and that vertebrate genetic code follows as a prediction in the sense that the numbers of counterparts of DNA codons coding for given amino-acid are predicted correctly [L2]. Prebiotic evolution as a process leading to a chemical realization of fundamental codes and counterparts of biomolecules existing already at the level of elementary particle physics together with the reduction of metabolic currencies to increments of zero point energies would solve two egg or hen problems of theoretical biology.

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

9. Although not directly related to the notion of magnetic body, the ability to construct “stories”, temporally scaled down or possibly also scaled up representations about the dynamical processes of external world, deserves to be mentioned. This ability might be actually one of the key aspects of intelligence [K3]. There is direct empirical evidence for this activity in hippocampus [J37]. 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.

How genetic code could be represented in terms of frequencies? The TGD based model of music harmony [L11] [K46] (see <http://tinyurl.com/zg3aa7>) relies on the idea that 12-note scale is representable as a closed non-self-intersecting curve (Hamilton’s cycle) at icosahedron having 12 vertices. The harmony assignable to a given Hamilton’s cycle is characterized in terms of 3-chords assignable to the 20 faces (triangles) of the icosahedron once the 12-note scale is represented as a particular Hamilton’s cycle.

Remarkably, the number of amino-acids is also 20! One indeed ends up with a model in which $20+20+20=60$ DNA codons are represented by 3-chords for a triplet of harmonies defined by Hamilton’s cycles predicting correctly the numbers of DNAs coding for a given amino-acid for vertebrate code. One must however assume that also tetrahedral harmony is present to get 64 DNA codons rather than only 60. TActually two variants of the code are predicted and altogether one obtains the standard 20 amino-acids plus two additional ones identified as Pyl and Sec known to be realized in living matter.

In music realization DNA codons can be represented as 3 dark photons or phonons with appropriate frequency ratios. This representation could explain the findings of Montagnier and Gariaev. There is also a connection with TGD inspired theory of consciousness. Music both expresses and induces emotions. The proposal is that the representation of DNA codons in terms of triplets of sounds or dark photons defines molecular level representation of emotions. There is large number of different harmonies and they could represent different moods.

2.6.4 Dark water and water memory: genetic code realized at elementary particle level?

The assumption was that water -possibly in liquid crystal like state- provides representations of molecules and in this manner makes possible water memory, frequency imprinting.

The hierarchy of Planck constants has brought additional details to this picture.

There is experimental evidence for what might be called dark hydrogen associated with water. The chemical formula of water is $H_{1.5}O$ in atto-second time scale and this could be explained if 1/4 of hydrogens are in dark phase. The dark portion of water could explain the numerous anomalies

of water as a condensed matter phase. Water memory can be assigned with the magnetic bodies of the water molecule clusters and braiding would again be an excellent candidate for memory representations. Cyclotron Bose-Einstein condensate provide representation of water memory as temporal radiation patterns. They could be generated in the liquid flows inducing braiding. An interesting idea is that archetypal liquid flows are selected as asymptotic self-organization patterns and are accompanied by characteristic radiation patterns making possible “naming” of these patterns and symbolic dynamics.

A simple model for dark nucleons, their states of dark predicts that the dark nucleon states are in one-one correspondence with DNA, RNA, tRNA, and amino-acids in a natural manner and that vertebrate genetic code emerges in a natural manner from the model. This suggests that genetic code is realized at nucleon level for the dark component of water and chemical realization is only secondary realization. This leads to a dramatic modification of views about the evolution of genome. It would not be anymore random choice followed by selection but much more like R&D in industry. The assumption that there is transcription of dark variants of the basic biomolecules to their chemical counterparts would make the new view possible. The basic mechanism of homeopathy would be basic mechanism of evolution allowing to modify genome as a response to environmental factors and also transfer the modifications to offspring.

The identification of bio-photons as ordinary photons resulting in the phase transition reducing the Planck constant assignable to dark photons is very natural and revises the model suggested in the article “A model for bio-photons” (see <http://tinyurl.com/ycr4hvfq2>). Dark photons propagating along magnetic flux tube would play a key role also in the physics of biological body and brain and would provide an additional very fast communication channel besides nerve pulse transmission and various biochemical signalling mechanisms. This leads to a proposal for a model of cell membrane.

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

The list of nice things made possible by the magnetic body is impressive and one can ask whether there is any experimental support for this notion. The evidence from water memory has been already mentioned. An explanation for the impressive list of anomalies of water [D7] discussed in [K20] provide one possible manner to justify the notion. For instance, it is known that in attosecond time scales water behaves as $H_{1.5}O$ [D6, D14, D5] as if part of hydrogen atoms would be dark.

The findings of Peter Gariaev and collaborators give evidence for the representation of DNA sequences based on the coding of nucleotide to a rotation angle of the polarization direction as photon travels through the flux tube and for the decoding of this representation to gene activation [I28], for the transformation of laser light to light at various radio-wave frequencies having interpretation in terms of phase transitions increasing \hbar [I1], and even for the possibility to photograph magnetic flux tubes containing dark matter by using ordinary light in UV-IR range scattered from DNA [I42].

2.6.6 Fractal hierarchy of magnetic flux sheets and the hierarchy of genomes

The notion of magnetic body is central in the TGD inspired theory of living matter. Every system possesses magnetic body and there are strong reasons to believe that the magnetic body associated with human body is of order Earth size and that there could be an entire hierarchy of these bodies with even much larger sizes. Therefore the question arises what one can assume about these magnetic bodies. The quantization of magnetic flux suggests an answer to this question.

1. The quantization condition for magnetic flux reads in the most general form as $\oint (p - eA) \cdot dl = n\hbar$. If supra currents flowing at the boundaries of the flux tube are absent one obtains $e \int B \cdot dS = n\hbar$, which requires that the scaling of the Planck constant scales up the flux tube thickness by r^2 and scaling of B by $1/r$. If one assumes that the radii of flux tubes do not depend on the value of r , magnetic flux is compensated by the contribution of the supra current flowing around the flux tube: $\oint (p - eA) \cdot dl = 0$. The supra currents would be present inside living organism but in the faraway region where flux quanta from organism fuse together, the quantization conditions $e \int B \cdot dS = n\hbar$ would be satisfied.

2. From the point of view of EEG especially interesting are the flux sheets which have thickness $L(151) = 10$ nm (the thickness of cell membrane) carrying magnetic field having strength of endogenous magnetic field. In absence of supra currents these flux sheets have very large total transversal length proportional to r^2 . The condition that the values of cyclotron energies are above thermal energy implies that the value of r is of order 2^{k_d} , $k_d = 44$. Strongly folded flux sheets of this thickness might be associated with living matter and connect their DNAs to single coherent structure. One can of course assume the presence of supra currents but outside the organism the flux sheet should fuse to form very long flux sheets.
3. Suppose that the magnetic flux flows in head to tail direction so that the magnetic flux arrives to the human body through a layer of cortical neurons. Assume that the flux sheets traverse through the uppermost layer of neurons and also lower layers and that DNA of each neuronal nuclei define a transversal sections organized along flux sheet like text lines of a book page. The total length of DNA in single human cell is about one meter. It seems that single organism cannot provide the needed total length of DNA if DNA dominates the contribution. This if of course not at all necessarily since supra currents are possible and outside the organism the flux sheets can fuse together. This implies however correlations between genomes of different cells and even different organisms.

These observations inspire the notion of super- and hyper genes. As a matter fact, entire hierarchy of genomes is predicted. Super genes consist of genes in different cell nuclei arranged to threads along magnetic flux sheets like text lines on the page of book whereas hyper genes traverse through genomes of different organisms. Super and hyper genes provide an enormous representative capacity and together with the dark matter hierarchy allows to resolve the paradox created by the observation that human genome does not differ appreciably in size from that of wheat.

2.6.7 Genetic code and dark nucleon states

New realization of the genetic code in terms of dark proton sequences identified as dark nucleons was discovered [L2, K25].

1. The states of dark proton are in natural one-one correspondence with DNA, RNA, tRNA, and amino-acids and vertebrate genetic code is realized in a natural manner. Dark nucleons realized DNA codons as entangled quark triplets. The effective chemical formula $H_{1.5}O$ for water in atto-second time scale supports this view [K18]. How the notion of dark nucleon relates to negentropic entanglement of electrons? Could dark electron pairs and dark nucleons correspond to the same value of Planck constant? Could both dark protons and dark electrons play a key role in metabolism.
2. The simplest guess is that DNA strands are accompanied by dark nuclei with one dark proton per DNA nucleotide. The resulting positive charged would stabilize the system by partially neutralizing the negative charge density due to the phosphorylation (2 negative charges per nucleotide). Dark proton sequences could be associated also with other important bio-polymers. If the spins of the dark protons are parallel the dipole magnetic fields give rise to flux tubes connecting the protons and one can assign to the large \hbar protons a macroscopically quantum coherent phase.
3. The natural guess would be that dark nucleus realization of the genetic code induces the biological realization as evolution assigns to dark nucleon sequences DNA, RNA, and amino-acid sequences with 1-1 correlation between dark nucleon state and basic unit of the sequence. The dark realization of genetic code suggest a totally new view about biological evolution as a process, which is analogous to R&D in high tech industry rather than being completely random [K25]. The candidates for new genes could be tested at dark matter level and in the case that they work they would be transcribed to their chemical equivalents.

Years after writing this I decided to work out the model for dark DNA again and found that codons could be represented instead of 3-dark quarks also by 3 dark nucleons [L16] (see <http://tinyurl.com/jgfjlbe>). Effectively one only replaces u and d quarks with proton and neutron. This option is more promising than the original option.

2.7 How To Build A Quantum Computer From Magnetic Flux Tubes

Magnetic flux tubes play a key role in TGD inspired model of quantum biology. Could the networks of magnetic flux tubes containing dark particles with large \hbar in macroscopic quantum states and carrying beams of dark photons define analogs of electric circuits? This would be rather cheap technology since no metal would be needed for wires. Dark photon beams would propagate along the flux tubes representing the analogs of optical cables and make possible communications with maximal signal velocity.

I have actually made much more radical proposal in TGD inspired quantum biology. According to this proposal, flux tube connections are dynamical and can be changed by reconnection of two magnetic flux tubes. The signal pathways $A \rightarrow C$ and $B \rightarrow D$ would be transformed to signal pathways to $A \rightarrow D$ and $B \rightarrow C$ by reconnection. Reconnection actually represents a basic stringy vertex. The contraction of magnetic flux tubes by a phase transition changing Planck constant could be fundamental in bio-catalysis since it would allow distant molecules connected by flux tubes to find each other in the molecular crowd.

DNA as a topological quantum computer is the idea that I have been developing for 5 years or so. I have concentrated on the new physics realization of braids and devoted not much thought to how the quantum computer problems might run in this framework. I was surprised to realize how little I know about what happens in even ordinary computation. Instead of going immediately to Wikipedia I take the risk of publicly making myself fool and try to use my own brain.

2.7.1 What can one learn from ordinary computer programs

One could begin with the question what happens in classical computation. How the program is realized and how it runs? The notion of Turing machine (see <http://tinyurl.com/7c4kl>) represents an extreme abstraction mentioning nothing about the technical side and does not help much in attempts to answer these questions. Turing paradigm also assumes that program is a temporal sequence of operations. These operations could however correspond to a linear spatial sequences and inputs and outputs in this case would correspond to boundary values at the ends of the linear structure. This requires that the dynamics is such that evolution in spatial direction is analogous to a deterministic time evolution. In this case it is much easier to imagine biological realizations of quantum computer programs in TGD inspired bio-world.

To develop concrete ideas, one can start from the picture provided by ordinary computer program.

1. Programs consist of temporal/spatial sequences of commands and commands represent basic functions from which one can build more complex functions by the composition of functions having some numbers of input and output arguments. The eventual output variable can be expressed by printing of a piece of text or as an image in the computer screen. Each step in the program corresponds to a composition of functions: $f_{n+1} = g_{n+1} \circ f_n$. There is some minimal set of primitive/prime functions from which one builds up more complex functions by composition.
2. How this is realized at the level of hardware? One can assume that the basic functions are at some fixed places in the computer memory having addresses given by integers represented as bit sequences. This address represents the command - a name of the function. The names for input variables and output variables are bit sequences giving the addresses of the places containing the values of these variables. Program is a sequence of commands represented as bit sequences giving the address of the function to be computed at a given step and the addresses of inputs and outputs. As the processing unit reads the command, it generates/activates connections from the addresses of inputs to the address representing the function and from this address to the addresses of outputs.

Essentially the challenge is to reconnect, build/activate connections. An interesting question is whether learning identified as strengthening of synaptic connections (see <http://tinyurl.com/cn7724o>) [J3] is one particular example of this process.

3. How the sequence of bits representing command address is realized? As the processing unit reads the address of command it should automatically create/activate a connection from this

address to the command address. The connections from the processing unit to the addresses could exist physically as wirings.

4. It is not necessary that program is dynamical so that the inputs and outputs would be initial and final values of variables. Inputs and outputs could also correspond to values of variables at the ends of a linear structure. In topological quantum computation space-like entanglement would represent superposition of input-output pairs characterizing a function as a rule with instances represented as instances appearing in the superposition.

If this picture is roughly correct, re-connection would be the basic process. Reconnection is the basic process for magnetic flux tubes and $ADP \leftrightarrow ATP$ has been assigned to this process with ATP molecule serving as a relay activating the flux tube connection. Maybe ADP-ATP process, which is usually seen as a basic step of metabolism, could be seen as the core step for quantum computation performed by living matter. One expects that the presence ATP makes the rule represented by negentropic quantum entanglement conscious.

2.7.2 Quantum computation magnetic flux tubes as connections

Consider now quantum computation could take place in a circuitry having magnetic flux tubes as wires and some bio-molecules of groups of them as units defining prime functions. DNA as topological quantum computer could be taken as a starting point. The outcome of quantum computation is determined statistically as ensemble average so that a large number of copies of the program should be present and realized in terms of groups of cells or molecules connected by braidings if the quantum computation is space-like. This option seems more natural than time-like quantum computation realized as a 2-D liquid flow of lipids in the lipid layers of the cell membrane.

1. *The hardware*

Consider first the hardware of topological quantum computation using space-like braids.

1. Magnetic flux tubes would represent the wires along which inputs and outputs travel in the case of classical computation or dynamical quantum computation. In the case of space-like topological quantum computation entanglement is between the ends of the flux tubes.
2. Variables could be represented in many ways. For space-like quantum computations they could correspond to spin states of dark electrons at flux tubes or to polarization states of dark electrons at the flux tubes. In the original model of DNA as topological quantum computer quarks and antiquarks were proposed as a representation of genetic codons: also this quite science fictive option could make sense in TGD Universe since TGD predicts scaled versions of QCD like dynamics and presence of elementary particles in several p-adic scales and in scales dictated by value of Planck constant for given p-adic length scale.

The spin states of electron pair has been proposed as one possible representation of the 4 genetic codons. Quantum variables would be represented by qubit sequences and the measurement of qubit would give a bit sequence characterizing the classical value of the variable. Bio-molecules would be natural places for storing the values of the variables. For dynamical computations the values of variables could be transmitted using dark photons.

3. There would exist basic processing units calculating the prime functions from which more complex functions would be obtained as composites. Basic units could correspond to bio-molecules. In the case of classical computation the inputs to molecules and outputs from them would travel along the flux tubes. In quantum computation these signals could be used to control the initial values of the variables. Molecules could also serve as gates for quantum computation.

2. *Representation of programs*

The basic program units in the case of quantum computation would be represented by braidings.

1. If the ends of braid strands are able to move freely when needed, it becomes possible to re-write programs. Lipid layers of cell membrane can be in liquid crystal state so that

these are ideal for this purpose. The time-like braiding resulting from lipid flow and representing running topological quantum computation program would induce space-like braiding representing space-like topological quantum computation or a rule. A particular quantum computer program represented as space-like braiding of the flux tubes would result as liquid crystal melts for a moment and freezes again.

Protein aggreion process (see <http://tinyurl.com/yarrblxn>) in which proteins covered by ordered water analogous to ice temporarily melt and form aggregates [I10] is basic process induced by the feed of energy to the cellular system and could be compared to cellular summer. This process could mean quite generally molecular re-programming induced by the flow of cellular water inducing molecular flows inducing re-braidings. The braiding would also store the highlights of the cellular summer to cellular memory! This could be also seen learning by a modification of various quantum computer programs.

2. Negentropic entanglement is highly suggestive and would conform with the idea that the rule represented by entanglement represents conscious information or information which can become conscious. The process of becoming conscious information could involve $ATP \rightarrow ADP$ and de-activating the flux tube and destroy the information. Time-like braiding represented by liquid flow would modify space-like braiding.

It is not quite clear whether the information is conscious when negentropic entanglement (and ATP) is present - as Bohm's notion of active information (see <http://tinyurl.com/qhx3suy>) [J29] would suggest - or when ATP is transformed to ADP and connection becomes passive. Negentropic entanglement can be stable with respect to NMP (see <http://tinyurl.com/yd3m1y5m>) [K33] so that the presence of ATP could mean period of conscious experience - negentropic entanglement could be analogous to active information.

TGD based model for the memory recall by sending negative energy signals to geometric past suggests that the absorption of negative energy photon transforms ATP to ADP. Conscious experience is regenerated in the geometric now where the negative energy signal came from - perhaps by transforming ADP to ATP by using the negative resulting by sending of negative energy signal! Conscious reading would be actually memory recall and analogous to teleportation? The destruction of the representation of memory in the geometric past would have interpretation in terms of no-cloning theorem (see <http://tinyurl.com/2dh14oe>) [B2].

3. Static realizations of the programs are easier to imagine since no temporal codes are needed for the transfer of bits. An attractive idea is that the computations are represented by static entanglements for linear structures and that time-like braiding allows to modify the programs.

3. The realization of program

The program would be basically a sequence of address lists. Address list would contain the address of the function to be performed and the addresses of the input molecules and output molecules. How to represent the address physically?

1. The simplest manner to realize this would use existing flux tubes connecting the processing unit to all possible input and output addresses as well as command addresses, and activate those flux tubes to which input and output data are assigned and reconnect them to the flux tubes connecting processing unit to the unit representing the function. The processing unit would have flux tubes coming from all possible inputs, going to all possible outputs, flux tubes going to places representing functions and coming from these places. Processing unit would be like a relay station or old fashioned telephone center whose sole purpose would be to create connections by reconnecting flux tubes. ATP molecule would be probably involved with the activation and - allowing a sloppy language - one could say that communication line becomes conscious when ATP is attached to it.
 - (a) Addressing would be just selection of activated molecules and analogous to that used in telephone network or computer network connected by cables. This would require static flux tube network and flux tubes could be either active or passive. In passive state flux

tubes could be short-cut by a reconnection with hydrogen bond so that the ends of cut flux tube would end up to water molecules. This is however not necessary. Activation in absence of the short cut would involve reconnection of a flux tube with a flux tube connecting two parts of ATP - possibly hydrogen bond again- so that ATP becomes part of the flux tubes. If also short cut is involved, the strands coming to the two water molecules reconnect and generate hydrogen bond and flux tube to which ATP would attach in the proposed manner. As ATP is used it transforms to ADP and de-attaches from the flux tube.

- (b) One can imagine also a dynamical addressing based on the generation of magnetic flux tubes between inputs and submodules. The computational process could be still space-like. The first manner to realize dynamical addressing would be by attaching to the ends of dynamical flux tubes biomolecules, which bind to specific receptors. Receptor mechanism would allow to connect distant cells to each other and build a magnetic flux tube connection between them. Computational unit specialized to run a specific program could excrete biomolecules binding to the input and output receptors: this program would realized function in terms of space-like entanglement. Glands (see <http://tinyurl.com/cxjro9z>) excrete hormones binding to receptors and various glands could in principle serve as computational units. Various information molecules bind very selectively and this might also relate to quantum space-like computations.
 - (c) Second mechanism of dynamical addressing would use dark photons. In this case resonant interaction selecting the target would replace the receptor mechanism. In this kind of situation one can claim that flux tubes are un-necessary, one can use just resonance to build connection to a desired place just as one does in radio communications. Of course, topological light rays could be accompanied by flux tubes. For instance, DNA nucleotide could attach by flux tube to its conjugate in distant DNA molecule and if the connection is based on resonance only similar nucleotide sequences could connect with each other. I have discussed this kind of mechanism in a model for remote replication of DNA (see <http://tinyurl.com/ybvsoy7h>) [K67] based on the experimental work by Peter Gariaev and his group. The resonance mechanism could also make possible to establish flux tube connections and the quantum computation could be a static operation.
2. DNA as topological quantum computer vision gives some idea about how the computer program could be realized as a spatial linear structure.
- (a) Program would be a sequence of topological quantum computations. Given topological quantum computation would be represented by a braiding of flux tubes connecting DNA nucleotides with the lipid molecules of the inner lipid layer. Program would correspond to a linear sequence of cells with the outer lipid layer connected to the DNA of the second cell.
 - (b) Lipid flows at given lipid layer could be used to rewrite programs and the programs could respond to the changes in environment in this manner: this would require that the lipid layer is in liquid crystal state during the period when program is changed. Also nerve pulse patterns would induce these flows. Programs would also represent memories as rules realized as quantum abstractions or as quantum functions.
 - (c) The program would “run” in the spatial direction. The selection of active input and output variables would be by acting the connection from molecule in question by attaching ATP as a relay through which the reconnected flux tube would traverse. This would be also part of the writing of the program. The superposition of entangled inputs and outputs could be seen as a quantum superposition of classical programs assigning outputs to inputs. Also microtubule-lipid layer braiding suggested also to play a key role in the realization of memories could give rise to similar space-like quantum computation representing rules.
 - (d) The effective 2-dimensionality implied by strong form of holography implied in turn by strong form of general coordinate invariance means that the physics depends on partonic 2-surfaces and 4-D tangent space data at them. This suggests that the dynamics on

space-like 3-surfaces and light-like orbits of partonic 2-surfaces is fixed by a process analogous to gauge selection. Does just this effective gauge symmetry make possible to write quantum computer programs? Already ordinary deterministic computer program means selection of one particular dynamics from several alternative options suggesting that strict determinism is broken.

3. What could be the role of bio-catalysis in the computation? Bio-catalysis is a central part of the biological information processing and it would not be surprising if the catalysts connected by flux tubes to substrate molecules were involved with the computations. An attractive idea is that various information molecules binding to receptors involved with bio-control (neurotransmitters, hormones, etc...) are involved with building the flux tube connections between cells. These bio-molecules could carry the ends of flux tubes to special places for which receptors serve as addresses and in this manner build hardware for topological quantum computation involving inputs and outputs in distant parts of the body. The final output could be transformed to controlled gene expression. Quite generally, catalysts bind very selectively and could play a role similar that played by information molecules in building up the quantum computer programs.
4. One can imagine also purely classical computation based on catalytic mechanism probably allowing generalization to quantum case. The idea is that computer program - understood now as dynamical structure - is analogous to what happens in fairy tale in which hero finds a key which fits to a lock of a room containing a key which... There exists a beautiful realization of classical computation in terms of chemical concentrations using DNA. The output of given reaction representing computational step appears in the next reaction provide the system contains additional participating molecules, which could be both substrate molecules and catalysts. The program could be represented as concentrations of molecules needed at intermediate steps and lock-to-key mechanism guarantees that they are performed in the correct temporal order. Inputs and output molecules could be connected by flux tubes to bio-molecules which bind to specific receptors associated with the molecule representing the particular subprogram. This would automatically create a large number of classical computations proceeding in fixed order, maybe even quantum computations.

2.8 DNA As Topological Quantum Computer

The vision about how DNA might act as a topological quantum computer (TQC) [B3] is few years old [K3]. TQC means that the time-like braidings of braid strands define TQC programs and M -matrix (generalization of S -matrix in zero energy ontology) defining the time-like entanglement between states assignable to the end points of strands define the TQC program coded as unitary time evolution for Schrödinger equation in the standard framework. One can end up to the model in the following manner.

1. Darwinian selection for which the standard theory of self-organization provides a model, should apply also to TQC programs. TQC programs should correspond to asymptotic self-organization patterns selected by dissipation in the presence of metabolic energy feed. The spatial and temporal pattern of the metabolic energy feed characterizes the TQC program - or equivalently - sub-program call.
2. Since braiding characterizes the TQC program, the self-organization pattern should correspond to a hydrodynamical flow or a pattern of magnetic field inducing the braiding. Braid strands must correspond to magnetic flux tubes of the magnetic body of DNA. If each nucleotide is transversal magnetic dipole it gives rise to transversal flux tubes, which can also connect to the genome of another cell. As a matter fact, the flux tubes would correspond to what I have used to call wormhole magnetic fields [K66] having pairs of space-time sheets carrying opposite magnetic fluxes. The wormholes themselves could have interpretation as dark scaled variants of ordinary elementary particles. The large value of Planck constant would zoom up the magnetic fields associated with ordinary elementary particles from weak scale to much longer length scale given by cell size or even a longer length scale.

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

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

4. Fluid flow would naturally induce the braiding which requires that the ends of braid strands must be anchored to the fluid flow. Recalling that lipid mono-layers of the cell membrane are liquid crystals and lipids of interior mono-layer have hydrophilic ends pointing towards cell interior, it is easy to guess that DNA nucleotides are connected to lipids by magnetic flux tubes and hydrophilic lipid ends are stuck to the flow. Also nerve pulse patterns could induce the flow of lipids inducing the braiding so that nerve pulse patterns would define TQC programs and be coded into memories.
5. The topology of the braid traversing cell membrane cannot be affected by the hydrodynamical flow. Hence braid strands must be split during TQC. This also induces the desired magnetic isolation from the environment. Halting of TQC reconnects them and make possible the communication of the outcome of TQC.

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

1. How nucleotides A, T, C, G are coded to the strand color and what this color corresponds to physically? The original proposal was that there are two options which could be characterized as fermionic and bosonic.
 - (a) Magnetic flux tubes having quark and anti-quark at their ends with u , d and u_c , d_c coding for A, G and T, C. CP conjugation would correspond to conjugation for DNA nucleotides.
 - (b) Wormhole magnetic flux tubes having wormhole contact and its CP conjugate at its ends with wormhole contact carrying quark and anti-quark at its throats. The latter are predicted to appear in all length scales in TGD Universe.

Recently it became clear that there is much simpler realization involving only spin 1/2 fermion pairs assignable to pairs of flux tubes. The spin states of fermion pairs form triplet and singlet and code for A, T, C, G. The first guess is that fermion is proton or electron but this does not allow coding of color qualia. Taking fermion to be u quark one can realize color qualia in terms of quark color and has good hopes about Coulomb stability since the charge assigned to nucleotide reduces from -2 to -2/3 (Coulomb stability of DNA is a well-known problem). Flux tubes are ordinary flux tubes. One ends up also to a concrete model for happens when color qualia are generated. An unexpected bonus is that statistics constraint implies that color and spin entanglement forces spatial entanglement realized as braiding of the flux tubes so that entanglement indeed has classical space-time correlate.

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

3. How magnetic flux tubes can be cut without breaking the conservation of the magnetic flux? The notion of wormhole magnetic field could save the situation now: after the splitting the flux returns back along the second space-time sheet of wormhole magnetic field. An alternative solution is based on reconnection of flux tubes. Since only flux tubes of same color can reconnect this process can induce transfer of color: "color inheritance": when applied at the level of amino-acids this would give strong constraints on the model of protein folding [K5]. Reconnection makes possible breaking of flux tube connection for both the ordinary magnetic flux tubes and wormhole magnetic flux tubes.
4. How magnetic flux tubes are realized? The interpretation of flux tubes as correlates of directed attention at molecular level suggests a rather concrete picture. Hydrogen bonds are by their asymmetry natural correlates for a directed attention at molecular level. Also flux tubes between acceptors of hydrogen bonds must be allowed and acceptors can be seen as the subjects of directed attention and donors as objects. Examples of acceptors are aromatic rings of nucleotides, $O =$ atoms of phosphates, etc.. A connection with metabolism is obtained if it is assumed that various phosphates XMP, XDP, XTP , $X = A, T, G, C$ act as fundamental acceptors and plugs in the connection lines. The basic metabolic process $ATP \rightarrow ADP + P_i$ allows an interpretation as a reconnection splitting flux tube connection, and the basic function of phosphorylating enzymes would be to build flux tube connections as also of breathing and photosynthesis.

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

The model leads also to an improved understanding of other roles of the magnetic flux tubes containing dark matter. Phase transitions changing the value of Planck constant for the magnetic flux tubes could be key element of bio-catalysis and electromagnetic long distance communications in living matter. There is also a fascinating connection with Peter Gariaev's work [I42] suggesting that the phase transitions changing Planck constant have been observed and wormhole magnetic flux tubes containing dark matter have been photographed in his experiments [K62].

2.9 What Is The Role Of Magnetic Body In DNA Replication, Mitosis, Meiosis, And Fertilization?

If magnetic body uses biological body as a motor instrument and sensory receptor, the natural question is whether basic process such as mitosis, meiosis. could be induced by more fundamental processes for the magnetic body. One can argue that if magnetic flux tubes are responsible for making living organism and even population a kind of Indra's net, cell division should be induced by magnetic body and should produce automatically this Indra's net.

As a matter of fact, cell division brings strongly in mind division of magnetic dipole but also the reconnection of magnetic flux tubes can be considered as a basic mechanism. At least the following basic mechanisms can be considered.

1. Consider a pair of magnetic flux tubes with opposite fluxes connecting objects A and B. The division of A+B to A and B would be induced by a reconnection process for the members of the pair producing two loops associated with A and B but no connection between A and B anymore. The problem of this option is that the flux tube connection defined in this manner might not be stable enough.
2. Magnetic dipole would correspond to a flux tube at the core of the dipole field itself decomposing to flux tubes with weaker magnetic flux at its ends. The division to two dipoles would correspond to a formation of segment in which flux tube decomposes into several flux tubes, which need not be parallel anymore. Two new dipole ends are formed and the old dipole ends remain connected so that the repetition of this process would yield a kind of Indra's net

predicting that all cells of living organism are connected by the flux tubes to single coherent whole.

The division of flux tube to several flux tubes could also correspond to the increase of Planck constant by integer factor n along a segment of flux tube. The resulting n flux sheets would corresponds to the sheets of the covering. The length of the segment would be scaled up by n .

3. If one has pair of dipoles A-B and C-D with same total flux, a reconnection leading to A-D and C-B is possible.

Could biochemical processes associated with cell division be induced by some of the listed processes? The two latter options would predict that the cells produced in cell division remain connected by magnetic flux tubes. The division of dipole creates two new dipole ends connected by short flux tube. The already existing ends remain connected by “long” flux tubes carrying weak magnetic fields as compared to that carried by the dipole itself. Also the processes of meiosis and fertilization could respect the presence of long flux tubes connecting the cells participating in the process so that flux tube connections could also exist between parents and offspring. The members of population could form a kind of super-organism. Remote interactions between DNA and other biomolecules of closely related members of species and even shared use of DNA (and its TGD variant “dark DNA”) can be imagined.

1. Consider first DNA replication and reshuffling taking place in meiosis (see <http://tinyurl.com/25jmwu>) [I7] essential for the sexual reproduction in eukariotes. The dividing nucleus (of form MMFF) is ordinary nucleus and contains two pairs of chromosomes coming both mother (MM) and father (FF). Division produces four haploid cells containing only two chromosomes (AB) with A and B obtained by reshuffling the DNAs of mother and father to obtained 4 unique chromosome pairs. In sexual reproduction these cells fuse to form diploid cells (MMFF).
 - (a) The reshuffling of a pair MF of DNA strands from father and mother could be induced by a repeated reconnection process for flux tubes parallel to DNA strands. The simplest reconnection for strands A-B and C-D produces strands A-X-D and C-Y-B where A-Z and C-Y are pieces of A-B and C-D with same number of codons.
 - (b) The replication of DNA takes place for all four chromosomes before reshuffling. One obtains a nucleus containing 4 pairs of doubled chromosomes. This double nucleus divides to two daughter nuclei containing 2 doubled chromosomes each. These divide further to two nuclei each containing only two chromosomes each (AB).
The DNA reshuffling could correspond to a multiple reconnection process if the two DNA strands are accompanied by by long magnetic dipoles (flux tubes). Note that in absence of additional restrictions many combinations (28) are possible.
 - (c) After replication and reshuffling the division of the nucleus two two intermediaries could be induced either by splitting of a flux tube connecting pairs of doubled chromosomes to flux tubes not anymore parallel to each other. The flux could diverge to a larger volume in this segment. Second possibility is that the increase of Planck constant increases the length of segment and at the same time divides the flux into sub-fluxes. Dipole field flux tube would give long flux tubes and split dipole shorter flux tubes connecting the resulting cells together.
 - (d) Also the chromosome pairs of the resulting intermediate nuclei could be connected to each other by flux tubes to form a connected structure A-B-C-D and reconnection process could divide it to A-B plus C-D (say) and lead to a division of the nucleus producing 4 ordinary daughter nuclei.
2. In mitosis (see <http://tinyurl.com/691f1n>) [I8] the initial nucleus corresponds to MMFF and DNA replication leads to pairs of doubled chromosomes but without re-shuffling. One doubled pair from mother and one pair from father the members of doubled chromosomes are connected by a kind of bridge. In the mitosis proper the doubled chromosome pairs are split and two chromosome pairs containing one chromosome from father and mother are formed. After this division leads to two diploid cells similar to the dividing cell.

3. In fertilization (see <http://tinyurl.com/2tzd6k>) [I4] gametes from father and mother fuse together to form a single cell with two pairs of chromosomes from both father and mother. The question is how the two gametes are able to find each other. The reconnection of closed magnetic flux tubes associated with the gametes could lead to a formation of bridges connection the two gametes and a phase transition reducing the value of Planck constant could lead the two gametes near each other and make possible the fusion.

DNA replication (see <http://tinyurl.com/2tbv2d>) [I2] is clearly the fundamental process, and the question is whether also this step could be reduced to a reconnection for a pair flux tubes: first would connect the separated DNA strands and second one free nucleotide and its conjugate.

1. Suppose that there are flux tubes connecting nucleotides of DNA and corresponding nucleotides of the conjugate strand: they could be rather short flux tubes of length shorter than 1 nm in the normal situation but could grow longer when DNA strands separate. This might involve a phase transition increasing temporarily the value of Planck constant assignable to these flux tubes and increasing the length of the segment and of connecting flux tube and therefore the distance of DNA strands.
2. There are also free DNA nucleotides and their conjugates in the environment which can be used in the replication process as building bricks. If also free nucleotides and their conjugates are connected in a pairwise manner by similar flux tubes and if the value of magnetic flux characterizes a given pair then reconnection could take place for these two kinds of flux tubes and lead to a correct pairing of DNA strand with conjugate nucleotides. Same would happen for the conjugate strand. The reduction of Planck constant would lead to a pair of ordinary DNA double strands.
3. The details of the dynamics would be determined by other factors but the outcome would be fixed by the nucleotide-conjugate pairing and dependence of the flux on the nucleotide pair. In particular, conservation of magnetic flux would guarantee that the nucleotides can be assigned only with their conjugates.

These arguments suggest that reconnection of magnetic flux tubes, temporary change of the Planck constant, and coding of nucleotide-conjugate pairs by magnetic flux could be key element of meiosis, mitosis, and reshuffling of chromosomes in meiosis. Also higher level processes - such as cell division and fertilization - could involve reconnection process as a fundamental step. These mechanisms would appear in several length scales corresponding to DNA, nucleus, and cell length scale. In an approach based on mere chemistry, this must be assumed as a result of kinematics.

2.10 Three pieces of evidence for the notion of magnetic body

Evidence for the notion of magnetic body has started to accumulate. The following discusses three rather recent pieces of evidence.

2.10.1 Evidence for the notion of magnetic body from brain synchrony without corpus callosum

The notion of magnetic body is central for the entire TGD based approach to living matter and it would be important to find experimental support for it. Quite recently I received a link to a rather baffling finding about brain [J21] (see <http://tinyurl.com/3gjhtgb>). Neuroscientists have believed that the two hemispheres communicate via the neural pathways associated with corpus callosum: kind of communication cables would be in question. Many areas of brain behave synchronously, which has led to the notion of resting state network.

The team led by Michael Tyszka, associate director of Caltech Brain Imaging Center, has however discovered that the resting state network seems to work normally in people born without corpus callosum! As if brain hemispheres were communicating by some other means than neural signalling! This finding challenges not only the views about the origin of brain synchrony as being created by neural circuits but also the models of autism and schizophrenia explaining them in terms of impaired communications between hemispheres.

One can for instance speculate with the possibility that there is electromagnetic communication between brain hemispheres. This does not look a bad idea at all: nowadays it is possible to extract information about EEG so that pilots are able to control the flight of tiny flying object by imagining what the object should do. Technological applications will probably appear in the market soon so that anyone can have robots controllable by thoughts.

This mechanism is consistent with the TGD inspired view about brain. This view however encourages to consider also a more imaginative explanation. In TGD Universe living system involves besides organism and environment also magnetic body (MB) acting as an intentional agent receiving sensory input from organism and controlling it. MB has hierarchical onion-like structure. For instance, brain hemispheres have their own MBs, and entire brain its own MB serving as a "boss" for the MBs of hemispheres.

Communications between magnetic body and part of organism take place using dark photons having non-standard value $h_{eff} = n \times h$ of Planck constant and thus energy $E = h_{eff}f$, which should correspond to ordinary photons with energies above thermal energy: otherwise quantal effects are masked by thermal fluctuations. Bio-photons in the visible and UV range could result in the transformation of dark photons to ordinary photons. The frequency range of dark photons depends on the level of the layer of MB characterized by h_{eff} and wavelength corresponds to the size scale of the layer.

In the case of brain the transfer of sensory information to MB would be realized as EEG - wavelength of 7.8 Hz radiation is order of the circumference of Earth so that MBs for brain would be really large. In Zero Energy Ontology (ZEO) control signals would be realized as negative energy signals propagating backwards in geometric time and having phase conjugate laser light as a counterpart in ordinary physics. This explains Libet's finding that neural activity precedes conscious decision. Coordination by using EEG rhythms would be part of control analogous to work songs.

The MB of entire brain controls it and could naturally do this via the intermediate control of brain hemispheres forcing them to operate in the same rhythm. Brain synchrony and resting network would not be produced by resonant neuro-circuits as usually believed but by the spatiotemporal coherence of the EEG radiation from the MB of entire brain forcing brain hemisphere MBs to oscillate in the same rhythm and in turning synchronizing the brain hemispheres. This would be like forcing soldiers to march in the same pace and brain hemispheres could co-operate without any neural communication between hemispheres. The communication between hemispheres would be needed for more refined collaboration involving "discussion" between hemispheres: hemispheres of a person without corpus callosum would be like soldiers obeying blindly the orders. This might be also an essential element of autism and schizophrenia.

2.10.2 Magnetic body and magnetic sense

Humans seem to have sixth sense: kind of sub-conscious magnetic sense of directions (see <http://tinyurl.com/j8rqskj>) possessed by many animals lower in the evolutionary tree - in particular birds and fishes and also many mammals. There is evidence that also humans but not all of us and not always - seem to respond to magnetic field.

Geophysicist Joe Kirschwink working at CalTech as professor of geobiology is already familiar to me. For instance, Kirschwink has introduced the term "snowball Earth". Kirschwink claims that he has proven that also humans have magnetic sense serving as a kind of compass. The experiment involves a slowly rotating constant magnetic field with strength between .25-.6 Gauss (Earth's magnetic field has nominal value of .5 Gauss and the "endogenous" magnetic field appearing in TGD inspired quantum biology has value about .2 Gauss). The field is created by coils located at the walls of a cube so that its direction is under control and it can be also cancelled. The subject person sits in the middle of a Faraday cage eliminating electromagnetic perturbations from environment and her EEG is measured. The explanation for why the earlier experiments often failed is that external perturbations cancelled the effect.

What was found that when the applied field rotates counterclockwise there is a response: the intensity in EEG alpha band drops down. The response however appears few hundred milliseconds later than one would expect if the response is passive response due to the electric currents induced by the applied field in brain. The signal appeared for up-down direction and counter-clockwise rotation but not the opposite. It also appeared when the direction of the field "yawed into the

floor”. I take yaw to mean the orientation angle of magnetic field with respect to the vertical axis.

A slow counterclock-wise rotation of the applied field was necessary. It was not mentioned how slow this rotation was. The rotation of the applied field mimicked the effect produced by the rotation of head with respect to the magnetic field of Earth, which is in good approximation non-rotating in the inertial frame of person. In TGD framework one can ask whether parity breaking effect in macroscopic length scales was involved. What comes in mind is the rotation of the water going down to drain taking always in clockwise direction. Magnetic field obeys same equation as incompressible hydrodynamic flow. Could it be that the magnetic field associated with magnetite sensors in magnetic receptor neurons rotates in clockwise direction much like water going in drain and the response is maximal when the rotation directions are opposite?

One can probably invent purely neuroscientific explanations for the time lag of few hundred milliseconds for EEG response (EEG consists of quasistationary pieces of duration about .3 seconds possibly identifiable as correlates of mental images). In TGD framework the lag could be understood as being due to the fact that the percept is communicated to MB responding by reducing the alpha wave responsible synchronization of the brain. This response could be kind of wake-up from synchrony.

2.10.3 Does the magnetic body of Earth protect planet’s atmosphere from cosmic rays?

Third piece of evidence for MB comes from NASA (see <http://tinyurl.com/j57h32u>). MIT scientists have found what the article calls mysterious “invisible” force field protecting planet’s atmosphere by preventing cosmic ray radiation entering to the lower atmosphere. The field was first noticed by two NASA spacecrafts orbiting in van Allen radiation belt at height of 11,000 km (Earth radius is 6,371 km). The field blocks highly radioactive higher energy electrons. These electrons are attracted towards Earth by the magnetic field of Earth but cannot approach planet closer than 13,300 km - slightly more than twice the Earth radius.

Low frequency electromagnetic fields are involved as with dark matter at magnetic bodies. My guess is that the guardian angel is the magnetic body of Earth carrying dark matter to which one can assign magnetic field strength of .2 Gauss (2/5 of the nominal value of the Earth’s magnetic field): actually entire spectrum of values is expected. The flux tubes or sheets carry dark matter and it could absorb the cosmic rays and tame them to Bose-Einstein condensates. For large $h_{eff} = n \times h$ the high energy E of cosmic ray corresponds to very low frequency $f = E/h_{eff}$ and very long wavelength of order Earth size scale. Ordinary cosmic ray would be transformed to dark cosmic ray with very long wave length. The effect of ordinary cosmic ray is in scale of wavelength and highly local and disastrous for biomolecules like DNA. Now the affect would be absent. Dark magnetic body would act like mattress.

3 The Relationship Between Information Processing And MetabolismIn TGD Universe

After the writing of the first version of this chapter for about decade ago several new ideas have emerged and the challenge is to unify these ideas.

3.1 Three Different Views About Living Matter As A Macroscopic Quantum System

There are three different views about how living system manages to be a macroscopic quantum system.

1. The first vision is based on various kinds of super-conductivities [K15]. Electronic super-conductivity is assigned with the cell membrane and plays a key role in the model of cell membrane as a Josephson junction. Furthermore, the effects of ELF em fields on vertebrate brain [K19] suggest that biologically important ions form macroscopic quantum states and cyclotron Bose-Einstein condensates of bosonic ions have been suggested. The TGD based view about atomic nuclei predicts exotic nuclei chemically equivalent with ordinary ones

but being bosons rather than fermions. Also these exotic ions could also form cyclotron Bose-Einstein condensates. Large value of Planck constant would guarantee that cyclotron energies proportional to \hbar are above thermal energy.

2. A more precise view about hierarchy of Planck constants as an implication of the enormous vacuum degeneracy of Kähler action has emerged [K21]. According to this view non-standard values of Planck constant are only effective.

As the idea about the hierarchy of Planck constants emerged, I proposed that favored values of Planck constant could come as powers of 2^{11} . This was just a first guess inspired partially by the observation that the mass ratio of proton and electron is $940/.5 = 1880 \sim 2^{11}$. I managed to find indications supporting this hierarchy and also this chapter contains traces of this idea. I became later skeptic but one could actually imagine a mechanism implying this kind of hierarchy. Dark protons with say $r = \hbar/\hbar_0 = 1836 = 4 \times 3^3 \times 17$ would correspond to approximately same Compton length as ordinary electrons. It is natural to assign this value of \hbar also to electrons and this gives Compton length 44.6 Angstroms not far from the p-adic length scale $L(149) \simeq 50$ Angstroms assigned with the lipid layer of cell membrane. The condition that dark proton corresponds to this Compton length gives $r = 1836^2$: the electron Compton length comes now $8.1 \mu\text{m}$, which corresponds to cell size scale. One could continue the resulting hierarchy of Planck constants indefinitely.

3. The notion of negentropic entanglement making sense for rational and even algebraic entanglement probabilities has emerged as a possible characterizer of living matter [K33]. Quantum arithmetics [K38] allows to generalize the notion of rational so that p-adic real correspondence mediated by canonical identification is fixed uniquely and is both continuous and respects symmetries [K38]. One implication is an explanation for Shnoll effect [K6], which could be important also in living matter.

This raises several questions.

1. How high T_c super conductivity based on dark electron pairs and negentropic entanglement relate?
2. Could it be that electron pairs in valence bonds are the carriers of negentropic entanglement (see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig. ??** in the appendix of this book) and that they generate the magnetic flux tubes as parts of their magnetic bodies? This makes sense only if the valence electron pairs in living matter have spin 1. The Cooper pairs of high T_c super-conductors are indeed known to have spin 1 [?] If this view is correct, biological evolution would favor the maximization of covalent electron pairs and this indeed seems to be the case.
3. Why large \hbar would make possible negentropic entanglement or even force it? Is there some purely number theoretic reason for this?

3.2 New Ideas Related To Metabolism

Also new ideas related to metabolism have emerged at the same time when evidence for quantal aspects of photosynthesis has been emerging [I37, I13, I11, I3]. The ideas about the detailed relationship between metabolism and negentropic entanglement are still in a state of turmoil. Let us sum up those concepts and ideas which could serve as starting point.

1. Negentropic entanglement is the first basic notion. There is a strong tendency to consider the presence of a magnetic flux tube connecting two objects and carrying negentropically entangled quantum state as a fundamental structure giving rise to a directed attention. Negentropic entanglement would be basic element of conscious cognition, and one can assign to it various attributes like experience of understanding. The mildest assumption is that negentropic entanglement is associated with the flux tube. A stronger assumption is that it is between states assignable to the ends of the flux tube identifiable as observer and target of attention.

An analogy with Orch OR is suggestive. The period of negentropic entanglement - period of directed attention - would correspond to Orch Or and its end to state function reduction.

2. Negentropic entanglement leads also to the idea about energy metabolism and negentropy transfer as different sides of the same coin. The model for DNA as topological in turn suggest that $ADP \rightarrow ATP$ and its reverse can be interpreted as a standardized reconnection process re-organizing connections between distant molecules connected by magnetic flux tubes by the relay defined by ATP molecule. Metabolic energy would - or at least could - go to the re-organization of the flux tube connections and therefore of the negentropic quantum entanglement. The question is how to fuse this vision with the hypothesis about metabolic currencies as differences of zero point kinetic energies for space-time sheets.
3. An attractive interpretation is that the presence of ATP at magnetic flux tube serves as a signature of negentropic entanglement. The period of negentropic entanglement could be seen as the analog of Orch OR period ending with state function reduction. This period would be accompanied by consciousness to which one can assign various attributes such as experience of understanding and positively colored emotions. It is of course difficult to say what the counterparts of these experiences are at the level of flux tubes. One can imagine two options.
 - (a) The high energy phosphate bond in ATP is the carrier of the negentropic entanglement. The transformation of ATP to ADP would liberate the metabolic energy and mean end of the period during which one can assign negentropic entanglement to the flux tube. ATP would be the correlate for consciousness at the flux tube level - the molecule of consciousness.
 - (b) $ATP \rightarrow ADP$ transfers metabolic energy quantum to the magnetic flux tube and creates a excited with negentropic entanglement. This process could correspond to either generation of negentropic entanglement (period of negentropic entanglement would begin with $ATP \rightarrow ADP$ rather than end) or transfer of it from ATP to the flux tube.
4. The radiation from Sun defines the fundamental metabolic currency. Solar radiation cannot be said to negentropic since negentropic entanglement is a 2-particle property. Solar photons could possess a large value of \hbar or - more plausibly - suffer at the magnetic body of the living system a phase transition increasing the value of \hbar . Could the absorption of large \hbar photons arriving from Sun or from magnetic body by electrons generate spin 1 valence electron pairs or provide the metabolic energy needed to re-arrange the flux tube connections between distant molecules by $ADP + P_i \rightarrow ATP$ process?
5. The identification of the increments zero point kinetic energies as universal metabolic energy quanta is one of the oldest hypothesis of TGD inspired theory of consciousness. Zero point kinetic energy is associated with the zero point motion of particle at space-time sheet. The finite size of the space-time sheet gives rise to this energy for which non-relativistic parameterization is $E_0 = k \times 3\hbar^2\pi^2/2mL^2(k)$. $L(k) = 2^{(-k+151)/2}L(151)$, $L(151) \simeq 10$ nm is the p-adic length scale of the space-time sheet, and k numerical factor not far from unity. Particle in 3-D box gives $k = 1$.

As particle is transferred to a larger space-time sheet the zero point kinetic energy is reduced, and the difference is liberated as usable metabolic energy. For proton the size scale of this space-time sheet could be atomic size scale $k = 137$. For electron it could electron Cooper pair $k = 149$ (prime) corresponding to a lipid layer of cell membrane could be in question. Entire hierarchy of metabolic energy quanta is predicted and the energy scale depends on the particle mass and p-adic length scale and geometric factors characterizing the shape of space-time sheet only.

One can ask whether the high energy phosphate bond in the phosphate of ATP molecule contains this kind of smaller space-time sheet and in the transition $ATP \rightarrow ADP$, electron or proton drops from this kind of space-time sheet. The following considerations show that this hypothesis is not necessary, and that one can also modify the identification of the fundamental metabolic energy quantum as zero point kinetic energy without losing anything. Therefore the details of the scenario are far from being fully nailed down.

6. Magnetic flux tubes are carriers of charged particles and the hypothesis is that cyclotron Bose-Einstein condensates for fermionic Cooper pairs and bosonic ions are relevant for consciousness. In particular, cyclotron transitions in which bosons in these condensates are excited would be important for the generation of consciousness. The hierarchy of Planck constants and the fact that cyclotron energy is proportional to \hbar allows to have arbitrarily high cyclotron energies in given magnetic field. This is essential in the model for the effects of ELF em fields on living matter [K12].
7. Becker's finding about the relevance of DC currents for healing of wounds lead to an idea about how electromagnetic radiation interacts with the charged particles at magnetic flux tubes [L9]. What would happen is that charged particles experience the electric and magnetic fields of the radiation field described in terms of massless extremals (topological light rays). Electric field would generate acceleration in the direct of the flux tube and could excite Becker currents which would give rise to biological effects - healing of wound in the simplest case. The proposal has been that this process gives rise to what could be seen as a loading of metabolic batteries.

The combination of this view with the notion of cyclotron BE condensate leads to a slightly more complex picture. Radiation field can excite single boson states both in transversal and longitudinal degrees of freedom. Transversal ones correspond to cyclotron states with energies $E_{c,n} = (n + 1/2)E_c$, $E_c = \hbar qB/m$ and the energies of excitations are of form nE_c . Longitudinal degrees of freedom correspond to a particle in 1-D box -possibly in presence of longitudinal electric field: a simple model for the states was derived in the model for Becker's DC currents.

In the absence of longitudinal electric field the energy spectrum is $E_n = n^2 E_0$, $E_0 = \hbar^2 \pi^2 / 2mL^2$, L the length of the flux tube. Longitudinal excitations correspond to energies $(n_f - n_i)^2 E_0$ and would classically correspond to the acceleration in the electric field component parallel to the flux tube giving rise to Becker currents. For both excitations negentropically entangled states result very naturally as superpositions of single particle excitations and possibly also multi-particle excitations. Both incoming photons and liberation of metabolic energy quantum as photon can induce the excitation.

One could reinterpret the idea about universal metabolic energy quanta by interpreting them as increments of longitudinal energies at flux tube. For the excitation $n = 1 \rightarrow 2$ the energy would be $3\hbar^2 \pi^2 / 2mL^2$ which is same as zero point kinetic energy for a particle in 3-D box of side L . Quantitative prediction is therefore same as that of the original model. One can of course consider also the original option that the transfer of particles from the flux tube to a larger space-time sheet indeed liberates metabolic energy.

Let us now try to weave these ideas to an internally consistent picture. It is perhaps best to proceed by making questions.

1. Could one assign negentropic entanglement with high energy phosphate bond? If so, the period of negentropic entanglement (having Orch OR as a counterpart) would correspond to the presence of ATP and the end of this period to $ATP \rightarrow ADP$. I have considered this possibility earlier. The problem is that it is difficult to understand how negentropic entanglement could be assigned simultaneously both to ATP and to the magnetic flux tube whose length and thickness are proportional to \hbar and therefore varies. One should treat ATP and flux tube as single basic structure and this does not sound convincing since the scales of flux tubes are expected to be much longer than the size scale of ATP molecule. Therefore there are two options.
 - (a) ATP is just what it is believed to be: provider of metabolic energy only. One can leave also open the question whether high energy phosphate bond can be interpreted in terms of zero point kinetic energy or not.
 - (b) ATP carries both metabolic energy and negentropic entanglement assignable to the phosphate bond and metabolic energy corresponds to zero point kinetic energy difference. In $ATP \rightarrow ADP$ a possibly dark photon or photons are emitted and is absorbed by a magnetic flux tube containing cyclotron Bose-Einstein condensate and the resulting

de-localized single particle excitation as quantum superposition of various single particle excitations carries negentropic entanglement in the length scale associated with the magnetic flux tube, which can be much longer. Even several flux tubes could be excited simultaneously. This would regenerate long range negentropic entanglement stable under NMP. Transfer of negentropic entanglement would be in question.

2. Could the non-local excitations of cyclotron Bose-Einstein condensates by large \hbar photon give rise to the negentropically entangled states? Excitation of cyclotron BE condensate requires energy so that metabolic energy is required. ATP could provide this energy. Cyclotron energy quantum is given by $E_c = \hbar q B / m$, q and m are charged and mass of the boson. As already found, the energy of boson is sum of two contributions: energy $E_n \propto n^2$ associated with free longitudinal motion and magnetic energy $E_{c,n} \propto n + 1/2$. Longitudinal excitations could be assigned to the generation of Becker currents. This proposal would integrate metabolism, negentropy generation, and quantum like behavior of ELF em fields in living matter to single picture.
3. Could it be that ATP - instead of being a carrier of negentropic entanglement as suggested earlier - only provides the metabolic energy quantum transformed to cyclotron energy quantum or longitudinal energy quantum when negentropic entanglement is generated by exciting the cyclotron BE condensate? Or could ATP carry both metabolic energy and negentropic entanglement and both of them are transferred to the magnetic flux tube in ATP \rightarrow ADP process?

- (a) Cyclotron energies are quite too small for this to make sense for the ordinary value of Planck constant. The nominal value of the metabolic energy quantum is $E_0 = 0.5$ eV which by $E_0 = \hbar_0 f_0$ corresponds to frequency $f_0 = 5 \times 10^{13}$ Hz in near infrared. The value of electron's cyclotron frequency in the endogenous magnetic field $B_{end} = .2 \times 10^{-4}$ Tesla postulated to explain the effects of ELF em fields on vertebrate brain is $f_{c,e} \simeq 6 \times 10^5$ Hz. If metabolic energy quantum is to excite cyclotron state ($n \rightarrow n + 1$), one must have $E_c = E_0$.

Even for electron E_c is much below E_0 small for $B = B_{end}$ and $\hbar = \hbar_0$. One can however scale both B from B_{end} and \hbar from \hbar_0 . Requiring $E_c(\hbar, B) = E_0$ and using $E_c = \hbar f$ gives $f_{ce}/f_0 = r_1 r$, $r_1 = \frac{B}{B_{end}}$ and $r = \frac{\hbar}{\hbar_0}$, where \hbar_0 denotes the standard value of Planck constant. This gives $r_1 r \simeq (5/6) \times 10^8$.

- (b) There are many ways to achieve the desired upwards scaling of cyclotron energies. Magnetic flux quantization gives further constraints. One could require that magnetic flux is quantized, and that for $\hbar = \hbar_0$ the flux quantum has radius of order $L(151)$ (1 nm, cell membrane thickness) corresponding to the thickness of a flux tube assignable to single DNA nucleotide.

The radius of flux quantum corresponds to the magnetic length $r_B = \sqrt{\hbar q B}$. In the scaling $B_{end} \rightarrow 1$ Tesla ($r_1 = 2.5 \times 10^4$), magnetic length scales as $r_B \simeq 2.5 \mu m \rightarrow 11$ nm. From the condition $r_1 r = (5/6) \times 10^8$ one has for the scaling of Planck constant $r \sim 3.3 \times 10^3$. The scaling of the flux tubes length of $L(151)$ would give flux tube length of order $3 \times 10 \mu m$, which corresponds to cell size so that a flux tube connecting DNA and cell membrane could be in question. Note that the scaling of \hbar does not affect zero point kinetic energy in the longitudinal direction since L scales as \hbar .

- (c) For flux tube length $L(151)$ and for $\hbar = \hbar_0$ the energy of the lowest longitudinal excitation is same order of magnitude as metabolic energy quantum so that the excitation of longitudinal states could be in key role in the generation of Becker's currents. There is evidence about non-local excitations of electrons in photosynthesis, [I17], which suggests that the longitudinal energy excitation could indeed play the role of fundamental metabolic energy quantum transferred to the energy of high energy phosphate bond of ATP. This interpretation leaves open the structure of high energy phosphate bond and there is no absolute need to assign zero point kinetic energy with it.

Longitudinal energies are negligible, one must require flux tube length to be considerably longer than $L(151)$ for the ordinary value of \hbar . Longitudinal energies are significant only

for electron for given flux tube length. Indeed, Becker currents are known to be carried by electrons.

- (d) If one allows ionic Bose Einstein condensates the value of Planck constant must be scaled up by the mass ratio m_I/m_e , where m_I and m_e are the masses of ion and electron. For proton this would give scaling ratio $r = 2^{11}$ and one would end up with the hierarchy of Planck constants coming as powers of 2^{11} suggests years ago. What is remarkable that in cyclotron degrees of freedom also protons and ions can play a significant role: the quantal effects of ELF em fields on vertebrate brain suggest that this is the case.
4. What happens if one has just electrons rather than Cooper pairs? In both transversal and longitudinal degrees of freedom one would have the analog of Fermi sphere with electron states filled up to some maximum values integers characterizing cyclotron energy and longitudinal momentum. Transitions induce also now negentropic entanglement. For cyclotron states the energy increment would be E_c so that basic metabolic energy quantum can induce the transitions. In longitudinal degrees of freedom the minimal energy increment would be $(2N + 1)E_0$, where N characterizes the populated state with maximal longitudinal momentum. This energy should be equal to the metabolic energy quantum. This can be arranged but is not so natural. Experimental work is sooner or later bound to reveal whether electrons or their Cooper pairs are in question.

The option developed above is perhaps the most elegant found hitherto: it would raise the BE condensates of electronic and ionic Cooper pairs in a special position, it would lead to an explicit proposal for what negentropic entanglement is at the level of flux tubes, and in minimal form it would require no modification of the ideas related to ATP, even the standard view about ATP can be kept. Also the original hypothesis that ATP carries metabolic energy as zero point kinetic energy makes sense and also ATP could carry negentropic entanglement.

This view suggests that electronic cyclotron BE condensates are essential also for the understanding of photosynthesis. The absorption of dark photon would generate a non-local excitation of BE condensate of electron Cooper pairs - also a negentropically entangled state. The energy gain in this process could be also interpreted as a fundamental metabolic energy quantum - the interpretation is to some degree a matter of taste- and the subsequent steps in photosynthesis would only take care of the storage of the energy transferred eventually to ATP. Also chemical storage could be storage of negentropic entanglement. The metabolic energy liberated in $ATP \rightarrow ADP$ could be realized universally as IR dark photon absorbed by cyclotron BE condensate at magnetic flux tube so that dark photon beams would become the key actors of metabolism and negentropy generation. Note that a maximal negentropy gain is obtained if the number of Cooper pairs in the condensate is power of prime. Relatively small primes in the scale defined by the p-adic length scales assignable to elementary particles would be in question.

3.3 Pessimistic Generalization Of The Second Law Of Thermodynamics

The possibility of negentropic entanglement raises the question about the fate of the second law of thermodynamics. The proposal for a generalization of the second law of thermodynamics (see chapter *Negentropy Maximization Principle* (see <http://tinyurl.com/yd3mly5m>) based on the most pessimistic vision is that entropy indeed increases also when negentropic entanglement is generated in state function reduction. If the generation of negentropic entanglement is accompanied by a compensating entropic entanglement, how it is generated? Or is the maximally pessimistic generalization really necessary? Is it implied automatically in time scales longer than the characteristic time scale associated with the causal diamonds serving as the basic correlates for conscious selves. One must apply ensemble description in these time scales: does the non-determinism of quantum jump imply second law at the level of ensemble automatically. If this argument is correct, second law would cease to hold in time scales than that characterizing the relevant causal diamond (CD). based on the most pessimistic vision is that entropy indeed increases also when negentropic entanglement is generated in state function reduction. If the generation of negentropic entanglement is accompanied by a compensating entropic entanglement, how it is generated? Or is the maximally pessimistic generalization really necessary? Is it implied automatically in time scales longer than the characteristic time scale associated with the causal diamonds serving as the basic

correlates for conscious selves. One must apply ensemble description in these time scales: does the non-determinism of quantum jump imply second law at the level of ensemble automatically. If this argument is correct, second law would cease to hold in time scales than that characterizing the relevant CD.

3.4 How To Understand Differentiation And De-Differentiation?

Differentiation and de-differentiation are fundamental processes in biology. Differentiation means specialization and more restricted gene expression and de-differentiation a reversal of this process. De-differentiation to the stem cell state takes place in healing of wounds and is induced by Becker's DC currents. Note that cancer cells are de-differentiated cells but Becker currents induce a further de-differentiation making them omnipotent.

De-differentiation and differentiation are strongly time-irreversible processes. Could differentiation and de-differentiation be seen as time reversals of each other and correspond to state function reductions at opposite boundaries of CD? De-differentiation would mean change of geometric arrow of time but basically a dissipative process would be in question.

The following argument based on purely entropic entanglement shows that this view cannot be correct.

1. There are two ways to see arrow of time corresponding to embedding space level and space-time level. The arrow of geometric time alternates only at the level of embedding space at space-time level alone it does not if irreversibility of quantum dynamics has space-time correlates as quantum classical correspondence requires. Space-time surface is not able to detect its own effective folding forth and back in time in the embedding space and the internal arrow of time remains the same. CD is able to detect the embedding space arrow of time for its sub-CD: . sub-CD seems to develop in reverse direction of geometric time. Dissipation occurs always in subjective time so that second law remains true.
2. Suppose that it makes sense to think that CD scans given sub-CDs again and again in time direction, which corresponds to its own arrow of geometric time. Suppose for definiteness that the scale of sub-CD is 1 year. CD observes evolution of sub-CD from 1 to 2 years then from 3 to 2 years, then from 5 to 4 years. Ageing occurs on the average. System would get 2 years older in sudden steps at both boundaries. The sudden agings by 2 years are compensated by 1 year of apparent rejuvenation between state function reductions. The interpretation as dedifferentiation is not possible. For instance, return to omnipotent stem cell stage is not possible for differentiated cells.

What is lacking is the notion of negentropic entanglement. Illness is a loss of negentropic entanglement and healing its regeneration. Aging is a loss of negentropic entanglement and de-differentiation identified as rejuvenation is regeneration of negentropic resources.

1. De-differentiation must involve a generation of negentropic entanglement defining the fundamental step in rejuvenation. Ageing is due to state function reductions destroying entanglement. Negentropically entangled states can be however stable under NMP and NMP can even force the reversal of ageing.
2. At the level of basic metabolism generation of ATP accompanies the generation of negentropic entanglement and its transformation to ADP to its disappearance. The creation of ATP would be fundamental process of rejuvenation, and ATP could be seen as elixir of youth at the molecular level. The analogy between ATP-ADP cycle and Karma's cycle is also rather precise. This picture conforms also with the model for healing currents as a tool to generate metabolic energy, ATP, and negentropic entanglement.

4 Exotic Charge Transfer Between Cell Interior And Exterior As Fundamental Control Mechanism

The notions of ionic channels and pumps associated with the cell membrane are central for the standard cell biology [I60]. There are however puzzling observations challenging this dogma and

suggesting that the currents between cell interior and exterior have quantum nature and are universal in the sense that they not depend on the cell membrane at all [I43, I31, I22, I62, I30]. One of the pioneers in the field has been Gilbert Ling [I43], who has devoted for more than three decades to the problem, developed ingenious experiments, and written several books about the topic. The introduction of the book [I39]) gives an excellent layman summary about the paradoxical experimental results.

It was a pleasant surprise to find that these experimental findings give direct support for the existence of an exotic charge transfer between cell interior and exterior.

Ionic supra currents and Josephson currents or the exchange of exotic W bosons could be in question. For the first option, the experimental data led to a model for cell homeostasis as a flow equilibrium in which very small densities of super-conducting ions (also molecular ions) and ionic supercurrents at cellular and other super-conducting space-time sheets dictate the corresponding densities at the atomic space-time sheets. Z^0 super-conductivity possible for almost vacuum extremals in principle allows to generalize the model also to the control of the densities of neural atoms and molecules at atomic space-time sheets.

This control mechanism need not be the only one. Magnetic flux tubes serving as colored braid strands connecting different bio-molecules in highly selective manner and phase transitions reducing or increasing \hbar could explain the mysterious precision of bio-catalysis as how the prebiotic evolution has led to the known biology [K3]. Magnetic flux tubes could also act as Josephson junctions between widely separated structures.

4.1 Strange Behavior Of The Intracellular Water

The basic strange feature of cellular interior is related to its gelatinous nature and is in fact familiar for everyone. Although 80 percent of hamburger is water, it is extremely difficult to extract this water out. Ling [I31] has demonstrated this at cellular level by using a centrifuge and cells for which cell membrane is cut open: centrifugal accelerations as high as 1000 g fail to induce the separation of the intracellular water.

The assumption that cytoplasm behaves like gel explains these findings. Egg is very familiar example of gel phase so that this proposal could have been made already by the pioneers. The dipolar nature of bio-molecules and induced polarization are basis prerequisites for the formation of gels. Ling raises the cohesion between water and protein molecules caused by electric dipole forces as a fundamental principle and calls this principle association-induction hypothesis [I43]. This cohesion gives rise to liquid [F1] [D2] like structure of water implying among other things layered structures and internal electric fields orthogonal to the plane of the layers [I51, I47, I43] . For instance, cell membranes can be understood as resulting from the self-organization of liquid crystals [K16]. The fundamental importance of electret nature of biomatter was also realized by Fröhlich [J26] and led him to suggest that macroscopic quantum phases of electric dipoles might be possible. This concept, which is in central role in many theories of quantum consciousness, has not been established empirically.

4.2 Are Channels And Pumps Really There?

Standard neurophysiology relies strongly on the concepts of what might be called hydro-electro-chemistry. The development of the theory has occurred through gradual improvements saving the existing theory.

The development began from the basic observation that cells are stable gelatinous entities not mixing with the surrounding water. This led to the hypothesis that cell membrane takes care that the contents of the cell do not mix with the cell exterior. It was however soon found that cell membrane allows some ions to flow through. The interaction between theory and experiment led gradually to the notions of ion channel and ion pump, which are still central for the standard paradigm of the cell [I60]. Note that also “electric pump” taking care that membrane potential is preserved, is needed.

These notions developed gradually during the period when cell was seen as a bag containing water and a mixture of various biochemicals. If cell biology would have started to develop during the latter half of this century and after the discovery of DNA, cell as a computer metaphor might have led to a quite different conceptualization for what happens in the vicinity of the cell membrane. Also

the notion of liquid crystals [D2] would have probably led to different ideas about how homeostasis between cell interior and exterior is realized [I51, I47, I43].

For me it was quite a surprise to find that pump-channel paradigm is not at all so well-established as I had believed as an innocent and ignorant outsider. The first chapter of the book “Cells, Gels and the Engines of Life” of Gerald Pollack [I39] provides a summary about the experimental paradoxes (the interested reader can find the first chapter of this book from web).

The standard theoretical picture about cell is based on the observation that cell exterior and interior are in a relative non-equilibrium. The measured concentrations of various atomic ions and organic molecules are in general different in the interior and exterior and cell membrane seems to behave like a semi-permeable membrane. There is also a very strong electric field over the cell membrane. In standard approach, which emerged around 1940, one can understand the situation 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 [I39] ! This does not however prove that pumping and channelling is the main function of these proteins on the case of basic biological ions 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 in the case of basic ions 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.

4.2.1 Selectivity problem

Cell membrane is extremely selective and this leads to an inflation in the complexity of channels and pumps. The problem might be christened as a dog-door problem: the door for dog allows also cat go through it. Channels cannot be simple sieves: it is known that channels which let some ions through do not let much smaller ions through. There must be more complicated criteria than geometric size for whether the channel lets the ion go through. Quite generally, channels must be highly selective and this seems to require complicated information processing to decide which ion goes through and which not. As a consequence, the models for channels inflate in their complexity.

The only reasonable way to circumvent the problem is to assume that there is kind of binary coding of various chemical compounds but it is difficult to see how this could be achieved in the framework of the standard chemistry. The notion of fractional atom proposed in [K20] to give rise to the emergence of symbols at the level of biochemistry could however allow this kind of coding. Channels and pumps (or whatever these structures actually are) could be also generated by self-organization process when needed.

4.2.2 Inflation in the number of pumps and channels

Channels and pumps for atomic ions and channels and pumps for an astronomical number of organic molecules are needed. The first question is where to put all those channels and pumps? Of course, one could think that pumps and channels are constructed by the cell only when they are needed. But how does the cell know when a new pump is needed if the cell as never met the molecule in question: for instance, antibiotic or curare molecule?

To realize how weird the picture based on channels and pumps is, it is useful to imagine a hotel in which there is a door for every possible client letting only that client through but no one else. This strange hotel would have separate door for every five point five milliard humans. Alternatively, the building would be in a continual state of renovation, new doors being built and old being blocked.

There is however an TGD based objection against this slightly arrogant argument. In TGD framework cell is a self-organizing structure and it might be that there is some mechanism which forces the cell to produce these pumps and channels by self-organization. Perhaps the basic characteristic of quantum control in many-sheeted space-time is that it somehow forces this kind of miracles to occur.

4.2.3 Why pumping does not stop when metabolism stops?

One can also wonder how metabolism is able to provide the needed energy to this 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 [I43] 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 manages to use extremely small amount of metabolic energy.

4.2.4 How it is possible that ionic currents through silicon rubber membrane are similar to those through cell membrane?

A crucial verification of the channel concept was thought to come in the experiment of Neher and Sakmann [I63] (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 [I62] 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 [I30] 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 [I22] 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 their properties seem to be universal and depend only on very weakly on the properties of the membrane. This conclusion need not apply to the currents of polar molecules for which genetically coded pump and channel proteins certainly exists. Neither does it imply that pumps and channels could not be used to achieve a more efficient transfer of ions. Pump - and channel proteins seem to be a well-established notion and TGD approach suggests that they serve as Josephson junctions.

This however requires a generalization of the ordinary thermodynamical approach to cell membrane by starting from zero energy ontology and replacing Boltzmann weight with the complex square roots. Chemical potentials giving dominant part to the change of energy as it goes through cell membrane is replaced with the difference of cyclotron energy which is in visible and UV range from the condition that dark EEG photons have energies of bio-photons [K19]. One ends up with a generalization of Josephson junction: the generalized Josephson energy includes besides Coulombic energy difference also the cyclotron energy difference. Dark cyclotron contribution raises the energy scale of 0.05-1 eV associated with cell membrane to 5-10 eVs and one can understand the nominal value of 5 eV of metabolic energy currency.

4.3 Cytoplasm As Gel

The solution to the above described anomalies proposed by Pollack is that cytoplasm is gel phase [I39]. Pollack describes in detail various aspects of cytoplasm as a gel phase and here only short summary can be given.

1. Cytoplasm can be regarded as a network consisting of cross-linked negatively charged proteins. Water is condensed around the proteins to form structured water. If protein is hydrophilic, water self-organizes around it as a multilayered structure: the number of molecular layers can as high as 600 and the thickness of the layered structure is a considerable fraction of micrometer. If the protein is hydrophobic, water forms another structured phase known as clathrate water: in this case the number of hydrogen bonds between water atoms is large. These phases can be regarded as intermediate between ice and water. Also ordinary ions have this kind of layered structure around them. Chemical cross-links tend to be stable with heat, pH, and solvent composition whereas physical cross-links formed by intermolecular interactions are sensitive to environmental interactions and are of special interest from the point of view of phase transitions.
2. Pollack proposes that the formation of polymers takes place in an environment containing layered water for the simple reason that monomers cannot diffuse to the layered water so that the probability of association with the end of the growing polymer increases.
3. Cell interior is populated by micro-tubules, various filamentary structures, and the so called micro-trabecular matrix. Micro-trabecular network divides cell into a compartments in such a manner that the typical distance between two proteins in water is about 5 nm: this corresponds to the p-adic length scale $L(149)$, the thickness of the lipid layer of cell membrane. This is probably not an accident and the micro-trabecular network might be closely involved with the highly folded network of intracellular membranes. There would be a layer of thickness of about 6 water molecules per given protein surface so that a dominating portion of intracellular water could be structured.
4. The layered water has several tell-tale signatures that have been observed in gels. It freezes at much lower temperature than ordinary water; various relaxation times are shorter since the energy transfer to the water lattice occurs faster than to non-structure water; the diffusion rates of particles into the structured water are much slower than to ordinary water by entropy argument; a simple geometric argument tells that the larger the size of the hydrated ion the lower the diffusion rate; strong gradients of ionic concentrations can form in gel phase as has been observed.

The identification of the cytoplasm as a gel has profound implications for the standard views about cell.

1. The original motivation for postulating semipermeable cell membrane, channels, and pumps was the need to hinder the diffusion of various ions between cell interior and exterior taking place if cytoplasm is ordinary water into which molecules are dissolved. If cytoplasm is in gel phase, cell membrane need not perform pumping and channeling anymore except perhaps in situations involving the formation of a local sol phase. This raises the question about the proper functions of the cell membrane.
2. It is possible to drill to cell membrane holes with size of order $1 \mu\text{m}$ without an appreciable effect on the functioning of the cell and also show that these holes remain as such for long periods of time [I39]. It is also possible to splice cells into pieces continuing to function for days. That K^+ flux through cell membrane does not change when lipids are partially removed. These findings force to ask whether the assumption about the continuity of the cell membrane might be too strong [I39]. Electron micrographs however demonstrate the presence of the bi-layered structure. What is intriguing that this structure is seen even in the absence of lipid layers. In TGD framework this paradoxical finding might be understood in terms of a presence of space-time sheets corresponding to p-adic length scales $L(k)$, $k = 149, 151$ as vacuum structures predicted also by TGD inspired model of high T_c super-conductivity [K15].
3. There is also the strange finding that water flux through cell membrane is much higher than the flux through isolate lipid bi-layer as if some unidentified channels were present. In TGD framework this might be seen as an evidence for the presence of (wormhole) magnetic flux tubes as carriers of water molecules.

4. The fundamental assumptions about ionic equilibrium must be reconsidered, and the Hodgkin-Huxley model for the generation of nerve pulse becomes more or less obsolete. Indeed, it has been found that action potentials can be generated even in absence of Na^+ and K^+ ions playing a key role in Hodgkin-Huxley model. Rather remarkably, the high concentration of K^+ ions and low concentration of Na^+ ions in cytoplasm could be understood on basis of gel property only. Also new view about cell (note membrane-!) potential emerges. The standard paradigm states that the resting potential is over the cell membrane. Potentials of same order of magnitude have been however seen in de-membrated cells (50 mV in slight excess of action potential and critical potential), colloidal suspensions, and gels which suggest that larger part of cell than mere cell membrane is involved with the generation of the action potential and one should thus speak of cell potential instead of membrane potential.
5. Pollack suggests that the phase transitions of the gel phase make possible to realize various functions at molecular and cellular level and represents empirical evidence for the phase transition like aspects assigned to these functions including sensitivity to various factors such as pH, temperature, chemical environment, electromagnetic fields, mechanical forces, etc... and the threshold behavior [I39]. Also the responses are typical for phase transitions in that they involve dramatic changes in volume, shape, di-electric constant, etc.. With these motivations Pollack discusses phase transition based models for contraction, motility, secretion, transport of molecules, organized flow of particles during cell division, cell locomotion, contraction of muscle, generation of action potentials, etc.. For instance, the transport of bio-molecules along micro-tubule could involve propagating gel-sol-gel phase transition meaning also propagating melting of the layered water around micro-tubule.
6. Divalent ions, such as Mg^{+2} and Ca^{+2} can act as cross links between negatively charged proteins binding them to form networks. Monovalent ions cannot do this. Peripheral cytoskeleton is this kind of network consisting of micro-tubules and actin molecules cross-linked - according to Pollack- by Ca^{+2} ions. On the other hand, it is known that Mg^{+2} (Ca^{+2}) ions dominate in the cell interior (exterior) and that the presence of Ca^{+2} ions in the cell exterior is crucial for generation of nerve pulse. The influx of Na^+ ions having higher affinity to proteins can induce a phase transition to sol-like phase. Pollack suggests a model of nerve pulse based on this mechanism of gel-sol phase transition for peripheral cytoskeleton: this model does not actually explain why Ca^{+2} ions in the exterior of axon are necessary.

4.4 TGD Based Vision Inspired By The Findings

The vision about dark matter and the model of nerve pulse formulated in terms of Josephson currents brings an additional perspective to the role of pumps and channels and allows to achieve harmony with the standard views about their role.

1. In long length scales visible matter forms roughly 5 per cent of the total amount of matter. In TGD Universe the dark matter would correspond to matter with large Planck constant including dark variants of ordinary elementary particles. In living matter situation could be the same and visible matter could form only a small part of the living matter. Dark matter would be however visible in the sense that it would interact with visible matter via classical electromagnetic fields and photon exchanges with photons suffering Planck constant changing phase transition. Hence one can consider the possibility that most of the biologically important ions and perhaps even molecules reside at the magnetic flux quanta in large \hbar phase.
2. Bosonic ions could form Bose-Einstein condensates at the flux tubes in which case supra currents flowing without any dissipation would be possible. The model for high T_c superconductivity suggests that only electronic and protonic superconductivity are possible at room temperature. If so, Cooper pairs of fermionic ions are excluded. New nuclear physics predicted by TGD could however come in rescue here. The TGD based model for atomic nucleus assumes that nuclei are strings of nucleons connected by color bonds having quark and antiquark at their ends. Also charged color bonds are possible and this means the existence of nuclei with anomalous charge. This makes possible bosonic variants of fermionic ions with

different mass number and it would be interesting to check whether biological important ions like Na^+ , Cl^- , and K^+ might actually correspond to this kind of exotic ions.

This leads to the following TGD inspired vision about cell as a gel.

1. DNA as TQC hypothesis and cell membrane as sensory receptor provide possible candidates for the actual functions of the cell membrane and ionic channels and pumps could act as kind of receptors. That standard physics is able to describe gel phase is of course a mere belief and (wormhole) magnetic flux tubes connecting various molecules (DNA, RNA, amino-acids, biologically important ions) would be “new physics” cross-links could explain the strong correlations between distant molecules of the gel phase.
2. Dark ionic currents are quantal currents. If the dark ions flow along magnetic or wormhole magnetic flux tubes connecting cell interior and exterior, their currents through cell membrane would be same as through an artificial membrane.
3. Pumps and channels could serve the role of sensory receptors by allowing to take samples about chemical environment. One cannot exclude the possibility that proteins act as pumps and channels in sol phase if magnetic flux tubes are absent in this phase since also in TGD Universe homeostasis and its control at the level of visible matter in sol phase might requires them. The metabolic energy needed for this purpose would be however dramatically smaller and a reliable estimate for this would allow an estimate of the portion of dark matter in living systems.
4. Quantum criticality suggests that the phase transitions for the gel phase are induced by quantum phase transitions changing the value of Planck constant for magnetic flux tubes and inducing the change of the length of the flux tube. Macroscopic quantum coherence would explain the observed co-operativity aspect of the phase transitions. Concerning locomotion and transport mountain climbing using pickaxe and rope inspires a guess for a general mechanism. For instance, a packet of molecules moving along actin molecule or a molecule carrying a cargo along micro-tubule could repeat a simple basic step in which a magnetic flux tube with large \hbar is shot along the direction of the electric field along micro-tubule and stuck to a ratchet followed by a phase transition reducing the value of \hbar and shortening the flux tube and forcing the cargo to move forward. The metabolic energy might be provided by the micro-tubule rather than molecular motor.
5. The reconnection of flux tubes would be a second phase transition of this kind. This phase transition could lead from a phase in phase proteins are unfolded with flux tubes connecting amino-acids to water molecules and thus possessing a large volume of layered water around them to a phase in which they become folded and flux tubes connect amino-acids to each other in the interior of protein. The phase transition could be associated with the contraction of connecting filaments of muscle cell. The phase transitions are also seen in “artificial protein” gels used for drug delivery applications, and are built from polymers arranged in alpha helices, beta sheets and common protein motifs [I39]. If wormhole magnetic flux are taken as a basic prerequisite of life, one must ask whether these “artificial proteins” represent artificial life.
6. The fact that cytoskeleton rather than only cell membrane is involved with the generation of action potential conforms with the idea that nerve pulse propagating along axon involves also axonal micro-tubules and that Josephson currents between axon and micro-tubules are involved in the process.
7. Di-valent ions (Ca^{+2} ions according to Pollack) serve as cross links in the peripheral cytoskeleton. The influx of monovalent ions from the exterior of axon induces gel-sol phase transition replacing di-valent ions with monovalent ions. One can consider two models.
 - (a) The minimal assumption is that this phase transition is induced \hbar increasing phase transition the flow of the monovalent ions like Na^+ from the cell exterior along the magnetic flux tubes connecting axonal interior and interior. Suppose that in the original situation the flux tubes end to axonal membrane (this is not the only possibility, they

could also end to Ca^{+2} ions). The flux tubes extending to the axonal exterior could result by \hbar increasing phase transition increasing the length of the flux tubes connecting peripheral cytoskeleton to the axonal membrane so that they extend to the exterior of axon. This option is rather elegant since gel-sol phase transition itself can be understood in terms of “standard chemistry”. In this model the very slow diffusion rate of the ions to gel phase would have explanation in terms of new physics involving dark matter and (wormhole) magnetic flux tubes.

- (b) One can consider also an option in which divalent ions such as Ca^{+2} or Mg^{+2} are connected by two flux tubes to amino-acids of two negatively charged proteins whereas monovalent biological ions like Na^{+} would have single flux tube of this kind and could not act as cross links. In the phase transitions removing the cross links the replacement of divalent ion with two monovalent positively charged ions would take place. If one believes in standard chemistry, Na^{+} ions would flow in automatically. First the increase of Planck constant would induce the lengthening of the magnetic flux tubes and thus the expansion of the gel phase making possible the influx of monovalent ions. If Na^{+} ions are dark, flux tubes connecting peripheral cytoskeleton to the axonal exterior are required and the mechanism of option i) is also needed.
8. The mechanisms i) and ii) could be fused to a single one. The hint comes from the presence of Ca^{+2} ions in the exterior of axon is necessary for the generation of action potential. The simplest possibility is that the flux tubes connecting proteins to intracellular Ca^{+2} cross links in gel phase connects them after the length increasing phase transition to extracellular Ca^{+2} ions and Na^{+} ions flow along these flux tubes.
 9. The increase of the Planck constant would induce the expansion of the peripheral cytoskeleton making possible the inflow of Na^{+} ions, and divalent ions binding negatively charged actin molecules to a network would be replaced with inflowing Na^{+} ions. After this a reverse phase transition would occur. Both phase transitions could be induced by a quantal control signal (Josephson current) inducing quantum criticality and a change of Planck constant.
 10. A propagating Ca^{+2} wave inducing the gel-sol-gel phase transition of peripheral cytoskeleton would accompany nerve pulse. Quite generally, Ca^{+2} waves are known to play a fundamental role in living matter as kind of biological rhythms. Irrespective of whether one believes option a) or b), this might relate to the cross-linking by flux tubes and gel-sol-gel phase transitions induce by phase transitions increasing Planck constant temporarily. The velocities and oscillation periods of Ca^{+2} waves vary in an extremely wide range: this can be understood if the flux tubes involved correspond to a very wide spectrum of Planck constant.

Besides basic ions cell membrane is non-permeable to various polar molecules such as the basic building bricks of DNA and amino-acids. The safest assumption is that genetically coded pump and channel proteins make possible the transfer. One must of course consider the possibility that channels and pumps are used to make the transfer of basic ions more effective. Taking this into account, the proposed vision does not differ so radically from the standard one as one might think first and only the model for nerve pulse generation must be modified radically.

To sum up, the strange discoveries about the behavior of cell membrane provide direct experimental evidence for the presence of dark matter in living systems, for the prediction that it interacts with ordinary matter via classical electromagnetic fields, and for the assumption that it does not dissipate appreciably and could therefore have large value of \hbar and form macroscopic quantum phases.

5 Quantum Model For The Direct Currents Of Becker

Robert Becker [J7] proposed on basis of his experimental work that living matter behaves as a semiconductor in a wide range of length scales ranging from brain scale to the scale of entire body. Direct currents flowing only in preferred direction would be essential for the functioning of living manner in this framework.

One of the basic ideas of TGD inspired theory of living matter is that various currents, even ionic currents, are quantal currents. The first possibility is that they are Josephson currents associated with Josephson junctions but already this assumption more or less implies also quantal versions of direct currents.

TGD inspired model for nerve pulse assumes that ionic currents through the cell membrane are quantal currents. If they are Josephson currents, the situation is automatically stationary and dissipation is small as various anomalies suggest. One can criticize this assumption since the Compton length of ions for the ordinary value of Planck constant is so small that magnetic flux tubes carrying the current through the membrane look rather long in this length scale. Therefore either Planck constant should be rather large or one should have a non-ohmic quantum counterpart of a direct current in the case of ions and perhaps also protons in the case of neuronal membrane: electronic and perhaps also protonic currents could be still Josephson currents. This would conform with the low dissipation rate.

In the following the results related to laser induced healing, acupuncture, and DC currents are discussed first. The obvious question is whether these direct currents are actually supracurrents and whether they could be universal in living matter. A TGD inspired model for quantal direct currents is proposed and its possible implications for the model of nerve pulse are discussed.

Whether the model for quantum direct currents is consistent with the proposed vacuum extremal property of the cell membrane remains an open question but both options explain the special role of Ca^{++} currents and current of Na^+ Cooper pairs in the generation of nerve pulse as in would take place in TGD Universe. In fact, it is not clear what one exactly means with the vacuum extremal property of cell membrane. Many-sheeted space-time (see **Fig.** <http://tgdtheory.fi/appfigures/manysheeted.jpg> or **Fig. 9** in the appendix of this book) allows to consider space-time sheets which can be both almost vacuum extremals and far from vacuum extremals. Also space-time sheets for which Planck constant is so large that both electronic and protonic Josephson currents become possible. Various pumps and channels could actually correspond to magnetic flux tubes along which various ionic supra currents or even Josephson currents can flow. The condition that both electronic and protonic supra currents are possible in same length scale leads to the hierarchy of Planck constants coming approximately as powers of $m_p/m_e \simeq 2^{11}$ proposed originally as a general truth. Radiation at Josephson frequency serves as a signature for Josephson currents.

In the following a TGD inspired quantum model for the direct currents of Becker as direct quantum currents is developed and shown to be consistent with what is known about nerve pulse generation.

5.1 Connection Between Laser Induced Healing, Acupuncture, And Association Of DC Currents With The Healing Of Wounds

The findings of Robert Becker (the book “The Body Electric: Electromagnetism and the Foundation of Life” by Becker and Selden, which can be found from web (see <http://tinyurl.com/y8rbgebw>) [J7], 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.

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 biochemistry. This suggests that bioelectromagnetic phenomena are fundamental attributes of living things, ones that must have been present in the first living things. 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 semi-conductivity, photoconductivity, and piezoelectricity. All of the reported effects of electromagnetic forces seem to lend support to the latter hypothesis.

5.1.1 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 the 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 microtubules 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 the same in a static situation.
2. A longitudinal potential along front to back in the brain with the frontal lobes in negative potential with respect to occipital lobes and with a 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 [K47]). Propagating potentials were also discovered 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 an external magnetic field (Hall effect) was shown to lead to a loss of consciousness.

5.1.2 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 the 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 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 salamanders but not in frogs. This motivated Becker and collaborators to compare these situations. In an amputated leg of both salamander and frog the original negative potential of approximately -1 mV was raised first to a positive value of about +10 mV. In the frog it returned smoothly to its original value without regeneration. In the salamander it returned over a period of 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 once regeneration had occurred. Thus the large negative potential is necessary for the regeneration and responsible for the formation of blastema. Furthermore, artificial electron current also induced regeneration also in the case of the frog, even in the denervated situation. Thus the flow of electrons to the stump seems to be 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 neuroepidermal junction (NEJ) formed in the healing process of salamander stump was responsible for the regeneration in the presence of denervation. The conclusion was that the DC voltage and electronic current relevant for regeneration could be assigned the interface between CNS and tissue rather than to the entire nerve and the regeneration seemed to be a local process, perhaps a feed of metabolic energy driving self-organization. Furthermore, NEJ seemed 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 thus possess nuclei. Becker and collaborators observed that red blood cells also dedifferentiated to form blastemas. Being normally in a quiescent state, they are ideal for studying de-differentiation. It was found that the electric current acted as a trigger at the level of cell membrane inducing de-differentiation reflected as an increased amount of mRNA serving as marker of 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 TGD inspired view about DNA-cell membrane system as topological quantum computer with magnetic flux tubes that are assumed to connect DNA and cell membrane and serve as braid strands in TGD inspired model of DNA as topological quantum computer [K3].
7. The experiments of Becker and collaborators support the identification of the charge carriers of DC currents responsible for the formation of the stump's large negative potential 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.

5.1.3 Gene activation by electrostatic fields?

The basic question concerns the method of activation. The discovery of chemists Guido Ebner and Guido Schuerch [J2] raises the hope that these ideas might be more than over-active imagination and their work also provides a concrete proposal for the activation mechanism. Ebner and Schuerch studied the effect of electrostatic fields on the growth and morphogenesis of various organisms. Germ, seeds, or eggs were placed between conducting plates creating an electric field in the range .5-2 kV/m: note that the Earth's electric field is in the range .1 – 4 kV/m and of the same order of magnitude.

The outcome was rather surprising and in the year 1989 their employer Ciba Geigy (now Novartis) applied for a patent "Method of enhanced fish breeding" [J2] for what is called Ciba Geigy effect. The researchers describe how fishes (trouts) develop and grow much better, if their eggs have been conditioned in an electrostatic field. The researchers also reported [J2] that the morphology of the fishes was altered to what seems to represent an ancient evolutionary form: this was not mentioned in the patent.

The chemists founded their own Institute of Pharmaceutical Research near Basel, where Guido Ebner applied for another very detailed patent, which was never granted. In the patent he describes the effect of electrostatic fields on several life forms (cress, wheat, corn, fern, micro-organisms, bacteria) in their early stage of development. A clear change in the morphogenesis was observed. For instance, in one example fern had all sort of leaves in single plant apparently providing a series of snapshots about the evolution of the plant. The evolutionary age of the first leaf appeared to be about 300 million years whereas the last grown-up leaf looked close to its recent form.

If one takes these finding seriously, one must consider the possibility that the exposure to an electrostatic field can activate passive genes and change the gene expression so that older morphologies are expressed. The activation of not yet existing morphologies is probably more difficult since strong consistency conditions must be satisfied (activation of program requires activation of a proper hardware). This would suggest that genome is a kind of archive also containing also older genomes even potential genomes or that topological quantum computer programs [K3] determine the morphology to a certain extent and that external conditions such as electric fields determine the self-organization patterns characterizing these programs.

It is known that the developing embryo has an electric field along the head-tail axis and that this field plays an important role in the control of growth. These fields are much weaker than the fields used in the experiment. p-Adic length scale hierarchy however predicts an entire hierarchy of electric fields and living matter is indeed known to be full of electret structures. The strength of the electric field in some p-adic length scale related to DNA might somehow serve as the selector of the evolutionary age. The recapitulation of phylogeny during ontogeny could mean a gradual shift of the activated part of both genome and "memone" (as as menetic analog of genome: for a proposal of memetic code see [K24]), perhaps assignable to topological quantum computer programs realized as braidings, and be controlled by the gradually evolving electric field strength.

The finding that led Ebner to his discovery was that it was possible to "wake up" ancient bacteria by an exposure to an electrostatic field. The interpretation would be in terms of loading of metabolic batteries. This would also suggest that in the case of primitive life forms like bacteria the electric field of the Earth has served as metabolic energy source whereas in higher life forms endogenous electric fields have taken the role of Earth's electric field.

5.1.4 A TGD based model for the situation

On the basis of these observations 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 - utilises the loading of many-sheeted metabolic batteries by supra currents as a basic mechanism.

The first series questions, observations, and ideas relates to the connection of DC currents with metabolism and ordinary biochemistry. The hierarchy of Planck constant is expected to be involved somehow.

1. How the DC currents relate to metabolism and ordinary biochemistry? For what purpose they are needed? The crucial point is that the energy of order 1 meV gained by electron in

the electric field is much below the metabolic energy quantum and also thermal energy so that the interpretation in terms of metabolic energy quantum does not look promising. This forces to consider the possibility that the basic role of electric field is to drive electrons to where they are needed, say wounded part of tissue in positive potential and thus attracting electrons. Electrons are indeed needed by the electron transport cycle appearing in both photosynthesis and cell respiration since the transport cycle induces leakage of electrons due to the formation of ROS (reactive oxygen species) such as O_2^- . The purpose of electronic Becker currents would be therefore the re-establishment of metabolism.

The change of the sign of the Becker potential to positive induce a loss of electrons and reduced metabolism. This could explain why consciousness is lost when the sign of Becker potential is changed or electrons are deviated by Hall effect. Wound damages the connections of the tissue to the organism and the transfer of electrons compensating for leaked electrons is prevented since Becker potential changes sign. The regeneration induced by an artificial Becker potential of correct sign would induce healing by re-establishing the electron feed.

The crucial question concerns the role of electrons. It seems that in all situations electron flow to the damaged tissue induces healing. Why electrons generating negative potential should help in healing? The first input is TGD model [K42] [L15] for the findings of Pollack [L15] involves the connection of dark matter hierarchy $h_{eff} = n \times h$ with negentropic entanglement characterized by density matrix reducing to $n \times n$ unit matrix for entanglement matrix proportional to a unitary matrix. In infinite-dimensional case the divisor is infinite unless one uses von Neumann's hyperfinite factor of type II_1 for which the normalization factor can be taken to be unity: in the case of quantum groups this corresponds to using quantum trace instead of the ordinary one. A further input is the observation that the gravitational Planck constant h_{gr} explaining planetary Bohr quantization rules can be equal to h_{eff} in living matter for microscopic systems like elementary particles, atoms, and ions, even molecules [K56, K45].

1. Pollack's findings about fourth phase of water formed when external energy feed induces formation of negatively charged exclusion zones of water obeying stoichiometry $H_{1.5}O$ with 1/4: th of protons going to the complement of exclusion zone. Something similar might happen also now.
2. In TGD framework this process is explained as a formation dark phase of protons at the magnetic flux tubes associated with the exclusion zone with dark protons realizing genetic code so that one obtains what might be regarded as primitive primordial life form.
3. There is evidence for a huge anomalous gravimagnetic Thomson field in rotating super conductors. Thomson field is proportional to square of Planck constant h_{eff} and TGD explanation is that large h_{gr} phase is formed at gravitational flux tubes. The assumption $h_{gr} = h_{eff}$ in elementary particle and atomic scales is possible and is consistent with the hypothesis that bio-photons in visible and UV energy range correspond to decay products of dark EEG photons.
4. \hbar_{gr} can be generalized to $\hbar_{em} = -Z_1 Z_2 e^2 / v_0$: v_0 would be typical rotational velocity in a system with opposite charges Z_1 and Z_2 . Exclusion zone would be good example. For ATP v_0 would be rotational velocity of ATP. For exclusion zone v_0 could be rotational velocity of Cooper pairs in magnetic field associated with flux tubes or walls or rotational velocity of magnetic body. $Z_2 = -Z_1$ is natural assumption by charge neutrality.
5. In this framework the feed of electrons would increase the value of h_{eff} by increasing the negative charge associated with the analog of exclusion zone accompanying the wound and induce also a flow of dark protons to the magnetic flux tubes associated with the magnetic body of the analog of exclusion zone.
6. The DC currents would be needed because the damage of the tissue means that the $\hbar_{eff} = \hbar_{em} = Z^2 e^2 / v_0$ is reduced for a pair formed by damaged system and its complement. Healing would be essentially attempt to increase h_{eff} to its original value. The parameter Z^2 is reduced and must be increased to its original value and perhaps even to a higher value since the larger ger the value of h_{eff} is, the richer the negentropic resources of system are.

The transfer of electrons to the system analogous to exclusion zone induces transfer of dark protons to the magnetic flux quanta of the magnetic body of the system. Recall that dark proton strings at flux tubes could be analogs of dark nuclei and that the model for dark nucleons allows to identify nucleon states as counterparts of DNA, RNA, amino-acids and even tRNA. This leads to a model of prebiotic lifeforms [K25].

7. ATP synthase transforming ADP to ATP involves rotating shaft and one can ask whether the velocity parameter v_0 appearing in the expression for \hbar_{em} equals to the rotation speed of the shaft. This predicts that the value of \hbar_{em} to be same order as \hbar_{eff} and \hbar_{gr} for Earth-electron system assuming that v_0 corresponds to the rotation velocity at the surface of Earth. The assumption $\hbar_{eff} = \hbar_{gr} = \hbar_{em}$ makes it possible for the gravitational and em flux tubes to reconnect.
8. The original guess was that electrons to provide energy giving rise to the formation of ATP in cell respiration and photosynthesis. Electrons themselves receive their energy either from the oxidation of molecules or from solar photons. This model is consistent with the model above since electron transport chain is crucial for cell transpiration and needs both electrons and dark protons located at the dark flux tubes associated with the exclusion zones. Dark protons would flow through the ATP synthase attached to mitochondrial membrane and liberate dark cyclotron energy if the value of the magnetic fields associated with the flux tube is different for the interior and exterior portions of the flux tube [K19, K41].

The experimental support for the role of bio-photons in living matter is accumulating and a natural question concerns their role in metabolism. In TGD framework dark photons with large value of \hbar_{eff} with energy of visible photon can transform to ordinary photons of same energy with some - presumably rather small - probability, and would be interpreted as bio-photons. Could dark photons take the role of solar photons and provide in some situations energy to the electrons in the electron transport cycle? This would mean a non-conventional non-local mechanism of metabolism. The effects of laser light on tissue suggest that laser light indeed takes the role of solar light and feed energy to the electron transport cycle transforming it to the energy of high energy phosphate bond of ATP. A more detailed TGD inspired view about what might happen is discussed in [K29].

One can consider also the possibility that quantum credit card mechanism (remote metabolism) could be at work in some the situations when chemical metabolic energy sources are absent. Damaged tissue might define this kind of exceptional situation. This brings in mind the strange ability of plants suffering under-nutrition to attract insects responsible for their pollination observed by Callahan, who has also reported that plants and insects communicate using infrared light which according to his findings serves as a sensor input in insect olfaction [I15]: also in this case quantum credit card mechanism building magnetic flux tube bridges guiding the insects to the plant might be at work. The electrons which have gained 1 meV energy during travel along pairs formed by MEs and parallel magnetic flux tubes (meridians), could send negative energy dark photons with energy of order -5 eV to gain same positive energy allowing to get over the semiconductor junction after they have arrived to the damaged tissue. These negative energy photons would be absorbed by a metabolic energy store (ATP in mitochondria transforming to ADP) in the healthy part of the organism.

$\hbar_{eff} = \hbar_{em}$ implies that the spectrum of bio-photons originating from dark cyclotron photons is universal having no dependence on ion mass and in visible and UV range, which is also the range for molecular excitation energies. Dark cyclotron photons decaying to bio-photons would therefore allow magnetic body to control biochemistry by resonant absorption inducing transitions of molecules.

The original model for the charging of the metabolic batteries and for effective semi-conductor junction assumed that the electrons of supra current are transferred to smaller space-time sheets.

1. For ground state electrons this requires energy which is at least the difference of zero point kinetic energies of electron at the two space-time sheets. This energy should be of the order of fundamental metabolic energy quantum of about .5 eV.

For Cooper pairs of electrons the sheet should correspond to p-adic length scale of order $L_e(k_e = 149) = 10$ nm, the thickness of lipid layer of cell membrane. For single pro-

ton corresponding scale would be $L_e(k_p = 139) \simeq 2^{-12}L_e(151)$ from $m_p/2m_e \simeq 2^{10}$ and $E_{0,p}/E_{0,2e} = (2m_e/m_p) \times (L_e(k_e)/L_e(k_p))^2 = (2m_e/m_p) \times 2^{k_e-k_p} \sim 1$.

This suggests that electron Cooper pair is kicked to a smaller space-time sheet assignable to a mitochondrial lipid layer having $k_e = 149$. The larger space-time sheet could be that of cell membrane with $k = 151$. For protons the zero point kinetic energies at these space-time sheets are by a factor $2m_e/m_p$ lower and of the order of .5 meV. This happens to be of the same order of magnitude as the energy gained by proton or electron in the Becker potential. May be this is not an accident.

There is also a second intriguing quantitative co-incidence. In the absence of an action potential, acetylcholine vesicles spontaneously leak into the synaptic junction and cause very small de-polarizations in the postsynaptic membrane known as miniature end plate potentials (see <http://tinyurl.com/y98zhxzh>) (mEPSP) of magnitude .5 mV. These potentials are too small to generate action potential but together they can sum up to the needed action potential. Maybe the interpretation in terms of proton kicked to lipid layer space-time sheet might make sense.

2. The re-charging mechanism should relate directly to ADP → ATP process occurring during electronic transport cycle in mitochondrial membrane. The connection with metabolism forces to ask how the formation of high energy phosphate bond in the addition of phosphate to ADP relates to the transfer of electrons to smaller space-time sheet. Somehow the energy of electrons must go to the formation of this bond: perhaps the dropping of electron back to larger space-time sheet transfers the energy to the high energy phosphate bond.

In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated.

3. The transfer of particles between space-time sheets with different p-adic length scales is not the only one that one can consider, and recently a more elegant mechanism has emerged [K29]. If the particles are free, a phase transition in which the p-adic prime of the space-time sheet containing particles decreases adiabatically increases the scale of kinetic energy but leaves particle quantum numbers unchanged. If the same happens for charge particles at magnetic flux tubes, similar increase of cyclotron energy scale takes place since magnetic field strength increase to conserve magnetic flux. The predictions are in good approximation the same as for the original model. If the phase transition reducing p-adic length scale is accompanied by a compensating increase of Planck constant, the size scale of space-time sheet remains unaffected but metabolic batteries are loaded. The reversal of this phase transition liberates metabolic energy. What is important that metabolic energy and negentropic entanglement (measured in terms of the value of Planck constant) are closely correlated for this mechanism. The loading/liberation of energy is also a quantum coherent process.
4. Acupuncture and the application of DC current are known to induce the generation of endorphins. Do endorphins contribute to well-being by reducing the pain? In TGD framework the deeper level interpretation of metabolism is as a provider of negentropic entanglement in turn giving rise to well-being. Are endorphins kind of negentropy packets or just conscious signals about the improved situation?

Second series of questions, observations, and ideas relates to the meridians, acu points, and “chi”.

1. A permanent potential difference of same sign between head and tail could mean an accumulation of positive and negative charges to the ends of the of the system if only electron currents are present. If both electron and proton currents with opposite directions are present, there is no accumulation of charge but there is an accumulation of protons and electrons. Probably there exists a pumping mechanism forcing the electrons (and possibly also protons) to

move against the potential gradient from the tail back to the head. This however requires metabolic energy and the simplest source of this energy would be just the energy of electrons otherwise used to generate ATP. If so, the leakage would not be an unavoidable dissipative effect but a way to avoid charge accumulation.

If the pumping mechanism is not at work, this situation cannot continue for ever and the sign of the potential difference must eventually change and induce loss of consciousness. The simplest possibility is that the potential difference changes sign rhythmically. A natural question is whether the sleep-awake rhythm is unavoidable and corresponds to the oscillatory behavior of the head-to-tail voltage.

“Chi” would correspond electrons or their Cooper pairs in this picture. Abnormal chi flow (reduced flow, flow in wrong direction, accumulation of chi) would cause various problems including also insomnia in which too much electron charge tends to accumulate.

3. What is the nature of acupuncture meridians, what kind of currents flow along them, and why are they not directly observed? The most natural identification in TGD Universe would be in terms of magnetic flux tubes accompanied by parallel massless extremals (MEs) making possible also the propagation of dark photons used for control purposes and perhaps even in metabolism as already discussed. Dark currents along pairs of MEs and magnetic flux tubes are ideal for the transfer of particles and energy.

If the length of the superconducting “wire” is long in the scale defined by the appropriate quantum scale proportional to \hbar , the classical picture makes sense and charge carriers can be said to accelerate and gain energy ZeV . For large values of \hbar_{eff} an oscillating Josephson current would be in question. Since Becker currents are associated with CNS, it would be natural to associate the meridians with neural pathways although this assignment is not necessary. Magnetic flux tube system defined kind of magnetic circulation which could serve as a template for the neural pathways. The transfer of energy with minimal dissipation would explain why a semiconductor like property is needed and why acupuncture points have a high conductivity value.

4. What about acu-points? Acu points are known to be in negative potential normally. This suggests that the density of electrons or their Cooper pairs at them is higher than elsewhere in the meridian. Could they serve as kind of electron stores providing electrons to their environment to compensate for losses caused by ROS. This would make possible higher metabolic activity in presence of nutrient molecules since the rate for the electron transform cycle should be proportional to the density of energizable electrons, “chi”.

When the potential of the acu-point is reduced or become positive, under-nutrition follows. This should relate to various symptoms like pain at acupuncture points. Acupuncture needle as an electronic conductor would develop a charge distribution with a concentration of electrons to the acu-point, and would re-establish the metabolic activity. Pain would be signature of lack of negentropic entanglement (see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig.** ?? in the appendix of this book) and positive/negative coloring of emotions and sensations would quite generally correlate with the amount of negentropic entanglement.

5. Nanna Goldman *et al* have provided empirical evidence (see <http://tinyurl.com/4to42pc>) [I29] for the expectation that the healing effect of the acupuncture involves metabolism (see the popular article in Sciencedaily (see <http://tinyurl.com/3734uub>) [I16]).

The group has found that adenosine is essential for the pain killing effects of acupuncture. For mice with a normal adenosine level acupuncture reduced dis-comfort by two-thirds. In special “adenosine receptor knock-out mice” acupuncture had no effect. When adenosine was turned on in the tissues, the discomfort was reduced even in the absence of acupuncture. During and after an acupuncture treatment, the level of adenosin in tissues near the needles was 24 times higher than before the treatment. In the abstract of the article it is stated that it is known for long time that acupuncture generates signals which induce brain to generate natural pain killing endorphins but that also adenosine acts as a natural pain killer.

Adenosine is the basic building block of AXP, X=M, D, T (adenosin-X-phosphate, X=mono, di, tri). Therefore the findings suggest that the flow of electrons from the needle to acu point

loads metabolic batteries by providing electrons to electron transport cycle needed to generate ATP. Adenosine could be partially generated as decay products of AXPs. Tissue itself could increase adenosine concentration to make possible its transformation to AXP utilizing electric field energy. From the popular article one cannot conclude whether the authors propose a connection with metabolism. The results are consistent with the assumption that the AXPs generated from adenosin accompany negentropic entanglement. This can occur in the scale of entire body and meridians could also make possible direct signalling with brain.

How can understand the semiconducting character of Becker's DC currents?

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. For metabolic energy quantum of order .5 eV this however makes sense only if the electrons transferred to the smaller space-time sheet have energy slightly below the minimum energy for the transfer to the smaller space-time sheet in absence of the Becker potential. The situation would be critical and 1 mV voltage could serve as a kind of control knob.

One can imagine the analog of this mechanism also when the external energy feed corresponds to a phase transition reducing p-adic length scale and increasing Planck constant so that the size of the space-time sheet remains unaffected. Again 1 mV voltage would have the role of control knob.

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 universal mechanism applying to various stages of the regeneration process? In quantal situation the metabolic energy quanta have very precise values as indeed required.
3. The findings of Becker provide support for electronic DC currents. The Cooper pairs of electrons are indeed the best candidates for the carriers of supra current by their small mass. In the minimal situation the currents defined by leaked electrons moving against potential gradient (utilising the energy used otherwise to generate ATP) could compensate the Becker currents and give rise to closed current loops without charge accumulation. If the electronic DC currents observed by Becker are much stronger than needed to compensate for the local electron leakage, a larger metabolically driven return current is needed to guarantee local charge neutrality. These currents seem to be assignable to CNS: maybe the two electron currents could be associated with sensory and motor pathways. An interesting question whether sympathetic-parasympathetic dichotomy also relates to electron currents in opposite directions.
4. Could also dark protonic and even ionic DC currents be present and running along their own flux tubes and perhaps defining cyclotron Bose-Einstein condensates? How large the scale of flux tubes can be: could it be much larger than that of biological body (by simple argument magnetic body should have layers with even size scale of Earth). What is the possible connection with cell respiration? When single ATP is generated, three protons are pumped through the mitochondrial membrane utilising the energy liberated in electron transport cycle. This does not however require protonic currents in longer scales.
5. In regeneration process NEJs are formed. They could consist of pairs of MEs and magnetic flux tube mediating the electronic DC current during blastema generation and regeneration proper during which also control signals from CNS would be present. Since NEJs seems to resemble cell membranes in some respects, the ideas inspired by 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 characterised by a large value of the effective Planck constant are involved with both meridians and NEJs. Magnetic flux tubes can act as DC current wires or Josephson junctions generating oscillatory supra currents of ions and electrons. Also for large values of the effective Planck constant meridians look short in the relevant dark length scale and could act as Josephson junctions carrying oscillatory Josephson currents.

One can raise also questions about the relationship between DC currents and de-differentiation.

1. Could cell de-differentiation be caused by the presence of Becker's DC current? Also acupuncture is known to induce de-differentiation. Could the mere ability to charge metabolic energy batteries provided by electron feed induce de-differentiation, which manifests as an increased genetic expression? Can one see differentiation as an eliminative process forced by the reduction of the electron feed and inducing a selective reduction of gene expression? If this were the case, de-differentiation could be induced by a feed of surplus electrons to the system using either external electron current or additional electric field. Local electron density would correlate negatively with the degree of differentiation.
2. In this framework it might be possible to understand the claimed effects of external electric fields on the development of plants and fishes. In this case rejuvenation means return to the earlier evolutionary stages. Maybe ontogeny-recapitulates-phylogeny principle might allow to understand this if genome in some sense contains archive about earlier stages of evolution. This archive might be virtual and realised by an epigenetic mechanism selecting different patterns of gene expression using the same genome.

If this is the case, the density of electrons or their Cooper pairs - "chi" - possessed by the cell would serve as a measure for the biological age of the cell and the meridian system feeding "chi" would serve as a rejuvenating agent with respect to gene expression. The average density of dark electrons would serve as a measure for the age of cell: the larger the density the higher the metabolic activity and the lower the biological age.

5.2 Quantum Model For Effective Semiconductor Property

Becker [J7] summarizes his findings by stating that living matter is an effective semiconductor. There are pairs of structures in positive and negative potential in various scales and the current between the plates of this effective capacitor flows when above some minimum potential difference. The current flows from positive to negative pole and could be an electron current. Also proton current in the opposite direction can be considered but the electron current is experimentally favored. For instance consciousness is lost when a magnetic field is used to deflect the current.

In TGD framework natural carriers of these currents would be magnetic flux tubes also carrying electric fields. A very simple deformation of the embedding of a constant longitudinal magnetic field also gives longitudinal electric field. With a slight generalization one obtains helical electric and magnetic fields. A crucial difference is that these currents would be quantal rather than ohmic currents even in the length scale of the biological body and even longer scales assignable to the magnetic body.

The following argument allows us to understand the physical situation.

1. A precise everyday analogy is vertical motion in the gravitational field of the Earth between surface and some target at given height h . If the kinetic energy is high enough, the particle reaches the target. If not, the particle falls back. In the quantum case one expects that the latter situation corresponds to a very small probability amplitude at the target (tunnelling to classically forbidden kinematic region).
2. Now the electric field replaces the gravitational field. Suppose that the classical electric force experienced by the particle is towards the capacitor plate taking the role of the surface of Earth. Below critical field strength the charged particle cannot reach the target classically and quantum mechanically this occurs only by tunnelling with vanishingly small probability.
3. Particles with opposite value of charge experience a force which accelerates them and classically they certainly reach the second plate. What happens in a quantum situation? It seems

that this situation is essentially identical with the first one: one has linear potential in finite interval and wave functions are localized in this range. One can equivalently regard these states as localized near the second capacitor plate.

4. A good analogy is provided by atoms: classically the electron would end down at the nucleus but quantization prevents this. One can imagine also now stationary solutions for which the electric currents for individual charges vanish at the plates although classically there would be a current in another direction. Also quantum mechanically non-vanishing conserved current is possible: all depends on boundary conditions.

5.2.1 Basic model

Consider now the situation at more quantitative level.

1. One can assign complex order parameters Ψ_k to various Bose-Einstein condensates of supra phases and obey Schrödinger equation

$$i\partial_t\Psi_k = \left(-\frac{\hbar^2}{2m_k}\partial_z^2 + q_k Ez\right)\Psi_k . \quad (5.1)$$

Here it is assumed that the situation is effectively one-dimensional. E is the value of constant electric field.

2. The Schrödinger equation becomes non-linear, when one expresses the electric field in terms of the total surface charge density associated with the plates of effective capacitor. In absence of external electric field it is natural to assume that the net surface charge densities σ at the plates are of opposite sign so that the electric field inside the capacitor is proportional to

$$\sigma = E = \sum_i \sigma_i = \sum_i q_i \bar{\Psi}_i \Psi_i . \quad (5.2)$$

This gives rise to a non-linear term completely analogous to that in non-linear Schrödinger equation. A more general situation corresponds to a situation in which the region interval $[a, b]$ bounded by capacitor plates a and b belongs to a flux longer tube like structure $[A, B]$: $[a, b] \subset [A, B]$. In this case one has

$$E_{tot} = E + E_0 . \quad (5.3)$$

This option is needed to explain the observations of Becker that the local strengthening of electric field increases the electron current: this would be the case in the model to be discussed if this field has a direct opposite to the background field E_0 . One could also interpret E as quantized part of the electric field and E_0 as classical contribution.

3. The electric currents are given by

$$j_k = \frac{i\hbar q_k}{2m_k} \bar{\Psi}_k \partial_z^{\leftrightarrow} \Psi_k . \quad (5.4)$$

In stationary situation the net current must vanish:

$$\sum_k j_k = 0 . \quad (5.5)$$

A stronger condition is that individual currents vanish at the plates:

$$j_k = 0 . \quad (5.6)$$

It must be emphasized that this condition does not make sense classically.

5.2.2 Explicit form of Schrödinger equation

Consider now the explicit form of Schrödinger equation in a given electric field.

1. The equation is easy to solve by writing the solution ansatz in polar form (the index k labelling the charge particle species will be dropped for notational convenience).

$$\Psi = R(a\exp(iU) + b\exp(-iU))\exp(-iE_n t) \quad (5.7)$$

For real solutions current vanishes identically and this is something which is not possible classically. It is convenient to restrict the consideration to stationary solutions, which are energy eigen states with energy value E_n and express the general solution in terms of these.

2. The Schrödinger equation reduces with the change of variable

$$\begin{aligned} z &\rightarrow \frac{(z - z_0)}{z_1} \equiv x, \\ z_0 &= \frac{E_n}{qE}, \quad z_1 = \left(\frac{\hbar^2}{2mqE}\right)^{1/3}. \end{aligned} \quad (5.8)$$

to

$$(\partial_x^2 + x)\Psi = 0. \quad (5.9)$$

The range $[0, z_0]$ for z is mapped to the range $[-z_0/z_1, 0]$. z_0/z_1 has positive sign as is easy to verify. The value range of x is therefore negative irrespective of the sign of qE . This is the differential equation for Airy functions (see <http://tinyurl.com/6b8yh7>) [B1]. Airy functions are encountered in WKB approximation obtained by linearizing the potential function: $V(x) = ax + b + O(x^2)$.

The change of variable leads automatically to solutions restricted near the plate where the situation is completely analogous to that in the gravitational field of the Earth. For stationary solutions a test charge in a given background field would be localized near the capacitor plate with opposite sign of charge. A strong background field could be created by charges which do not correspond to the ionic charges defining ionic currents. Electrons and protons could define this field possibly associated with flux tubes considerably longer than the distance between capacitor plates.

3. Using the polar representation $\Psi = R\exp(iU)$ Schrödinger equation reduces to two equations

$$\begin{aligned} [(\partial_x^2 - U_x^2 + x)R] \cos(U) + [U_{xx} + 2\partial_x R \partial_x U] \sin(U) &= 0, \\ [(\partial_x^2 - U_x^2 + x)R] \sin(U) - [U_{xx} - 2\partial_x R \partial_x U] \cos(U) &= 0. \end{aligned} \quad (5.10)$$

Note that both (R, U) and $(R, -U)$ represent solutions for given value of energy so that the solution can be chosen to be proportional to $\cos(U)$ or $\sin(U)$. The electric current j is conserved and equal to the current at $x = 0$ and given by

$$j = \frac{\hbar}{2m} \frac{U_x}{z_1} R^2, \quad z_1 = \left(\frac{\hbar^2}{2mqE}\right)^{1/3}. \quad (5.11)$$

The current vanishes if either U_x is zero or if the solution is of form $\Psi = R\sin(U)$.

5.2.3 Semiclassical treatment

In semiclassical approximation the potential is regarded as varying so slowly that it can be regarded as a constant. In this situation one can write the solution of form $Rexp(iU)$ as

$$\Psi = R_0 exp\left(\frac{i}{\hbar} \int_0^z \sqrt{2m} \sqrt{E - qEz} dz\right) = R_0 exp\left(i \int_0^x x^{1/2} dx\right) . \quad (5.12)$$

The plate at which the initial values are given can be chosen so that the electric force is analogous to gravitation at the surface of Earth. This requires only to replace the coordinate z with a new one, vanishing at the plate in question - and gives to the energies a positive shift $E_0 = qE_0h$.

1. The semiclassical treatment of the equation leads to Bohr rules

$$\frac{\oint p_z dz}{\hbar} = \frac{2}{\hbar} \int_0^h p_z dz = n . \quad (5.13)$$

This gives

$$\frac{\oint p_z dz}{\hbar} = \frac{2\sqrt{2m}}{\hbar} \int_0^h \sqrt{E_n - qEz} dz = 2 \int_0^{x_0} x^{1/2} = \frac{4}{3} x_0^{3/2} = n . \quad (5.14)$$

Note that the turning point for classical orbit corresponds to $z_{max} = E_n/qE$.

2. One obtains

$$E_n = \frac{1}{2} \left(\frac{nqE\hbar^2}{r\sqrt{m}}\right)^{2/3} , \quad r = \int_0^1 (1-u)^{1/2} du = \frac{2}{3} . \quad (5.15)$$

The value of z_{max} is

$$z_{max} = \frac{E_n}{qE} = \frac{n^{2/3}}{2r^{2/3}} \left(\frac{\hbar^2}{qEm}\right)^{1/3} . \quad (5.16)$$

3. The approximation $R = R_0 = constant$ can make sense only if the position of the second plate is below z_{max} . This is possible if the value of n is large enough ($n^{2/3}$ proportionality), if the mass m of the charged particle is small enough ($m^{-1/3}$ proportionality) raising the electron and also the proton to a special position, or if the strength of the electric field is small enough ($E^{-1/3}$ proportionality). The value z_{max} is proportional to $\hbar^{2/3}$ so that a phase transition increasing Planck constant can induce current flow.

5.2.4 Possible quantum biological applications

The proposed model for quantum currents could provide quantum explanation for the effective semiconductor property of Becker's DC currents.

1. The original situation would be stationary with no currents flowing. The application of an external electric field in the correct direction would reduce the voltage below the critical value and currents would start to flow. This is consistent with Becker's findings if there is a background electric field E_0 with direction opposite to that of the applied field has a direction opposite to E_0 so that the field strength experienced by charged particles is reduced and it is easier for them to reach the second plate.

2. Becker's DC currents appear in several scales. They are assigned with the pairs formed by CNS and perineural tissue (this includes also glia cells) and by frontal and occipital lobes. Acupuncture could involve the generation of a DC supra current. The mechanism would be essential in the healing. Also the mechanism generating qualia could involve generation of supra currents and dielectric breakdown for them. The role of the magnetic flux tubes in TGD inspired biology suggests that the mechanism could be universal. If this were the case one might even speak about a Golden Road to the understanding of living matter at the basic level.

Even the generation of nerve pulse [K47] might be understood in terms of this mechanism. One can argue that neurons have a higher evolutionary level than the system pairs to which only electron currents or electron and proton currents can be assigned. This is because the value of the effective Planck constant is higher for the magnetic flux tubes carrying the quantal ionic currents.

1. For Bose-Einstein condensate the simplest choice is $n = 1$ at both plates. The energy eigenvalues would naturally differ by the shift $E_0 = qE_0h$ at the two plates for a given particle type. Under these assumptions the current can flow appreciably only if the voltage is below the minimum value. This is certainly a surprising conclusion but brings in mind what happens in the case of neuronal membrane. Indeed, hyper-polarization has a stabilizing - something difficult to understand classically but natural quantum mechanically.
2. The reduction of membrane potential slightly below the resting potential generates nerve pulse. Also a phase transition increasing the value of the effective Planck constant might give rise to quantal direct currents and generate flow of ionic currents giving rise to nerve pulse. Stationary solutions are located near either capacitor plate. What comes to mind is that the nerve pulse involves a temporary change of the capacitor plate with this property.
3. If the electron and proton currents flow as direct currents, one encounters a problem. Nerve pulse should begin with direct electronic currents and be followed by direct protonic currents and only later ions should enter the game if at all. The existing model for nerve pulse however assumes that at least electrons flow as oscillating Josephson currents rather than direct quantal currents. This is quite possible and makes sense if the cell membrane thickness is small - that is comparable to electron Compton length as assumed in large \hbar model for the nerve pulse. This assumption might be necessary also for proton and would make sense if the Planck constant for protonic flux tubes is large enough. For ions the Compton length would be much smaller than the thickness of cell membrane and direct currents would be natural.

If the value of the effective Planck constant is the same for biologically important ions, direct quantum currents would be generated in definite order since in $\hbar < z_{max}$ one has $z_{max} \propto m^{-1/3} \propto A^{-1/3}$. The lightest ions would start to flow first.

- (a) Nerve pulses can be generated by voltage gated channels for potassium and calcium. Voltage gated channels would correspond to magnetic flux tubes carrying electric field. For voltage gated channels Na^+ ions with atomic weight $A = 23$ and nuclear charge $Z = 11$ start to flow first, then K^+ ions with atomic weight $A = 39$ and $Z = 19$ follow. This conforms with the prediction that the lightest ions flow first. The nerve pulse duration is of the order of 1 millisecond at the most.
- (b) Nerve pulses can be also generated by voltage gated Ca^{+2} channels. In this case the duration can be 100 ms and even longer. Ca has $A = 40$ and $Z = 20$. The proper parameter is $x = r^2/qA$, $r = \hbar/\hbar_0$. One has

$$\frac{x(\text{Ca}^{++})}{x(\text{Na}^+)} = \left(\frac{r(\text{Ca}^{++})}{r(\text{Na}^+)}\right)^2 \times \frac{23}{2 \times 40} . \quad (5.17)$$

$r^2(\text{Ca}_{++}) \sim 2r^2(\text{Na}_+)$ would allow to compensate for the increased weight and charge of Ca_{++} ions.

4. The objection is that Na^+ and K^+ are not bosons and therefore cannot form Bose-Einstein condensates. The first possibility is that one has Cooper pairs of these ions. This would imply

$$\frac{x(Ca^{++})}{x(2Na^+)} = \left(\frac{r(Ca^{++})}{r(Na^+)}\right)^2 \times \frac{23}{20} .$$

Ca^{++} and Na^+ pair would be in very similar position for a given value of Planck constant. This is a highly satisfactory prediction. Another manner to circumvent the problem is more science fictive and assumes that the Na^+ ions are exotic nuclei behaving chemically as Na^+ but having one charged color bond between nucleons [L2].

It remains to be seen whether this model is consistent with the model of cell membrane as almost vacuum extremal or whether the vacuum extremal based model could be modified by treating ionic currents as direct currents. In the vacuum extremal model classical Z^0 gauge potential is present and would give a contribution to the counterpart of Schrödinger equation. The ratio $x(Ca^{++})/x(2Na^+)$ for the parameter $x = r^2/q(A - Z)A$ (em charge q is replaced with neutron number in good approximation) equals to 1.38 and is not therefore very far from unity.

The many-sheetedness of space-time is expected to play a key role and one should precisely specify which sheets are almost vacuum extremals and which sheets are far from vacuum extremals. One expects that magnetic flux tubes are far from vacuum extremals and if voltage gated ionic channels are magnetic flux tubes, the proposed model might be consistent with the model of cell membrane as almost vacuum extremal.

5.2.5 The effects of ELF em fields on vertebrate brain

The effects of ELF em fields on vertebrate brain occur both in frequency and amplitude windows. Frequency windows can be understood if the effect occur at cyclotron frequencies and correspond to absorption of large \hbar photons. A finite variation width for the strength of magnetic field gives rise to a frequency window. The observed quantal character of these effects occurring at harmonics of fundamental frequencies leads to the idea about cyclotron Bose-Einstein condensates as macroscopic quantum phases. The above considerations support the assumption that fermionic ions form Cooper pairs.

I have tried to understand also the amplitude windows but with no convincing results. The above model for the quantum currents however suggests a new approach to the problem. Since ELF em fields are in question they can be practically constant in the time scale of the dynamics involved. Suppose that the massless extremal representing ELF em field is orthogonal to the flux tube so that the ions flowing along flux tube experience an electric force parallel to flux tube. What would happen that the ions at the flux tube would topologically condensed at both the flux tube and massless extremal simultaneously and experience the sum of two forces.

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

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

potential of about 6×10^6 V/m. This is of course only a rough order of magnitude estimate since perturbations of these field are in order.

Fractality motivates some guess for voltage and electric field.

1. The voltage along the flux tube could be invariant under the scaling of Planck constant. The interpretation could be that the charges at the ends of the linear structure generate an electric flux running along the structure do not depend on the length L of the structure so that the electric field along linear structure behaves as $1/L \propto 1/h_{eff}$ as a function of the length scale $L \propto h_{eff}$ so that voltage between the ends does not depend on the length of the structure. This would give rise to a universal amplitude window for voltage rather than potential. The cell membrane electric field of 6×10^6 V/m would correspond to the field 6 mV/m. This kind of voltages could be associated with Becker's DC currents and the order of magnitude would be around few mV.

Note that if the electric flux is like that between point charges, the scaling law $E \propto 1/h_{eff}^2$ holds true.

2. There could be also a constant electric field along microtubular structures due to polarization - most naturally tubulin polarization. This field strength serves as a candidate for a universal amplitude window for electric field.

The idea that the direct currents of Becker run between lipid layers of cell does not conform with the hypothesis about generalized Josephson currents between them. There are electric fields along microtubules and one could wonder whether the DC voltages of Becker could relate to the voltages between the ends of linear structures formed by axonal and dendritic microtubules connected to each other by MAPs - single MT can have a length up to about 1 cm. The longitudinal electric field due to the dipole moments of tubulins and confined to tubulin structure does not depend on its length L , and the electric field of 1 mV/m would correspond 10^3 V/ μ m, which is by order of magnitude larger than the constant longitudinal dipole electric field of order 10^2 eV/ μ m generated by tubulin dipoles estimated to have strength 337 Debye in [I34] (note that MT has radius of $R = 25$ nm, thickness of $\Delta R = 4$ nm and length of $d = 8$ nm and the volume of MT fragment defined by 13 parallel tubulins is given by $V = 13 \times 2\pi R^2 \Delta R$ and that electric is $E = p/V$). If Becker's direct currents correspond to electric fields due to the charge difference between the ends of tubulins, one can consider the possibility that Becker's longitudinal electric fields have micro.tubular origin.

3. Electric field in the range $E = 1 - 10$ V/m assignable to EEG would correspond to field of $(1 - 10) \times 10^3$ V/ μ m and seems to be too large to be assigned with microscopic structures. DNA is a possible candidate since the smaller thickness of DNA would increase the dipole moment density by a factor of order 10^3 from that for MTs. The electric field of 10^{-7} eV/m seems to be associated with much larger structure than organism.

5.2.6 Effects of 50 Hz magnetic fields on living matter

The vision about the role of cyclotron Bose-Einstein condensates was inspired by the effects of ELF em fields on vertebrate brain. The magnetic field strength explaining the effects was about .2 Tesla, 2/5 of the nominal value for the strength of Earth's magnetic field.

There are also other experiments have demonstrated that oscillating electromagnetic fields have effects on living matter. In particle oscillatory magnetic fields with frequency of 50 Hz and with field strengths typically in the range .1-1 mT are used: these effects are summarized in [J34]. Even fields of order .14 Tesla are used.

It is interesting to look at the values of basic parameters associated with these fields.

1. For 50 Hz oscillation frequency the wave length λ is 6000 km to be compared with the radius of Earth which is 6371 km. If one takes seriously the notion of magnetic body this need not be an accident. I do not know how essential it is to have just 50 Hz frequency. The magnetic field is nearby oscillating dipole field (see <http://tinyurl.com/36c4pfg>) up to distances of order λ and radiation field at much longer distances. Therefore the field in question is in good approximation nearby field as far as biological body is considered. For magnetic body the radiation field could dominate

2. For the endogenous magnetic field $B_{end} = .2$ Gauss cyclotron frequencies of ions are in EEG range: Ca^{++} cyclotron frequency is 15 Hz. The scaling up to $r=.1-1$ mT means scaling of cyclotron frequencies by a factor 5 – 50. For Ca^{++} this would give frequency range 75-750 Hz. For K^+ and Cl^+ ions the frequency range would be about 35-375 Hz.
3. The magnetic length $r = \sqrt{2/eB}$ characterizing flux tube thickness for flux quantization with minimum value of flux is for $B = .05$ mTesla equal to $5 \mu m$. For the fields in the range $.1-1$ mTesla it is in the range $3.5 \mu m- 1.1 \mu m$. $2.5 \mu m$ corresponds to p-adic length scales $L_e(k)$ associated with Gaussian Mersenne $M_{G,k} = (1+i)^k - 1$, $k = 167$, and Gaussian Mersenne corresponding to $k = 163$ would correspond to p-adic length scale $.36 \mu m$. $.14$ Tesla corresponds to magnetic length of 9.4 nm rather near to cell membrane thickness of 10 nm which corresponds to p-adic length scale $L_e(151)$ assignable to Gaussian Mersenne $M_{G,151}$.

5.2.7 The effects of polarized light on living matter

Polarized light is known to have effects on living matter [J34]. For instance, Peter Gariaev has found that the polarized light generated by living matter sample irradiated by polarized laser light has effects on distant organism and there are even indications that genetic code might be realized in terms of radiation patterns [K67]. The quantum model for Becker currents suggest that these effects result as a modification of the voltage between the ends of magnetic flux tubes. If the flux tubes are near criticality for the generation of quantal DC currents, polarized light could be utilized both communication and control purposes whereas the acceleration in the electric fields along flux tubes would serve as a provider of metabolic energy allowing to load metabolic batteries. This process could be initiated by an electromagnetic signal inducing generation of quantal currents. The same basic mechanism could be at work also in DNA transcription, replication and other similar processes.

If the polarized low frequency radiation corresponds to a massless extremal (ME) orthogonal to the flux tube such that the polarization of the radiation is parallel to the flux tube, the voltage is affected by a contribution given by $\Delta V = Ed$, d the thickness of ME. If the flux tube is near criticality to a generation of quantal currents this change of voltage could serve as a signal inducing the generation of quantal currents.

The maximal effect is obtained for the flux tubes having direction parallel to the electric polarization so that the effect is highly selective. In the case of DNA double strand the direction of flux tube changes so that the effect would be maximal on DNAs which correspond to the same angular position on the super-coil of radius of order 10 nm formed by DNA double helix. This allows to imagine signals for which temporal variation of polarization direction means scanning of DNA.

It is known that the energy of radiation can be transformed to metabolic energy. For instance, IR light for which photons have energies of order metabolic quantum has biological effects [I65]. The mechanism could be following. Suppose that the electric field of IR photon is parallel to the flux tube which carries an electric field and is near criticality for the generation of quantal DC currents. If the direction of polarization is correct, the additional contribution to electric field induces direct current and acceleration of electrons and protons and their transfer to smaller space-time sheets and therefore loading of metabolic batteries. This could also make generation of ATP possible.

Suppose that one takes seriously the model for remote replication of DNA [K67] involving flux tubes connecting identical DNA nucleotides and that the radiation propagating along them induces quantal currents along the receiving DNA inducing replication and perhaps even transcription. The direction of polarization for the emitted radiation should be parallel to the DNA strand locally and during its travel to the target the polarization should remain orthogonal to the flux tube so that one would have what might be called polarization window. Parallel translation of the polarization vector in the induced metric suggests itself.

5.2.8 Support for the proposed interaction mechanism of em radiation fields with flux tubes

The basic prediction of the interaction mechanism is that the effects of em field with a given frequency occur only at the second half period when the direction of electric field is “correct”. This prediction might be testable. In fact, there is evidence for this interaction mechanism in the

case of theta waves of EEG. The memory storage occurs only at the second half of the theta wave. This is discussed from different point of view in [K3].

The place coding by phase shifts was discovered by O'Reefe and Recce [J31]. In [J37, J36]. Y. Yamaguchi describes the vision in which memory formation by so called theta phase coding is essential for the emergence of intelligence. It is known that hippocampal pyramidal cells have "place property" being activated at specific "place field" position defined by an environment consisting of recognizable objects serving as landmarks. The temporal change of the percept is accompanied by a sequence of place unit activities. The theta cells exhibit change in firing phase distributions relative to the theta rhythm and the relative phase with respect to theta phase gradually increases as the rat traverses the place field. In a cell population the temporal sequence is transformed into a phase shift sequence of firing spikes of individual cells within each theta cycle.

Thus a temporal sequence of percepts is transformed into a phase shift sequence of individual spikes of neurons within each theta cycle along linear array of neurons effectively representing time axis. Essentially a time compressed representation of the original events is created bringing in mind temporal hologram. Each event (object or activity in perceptive field) is represented by a firing of one particular neuron at time τ_n measured from the beginning of the theta cycle. τ_n is obtained by scaling down the real time value t_n of the event. Note that there is some upper bound for the total duration of memory if scaling factor is constant.

One can say that neurons in ensemble provide a representation for the external world and the location of the rodent in the external world is represented as a firing of a neuron in this landscape. Besides this also temporal scaling down by a factor about ten is carried out so that actual event is represented as much shorter copies of it. Obviously this represents temporal fractality.

This scaling down - story telling - seems to be a fundamental aspect of memory. Our memories can even abstract the entire life history to a handful of important events represented as a story lasting only few seconds. This scaling down is thought to be important not only for the representation of the contextual information but also for the memory storage in the hippocampus. Hierarchy of Planck constants and phase transitions changing Planck constant make this story building possible.

The finding of Yamaguchi and collaborators relevant in the recent context is that the gradual phase shift occurs at half theta cycle whereas firings at the other half cycle show no correlation [J37]. The proposed model for the interaction of theta waves with flux tubes could explain this naturally. The relevant neural sub-system would be critical to the generation of quantal DC current only when the direction electric field of synchronizing theta wave generated by magnetic body is correct. Hence synchronous neural activity would be induced only at second half cycle of theta wave and firing would be random during the other half cycle.

5.3 A Model For Remote Gene Expression Based On Becker Currents

If one accepts the notion of magnetic body as intentional agent, the basic challenge is to understand how magnetic body realizes its intents as remote mental interactions on biological body. This model must of course apply also to the more conventional remote mental interactions such as remote realization of intent.

The hypothesis is that electromagnetic and possibly also other massless classical fields assignable to so called massless extremals are in a key role. Also cyclotron frequencies characterizing magnetic bodies play a key role. The vision is that magnetic flux sheets traverse many-sheeted DNA in various scales giving rise to a hierarchy of genomes and coherent gene expression in scales of cell, organelles, organism, and even population, and species. Hierarchy of Planck constants is in an essential role in realizing this hierarchy in terms of photons with energies above the thermal energy at physiological temperature and having spectrum of wavelengths coming as multiples $\lambda = n\lambda_0$, $n = \hbar/\hbar_0$.

The findings of Benveniste and followers relating to water memory and homeopathy, the recent work of group led by HIV Nobelist Luc Montagnier coupling the findings with genetics and suggesting a new nanoscale realization of genetic code [L4]), the work of the group of Popp with bio-photons identified as decay produces of large \hbar photons with visible energies (in particular dark EEG photons), and the work of Peter Gariaev and collaborators supporting remote gene expression and replication discussed [K67] suggest that electromagnetic radiation is indeed involved. In the case of water memory and homeopathy the spectrum of cyclotron frequencies for the chemical

invader characterizes it and induces immune response trying to eliminate it. I have also proposed a model for how genes coding for proteins eliminating the invader could be generated almost automatically: the model is based on the predicted realization of vertebrate genetic code in terms of dark proton states [K25]. DNA would like an animal which sniffs the invaders magnetic body and automatically reacts to the smell.

The discussions with Lian Sidorov and people who have realized that new era is beginning in biology have served as a driving force in the attempts to formulate in more detail TGD inspired view about how remote mental interactions - which are basic element of the model in TGD framework - might be realized. As a matter fact, I have added to my homepage a new book summarizing briefly the recent view about quantum TGD and its applications to quantum consciousness, quantum biology, to quantum neuroscience, and to remote mental interactions with some proposals for possible tests [K59]).

To start with, suppose that in the case of biological target realization of intent in the simplest situation reduces to expression of genes. This is of course a strong limitation to the type of remote mental interactions. The challenge is to develop a model for remote realization of genetic activities like replication, and transcription. For some time ago I proposed a model with Peter Gariaev [K67] but it was still too clumsy since it required too much of information transfer between the genomes of sender and receiver. Much simpler model involving only sending of simple commands initiating genetic programs suggests itself. The following proposal tries to achieve this and involves three basic ideas.

1. The idea of password and addressing is familiar from ordinary computers. Collection of frequencies as password/address allows to reach tuned targets without specific targeting of the command. This is a dramatic improvement to the previous model.
2. Password and fractal addressing realized in terms of frequencies coupling resonantly (already in the original model: I did not however realize the implications of resonant coupling!) and the hierarchy of Planck constants to realize the hierarchical addressing. I have discussed analogous addressing based on information molecules and their receptors at the biochemical level to realize magnetic flux tube connections between sender and target inside organism (hormonal action would be very analogous to what I am proposing here).
3. Becker's DC currents as supra currents flowing along DNA and activated optimally when the incoming laser light has polarization parallel to DNA's local direction, activation of super currents would mean activation of the gene. This is second new element to the original model.

In the following I discuss this with more details.

5.3.1 The analogy with ordinary computer

Consider first the analog of remote mental interactions for ordinary computer. Computer sends a password to the other computer and after that it can use it to run programs of the other computer. Whisling to a dog is another example: extremely simple command activates arbitrary complex programs.

In the recent case electromagnetic radiation with a given frequency coupling resonantly like radio signal to a tuned radio receiver would be the simplest command activating the target. There would no need to specify the direction or distance of the target precisely since essentially mass communications would be in question: intent would be enough. Password could consist of several frequencies which must be received simultaneously by the target before it would activate and tunes to receive more frequencies representing simple commands - perhaps acting on the intronic portion of DNA and activating the genome to remote gene expression or something else such as activating DNAs of other cells by sending similar em addresses!

I have discussed topological quantum computer programs (see <http://tinyurl.com/y84g3tk7>) based on braiding could look like in this framework [L8]. Also here addressing but now realized as information molecule-receptor pair would play a key role.

5.3.2 Hierarchy of Planck constants and hierarchical addressing

Fractal hierarchy of frequencies (in Peter's experiment laser light induced generation of radiation at frequencies down to about 10 kHz) would allow to transform passwording to addressing. Very naïvely, the longest wavelengths: about 10^4 meters would reach the tuned receivers in nearly the same phase in a region of this size. One would have some subregions in tune. The shorter wavelengths would allow to pinpoint the tuned receivers inside each of these subregions and so on. This would be fractal addressing with most significant bits correspond to the longest wavelengths. Only those receivers which would be tuned to all frequencies would start to express the gene in the case of AND logic. Of course, also other Boolean functions of tuned-not tuned bits can be considered.

A good guess is that all photons correspond to the same energy of visible photon and only Planck constant varies. For ordinary value of Planck constant one would have a photon with wavelength of order size scale of single cell, and the frequencies in this range would select single gene in the genome of a particular kind of cell, say neuron within particular region of brain.

In Peter Gariaev's experiment involving 2 eV incoming red laser light the outgoing photons would have same energy but larger Planck constant so that also wavelengths would be longer and range down to at least 3×10^4 meters corresponding to radiofrequency scale of 10 kHz. What is interesting that 2 eV is 4 times the nominal value of the metabolic energy quantum of 5 eV identifiable as zero point kinetic energy of electron or proton for the p-adic length scale $L_e(151)$ corresponding to cell membrane thickness and Gaussian Mersenne $M_{151} = (1 + i)^{151} - 1$. Could it be that 2 eV could be preferred photon energy or is its use simply due to the unavailability of continuous frequency spectrum for laser light. And why the laser light induces the generation of the command inducing remote gene expression?

This picture conforms with Peter's experiment and with the reports of Benveniste and followers about the possibility of representing homeopathic remedy using very low frequency spectrum - presumably cyclotron frequencies - assignable to remedy. These frequencies would be addresses for genes activating genes transcribing building bricks of biomolecules of immune response eliminating the substance from the organism. The proposal could be seen as a generalization of Benveniste's observation and realization of wave DNA proposal.

5.3.3 DNA supra currents and activation of genes by Becker mechanism

The third building brick of the model would be quantum model for Becker currents (see <http://tinyurl.com/ybnjk9bq>) [L9] as supra currents or quantal DC currents: also this element is new. Assume - in accordance with the general vision - that these supra currents can flow also along the strands of many-sheeted DNA (flux sheets associated with the strand, entire hierarchy labelled by the values of \hbar). Assume also that the interaction of polarized photons addressing for genes with DNA is such that the electric fields of DNA flux tube and "massless extremal" representing laser beam superpose and charges (electrons) experience the superposition of field already present and the field of ME. If the net electric field is near criticality originally (think as analog neuronal membrane) and becomes over-critical, quantal Becker current starts to flow and the machinery responsible for gene activation is activated.

This means also the activation of metabolic machinery since the acceleration of electrons in the electric field gives them energy making possible a transfer to smaller space-time sheets where they form Cooper pair like states with negentropic entanglement. Metabolic energy corresponds to zero point kinetic energy and negentropic entanglement is relevant from the point of view of consciousness: in the case of healing understood as a regeneration of negentropic resources this aspect is especially important. This mechanism generates high energy phosphate bonds in ATP and the decay $ATP \rightarrow ADP$ liberates the metabolic energy and destroys the negentropic entanglement possibly associated with ATP so that the second law in generalized form (see <http://tinyurl.com/yakmqhz6>) [L6] allowing local generation of genuine negentropy (but assigned to information carried by entanglement defining a quantum rule) wins after all.

It could also happen that the decay of ATP generates dark photon or photons absorbed by cyclotron condensate at magnetic flux tube. The excited state is non-local single particle excitation and involves very simple negentropic entanglement between the particles of the condensate. In this case the negentropy of ATP would be transformed to the negentropy of the magnetic flux tube

or even several of them if large value of Planck constant is associated with the photon. This mechanism could allow the generation of negentropic entanglement associated with attention. The storage of metabolic energy in photosynthesis could involve similar excitation of cyclotron state at the first step. The most plausible candidate is cyclotron condensate for electron Cooper pairs. Also electrons filling state up to some Fermi energy could be in question. In this case the excitations would be excitation in longitudinal degrees of freedom of the flux tube generating current.

5.4 DNA, Speech, Music, And Ordinary Sound

Peter Gariaev's group has made rather dramatic claims about DNA during years [I26, I27, I42, I41].

1. The group has proposed that the statistical distributions of nucleotides and codons in the intronic portion of DNA resemble the distribution of letters and words in the natural languages [I41]. For instance, it is proposed that Zipf law [J24] applying to natural languages applies to the distributions of codons in the intronic portion of DNA. One can study the popularity of the words in natural languages and order them against their popularity. Zipf law states that the integer characterizing popularity is in constant proportion to the number of times it appears in given long enough text.
2. It has been also claimed that DNA can be reprogrammed using modulated laser light or even radio waves. I understand that reprogramming means a modified gene expression. Gariaev's group indeed proposes that the meaning of the third nucleotide (having a rather low significance in the DNA-amino-acid correspondence) in the genetic codon depends on the context giving rise to a context dependent translation to amino-acids. This is certainly a well-known fact for certain variants of the genetic code. This context dependence might make possible the re-programming. The notion of dark DNA allows to consider much more radical possibility based on the transcription of dark DNA to mRNA followed by translation to amino-acids. This could effectively replaced genes with new ones.
3. Also the modulation of the laser light by speech is claimed to have the re-programming effect. The broad band em wave spectrum resulting in the scattering of red laser light on DNA is reported to have rather dramatic biological effects. The long wave length part of this spectrum can be recorded and transformed to sound waves and these sound waves are claimed to have the same biological effects as the light. The proposal is that acoustic solitons propagating along DNA represent this effect on DNA.

I do not have the competence to make statements about the plausibility of these claims. TGD view about quantum biology makes also rather strong claims. The natural question is however whether a justification for the claims of Gariaev and collaborators could be found in TGD framework? In particular, can one say about possible effects of sound on DNA. One intriguing fact about sound perception is that music and speech have meaning whereas generic sounds do not. Could one say something interesting about how this meaning is generated at the level of DNA?

5.4.1 Basic picture

Before continuing it is good to restate the basic TGD inspired ideas about the generation of meaning.

1. The generation of the negentropic entanglement is the correlate for the experience of the meaning. In the model inspired by Becker's findings [L9], the generation of negentropic entanglement (see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig. ??** in the appendix of this book) involves a generation of supra currents along flux tubes moving in the electric field parallel to them. This is a critical phenomenon taking place when the voltage along the flux tube is near critical value. The generation of nerve pulse near critical value of the resting potential is one example of this criticality. Becker's direct currents involved with the healing of wounds is another example.

The flow of the supra current gives rise to the acceleration of charges along the flux tubes and generation of Cooper pairs or even many-electrons systems at smaller space-time sheets in

negentropically entangled state and carrying metabolic energy quantum as zero point kinetic energy. The period of negentropic entanglement gives rise to a conscious experience to which one can assign various attributes such as understanding, attention, and so on. Negentropic entanglement would measure the information contained by a rule having as instances the state pairs in the quantum superposition defining the entangled state. When the period of negentropic entanglement ceases, the metabolic energy is liberated.

2. Remote activation of DNA by analogs of laser beams is another essential piece of TGD inspired quantum biology [L9]. In the proposed addressing mechanism a collection of frequencies serves as a password activating intronic portions of DNA. This would take place via a resonance for the proposed interaction between photons and dark supra currents flowing along magnetic flux tubes and perhaps also along DNA strands or flux tubes parallel to them. The superposition of electric fields of photons (massless extremals) with the electric fields parallel to flux tubes (so that massless extremals serving as correlates for laser beams would traverse the flux tube in orthogonal direction).
3. The flux tubes, and more generally flux sheets labelled by the value of Planck constant, and along which the radiation arrives would be transversal to DNA and contain DNA strands. This kind of flux tubes and sheets also define the connections to the magnetic body, and form parts of it. A given flux sheet would naturally select the portion of DNA, which is activated by the radiation: it could be a portion of intronic part of DNA activating in turn a gene. These flux tubes and sheets could be connected to the lipids of nuclear and cell membranes - also cell membranes of other cells - as assumed in the model of DNA as topological quantum computer [K3]. The sheets could also give rise to a hierarchy of genomes - besides genome one would have super-genome in which genomes are organelles are integrated by flux sheets to a large coherently expressed structure containing individual genomes like page of a book contains lines of text. These pages would be in turn organized to a book - hyper-genome as I called it. One could have also libraries, etc... There would fractal flux quanta inside flux quanta structure.

5.4.2 Phonons and photons In TGD Universe

Consider next phonons and their coupling to photons in TGD Universe.

1. Sound waves could quite well transform to electromagnetic radiation since living matter is piezo-crystal transforming sound to radiation and vice versa. Microwave hearing represents an example of this kind transformation. This would require that photons of given energy and varying value of Planck constant couple to phonons with the same energy, Planck constant, and frequency.
2. Whether one can assign to phonons a non-standard value of Planck constant is not quite clear, but there seems to be no reason preventing this. If so, even photons of audible sounds would have energies above thermal threshold and have direct quantal effects on living matter if they have same Planck constant as the photons with same frequency.
3. Acoustic phonons represent longitudinal waves and this would require longitudinal photons. In Maxwell's electrodynamics they are not possible but in TGD framework photon is predicted to have a small mass and also longitudinal photons are possible.
4. For general condensed matter systems one can have also optical phonons for which the polarization is orthogonal to the wave vector and these could couple to ordinary photons. The motion of the charged particles in the electromagnetic field of massless extremal (topological light ray) would be a situation in which phonons and photons accompany each other. This would make possible the piezo-electric mechanism.

Under these assumptions the collections of audible frequencies could also represent passwords activating the intronic portion of the genome and lead to gene expression or some other activities. If one believes on the hypothesis that DNA acts like topological quantum computer based on the braid strand connections between nucleotides in the intronic portion of DNA with the lipids of the nuclear and/or cell membranes, also topological quantum computation type processes could be activated by the collections of sound frequencies [K3].

5.4.3 What distinguishes speech and music from sounds without meaning?

Speech and music are very special forms of sound in that they have direct meaning. The more one thinks about these facts, the more non-trivial they look. For music - say singing - the frequency of the carrier wave is piecewise constant whereas for speech it remains constant and the amplitude modulation is important. In fact, by slowing down the recorded speech, one gets the impression that carrier frequency is actually modulated like in chirp (frequency goes down and covers a range of frequencies). What is the mechanism giving to speech and music its meaning and in this manner distinguishes them from other sounds?

Besides the frequency also phase is important for both speech and music experience. Speech and reverse speech sound quite different the intensity in frequency space is same. Therefore the relative phases associated with the Fourier coefficients of various frequencies must be important. For music simple rational multiples of the fundamental define the scale. Could it be that also the frequencies relevant to the comprehension of speech correspond to these rational multiples?

Suppose that one indeed believes on the proposed vision based on the fundamental role of negentropic entanglement in generation of meaning and takes seriously the proposed mechanisms for generating it. Can one understand why music and speech differ from general sounds and what distinguishes between them?

1. With these assumptions suitable collections of frequencies sound wave would indeed activate the intrinsic portion of DNA by generating negentropic entanglement. Also other dark flux tubes than those assignable to DNA are involved. For instance, hair cells responsible for hearing of sounds around particular frequencies could involve flux tubes and utilize similar mechanism. Allowing only hair cells would define the conservative option. On the other hand, one could well claim that what happens in ear has nothing to do with the understanding of the speech and music, it could take place only at the level of neuronal nuclei.
2. Could the direct interaction of sound waves with magnetic flux tubes generate the experiences of speech and music? In other words, assign meaning to sounds? The criterion for sound to have an interpretation as speech or music would be that it contains the resonance frequencies needed to activate the DNA, or more generally generate dark super currents generating Cooper pairs in this manner loading metabolic energy storages. This would apply to both speech and musical sounds.
3. The pitch of the speech and musical sound can vary. We are aware of the key of the music piece and of modulations of the key and remember the starting key, and it is highly satisfactory to make a return to "home" defined by the original key. This would imply that the overall scale of the collection of frequencies can be varied and that the pitch of the speech defines a natural expectation value of this scale. For persons possessing so called absolute ear this scaling symmetry would be broken in a well-defined sense.
4. Musical scales involve frequencies coming as rational multiples of the basic frequency. Octaves - power of two multiples - of the frequency can be said to be equivalent as far as musical experience is considered. One might understand the special role of rational multiples of the basic frequency if the Fourier components have same phase periodically so that the experience is invariant under discrete time translations. This requires commensurable frequencies expressible as rational multiples of the same fundamental frequency. The preferred role of p-adic primes coming as powers of two could relate to the octave phenomenon.
5. Are the relative phases of different Fourier components important for music experience? If one requires a periodical occurrence of maximal possible intensity (maximal constructive interference) then the relative phases must vanish at the values of time for maximal possible intensity. What seems essential is that the presence of commensurate frequencies gives rise to time translation invariant sensation whereas speech consists of pulses.

5.4.4 Are speech and music quantum duals like position and momentum?

Frequencies are crucial for music experience. In the case of speech the relative phases are very important as the example of reverse speech demonstrates. How a given phoneme is heard

is determined to high degree by the frequency spectrum in the beginning of the phoneme (this distinguishes between consonants). Vowels are nearer to notes in vocalization. Speech consists of pulses and destructive interference between different frequencies is required to generate pulses and different pulse shapes so that phase information is important. At least the harmonics of the basic rational multiples of the fundamental are necessary for speech.

One can criticize the previous discussion in that it has been completely classical. Phase and frequency are in wave mechanics canonically conjugate variables analogous to position and momentum. Is it really possible to understand the difference between music and speech purely classically by assuming that one can assign to sound waves both frequencies and phases simultaneously - just like one assigns to a particle sharp values of both momentum and position? Or should one use either representation either in terms numbers of phonons in different modes labelled by frequencies or as coherent states of phonons with ill defined phonon numbers but well defined amplitudes? Could the coherent states serve as the analogs of classical sound waves. Speech would be as near as possible to classical sound and music would be quantal. Of course, there is a large variety of alternative choices of basis states between these two extremes as a specialist in quantum optics could tell.

Suppose that this picture is more or less correct. What could be the minimal scenario allowing to understand the differences between speech and music?

1. Only a subset of frequencies could activate DNA (or if one wants to be conservative, the hair cells) also in the case of speech. One could still pick up important frequencies for which the ratios are simple rational numbers as in the case of musical scale plus their harmonics. If this assumption is correct, then speech from which all frequencies except for the harmonics of the simple rational multiples of the fundamental are removed, should be still be comprehensible as speech. The pitch of the speech would determine a good candidate for the fundamental frequency.
2. The harmonics of frequencies activating DNA would be crucial for speech. Harmonics are present also in music and their distribution allows to distinguish between different instruments and persons. The deviation of musical notes from ideal Fock states would correspond to this.
3. The naïve guess is that the simple rational multiples of fundamental and the possibility of having their harmonics could be reflected in the structure of intronic portions of DNA as repetitive structures of various sizes. This cannot be the case since the wavelengths of ordinary photons would be so small that the energies would be in keV range. Neither is this expected to be the case. It is magnetic flux tubes and sheets traversing the DNA which carry the radiation and the natural lengths assignable to these flux quanta should correspond to the wave lengths. The larger, the flux quantum, the lower the frequency and the larger the value of Planck constant. Harmonics of the fundamental would appear for given flux tube length naturally.

The DNA strands and flux tubes and sheets form a kind of electromagnetic music instrument with flux quanta taking the role of guitar strings and DNA strands and other structures such as lipids and possible other molecules to which flux tubes get attached taking the role of frets in guitar. This analogy suggests that for wave lengths measured in micrometers the basic frequencies correspond to the distances between “frets” defined by cell and nuclear membranes in the tissue in the scale of organism. This would relate the spectrum of resonance frequencies to the spectrum of distances between DNAs in the tissue.

For wave lengths corresponding to very large values of Planck constant giving rise to frequencies in VLF and ELF range and corresponding also to audible frequencies, the preferred wave lengths would correspond to lengths of flux quanta in Earth size scale. One should understand whether the quantization of these lengths in simple rational ratios could take place for the preferred extremals.

4. Could the pulse shape associated with massless extremals (MEs, topological light rays) allow to distinguish classically between speech and music at the level of space-time correlates? Linear superposition of Fourier components in the direction of ME is possible and this allows to speak about pulse shape. It allows also the notions of coherent state and Fock state for

given direction of wave vector. Essential would be the restriction of the superposition of fields in single direction of propagation to be distinguished from the superposition of the effects of fields associated with different space-time sheets on multiply topologically condensed particle. Maybe this would allow to make testable predictions.

6 Pythagoras, Music, Sacred Geometry, And Genetic Code

The conscious experiences generated by music demonstrate a fascinating connection between algebra and emotions. How can major and minor scale using different frequency ratios generate so different emotional experiences. This strongly suggests the we experience music as entire time interval, 4-D patterns - rather than time=constant snapshots. Also the ability remember the key and the tension lasting as long as the return to the basic key has not taken place, is example of this. One of the key questions is why octaves - that is powers of 2 of the basic note of the scale - are experienced as equivalent? One can also wonder what is behind consonance and dissonance.

I have already earlier tried to understand music experience and considered some ideas inspired by p-adic numbers fields - such as the idea that Pythagorean scale coming as powers of 3 for the basic note modulo octave equivalence might relate to 3-adicity. Reading of a book titled "Interference: A Grand Scientific Musical Theory" by Richard Merrick [J33] freely available in web (<http://tinyurl.com/8d2hfka>) re-stimulated my interest. In particular, I found the idea about a connection between music scale and harmonies with Platonic solids (3-D "sacred geometry") as highly inspiring. The basic question was whether the 12-tone scale could be mapped to a curve going once through each point of icosahedron having 12 vertices and whether the 20 faces of icosahedron, which are triangles could define the basic chords in 12-tone scale. These curves are known as Hamiltonian cycles and in the case of icosahedron there are 2^{10} of them: those obtained from each other by rotation leaving icosahedron invariant are however equivalent.

A given triangle of icosahedron can contain 0, 1 or 2 edges of the cycle and the numbers of the triangles corresponding to these triangle types classify partially the notion of harmony characterized by the cycle. Quint cycle suggests the identification for the single edge of curve as quint interval so that triangles would represent basic 3-chords of the harmony with 0, 1, or 2 quints.

One can make same questions also for other Platonic solids- tetrahedron (4 vertices), octahedron and cube which are duals of each other and have (6 and 8 vertices respectively, and dodecahedron which is dual of icosahedron having 20 vertices and 12 faces. Arabic music uses half intervals and scales with 19 and 24 notes are used. Could 20-note scale with harmony defined by 5-chords assigned to the pentagons of dodecahedron have some aesthetic appeal? Nowadays it is possible to develop electronically music based on this kind of scale and this kind of experimentation might be a fascinating intellectual and artistic adventure for a young composer.

I have also played with the idea that the 20 amino-acids could somehow correspond to the 20 triangles of icosahedron. The combination of this idea with the idea of mapping 12-tone scale to a Hamiltonian cycle at icosahedron leads to the question whether amino-acids could be assigned with the equivalence class of Hamiltonian cycles under icosahedral group and whether the geometric shape of cycle could correspond to physical properties of amino-acids [I12]. The identification of 3 basic polar amino-acids with triangles containing no edges of the scale path, 7 polar and acidic polar amino-acids with those containing 2 edges of the scale path, and 10 non-polar amino-acids with triangles containing 1 edge on the scale path is what comes first in mind.

The number of DNAs coding for a given amino-acid [I5] could be also seen as such a physical property. The model for dark nucleons leads to the vertebrate genetic code with correct numbers of DNAs coding for amino-acids. It is not however clear how to interpret DNA codons geometrically.

It however turns out that one can understand only the role of 60 codons in the icosahedral framework. The treatment of the remaining 4 codons and of the well-known 21st and 22nd amino-acids requires the fusion of icosahedral code with tetrahedral code represented geometrically as fusion of icosahedron and tetrahedron along common face which has empty interior and is interpreted as punct coded by stopping codons. In this manner one can satisfy the constraints on the Hamiltonian cycles, and construct explicitly the icosahedral Hamiltonian cycle as (4, 8, 8) cycle whose unique modification gives (4, 11, 7) ico-tetra cycle. Remarkably, two months after writing the first version of the article I learned that the data needed to calculate the Hamiltonian cycles can be found from web and that (4, 8, 8) cycle allows at least two realizations whereas

the original candidate (3, 10, 7) allows no realization with symmetries but could do so with no symmetries.

6.1 Could Pythagoras Have Something To Give For The Modern Musicology?

The ideas of Pythagorean school about music were strongly based on the number theory of that time. So called modern approaches tend to seem music scales as cultural phenomena. There are however many reasons to suspect that Pythagorean school might have been much nearer to truth.

6.1.1 Pythagoras and transition from rational numbers to algebraic numbers

Pythagoras was one the greatest ancient mathematicians. The prevailing belief at that was that the world can be described solely in terms rational numbers. During the times of Pythagoras the ancient mathematical consciousness had entered at the verge of a profound revolution: the time had become ripe for the discovery of algebraic numbers expanding rational numbers to an infinite series of algebraic extensions of rationals containing also rational multiples for finite number of algebraic numbers emerging as roots of polynomials with rational coefficients. Euclid introduces square root geometrically as length of the diagonal of square. In ancient India it was discovered 800-500 BC, possibly much earlier. Unfortunately, the emergence of Christianity stopped the evolution of mathematics and new progress began at times of Newton when also reformation took place.

The well-known but story (good story but probably not true) tells that a pupil of Pythagoras demonstrated that the diagonal of unit square ($\sqrt{2}$) cannot be rational number and had to pay with his life for the discovery. Pythagoras himself encountered $\sqrt{2}$ through music theory. He asked what is the note exactly in the middle of the of the scale. Modern mathematician would answer half of octave corresponding to the frequency ratio $2^{1/2}$. Algebraic numbers did not however belong to the world of order of Pythagoras and he obtained to a non-satisfactory rational approximation of this number. This was very natural since only rational approximations of algebraics are possible in the experimental approach using only strings with rational number valued lengths. $\sqrt{2}$ represents the interval $C - F_{\#}$ known as tritone and this interval was associated with devil and its use was denied also by church. Only after reformation $\sqrt{2}$ was accepted and this interval appears repeatedly in the compositions of Bach.

The amazing connections between evolution of mathematics and evolution of the religious beliefs inspires the question whether the evolution of consciousness could at basic level correspond to the evolution of the complexity of the number field behind the dynamics underlying consciousness. For instance, in TGD framework the vision about physics as generalized number theory allows one can to ask whether the mathematical evolution could have meant quite concretely the emergence of increasingly algebraic extensions of rationals for the coefficients of polynomials describing space-time surfaces serving as space-time correlates of consciousness.

6.1.2 Pythagoras and music

Pythagoras was both mathematician and experimentalist studying the world of musical experience experimentally. String instruments were his tool. The notion of frequency was not known at the time and length of vibrating part of string was the notion used. The experienced equivalence of notes differing by octave was known at that time and octave equivalence was understood as a fundamental symmetry of music manifesting itself as a scaling-by-2 symmetry for the length of a vibrating string.

Pythagoras developed 8 note scale CDEFGAHC (as a matter of fact, 7 notes by octave equivalence) as we know as a combination of two scales EFGA and HCDE using octave equivalence and it was established as the official music scale. Pythagorean scale is expressed solely in terms of rational number valued ratios of the string length to that for the basic note of the scale (ratio of frequency to the fundamental).

Pythagorean scale (<http://tinyurl.com/28cu6j>, <http://tinyurl.com/7mc4ut>) is expressed solely in terms of powers of the ratio $3/2$ for lengths of vibrating strings correspond to an interval known and complete fifth (C-G). The series of complete fifths (C-G-D-A...) known as progression by fifths gives very nearly 7 octaves but not quite: $(3/2)^{12} \simeq 128 + 1.75 = 2^7 + 1.745$. It would

have been very natural to build 12-note scale as powers of rational ($3/2$) or by octave equivalence as powers of 3. The failure to close is very small but people with absolute ear experience the transposition of a melody to different key as dissonant since the frequency ratios do not remain quite same. At the time of Bach (Well tempered Klavier) the equal tempered scale obtained by diving the logarithmic scale to 12 equally long parts emerged and replacing powers of $3/2$ with the 12 powers of algebraic number $2^{1/12}$ inside same octave even without octave equivalence emerged.

By octave equivalence Pythagorean scale means that all notes of the scale come in powers of 3 which strongly brings in mind 3-adicity. If one does not use octave equivalence when generalization of p-adicity to q-adicity with $q = 3/2$ is highly suggestive. q-adic numbers do not in general form number field, only an algebra.

Later more complex rational number based representations of scale using octave equivalence have been developed. The expression of the frequency ratios of the notes of the scale in terms of harmonic of fundamental modulo octave equivalence and involving only integers consisting of primes 2, 3, 5 is known as just intonation (<http://tinyurl.com/7mc4ut>).

1. Music and Platonic solids

Pythagoras was also aware of a possible connection between music scales and Platonic solids. Pythagoras is claimed to have discovered tetrahedron, hexahedron (cube) and dodecahedron while octahedron and icosahedron would have been documented by greek mathematician Thaletus two hundred years later. The tetrachord and was assigned with tetrahedron and one and imagined that Pythagorean scale could have been assigned with pair of tetrahedra somehow - cube or octahedron which comes in mind. Note that this would require that basic note and its octave should be regarded as different notes.

These attempts inspire the question whether the mapping music scales to the vertices of Platonic solids could provide insights about music experience. One can also ask whether there might be a mapping of music understood as melodies and chords in some scale to the geometries defined by Platonic solids.

1. Since 12-note scale is used in practically all classical western music and even in atonal music based on 12-note scale, the natural question is whether 12-note scale could be mapped to a connected, closed, non-self-intersecting path on icosahedron going through all 12 vertices and consisting of edges only. Closedness would mean that base note and its octave are identified by octave equivalence.
2. This mathematical problem is well-known and curves of this kind are known as Hamilton cycles and can be defined for any combinatorial structure defined by vertices and faces. Hamilton proved that Hamiltonian cycles (possibly identifiable as 20-note scale) at dodecahedron is unique module rotations and reflection leaving dodecahedron invariant. Also in the case of tetrahedron and cube the Hamiltonian cycle is unique.
3. For octahedron and icosahedron this is not the case [A3] and there are both cycles containing only faces with at least 1 edge of the path and also cycles containing no faces containing no edges of the path. Numerical experimentation in rather straightforward manner to determine Hamiltonian cycles and $H = 2^{10} = 1024$ cycles can be found. The number of topologically non-equivalent cycles (not transformable to each other by the isometries of icosahedron) is factor of this number. The group of orientation preserving isometries of icosahedron is the alternating group A_5 of 60 even permutations of five letters. The full group of isometries is $G = A_5 \times Z_2$ containing $N = 120$ elements.
4. Some subgroup of G leaves given path invariant and its order must be factor M of N so that topological equivalence class of cycles contains $R = N/M$ elements. The number of topologically non-equivalent cycles in given class with $H(top)$ elements is $N_{tot} = H(top)/R$ so that R must be a factor of $H(top)$.

Before continuing it is good so summarize the geometry of icosahedron shortly. There are 20 faces which are triangles, 12 vertices, and 30 edges. From each vertex 5 edges. Therefore the construction of Hamiltonian cycles means that at each vertex on path one must select between four options edges since one cannot return back. This gives $4^{12} = 2^{24} \sim 1.6 \times 10^7$ alternatives to

be considered. Therefore the numerical search should be relatively easy. Keeping account of the points already traversed and not allowing self intersections, the actual number of choices is reduced. The construction requires labeling of the vertices of the icosahedron by integers 1, ..., 12 in some manner and defining 12×12 matrix $A(i, j)$ whose element equals to 1 if vertices are neighbours and 0 if not. Only the edges for which $A(i, j) = 1$ holds true are allowed on the path. A concrete representation of icosahedron as a collection of triangles in plane with suitable identifications of certain edges is needed. This helps also to visualize the classification of triangles to three types discussed below. This can be found in the Wikipedia article (see <http://tinyurl.com/ns9aa>).

2. *Numbers of different triangles as characterizers of harmony*

A possible interpretation for topologically non-equivalent paths is as different notions of harmony.

1. Proceeding in Pythagorean spirit, the neighboring points would naturally correspond to progression by fifths - that is scalings by powers of $3/2$ or in equal tempered scale by powers of $2^{7/12}$. This would mean that two subsequent vertices would correspond to quint.
2. The twenty triangles of the icosahedron would naturally correspond to 3-chords. Triangles can contain either 0, 1, or 2 edges of the 12-edge scale path. The triangle containing 3 edges is not possible since it would reside on a self-intersecting path. A triangle containing one edge of path the chord would contain quint which suggest a chord containing basic note, quint and minor or major third. The triangle containing two edges would contain subsequent quints - CDG is one possible example by octave equivalence. If the triangle contains no edges of the path one can say that the chord contains no quints.

The numbers of triangles classified according to the number of path edges contained by them serves as the first classification criterion for a given harmony characterized by the Hamiltonian cycle (note that one cannot exclude the possibility of non-closed paths since Pythagorean construction of the scale by quints does not yield quite precisely octave as outcome).

Fig 1. There are 3 different types of triangles characterized by the number of edges contained by them. This predicts chords with 0, 1 or 2 quints.

<http://tgdtheory.fi/appfigures/kolmiot.jpg>

Consider now the situation in more detail.

1. The topologically equivalent cycles must have same numbers of faces containing 0, 1, or 2 edges of the Hamiltonian path since isometries do not change these numbers. Let us denote these numbers by n_0, n_1 and n_2 . The total number of faces is 20 so that one has

$$n_0 + n_1 + n_2 = 20 \ .$$

Furthermore, each of the 12 edges on the path is contained by two faces so that by summing over the numbers of edges associated with the faces one obtains twice the number of edges:

$$0 \times n_0 + 1 \times n_1 + 2 \times n_2 = 2 \times 12 = 24 \ .$$

From these constraints one can solve n_0 and n_1 as function of n_2 :

$$\begin{aligned} n_0 &= n_2 - 4 \ , & n_2 &\geq 4 \ , \\ n_1 &= 24 - 2n_2 \ , & n_2 &\leq 12 \ . \end{aligned}$$

If these integers characterize the topological equivalence completely and if the allowed combinations are realized, one would have $12-4=8$ topologically nonequivalent paths. The actual number is $N_{tot} = 2^k$, $k \geq 7$, so that the integers cannot characterize the topology of the path completely.

- The number of Hamiltonian cycles on icosahedron is known to be 2560 [A1]. Numerical calculations [A2] (<http://tinyurl.com/pmghcwd>) shows that the number of Hamiltonian cycles with one edge fixed is $2^{10} = 1024$. Here one regards cycles with different internal orientation as different. This would mean that the sum over the numbers $N(n_2)$ if cycles associated with differ values of n_2 satisfies

$$\sum_{n_2=4}^{12} \sum_i N(n_2, i) = 2^{10} .$$

$N(n_2, i)$ is the number of paths of given topology with fixed n_2 . The numbers $N(n_2, i)$ are integers which are factors of $N = 120$ of the order of the isometry group of the icosahedron. The average of $N(n_2, i)$ is $2^7 = 128$.

3. *Additional topological invariants characterizing the notion of harmony*

The interpretation of amino-acids in terms of 20 triangles of icosahedron interpreted as allowed chords for a given notion of harmony leads to a unique identification of the integers n_i as $(n_0, n_1, n_2) = (3, 10, 7)$. The attempt to interpret this “biological harmony” leads to the identification of additional topological invariants characterizing the notion of harmony. It will be assumed that edges correspond to quints. If they would correspond to half-step the chords would contains 0, 1, or 2 subsequent half-intervals which does not conform with the usual views about harmony. In Pythagorean scale quint corresponds to $3/2$ and in equal tempered scale quint corresponds to the algebraic number $2^{7/12}$.

Above the attention was paid to the properties of the triangles in relation to the Hamiltonian cycle. One can consider also the properties of the edges of the cycle in relation to the two neighboring triangles containing it. Restrict first the attention to the biological harmony characterized by $(n_0, n_1, n_2) = (3, 10, 7)$.

Fig. 2. The edge of the cycle belongs to 2 triangles, which as chords can correspond to 1 resp. 2, 1 resp. 1 and 2 resp. 2 quints.

<http://tgdtheory.fi/appfigures/sivut.jpg>

- Everyone of the 12 quints $C-G, C\#-G\#, \dots$ would be contained to neighboring triangles that is 3-chords containing at least one quint. Denote by p_{12}, p_{11} resp. p_{22} denote the number of edges shared by 1-quint triangle and 2-quint triangle, by 2 1-quint triangles, resp. 2 2-quint triangles. Besides $p_{ij} \geq 0$ one has

$$\sum p_{ij} = 12 .$$

since the cycle contains 12 edges. There are $p_{12} + 2p_{11} = n_1$ 1-quint triangles and $(p_{12} + 2p_{22})/2 = n_2$ 2-quint triangles (note double counting responsible for division by two). Altogether this gives

$$\begin{aligned} p_{22} &= 12 - p_{11} - p_{12} , \\ p_{22} &= p_{11} + n_2 - \frac{n_1}{2} , \\ p_{22} &= n_2 - \frac{p_{12}}{2} . \end{aligned}$$

- These three Diophantine equations are for integers and would allow for real numbers only single solution and for integers it in the generic case there are no solutions at all. Situation changes if the equations are not independent which can happen if the integers n_i satisfy additional conditions. By subtracting first and second and second and third equation from each other one obtains the consistency condition

$$n_1 = 24 - 2n_2 .$$

This condition is however second of the conditions derived earlier so that only two equations, say the first two ones, are independent.

$$\begin{aligned} p_{22} &= p_{11} + n_2 - \frac{n_1}{2} , \\ p_{22} &= n_2 - \frac{p_{12}}{2} . \end{aligned}$$

giving

$$\begin{aligned} p_{11} &= (n_1 - p_{12})/2 , \\ p_{22} &= p_{11} + n_2 - \frac{n_1}{2} = n_2 - \frac{p_{12}}{2} . \end{aligned}$$

One must have $0 \leq p_{ij} \leq 12$ and $p_{12} \leq n_1$ from $p_{11} = (n_1 - p_{12})/2$. Here one has $p_{12} \in \{0, 2, \dots, \text{Min}\{12, 2n_2, n_1\}\}$ so that $\text{Min}\{7, n_2 + 1, \lceil n_1/2 \rceil + 1\}$ solutions are possible. The condition that the cycle has no self-intersections can forbid some of the solutions.

3. The first guess for the “biological harmony” possibly associated with amino-acids would be $(n_0, n_1, n_2) = (3, 10, 7)$: this if one neglects the presence of 21st and 22th amino-acid also appearing in proteins. It turns out that a more feasible solution fuses tetrahedral code and icosahedral codes with $(n_0, n_1, n_2) = (4, 8, 8)$ giving $(n_0, n_1, n_2) = (4, 11, 7)$ for icosatetrahedral code.

For instance, $(n_0, n_1, n_2) = (3, 10, 7)$ would give $p_{12} \in \{0, 2, 4, 6, 8, 10\}$, $p_{11} \in \{5, 4, 3, 2, 1, 0\}$, $p_{22} \in \{7, 6, 5, 4, 3, 2\}$ so that one has 6 alternative solutions to these conditions labelled by p_{12} . The number of neighboring triangles containing single quint is even number in the range $[0, 10]$: this brings in mind the possibility that the neighboring single quint triangles correspond to major-minor pairs. Clearly, the integer p_{12} is second topological invariant characterizing harmony.

4. Distribution of different types of edges

Also the distribution of the 12 edges to these 3-types is an invariant characterizing the shape of the curve and thus harmony as isometric invariant.

Fig. 3. There are different distributions of edge types characterized by the neighboring triangles of the edge.

<http://tgdtheory.fi/appfigures/jakauma.jpg>

1. p_{12} 1-1 edges can be chosen in

$$N(1 - 1, p_{12}) = \binom{12}{p_{12}}$$

ways and 1-2 edges in

$$N(1 - 2, p_{12}) = \binom{12 - p_{12}}{p_{12}}$$

ways. The remaining 2-2 edges can be chosen only in one manner. This gives altogether

$$N(p_{12}) = N(1 - 1, p_{12}) \times N(1 - 2, p_{12})$$

ways for given value of p_{12} .

To summarize, one obtains large number of notions of harmony are possible although one cannot expect that the absence of self-intersections does not allow all topologies for the cycle.

6.1.3 Would you come with me to icosadisco?

This map would allow one-to-one map of the notes of any music piece using icosahedral geometry. If octave equivalence is assumed, a given note would be mapped to a fixed vertex of icosahedron at which lamp is turned on and also to the wavelength of the light in question since visible light spans an octave. Chords would correspond to the turning on of lights for a group of icosahedral points. Icosahedrons with size scaled up by two could correspond to octave hierarchy: for practical purposes logarithmic scale implying that icosahedrons have same distance would be natural as in the case of music experience since piano spans 7 octaves and human ear can hear 10 octaves. Church would nowadays allow icosadiscos to use also half octaves to amplify further the audiovisual inferno effect so characteristic for discos. One could also try to realize special effects like glissandos, vibratos and tremolos.

6.2 Connection Between Music Molecular Biology?

Music affects directly emotions, and consciousness is one aspect of being living. This raises the question whether the Platonic geometries might have something to do with basic building bricks of life and with genetic code.

6.2.1 Could amino-acids correspond to 3-chords of icosahedral harmony?

The number of amino-acids is 20 and same as the number of triangular faces of icosahedron and the vertices of dodecahedron. I have considered the possibility that the faces of icosahedron could correspond to amino-acids [K3]. Combined with the idea about connection between music scale and icosahedron this inspires the following consideration.

1. For a proper choice of the mapping of the 12-note scale to the surface of icosahedron the 20 triangles could correspond to 20 amino-acids analogous to 3-chords and that the 3 types of 3-chords could correspond to 3 different classes of amino-acids. One can of course consider also the mapping of amino-acids to a unique sequence of 20 vertices of dodecahedron representing 20-note scale or 20-chord scale and replacement of the 3-chords defining the harmony with 12 5-chords.
2. Amino-acids are characterized by the non-constant side chain and these can be classified to three categories: basic polar, non-polar, and polar (<http://tinyurl.com/ycvm6yjs>). The numbers of amino-acids in these classes are $a_0 = 3$, $a_1 = 10$, $a_2 = 7$. Could these classes correspond to the numbers n_i characterizing partially some topological equivalence classes of Hamiltonian paths in icosahedron? There is indeed a candidate: $a_0 = n_0 = 3$, $a_1 = n_1 = 10$, $a_2 = n_2 = 7$ satisfies the conditions discussed above. 3 basic polar amino-acids would correspond to the triangles with no edges on the Hamiltonian cycle, 10 non-polar amino-acids to triangles containing one edge, and 7 acidic polar and polar amino-acids to those containing two edges. One can criticize the combination of polar and acidic polar amino-acids in the same class. One can also classify amino-acids to positively charged (3), negatively charged (2) and neutral (15) ones. In this case the condition is however not satisfied. Thus the proposal survives the first test - assuming of a course that these Hamiltonian cycles exist! This has not been proven and would require numerical calculations.
3. As found Hamiltonian paths have also other topological characteristics and they could correspond to physical characteristics and it would be interesting to see what they are. To proceed further one should find the total number of the Hamiltonian paths with $n_2 = 7$ and identify the isometries of different topological equivalence class having $n_2 = 7$.

Amino-acid sequences would correspond to sequences of 3-chords. The translation of mRNA of gene to amino-acid sequence would be analogous to the playing of a record. The ribosome complex would be the record player, the amino-acid sequence would be the music, and mRNA would be the record. Hence genes would define a collection of records characterizing the organism.

d	6	4	3	2	1
N	3	5	2	9	2

Table 2: The number of amino acids N associated with a given degeneracy d telling the number of DNA triplets mapped to the amino acid in the genetic code. The degeneracies are always smaller than 7 as predicted by the proposed explanation of the Genetic Code.

6.2.2 Can one understand genetic code?

What remains open is the interpretation of genetic code [I5]. DNA triplets would correspond naturally to triangles but why their number is 64 instead of 20. They would be obviously the analogs of written notes: why several notes would correspond to the same chord?

1. Could different DNA triplets coding for the same amino-acid correspond to various octaves of the chord? The most natural expectation would be that the number of octaves so that one would have 3 DNAs would code single amino-acid and stopping codon would correspond to 4 DNAs. It is difficult to understand why some 3-chords could correspond to 6 octaves and one of them only one.
2. Could the degeneracy correspond to the ordering of the notes of the 3-chord? For the 3-chords there are 6 general orderings and 3 cyclic orderings modulo octave equivalence and characterizing by the choice of the lowest note. The simplest assumption would be that the allowed orderings - degeneracies - are characterized by a subgroup of the cyclic group S_3 yielding the allowed permutations of the notes of the chord. The subgroup orders for S_3 are 1, 2, 3, and 6. The allowed degeneracies are 6, 4, 3, 2, and 1 so that this identification fails for $D = 4$.
3. Could the different correspondences between DNA codons and amino-acids correspond to the different topological equivalence classes of $n_2 = 7$ Hamiltonian cycles. This does not seem to be the case. The number of different DNA-amino-acid correspondences obtained by choosing one representative from the set of DNAs coding for a given amino-acid (and not stopping sign) is the product of the numbers $D(a_i)$ coding amino-acid a_i . From **Table 2** this number is given by $6^3 \times 4^5 \times 3^1 \times 2^9 \times 1^2 = 3^4 \times 2^{21}$ and clearly much larger than $N = 2^{10}$.
4. Could the different codons coding for codon code for some additional information so that amino-acids would in some aspect differ from each other although they are chemically identical? Here the magnetic body of amino-acid is a natural candidate. This would suggest that the folding pattern of the protein depends on what DNA sequence codes it. This information might be analogous to the information contained by notes besides the frequencies. Durations of notes corresponds is the most important information of this kind: the only candidate for this kind of information is the value of $h_{eff} = n \times h$ associated with the amino-acid magnetic body determining its size scale. Magnetic fields strength could be also code by DNA codon besides amino-acid.

Second question concerns genetic code itself. Could the DNA degeneracies $D(a_i)$ (number of DNAs coding for amino-acid a_i) be understood group theoretically in terms of icosahedral geometry? The triangles of the icosahedron are mapped the triangles under the isometries.

1. One can start by looking the **Table 2** for the genetic code telling the number $N(d)$ of amino-acids coded by d DNA codons. One finds that one can divide DNAs to three groups containing $n = 20$, $n = 20$, resp. $n = 21$ codons.
 - (a) There are 3 amino-acids codes by 6 codons and 2 amino-acids coded by 1 DNA: $3 \times 6 + 2 \times 1 = 20$ codons altogether.
Note: One could also consider 1 amino-acid coded by 2 codons instead of 2 coded by 1 codon $3 \times 6 + 1 \times 2 = 20$.
 - (b) There are 5 amino-acids coded by 4 codons making $5 \times 4 = 20$ codons altogether.

- (c) There are 9 amino-acids coded by 2 codons and 1 by 3 codons making $9 \times 2 + 1 \times 3 = 21$ codons.

Note: One could also consider the decomposition $8 \times 2 + 2 \times 1 + 1 \times 3 = 21$ codons implied if 1 amino-acid is coded by 2 codons in the first group.

This makes 61 codons. There are however 64 codons and 3 codons code for stopping of the translation counted as punct in the table.

1. This would suggest the division to $60 + 4$ codons. The identification of additional 4 codons and corresponding amino-acids is not so straightforward as one might first think. 3 of the 4 additional codons could code for punct (Ile) and 1 of them to Ile (empty amino-acid).
2. What suggests itself strongly is a decomposition of codons in 3 different ways. 3 groups of 6 codons plus 2 groups of 1 codon (1 group of 2 codons), 5 groups of 4 codons, and 10 groups of 2 codons (9 groups of 2 codons plus plus 2 groups of 1 codon).

This kind of decompositions are induced by the action on the triangles of icosahedron by three subgroups of the isometry group $A_5 \times Z_2$ of the icosahedron having $120 = 2 \times 2 \times 2 \times 2 \times 3 \times 5$ elements and subgroups for which number of elements can be any divisor of the order. The orbit associated with a subgroup with n elements has at most n triangles at its orbit. This allows immediately to deduce the values of n possibly explaining the genetic code in the proposed manner.

1. The 3 amino-acids coded by 6 codons must correspond to $n = 6$. This subgroup must have also two 1-element orbits (1 2-element orbit): in other words, 2 triangles must be its fixed points (form its orbit).
 - (a) The non-abelian group S_3 permuting the vertices of is the first candidate for the subgroup in question. The triangles at the opposite sides of the icosahedron remain invariant under these permutations. S_3 however has two orbit consisting of 3 triangles which are “wall neighbours” of the triangles which remains fixed.
 - (b) Second candidate is the abelian group $\tilde{Z}_2 \times Z_3$. Here Z_3 permutes the vertices of triangle and \tilde{Z}_2 is generated by a reflection of the triangle to opposite side of icosahedron followed by a rotation by π . This group has 3 orbits consisting of 6 triangles and 1 orbit consisting of 2 triangles (the triangles at opposite side of icosahedron). This group seems to be the only working candidate for the subgroup in question.
2. The 5 amino-acids coded by 4 codons must correspond to $n = 4$ and therefore to $\tilde{Z}_2 \times Z_2$. This is indeed subgroup of icosahedral group which permutes triangles at the vertices of inscribed tetrahedron. Now all orbits contain 4 triangles and one must have 5 orbits, which are obtained by acting on the 5 triangles emanating from a given vertex. Note that also Z_5 is subgroup of icosahedral group: this would give a variant of code with 4 amino-acids coded by 5 codons if it were possible to satisfy additional consistency conditions.
3. Consider next the group consisting of 9 amino-acids coded by 2 codons and Ile (“empty” amino-acid) coded by 3 codons. Since only the $\tilde{Z}_2 \times Z_3$ option works, this leaves 9 amino-acids coded by 2 codons and 2 amino-acids coded by 1 codon. The subgroup must correspond to $n = 2$ and thus Z_2 acting on fixed triangle and leaving it and its \tilde{Z}_2 image invariant. One has 9 2-triangle orbits and two single triangle orbits corresponding to the triangles at opposite sides of the icosahedron. The 9 amino-acids coded by 2 codons are all real or 8 of them are real and 1 corresponds to “empty amino-acid” coded by two codons.

3-element orbits are lacking and this forces to consider a fusion of of icosahedral code with tetrahedral code having common “empty-acid” - common triangle of icosahedron and tetrahedron) coded by 2 icosahedral codons and 1 tetrahedral codon. Ile would be coded by 3 codons assignable to the orbit of Z_3 subgroup of tetrahedral symmetry group S_3 and would be associated with the tetrahedron. This would predict 2 additional amino-acids which could be understood by taking into account 21st and 22nd amino-acid (Sec and Pyl [I12]).

The Hamiltonian cycle is not explicitly involved with the proposed argument. Some property of the cycle respected by the allowed isometries might bring in this dependence. In Pythagorean

spirit one might ask whether the allowed isometries could leave the Hamiltonian cycle invariant but move the vertices along it and induce a mapping of faces to each other.

The amino-acid triangle at given orbit cannot be chosen freely. The choices of amino-acid triangles associated with the three groups of 20 DNAs must be different and this gives geometric conditions for the choices of the three subgroups and one can hope that the assignment of amino-acid to a given triangle is fixed about from rotational symmetries.

6.2.3 Does the understanding of stopping codons and 21st and 22nd amino-acids require fusion of tetrahedral and icosahedral codes?

Several questions remain. Could one also understand the additional 4 DNA codons? Could one understand also how one of them codes amino-acid (Ile) instead of stopping codon? Can one related additional codons to music?

1. Attachment of tetrahedron to icosahedron as extension of icosahedral code

The attachment of tetrahedron to icosahedron allows to understand both stopping codons and punct as well as the 21st and 22nd amino-acids geometrically.

1. Something is clearly added to the geometric structure, when at least 4 additional DNA codons and 2 amino-acids are brought in. The new codons could represent orbits of faces of Platonic solid with 4 faces representing punct and 3 real amino-acids: say Ile, Pyl, and Sec. The 4 faces should be triangles and actually must be so since tetrahedron is the only Platonic solid having 4 faces and its faces are indeed triangles. Tetrahedron has symmetry group S_3 containing Z_3 and Z_2 as subgroups. Z_3 leaves one of the tetrahedral triangles invariant so that one has two orbits consisting of 1 and 3 triangles respectively.
2. One amino-acid is coded by 3 rather than only 2 codons. One can indeed understand this symmetry breaking geometrically. Suppose that the tetrahedron is attached on icosahedron along one of its triangular faces and that this icosahedral face corresponds either Ile or punct coded by 2 icosahedral codons. This face remains also fixed by the action of Z_3 and S_3 subgroups of tetrahedron so that 1 tetrahedral codon codes also for the amino-acid in question.
3. The three other faces of tetrahedron should bring in three additional amino-acids. punct could correspond to either one of them or to the common base triangle which is indeed geometrically in unique position. One could even demand that this triangle is “empty” so that tetra-icosahedron would be non-singular continuous manifold. The 3-triangle orbit outside the icosahedron would correspond to Ile and base triangle to empty amino-acid. Base triangle would be coded by 1 tetrahedral codon plus 2 icosahedral codons.
4. One of the outsider triangles would thus correspond to Ile but two other triangles to two new exotic amino-acids. In some species there indeed are 21st and 22nd amino-acids (seleno-cysteine (Sec) and pyrrolysine (Pyl), <http://tinyurl.com/2byr2b>) with sulphur replaced with selene. This modification does not change the polarity properties of cys and lys: cys and thus Sec is non-polar and lys and thus Pyl is basic polar implying $(n_0, n_1, n_2) = (3, 10, 7) \rightarrow (4, 11, 7)$.
5. The two other outsider tetrahedral triangles could correspond to the orbits of Z_2 subgroup of S_3 acting as reflection with respect to median of the base triangle. Outside faces form orbits consisting of 1 triangle and 2-triangles. Could these orbits correspond to 21st and 22nd amino-acids coded by 1 and 2 exotic codons?

Since Ile and Sec are non-polar, they can correspond to 1-quint triangles at tetrahedron. 2-quint triangle cannot however correspond to Pyl which should correspond 0-quint triangle. Hence the 0-quint triangle must be at the icosahedron and the 2-quint triangle must correspond to basic polar amino-acid coded by single codon: Tyr is the only possible option). Hence the tetrahedral amino-acids are fixed to be Ile, Sec, and Tyr and Pyl must correspond to some icosahedral amino-acid.

The second implication is that the icosahedral Hamiltonian cycle from which the icosatetrahedral cycle is obtained as deformation must correspond to (4, 8, 8) since one cannot deform (3, 7, 10) in such a manner that one would obtain one additional 0-quint triangle.

It should be noticed that the 2 exotic amino-acids are coded by codons which are usually interpreted as stopping codons. Something must however distinguish between standard and exotic codings. Is it “context” giving different meaning for codons and perhaps characterized by different magnetic bodies of codons [K43] ?

Fig. 4. tetra-icosahedron is obtained by attaching tetrahedron along one of its faces to icosahedron. The resulting structure is topological manifold if the common face is replaced with empty set and it is natural to identify it as punct.

<http://tgdtheory.fi/appfigures/tetra-icosahedron.jpg>

2. How the icosahedral Hamiltonian cycle is modified?

The properties of exotic amino-acids give constraints on how the modification of the Hamiltonian cycle should be carried out. The naïve expectation that the outer triangles of added tetrahedron correspond to punct and 2 exotic amino-acids is not correct. A more appropriate interpretation is as a fusion of icosahedral and tetrahedral codes having common “empty amino-acid” coded 2 icosahedral and 1 tetrahedral 1 stopping codons respectively and obtained by gluing these Platonic solids together along the triangle representing the “empty” amino-acid. That the common triangle corresponds to punct means geometrically that its interior is not included so that the resulting structure is continuous manifold having topology of sphere.

Consider now the detailed construction.

1. One should be able to modify the icosahedral Hamiltonian cycle so that the numbers (n_0, n_1, n_2) characterizing icosahedral cycle change so that they conform with the properties of the two exotic amino-acids. Selenocystein (Sec) is nonpolar like cys and pyrrolysine (Pyl) basic polar like Lys so that (4, 11, 7) seems to be the correct characterization for the extended system. One must have $(n_0, n_1, n_2) \rightarrow (4, 11, 7)$.
2. One must visit the additional vertex, which means the replacement of one edge from the base triangle with wedge visiting the additional vertex. There are several cases to be considered depending on whether the base triangle is 1-quint triangle or 2-quint triangle, and what is the type of the edge replaced with wedge. One can even consider the possibility that the modified cycle does not remain closed.

If the icosahedral cycle has $(n_0, n_1, n_2) = (3, 10, 7)$, the value of n_2 is not changed in the construction. For a closed cycle edge is replaced with wedge and the only manner to preserve the value of n_2 is that the process producing 1 tetrahedral 2-quint triangle transforms 1 icosahedral 2-quint triangle identified as base triangle to 1-quint triangle. If the replaced edge of base triangle is of type 2-1, one has $n_1 \rightarrow n_1 + 1$ since one icosahedral 1-quint triangle disappears and 2 tetrahedral ones appear. Icosahedral n_0 increases by 1 units. Hence the condition $(3, 10, 7) \rightarrow (4, 11, 7)$ would be met. It however seems that (4, 8, 8) is more promising starting cycle as the argument below shows.

3. The number options is at most the number n_2 of 2-quint triangles serving as candidates for punct. An additional condition comes from the requirement that replaced edge is of type 2-1.

Fig. 4. tetra-icosahedron is obtained by attaching tetrahedron along one of its faces to icosahedron. The resulting structure is topological manifold if the common face is replaced with empty set and it is natural to identify it as punct.

Fig. 5. The modification of (4, 4, 8) icosahedral Hamiltonian cycle consistent with the constraints that icosatetrahedral cycle corresponds to (4, 11, 7) consistent the classification of amino-acids in three classes.

<http://tgdtheory.fi/appfigures/tetraikosahedroni.jpg>

3. Direct construction of Hamiltonian cycle corresponding to bio-harmony

Consider bio-harmony as an example about Hamiltonian cycle taking seriously the extension of the genetic code. I have made very many unsuccessful triangles starting from the assumption that icosahedral cycle satisfies $(n_0, n_1, n_2) = (3, 10, 7)$, and the following proposal starts from different icosahedral cycle. The following is just a trial, which should be checked by a direct calculation.

1. The most obvious guess for the cycle to be modified to cycle at tetra-icosahedron having $(n_0, n_1, n_2) = (4, 11, 7)$ (the triangle corresponding to “empty” amino-acid (to be called punct) is not counted) is $(n_1, n_2, n_3) = (3, 10, 7)$. I have not found cycle with these characteristics.
2. It seems however possible to find cycle with $(n_1, n_2, n_3) = (4, 8, 8)$. From this can obtain the desired kind of extended cycle if the “empty” triangle is 2-quint triangle and the edge replaced with the wedge is of type 2-2. The replacement of icosahedral edge eliminates two icosahedral 2-quint triangles and generates 1 tetrahedral 2-quint triangle giving $n_2 \rightarrow n_2 - 2 + 1 = n_2 - 1 = 7$. The disappearance of the icosahedral edge generates two icosahedral 1-quint triangles of which second one corresponds to empty amino-acid and is not counted and 2 tetrahedral 1-quint triangles giving $n_1 \rightarrow n_1 + 3 = 11$.

The figure below represents the construction of cycle $(4, 8, 8,)$. The icosahedron is constructed from regions $P(I)$ glued to the triangle t along one edge each. The arrows indicate that the one pair of edges of type 1 and 2, 1 and 3 and 3 and 2 are identified. Also the long edges I of T are identified with pairs of subsequent edges of $P(I)$ as the arrows indicate.

Fig. 6. A proposal for a Hamilton cycle realizing bio-harmony $(n_1, n_2, n_3) = (4, 8, 8)$ allowing extension to cycle $(3, 11, 7)$ on tetra-icosahedron. Circled “0”, “1” and “2” indicates whether a given small triangle is 0-, 1-, or 2-quint triangle. It is relatively easy to verify that the condition $(n_1, n_2, n_3) = (4, 8, 8)$ for bio-harmony is satisfied.

<http://tgdtheory.fi/appfigures/aikosahedroni.jpg>

4. Stopping codons and music

What could be the interpretation of the attached tetrahedron in terms of music harmony?

The attachment of tetrahedron means addition of an additional note to the 12-note scale. The scale constructed in Pythagorean spirit identifying quint as scaling by $3/2$ contains the 12th note as scaling by $(3/2)^{12}$ of the basic frequency modulo octave equivalence. This is slightly more than scaling by 2^7 so that exact octave is not obtained. The attempt to solve this problem has lead to scales in which one allows a pair of notes with a very small interval between them - say $G_{\#}$ and A_b being regarded as different notes.

This suggests that the outsider vertex of the attached tetrahedron corresponds to a note very near to some note of the 12-note scale. Which note is in question depends on which of the 10 1-quint triangles is chosen as the base triangle. This is expected to imply additional refinements to the notion of bio-harmony. 2 or three additional 3-chords emerge depending on whether empty amino-acid is interpreted as a real chord.

5. Geometric description of DNA-amino-acid correspondence

The mathematical structure which suggests itself is already familiar from some earlier attempts to understand genetic code [K24]. For icosahedral part of code one would have a discrete bundle structure with 20 amino-acids defining the base space and codons coding the amino-acid forming the fiber. The number of points in the fiber above based point depends on base point and is the number of codons coding the corresponding amino-acid. A discrete variant of singular fiber bundle structure would be in question.

Forgetting for a moment the 4 troublesome codons, the bundle would be the union of the orbits associated with groups S_3 , Z_4 and Z_2 of icosahedral group, and the base would consist of 20 amino-acids, one for each orbit. The point of orbit must be selected so that the selections for orbits of two different groups are different.

The addition of the additional codons, punct and two exotic amino-acids would mean gluing of tetrahedron along one of its faces to icosahedron. This would induce extension of the singular

bundle like structure. To each of the new faces one would attach the orbit of triangles representing the codons coding for the corresponding amino-acid.

To sum up, in its strongest form the model makes several purely mathematical predictions, which could easily kill it.

1. The identification of the 3-chords assignable to the triangles of the icosahedron.
2. The existence of $n_2 = 7$ Hamiltonian cycle requiring however the lumping of acidic polar and polar amino-acids in the same class.

6.2.4 How could one construct the Hamiltonian cycles on icosahedron with a minimal computational work?

Although the construction of Hamiltonian cycles is known to be an NP hard problem for a general graph, one can hope that in case of Platonic solids having high symmetries, a direct construction instead of straightforward numerical search might work. The following is a proposal for how one might proceed. It relies on paper model for icosahedron.

1. The basic observation about one can get convinced by using paper model is following. One can decompose the surface of icosahedron to three regions $P(I)$, $I = 1, 2, 3$, with pentagonal boundary and containing 5 triangles emanating from center vertex plus one big triangle T containing 4 pentagonal triangles and one lonely small triangle t opposite to it. These 5 regions span the surface of icosahedron. There is clearly a symmetry breaking and there is great temptation to assume that t corresponds to the triangle along which the tetrahedron is glued to the icosahedron in the model of genetic code realizing the modification of (3, 7, 10) bio-harmony.
2. The Hamiltonian cycle must visit at the centers of each $P(I)$: one enters pentagonal region $P(I)$, $I = 1, 2, 3$ along one of the five interior edges beginning at pentagonal vertex $a_{I,i}$, $i = 1, \dots, 5$ and leaves it along second edge ending at vertex $b_{I,j}$, $j \neq 5$. One can call these edges interior edges. The edges at boundaries of $P(I)$ can be called boundary edges. Interior edge can correspond to $|i - j| = 0, 1$ or $i - j > 1$. For $|i - j| = 1$ the interior edge gives rise to 2-*quint* triangle. For $i - j = 0$ there is no boundary edge after $b_{I,j}$.
3. Pentagonal boundary edges come in three types. 2 of them are shared with T , 1 with t opposite to it, and 2 with another pentagonal region $P(I)$. One can label $P(i)$ in such a way that the $P(I)$ shares two boundary edges with $P(I + 1)$.

The boundary edges of small and big triangle are boundary edges of the 3 pentagonal regions so that they are not counted separately.

4. One can assume that the cycles begins from a vertex of T . Since the cycle is closed it returns back to this vertex. The last edge is either at the boundary of T or goes through one or two edges of the small interior triangle of T so that this triangle is either 0-, 1- or 2-*quint* triangle.

t can be 0-, 1-, or 2-*quint* triangle.

5. The total number of the interior edges inside the 3 pentagonal regions is $3 \times 2 = 6$ so that 6 remaining edges must be boundary edges associated with $P(I)$ and interior edges of T : otherwise one would visit some pentagonal center twice and self-intersection would occur. The boundary edges associated with t and T are boundary edges of $P(I)$, $I = 1, 2, 3$
6. At the vertex $b_{I,j}$ of pentagonal region one must turn right or left and move along the boundary edge. One can move at most $n_I = 4 - j$ boundary edges along the pentagonal boundary in clockwise direction and $n_I = j - 2$ edges in counterclockwise direction (clockwise is the direction in which the index labelling 5 vertices grows). The maximum number of boundary edges is 3 and obtained for $j - i \pm 1$.
7. The condition $\sum n_I + n(T) = 6$, where $n(T) = 1, 2$ is the number of interior edges of T , holds true so that one has $\sum n(I) \equiv n_{tot} \in \{4, 5\}$. The numbers and types (shared with pentagon,

T , or t) of the boundary edges of $P(I)$, the differences $\Delta(I) = j_I - i_I$, the number of edges in t and the number of interior edges of T characterize the Hamiltonian cycle besides the condition that it is closed. The closedness condition seems possible to satisfy. One must enter big triangle through one of the vertices of T and this vertex is uniquely determined once the third pentagon is fixed. One can therefore hope that the construction gives directly all the Hamiltonian cycles with relatively small amount of failed attempts, certainly dramatically smaller than $n = 2^{24} \sim 10^7$ of blind and mostly un-successful trials.

8. Each $P(I)$ containing boundary edges gives rise to least 2 2-quint triangles associated with $b_I(I)$ and a_{I+1} .

If all 3 $P(I)$ have $|i-j| > 1$, one has $n_2 = 3 \times 2 = 6$. The contribution of regions $P(I)$ is larger if some pentagon interiors have $|\Delta(I)| = |j(I) - i(I)| = 1$. $|j(I) - i(I)| = 1$ gives $\Delta n_2(I) = 1$ and $\Delta n_1(I) = 0$ since 2 1-quint triangles are replaced with single 2-quint triangle.

The interior of the T can give 1 2-quint triangle.

9. The number n_1 of 1-quint triangles can be estimated as follows.

- (a) Each pentagonal interior edge pair leading from $a(I, j)$ to $b(I, j)$ contributes 2 1-quint triangles for $\Delta(I) \neq \pm 1$, otherwise one obtains only 1 2-quint triangle. This would give maximum number of 6 1-quint triangles associated with the interior edges of 3 pentagons.
- (b) $P(I)$ pentagonal boundary edges contribute $2 \times (P(I) - 1)$ additional 1-quint triangles.
- (c) T contributes at most 4 1-quint triangles.
- (d) t can correspond 1-quint triangle and would do so if the interpretation of extended code is correct.

10. The construction also breaks the rotational symmetry since the decomposition of icosahedron to regions is like gauge fixing so that one can hope of obtaining only single representative in each equivalence class of cycles and therefore less than 2^{10} . By the previous argument related to icosatetrahedral code, t and the triangle opposite to it cannot however correspond to amino-acids coded by 1 codon as one might guess first. Rather, t corresponds to punct and to 1-quint triangle belonging to Z_2 orbit.

The number of cycles should be 2^{10} . One can try to estimate this number from the construction. Each $b_{I,j}$ can be chosen in 4 ways at the first step but at later steps some vertices of the neighboring pentagon might have been already visited and this reduces the available vertices by $n + 1$ if n subsequent edges are visited. At each vertex $b_{I,j}$ one has 4 options for the choice of the boundary edges unless some boundary edges of pentagon (shared with other pentagons) have been already visited. It is also possible that the number of boundary edges vanishes. One can start from any vertex of triangle. This gives the upper bound of 2^4 choices giving $N < 2^{12}$ paths going through 4 pentagon-like regions. The condition that the path is closed, poses constraints on the edge path assignable to T but the number of choices is roughly 24. The condition that path goes through all vertices and that no edge is traversed twice must reduce this number to 2^{10} .

The numerical construction of Hamiltonian cycles should keep account about the number of vertices visited and this would reduce the number of candidates for $b(I, j)$ and for the choices of $P(I)$ for $I > 1$ as well as the number of edge paths associated with T .

6.2.5 Icosahedral Hamiltonian cycles numerically

A couple of months after writing the article I decided to look at the numerical problem of calculating the Hamiltonian cycles for icosahedron. Recall that the earlier source [A2] (<http://tinyurl.com/pmgncwd>) telling that there are 2^{10} different Hamiltonian cycles when orientation is taken into account and one edge is fixed: if orientation does not matter there are 2^9 cycles. If one does not fix one cycle one obtains 2560 cycles - not Hamiltonian paths as I had erratically concluded. The cycles were actually listed (<http://tinyurl.com/yacgz9x>) and classified to five different basic classes according to their symmetries. Even better, examples of cycles with symmetries were illustrated.

Cycles can be divided to isomorphy classes within which cycles have same shape.

1. It is possible to perform a shift of the edges along the cycle. The shape of the cycle is not affected but cycle changes. Using music terms the key changes. There are 12 different keys.
2. Also the mirror image mapping i^{th} edge to $(13-i)^{\text{th}}$ edge is a symmetry which in the generic case produces a new cycle. This symmetry should be distinguished from the change of the internal orientation which does not affect the cycle.
3. Also the isometries of icosahedron leaving the fixed edge as such act as symmetries. Fixed edge belongs to a triangle and the reflection mapping the two other edges of the triangle to each other is this kind of symmetry. Therefore there are two reflection symmetries and the number of cycles of same shape in the generic case is expected to be $4 \times 12 = 48$. If some of the symmetries acts trivially or if some isometries of icosahedron act as its symmetries, the number of isomorphic cycles is reduced.

It is even possible to find illustrations of the symmetric cycles (<http://tinyurl.com/y8ek7ak8>) obtained using Brendan McKay's NAUTY software (<http://tinyurl.com/dkftsr>)! From these illustrations (see **Figs. 1, 3** and **2**) one can by visual inspection deduce the numbers (n_0, n_1, n_2) characterizing the cycle for classes involving symmetries. Also the basic chords can be deduced. If one trusts the condition $n_1 + 2 \times n_2 = 24$, it is enough to count the number n_2 triangles containing to path edges. I have also directly checked that n_1 comes out correctly.

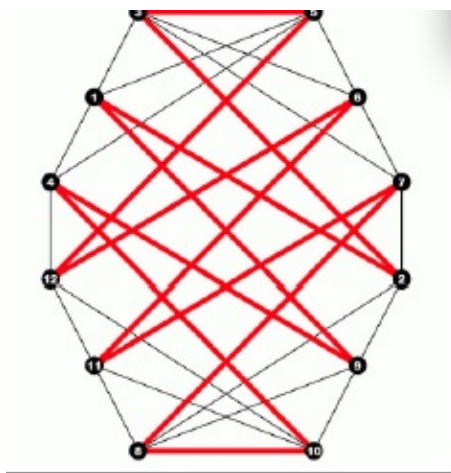


Figure 1: $((n_0, n_1, n_2) = (4, 8, 8))$ Hamiltonian cycle with 2 reflection symmetries acting in vertical and horizontal directions.

There are following isomorphic collections.

1. 6 asymmetric collections containing the maximal number of 48 cycles each. In this case images are not given.
2. 3 collections with 2-fold rotation symmetry containing $48/2=24$ cycles each. One has $(n_0, n_1, n_2) \in \{(0, 16, 4), (0, 16, 4), (4, 8, 8)\}$.
3. 5 collections with reflectional symmetry containing $48/2=24$ cycles each. One has $(n_0, n_1, n_2) \in \{(2, 12, 6), (2, 12, 6), (4, 8, 8), (2, 12, 6), (2, 12, 6)\}$.
4. 2 collections with 2 reflectional symmetries containing $48/4=12$ cycles each. One has $(n_0, n_1, n_2) \in \{(0, 16, 4), (4, 8, 8)\}$.
5. 1 collection with 6-fold rotational symmetry containing $48/6=8$ cycles. One has $(n_0, n_1, n_2) = (2, 12, 6)$.

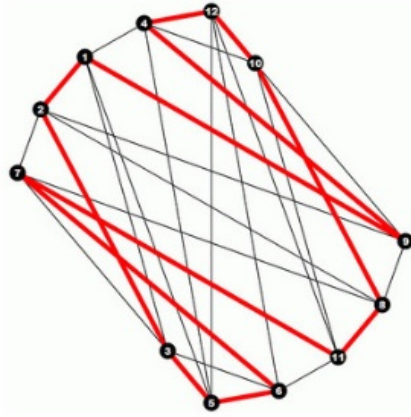


Figure 2: $((n_0, n_1, n_2) = (4, 8, 8)$ Hamiltonian cycle with 2-fold rotational symmetry acting as 6-quint rotation.

There are therefore 5 different notions of harmony and they correspond to $n = \{6, 3, 5, 2, 1\}$ sub-harmonies. This gives altogether $6+3+5+2+1=17$ different notions of harmony.

What is remarkable that the original candidate $(3, 10, 7)$ for bio-harmony is not realized as a cycle possessing symmetries (it might be realized as one of the asymmetric cycles) but that there are at least three realizations for $(4, 8, 8)$, which is forced by the condition that bio-harmony corresponds to the extended genetic code! The three $(4, 8, 8)$ cycles are illustrated in **Figs. 1, 2** and **3**.

6.3 Other Ideas

The book of Merrick discusses also other ideas. The attempts to understand music in TGD framework relate to these ideas.

6.3.1 p-Adic length scale hypothesis and music

One of the key ideas is the reduction of the octave phenomenon to the p-adic length scale hypothesis predicting that octaves and half-octaves correspond to p-adic scalings allowed by the hypothesis $p \simeq 2^k$ for the preferred values of the p-adic primes, and yielding scaled variants of physical systems. This idea will not be discussed in the following: suffice it to say that Pythagorean scale coming as powers of $p = 3$ strongly suggests approximate 3-adicity.

6.3.2 EEG and music

First of the key ideas relates to the idea that genetic code relates to the music scale.

1. Music metaphor is key element of TGD inspired view about biology and neuroscience. In particular, TGD based view about dark matter leads to the proposal that bio-photons are ordinary photons resulting as transformations of dark photons with large Planck constant $h_{eff} = nh$ to ordinary photons. The further hypothesis is that the energy spectrum of bio-photons is universal and contains visible photons and UV photons, which defined transition energies of biomolecules. This hypothesis follows if the value of h_{eff} assignable to a magnetic flux tube characterizes ion and is proportional to its mass number. The notion of gravitational Planck constant identified as $\hbar_{gr} = GMm/v_0$, where v_0 is a velocity parameter assignable to the two-particle system can be identified in the case of elementary particles and ions with h_{eff} and predicts also the universality of bio-photon spectrum.
2. In this framework bio-photons would represent music as light inducing molecular transitions. Notes that is different energies of bio-photons would correspond to different magnetic field

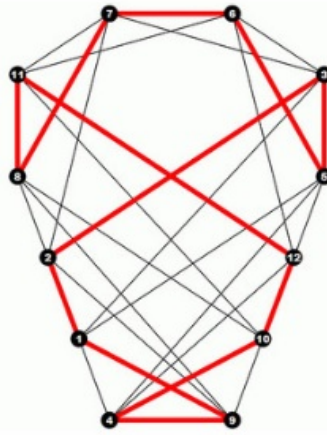


Figure 3: $((n_0, n_1, n_2) = (4, 8, 8)$ Hamiltonian cycle with 2-fold reflection symmetry acting as horizontal reflection.

strengths at magnetic flux tubes as was proposed much earlier in the quantum model of hearing [K46]. Could the biochemical and physiological aspects involved with the generation of music experience be realized in terms of bio-photon emission induced by the listening of music?

6.3.3 Standing waves and music

Merrick consider the idea that standing waves are essential for music experience. Preferred extremals of Kähler action representing standing waves does not seem to be feasible. The known preferred extremals (with “massless extremals” (MEs) included) would represent superpositions of Fourier components with four-wave-vectors which are proportional to each other. Essentially pulse propagating in fixed direction. For more general extremals this direction can depend on position.

Although standing waves are not feasible, effects which would be explained in Maxwell’s theory in terms of standing waves are possible in many-sheeted space-time. A particle in a region of Minkowski space containing several space-time sheets touches all space-time sheets having non-vanishing Minkowski space projection to this region and the forced experience by it is sum of the forces caused by them. This leads to an operational defines of gravitational and gauge fields of Einstein-Maxwell limit of TGD as sum of the deviations of the induced metric from Minkowski metric and sum of the components of the induced spinor connection defining classical gauge potentials in TGD framework.

Test particles can clearly experience the presence of standing waves. It is enough to take two massless extremals with opposite directions of three momentum but same energy with non-empty projections to same M^4 region. Particle with experience standing wave oscillating with the frequency involved. The arrangements in which photons are taken to rest effectively could correspond to this kind of situations since if it is the motion of test particles which serves as a signature. Note however that there are also vacuum extremals for which the light velocity at the space-time surface corresponds to arbitrarily low velocity at the level of embedding space.

6.3.4 Emotions and 4-D character of music experience

Music experience involves in an essential manner time unlike visual experience which is essentially 3-dimensional. Music experience affects also emotions very directly. For instance, we somehow know the key of the piece and expect that it ends to the basic note and chord. We somehow know also the scale used (say major or minor) by the emotional response stimulated by it. All this requires information about entire time evolution of the music piece. The recent neuroscience based models of memory do not help much in attempts to understand how this is possible. The

reason is that in the ordinary materialistic view in which the state of the brain at fixed time should determine the contents of consciousness.

The general vision in Zero Energy Ontology and Quantum Classical Correspondence is that space-time surface provide classical physics correlates for quantum states and also quantum jumps: the failure of the strict determinism is essential for the latter. The space-time surfaces are restricted inside causal diamond (CD) and have space-like 3-surface as their ends: the interpretation is as counterparts for the initial and final states of physical events.

The replacement of states with events makes it possible to understand mysterious looking facts about living matter such as standardized temporal patterns - say those appearing during morphogenesis. The maxima of the vacuum function defined by the exponent of Kähler function in term identified as Kähler action for Euclidian space-time regions representing analogs for the lines of Feynman graph correspond to the most probably temporal patterns.

The basic aspect of emotions is positive/negative dichotomy. An attractive identification for the physical correlated of this aspect is whether the quantum jump generating the emotion increases or decreases the negentropy of the subsystem involved. For instance, pain would correspond to a reduction of the negentropy for the body part involved. In music experience negentropy could flow between different parts of the system involved and create also sensation with local negative coloring but with overall positive coloring (by NMP [K33]). The ability of temporal patterns of music to generate negentropy flows inside the system involved could explain its effectiveness in generating emotions.

Dissonances were used by composes like Bach to generate melancholic emotions which suggests that the dissonance represent local reduction of negentropy. Also vibrato has emotional content. Physically dissonance and vibrato are assignable to the interference of frequencies which are near to each other (<http://tinyurl.com/5r34ch>). The basic formula is

$$\cos(x) + \cos(y) = \cos((x + y)/2) \times \cos((x - y)/2) .$$

Acknowledgements: I want to thank Tommi Ullgren for directing my attention to the book of Richard Merrick as well as for fascinating discussions about music.

7 Water And Life

7.1 Latest View About Water Memory

The notion of water memory has several aspects. Water memory was introduced by Benveniste [I24, I25] to explain the claimed ability of homeopathically treated water to behave as if it contained the original molecules. Already Benveniste discovered the connection with very low frequency electromagnetic radiation and claimed that the patterns of this radiation carry the information about the molecule and represent its biologically relevant aspects. Water memory has been also assigned to the observation suggesting that the human intent has effect on the crystal structures formed as water near criticality freezes [I48, I14].

7.1.1 Basic aspects of water memory

The first aspect of water memory relates to homeopathy and is discussed from strongly skeptic point of view in Wikipedia article (see <http://tinyurl.com/obvevp>. Mae Wan-Ho (see <http://tinyurl.com/29am8hz>) takes a more balanced view on homeopathy in her article discussing the recent findings of the research group of HIV Nobelist Luc Montagnier providing strong support for water memory and suggesting also a connection with gene level [I32, I33].

The basic principle of homeopathy is “let like be cured by like”. Homeopathic remedies are highly diluted preparations believed to cause in the healthy individuals effects similar to the undesired symptoms of the person treated. Homeopathy is not in accordance with the naïve materialistic beliefs about what water is (just the letters $H_2O!$) and what happens in succussion process producing the remedy. Not surprisingly, hard-nosed skeptics are not able to discuss the subject without bursts of rage. Obviously, the claimed effect of homeopathic remedy resembles that of vaccine and one might say that the harmful substance serves as its own antibody (see

<http://tinyurl.com/7obde>) eliminating the effect of the harmful substance. If one takes homeopathy seriously, the challenge is to explain this auto-antibody behavior. One can of course ask whether this behavior could in some sense be the basic mechanism of immune system.

In Benveniste's experiments [I24, I25] antibodies of human basophils were dissolved in water and the claim of experiments was that basophils added to the homeopathically treated water produced allergic reaction serving usually as a signature for the presence of antibody. As if water were able to mimic the antibodies in biologically relevant aspects. Later Benveniste was labeled as a fraud but the research has continued and it has been for long time thought that low frequency electromagnetic fields are essential for water memory. The frequencies in question extend to kHz range and cannot relate to molecular transitions. Cyclotron frequencies assignable to charged particles at the magnetic body of the molecule are the natural candidate in TGD framework.

Second aspect of water memory relates to the claim that human intent has an effect on the molecular structure of water. Clearly a special variant of remote mental interaction would be in question. Masaru Emoto [I48] has photographed water crystals resulting from water contained by a glass and subject to human intent. Depending on the origin of water the resulting water crystals can vary from random to very organized and aesthetic. Words, pictures, and music are used to generate the crystals. It is important to not forget that human intent is a decisive factor so that water need not be able to read as one especially simplistic and aggressive fanatic ridiculing Emoto claimed! Emoto has published several books containing pictures of the crystals and makes explicit that he is not a scientist but photographer who has discovered a fascinating new phenomenon and loves to document it.

Mae Wan-Ho has written an article titled "Crystal Clear - Messages from Water" (see <http://tinyurl.com/yjj9t4k>) [I48] in which she discusses Emoto's work with intellectual honesty and giving primacy for facts instead of dogmas. The basic argument of skeptic is that water is just H_2O as we learned in school and therefore Emoto must be a swindler. The Wikipedia article (see <http://tinyurl.com/dh4g6s>) [I6] about Masaru Emoto's work represents a rather civilized skeptic reaction as compared to Harriet Hall's (see <http://tinyurl.com/ot8zunw>) piece of bad rhetorics filled with nasty ad hominem attacks. More ambitious skeptic believer bothers to develop an argument claiming that aesthetic appeal is highly subjective measure to characterize the water crystals. Here common sense and intellectual honesty clash with materialistic dogmas categorically denying this kind of effects, and the reader of these books must make a personal decision about what might be the truth - unless they decide to become photographers of water crystals.

The reader can also form his or her opinion about this aspect of water memory by looking the You tube video "Water has Memory" (see <http://tinyurl.com/d7oto3d>) [I14] prepared in Aerospace Institute in Stuttgart illustrating that the effect of human intent on the structure of water droplets is same for droplets from same source, is repeatable, and characterizes the operator. Also the effect of flowers dropped into the water is illustrated. All drops from a given source give rise to same structure characterizing the flower. It is suggested that water is a huge information source and serves as a kind of data medium. This proposal is highly trivial and would mean a profound modification of world view.

7.1.2 A simple model for water memory

Suppose that we just for a moment decide to overcome our intellectual laziness and are not satisfied with the standard rhetoric tricks of skeptics to convince ourselves that water memory researches must be swindlers or fools. In other words, we take the experimental evidence supporting water memory as something worth of considering seriously and try to build a model for the claimed phenomena. We can indeed imagine when we do not know. The challenge of the model for water memory is to explain the claimed basic aspects of water memory with minimal assumptions. Let us restrict the model building further by assuming that we live in TGD Universe and that our vision about this Universe is roughly correct.

The ability of water molecule clusters to mimic the possibly harmful substances - call them just H - dissolved in water in some biologically relevant aspects could explain the effectiveness of homeopathic remedies. Water should make possible a symbolic representation of the molecules or their magnetic bodies.

1. Suppose H is a polar molecule so that it is biologically effective and that magnetic body characterizes the relevant biological effects of a polar molecule. Suppose that mechanical

agitation causes some polar molecules to lose their magnetic bodies so that they attach to water molecule clusters, which therefore become “actors” representing H . In the dilution the density of the fake molecules is also reduced but if the energy provided by shaking can be used as metabolic energy makes possible for the “actors” to replicate and their population can survive and even evolve in the sequence of “environmental catastrophes” induced by repeated successions possibly also inducing evolution as an increase of Planck constant for the magnetic body of the “actor”. Also the replication of the magnetic body of the “actor” is required. Cyclotron frequency spectrum would serve as a characterizer of molecule’s magnetic body and cyclotron radiation would make possible communications between fake molecules and their magnetic body.

2. What the dropping of magnetic bodies really means? To answer the question consider a general vision about what happens as energy is fed into a system consisting of proteins dissolved in water. The proteins originally in closed globular configuration open as the ordered water covering their surfaces with “ice” melts. This leads to a protein aggregation (see <http://tinyurl.com/yarrblxn>) during the short “molecular summer” provided by the energy feed. The outcome is braiding and reconnection of flux tubes.

Suppose that this mechanism is at work also when proteins are replaced with harmful polar molecules. During “molecular summer” a reconnection process for closed loops emerging from water clusters and polar molecules would connect them with water clusters. Also the magnetic bodies of polar molecules would generate connections to water clusters via molecules. Self-reconnection for the flux tubes going through H molecules makes possible the transfer of the magnetic body of H to water molecule cluster. Water molecule cluster would “steal” the magnetic coat of H and H molecules would be left with short-cut closed flux tubes after the reconnection.

3. What is required that these water clusters or something associated with them can replicate and develop to a population representing the original molecules. The needed metabolic energy would come from mechanical agitation. Note that this replication should involve also the replication of magnetic bodies which suggests that linear structures generating planar flux tubes emanating from the basic building bricks of the structure are involved. This will be discussed below.

What could then be the healing mechanism in homeopathy? Why the presence of the fake molecules in organism would prevent the harmful actions of real molecules in the organism? What could be the translation of “Let like be cured by like” to the language of quantum TGD?

1. Suppose that the effects of H on bio-molecules are due to cyclotron radiation along the flux tubes of its magnetic body connecting it to bio-molecules of the organism. Suppose that the fake representatives of H contained by the homeopathic remedy and real molecules H reconnect so that the flux loops associated with H and fake H reconnect to a pair of flux tubes connecting H and fake H . Suppose that this happens with such high a rate that the fraction of the connections to other biomolecules remains low.
2. If so, fake H would effectively act antibody of H and the effects of H via its magnetic body on organism would be minimized. Like would indeed cure like. Could this reconnection mechanism be at work also when antibody attaches to the harmful molecule? If so, the basic mechanism of immunization would be universal and involved the notion of magnetic manner in an essential manner.

7.1.3 Dark nucleon genetic code as realization of water memory, and homeopathic mechanism as basic mechanism of immune system

The proposal says nothing about the detailed structure of water clusters, and does not mention dark nucleons nor the proposal for the realization of genetic code based on them. A more refined model would include also these and give a connection for how immune system would utilize the reconnection of flux tubes defining the basic mechanism of homeopathy.

1. TGD predicts a realization of vertebrate genetic code at the level of dark nucleons. Dark nucleons correspond to the states of DNA, RNA, tRNA, and amino-acids and represent vertebrate genetic code under rather general assumptions [L2]. One could even consider the extension of the genetic code to a naming of polar molecules by sequences of representatives of DNA letters. Suppose that dark proton sequences are attached to a polar molecule dissolved in water, and define a representation of the molecule in terms of code letters realized as exotic protons with Compton length in nano-scale. The assignment of the magnetic body of the molecule to water cluster would give it the same “name” as for the original molecule. It is of course possible to have other representation and one of them would be in terms of dark u quarks providing representation of A, T, C, G in terms of spin states.
2. If the population of dark DNA molecules assigned with the harmful substance H is able to use the energy provided by the succession process as a metabolic energy for replication, the disappearance of H is compensated by the replication of dark DNA representing it. Dark DNA becomes the representative of H . The growing population would consist of dark DNA and the flux tubes of the magnetic body connect to dark DNA strands. Replication would be the analog of that for ordinary DNA and involve also the replication of magnetic bodies. The water would contain pairs of dark DNA and its conjugate connected by a flux tube and these flux tubes would reconnect with flux tubes connecting the dark DNA sequence representing H and connected by flux tubes to its conjugate.
3. It is known that the DNA of the immune system evolves with an especially high rate. Could the universal naming mechanism allow the immune system to generate new immune responses via the transcription of the dark DNA sequence representing the harmful molecule to a real DNA, which in turn codes for amino-acid attaching to the harmful molecules along the dark nucleon sequence? A model for homeopathy would extend to a model for the functioning of immune system. This would be of course also a mechanism of evolution as a reaction to changing chemical environment. This would explain also the effect of the homeopathic remedy as an effect at gene level.

It is difficult to exaggerate the potential significance of this mechanism for biology, genetic engineering, and medicine. Understanding of the contemptible homeopathy could induce decisive step in the understanding of biology. This possibility shows how dangerous it is to take the claims forced by a particular belief system like materialism as final truths.

Reader has certainly noticed that reconnection mechanism pops up again and again in the model and would be also the fundamental mechanism of ordinary DNA replication, transcription, translation of mRNA to proteins, and of process catching tRNA molecules carrying amino-acids to form protein at mRNA. This mechanism would be realized even in the mutual interactions between living organisms and between living organisms and inanimate matter.

7.1.4 Braiding represents as a higher level aspect of water memory

Braiding represents another aspect of water memory relating to the representation as dark nucleon sequences as the quantum computer programs represented by braidings to DNA in the model of DNA as topological quantum computer [K3]. The memories represented by braiding would be about the flow of water and molecules rather than about substances present in the water. The model of qualia [K22] is based on flux tube connections between system representing self and environment. For polar molecules the qualia would relate to charge and electric polarization. Could the qualia assignable to polar molecule plus environment have scaled down fractal variants at the level of water clusters of environment? If this were the case then water would effectively produce representations about molecule at the level of qualia. Could also these relate to water memory?

7.1.5 Effects of intent on water crystallization

One should understand the effect of intent on water in terms of water memory. The proposed representation of polar molecules in terms of dark DNA sequences is one possible realization of water memory reducing naming of molecules to genetic code letters. Essentially addressing of

molecules would be in question. This aspect of water memory is not relevant now. Rather, what matters is the interaction of water with human operator and reconnection of flux tubes of magnetic bodies is a good guess for how this interaction is realized. The same mechanism is involved also with the interaction of homeopathic remedy and harmful substance.

How could one understand the effect of intent on water crystallization, which characterizes the operator involved. The situation would be very much like that in the experiments of Tiller [J35]. The magnetic bodies assignable to the operator and water must interact and produce the effects. This would not be surprising if similar interaction takes place in the case of dissolved substances.

A concrete model for the interaction would be in terms of the reconnections of closed flux tubes emerging from the biological body of subject person with the flux tubes of the magnetic body of water creating direct flux tube contacts between the two bodies. The presence of magnetic flux tube connections between water sample and operator's magnetic and biological body would induce the effects on crystallization of water. Water memory should be stable in human time scales. This requires that these flux tube patterns are rather stable modification of the magnetic body of water. Large values of Planck constant assignable to the magnetic body of human agent would be needed. What is required is that the crystallization patterns and therefore structures of water clusters correlate with the structure of the magnetic body of the water sample.

7.1.6 Magnetic body and migrating birds

What happens when the water glass in the experiments of Emoto is taken to a large distance from operator? Does the effect prevail? If the magnetic flux tubes stretch, this interaction need not cease as the distance between operator and water glass increases unless the double flux tube splits by self-reconnection. If so, water could indeed act as a data medium as proposed in the video about water memory.

Magnetic body could play key role in understanding how birds and fish manage to find their birth places during migration is one of the many unresolved mysteries of biology. It has been suggested that orienteering in magnetic field of Earth using neuron level compass is in question but this proposal has its difficulties. Could it be that the birds and fish are connected by the magnetic flux tubes of their personal magnetic body or of that of the species to the birth place so that they would only follow Ariadne's thread?

7.2 Genes And Water Memory

After long time I had opportunity to read a beautiful experimental article about experimental biology. Yolene Thomas, who worked with Benveniste, kindly sent the article to me. The freely loadable article is *Electromagnetic Signals Are Produced by Aqueous Nanostructures Derived from Bacterial DNA Sequences* by Luc Montagnier, Jamal Aissa, Stephane Ferris, Jean-Luc Montagnier, and Claude Lavall'e published in the journal *Interdiscip. Sci. Comput. Life Sci.* (2009) [I32].

7.2.1 Basic findings at cell level

I try to list the essential points of the article. Apologies for biologists: I am not a specialist.

1. Certain pathogenic micro-organisms are objects of the study. The bacteria *Mycoplasma Pirum* and *E. Choli* belong to the targets of the study. The motivating observation was that some procedures aimed at sterilizing biological fluids can yield under some conditions the infectious micro-organism which was present before the filtration and absent immediately after it. For instance, one filtrates a culture of human lymphocytes infected by *M. Pirum*, which has infected human lymphocytes to make it sterile. The filters used have 100 nm and 20 nm porosities. *M. Pirum* has size of 300 nm so that apparently sterile fluids results. However if this fluid is incubated with a mycoplasma negative culture of human lymphocytes, mycoplasma re-appears within 2 or 3 weeks! This sounds mysterious. Same happens as 20 nm filtration is applied to a minor infective fraction of HIV, whose viral particles have size in the range 100-120 nm.
2. These findings motivated a study of the filtrates and it was discovered that they have a capacity to produce low frequency electromagnetic waves with frequencies in good approximation coming as the first three harmonics of kHz frequency, which by the way plays also a

central role in neural synchrony. What sounds mysterious is that the effect appeared after appropriate dilutions with water: positive dilution fraction varied between 10^{-7} and 10^{-12} . The uninfected eukaryotic cells used as controls did not show the emission. These signals appeared for both *M. Pirum* and *E. Choli* but for *M. Pirum* a filtration using 20 nm filter canceled the effect. Hence it seems that the nano-structures in question have size between 20 and 100 nm in this case.

A resonance phenomenon depending on excitation by the electromagnetic waves is suggested as an underlying mechanism. Stochastic resonance familiar to physicists suggests itself and also I have discussed it while developing ideas about quantum brain [K48]. The proposed explanation for the necessity of the dilution could be kind of self-inhibition. Maybe a gel like phase which does not emit radiation is present in sufficiently low dilution but is destroyed in high dilutions after which emission begins. Note that the gel phase would not be present in healthy tissue. Also a destructive interference of radiation emitted by several sources can be imagined.

3. Also a cross talk between dilutions was discovered. The experiment involved two tubes. Donor tube was at a low dilution of *E. Choli* and “silent” (and carrying gel like phase if the above conjecture is right). Receiver tube was in high dilution (dilution fraction 10^{-9}) and “loud”. Both tubes were placed in mu-metal box for 24 hours at room temperature. Both tubes were silent after his. After a further dilution made for the receiver tube it became loud again. This could be understood in terms of the formation of gel like phase in which the radiation does not take place. The effect disappeared when one interposed a sheath of mu-metal between the tubes. Emission of similar signals was observed for many other bacterial specials, all pathogenic. The transfer occurred only between identical bacterial species which suggests that the signals and possibly also frequencies are characteristic for the species and possibly code for DNA sequences characterizing the species.
4. A further surprising finding was that the signal appeared in dilution which was always the same irrespective of what was the original dilution.

7.2.2 Experimentation at gene level

The next step in experimentation was performed at gene level.

1. The killing of bacteria did not cancel the emission in appropriate dilutions unless the genetic material was destroyed. It turned out that the genetic material extracted from the bacteria filtered and diluted with water produced also an emission for sufficiently high dilutions.
2. The filtration step was essential for the emission also now. The filtration for 100 nm did not retain DNA which was indeed present in the filtrate. That effect occurred suggests that filtration destroyed a gel like structure inhibiting the effect. When 20 nm filtration was used the effect disappeared which suggests that the size of the structure was in the range 20-100 nm.
3. After the treatment by DNase enzyme inducing splitting of DNA to pieces the emission was absent. The treatment of DNA solution by restriction enzyme acting on many sites of DNA did not suppress the emission suggesting that the emission is linked with rather short sequences or with rare sequences.
4. The fact that pathogenic bacteria produce the emission but not “good” bacteria suggests that effect is caused by some specific gene. It was found that single gene - adhesin responsible for the adhesion of mycoplasma to human cells- was responsible for the effect. When the cloned gene was attached to two plasmids and the *E. Choli* DNA was transformed with the either plasmid, the emission was produced.

7.2.3 Some consequences

The findings could have rather interesting consequences.

1. The refinement of the analysis could make possible diagnostics of various diseases and suggests bacterial origin of diseases like Alzheimer disease, Parkinson disease, Multiple Sclerosis and Rheumatoid Arthritis since the emission signal could serve as a signature of the gene causing the disease. The signal can be detected also from RNA viruses such as HIV, influenza virus A, and Hepatitis C virus.
2. Emission could also play key role in the mechanism of adhesion to human cells making possible the infection perhaps acting as a kind of password.

The results are rather impressive. Some strongly conditioned skeptic might have already stopped reading after encountering the word “dilution” and associating it with a word which no skeptic scientist in his right mind should not say aloud: “homeopathy” ! By reading carefully what I wrote above, it is easy to discover that the experimenters unashamedly manufactured a homeopathic remedy out of the filtrate! And the motivating finding was that although filtrate should not have contained the bacteria, they (according to authors), or at least the effects caused by them, appeared within weeks to it! This is of course impossible in the word of skeptic.

The next reaction of the skeptic is of course that this is fraud or the experimenters are miserable crackpots. Amusingly, one of the miserable crackpots is Nobelist Luc Montagnier, whose research group discovered AIDS virus.

7.2.4 How TGD could explain the findings?

Let us leave the raging skeptics for a moment and sketch possible explanations in TGD framework.

1. Skeptic would argue that the filtration allowed a small portion of infected cells to leak through the filter. Many-sheeted space-time suggests a science fictive variant of this explanation. During filtration part of the infected cells is “dropped” to large space-time sheets and diffused back to the original space-time sheets during the next week. This would explain why the micro-organisms were regenerated within few weeks. Same mechanism could work for ordinary molecules and explain homeopathy. This can be tested: look whether the molecules return back to the diluted solution in the case of a homeopathic remedy.
2. If no cells remain in the filtrate, something really miraculous looking events are required to make possible the regeneration of the effects serving as the presence of cells. This even in the case that DNA fragments remain in the filtrate.
 - (a) The minimum option is that the presence of these structures contained only the relevant information about the infecting bacteria and this information coded in terms of frequencies was enough to induce the signatures of the infection as a kind of molecular conditioning. Experimentalists can probably immediately answer whether this can be the case.
 - (b) The most radical option is that the infecting bacteria were actually regenerated as experimenters claim! The information about their DNA was in some form present and was transcribed to DNA and/or RNA, which in turn transformed to proteins. Maybe the small fragment of DNA (adhesin) and this information should have been enough to regenerate the DNA of the bacterium and bacterium itself. A test for this hypothesis is whether the mere nanoparticles left from the DNA preparation to the filtrate can induce the regeneration of infecting molecules.

The notion of magnetic body carrying dark matter quantum controlling living matter forms the basic element of TGD inspired model of quantum biology and suggests a more concrete model. The discovery of nanotubes connecting cells with distance up to 300 μ [I20] provides experimental support for the notion.

1. If the matter at given layer of the onion-like structure formed by magnetic bodies has large \hbar , one can argue that the layer corresponds to a higher evolutionary level than ordinary matter with longer time scale of memory and planned action. Hence it would not be surprising if the magnetic bodies were able to replicate and use ordinary molecules as kind of sensory receptors

and motor organs. Perhaps the replication of magnetic bodies preceded the replication at DNA level and genetic code is realized already at this more fundamental level somehow. Perhaps the replication of magnetic bodies induces the replication of DNA as I have suggested.

2. The magnetic body of DNA could make DNA a topological quantum computer [K3]. DNA itself would represent the hardware and magnetic bodies would carry the evolving quantum computer programs realized in terms of braidings of magnetic flux tubes. The natural communication and control tool would be cyclotron radiation besides Josephson radiation associated with cell membranes acting as Josephson junctions. Cyclotron frequencies are indeed the only natural frequencies that one can assign to molecules in kHz range. There would be an entire fractal hierarchy of analogs of EEG making possible the communication with and control by magnetic bodies.
3. The values of Planck constant would define a hierarchy of magnetic bodies which corresponds to evolutionary hierarchy and the emergence of a new level would mean jump in evolution. Gel like phases could serve as a correlate for the presence of the magnetic body. The phase transitions changing the value of Planck constant and scale up or down the size of the magnetic flux tubes. They are proposed to serve as a basic control mechanism making possible to understand the properties and the dynamics of the gel phases and how biomolecules can find each other in the thick molecular soup via a phase transition reducing the length of flux tubes connecting the biomolecules in question and thus forcing them to the vicinity of each other.

Consider now how this model could explain the findings.

1. Minimal option is that the flux tubes correspond to “larger space-time sheets” and the infected cells managed to flow into the filtrate along magnetic flux tubes from the filter. This kind of transfer of DNA might be made possible by the recently discovered nanotubes already mentioned.
2. Maybe the radiation resulted as dark photons invisible for ordinary instruments transformed to ordinary photons as the gel phase assignable with the dark matter at magnetic flux tube network associated with the infected cells and corresponding DNA was destroyed in the filtration.

This is not the only possible guess. A phase conjugate cyclotron radiation with a large value of Planck constant could also allow for the nanostructures in dilute solute to gain metabolic energy by sending negative energy quanta to a system able to receive them. Indeed the presence of ambient radiation was necessary for the emission. Maybe that for sufficiently dilute solute this mechanism allows to the nanostructures to get metabolic energy from the ambient radiation whereas for the gel phase the metabolic needs are not so demanding. In the similar manner bacteria form colonies when metabolically deprived. This sucking of energy might be also part of the mechanism of disease.

3. What could be the magnetic field inducing the kHz radiation as a synchrotron radiation?
 - (a) For instance, kHz frequency and its harmonics could correspond to the cyclotron frequencies of proton in magnetic field which field strength slightly above that for Earth’s magnetic field (750 Hz frequency corresponds to field strength of B_E , where $B_E = .5$ Gauss, the nominal strength of Earth’s magnetic field). A possible problem is that the thickness of the flux tubes would be about cell size for Earth’s magnetic field from flux quantization and even larger for dark matter with a large value of Planck constant. Of course, the flux tubes could make themselves thinner temporarily and leak through the pores.
 - (b) If the flux tube is assumed to have thickness of order 20-100 nm, the magnetic field for ordinary value of \hbar would be of order .1 Tesla from flux quantization and in the case of DNA the cyclotron frequencies would not depend much on the length of DNA fragment since it carries a constant charge density. Magnetic field of order .2 Tesla would give cyclotron frequency of order kHz from the fact that the field strength of .2 Gauss gives

frequency of about .1 Hz. This correspond to a magnetic field with flux tube thickness ~ 125 nm, which happens to be the upper limit for the porosity. Dark magnetic flux tubes with large \hbar are however thicker and the leakage might involve a temporary phase transition to a phase with ordinary value of \hbar reducing the thickness of the flux tube. Perhaps some genes (adhesin) plus corresponding magnetic bodies representing DNA in terms of cyclotron frequencies depending slightly on precise weight of the DNA sequence and thus coding it correspond to the frequency of cyclotron radiation are the sought for nano-structures.

4. While developing a model for homeopathy based on dark matter I ended up with the idea that dark matter consisting of nuclear strings of neutrons and protons with a large value of \hbar and having thus a zoomed up size of nucleon could be involved. The really amazing finding was that nucleons as three quark systems allow to realize vertebrate code in terms of states formed from entangled quarks [L2], [L2] described also in this chapter! One cannot decompose codons to letters as in the case of the ordinary genetic code but codons are analogous to symbols representing entire words in Chinese. The counterparts of DNA, RNA, and amino-acids emerge and genetic code has a concrete meaning as a map between quantum states.

Without any exaggeration this connection between dark hadronic physics and biology has been one of the greatest surprises of my professional life. It suggests that dark matter in macroscopic quantum phase realizes genetic code at the level of nuclear physics and biology only provides one particular (or probably very many as I have proposed) representations of it. If one takes this seriously one can imagine that genetic information is represented by these dark nuclear strings of nanoscopic size and that there exists a mechanism translating the dark nuclei to ordinary DNA and RNA sequences and thus to biological matter. This would explain the claimed regeneration of the infected cells.

5. Genetic code at dark matter level would have far reaching implications. For instance, living matter - or rather, the magnetic bodies controlling it - could purposefully perform genetic engineering. This forces me to spit out another really dirty word, "Lamarckism" ! We have of course learned that mutations are random. The basic objection against Lamarckism is that there is no known mechanism which would transfer the mutations to germ cells. In the homeopathic Universe of TGD the mutations could be however performed first for the dark nucleon sequences. After this these sequences would diffuse to germ cells just like homeopathic remedies do, and after this are translated to DNA or RNA and attach to DNA.

The findings of both Montagnier and Gariaev suggests that also the representation of genetic code in terms of dark photons is involved. How genetic code could be represented in terms of frequencies? The TGD based model of music harmony [L11] [K46] (see <http://tinyurl.com/zg3aaaj7>) relies on the idea that 12-note scale is representable as a closed non-self-intersecting curve (Hamilton's cycle) at icosahedron having 12 vertices. The harmony assignable to a given Hamilton's cycle is characterized in terms of 3-chords assignable to the 20 faces (triangles) of the icosahedron once the 12-note scale is represented as a particular Hamilton's cycle.

Remarkably, the number of amino-acids is also 20! One indeed ends up with a model in which $20+20+20=60$ DNA codons are represented by 3-chords for a triplet of harmonies defined by Hamilton's cycles predicting correctly the numbers of DNAs coding for a given amino-acid for vertebrate code. One must however assume that also tetrahedral harmony is present to get 64 DNA codons rather than only 60. TActually two variants of the code are predicted and altogether one obtains the standard 20 amino-acids plus two additional ones identified as Pyl and Sec known to be realized in living matter.

In music realization DNA codons can be represented as 3 dark photons or phonons with appropriate frequency ratios. This representation could explain the findings of Montagnier and Gariaev. There is also a connection with TGD inspired theory of consciousness. Music both expresses and induces emotions. The proposal is that the representation of DNA codons in terms of triplets of sounds or dark photons defines molecular level representation of emotions. There is large number of different harmonies and they could represent different moods.

7.3 Water Electric As Protocell

Ulla Matfolk sent to me some interesting material at the web page of Dr. Mae-Wan Ho which provides further insights into the model of cell. The articles are “Water electric” [D12] and “Making Fuel from Water” [D10]. The articles summarize an experimental discovery which could be called Pollack-Zheng effect [D15, D13]. Both articles relate closely to what might be called the holy grail of artificial photosynthesis. The unreasonable effectiveness of photosynthesis in the sense that the waste of energy during the process is extremely small, makes artificial photosynthesis an excellent candidate for the final solution of energy problems as far energy sources and minimization of wastes are considered. In the following I comment only the first paper in detail from TGD viewpoint.

How photosynthesis manages to be so effective is one of the mysteries of biology. TGD based view about metabolic energy involves two ideas.

1. TGD predicts a hierarchy of metabolic energy quanta [K12, K28]. The basic quanta come as $E(k) = 2^k E_0$, where k is positive or negative integer and $E_0 \simeq .5$ eV holds true. For instance, 2 eV metabolic energy quantum corresponding to red light corresponds to $k = 3$. This is actually oversimplification since there is a cascade of quanta $E(k, n) = (1 - 2 -n </sup> </sup> / </sup>) $E(k)$ converging to $E(k)$ for each p-adic length scale. These energies correspond to energies liberated when electron or proton drops to a larger space-time sheet at the limit when second space-time becomes very large and the particle starts from rest and remains to rest: this is second idealization as also the particle in a box geometry. The idea is that these universal metabolic energy quanta preceded the metabolism based on chemical storage of energy and that the primary step in photosynthesis is kicking of proton or electron to a smaller space-time sheet.$
2. Second idea relies on the hierarchy of Planck constants.
 - (a) The rate of dissipation - that this the energy wasted per unit time - is inversely proportional to \hbar in the first naïve guess and means that macroscopically quantum coherent dark matter dissipates very little. Could photon kick charged dark particles to smaller space-time sheet where they dissipate very little? Or could photosynthesis capture ordinary or dark photons of sunlight to some layer of the onion like structure formed by the magnetic body of the organism, where it kicks particles to smaller space-time sheets. This light could correspond to bio-photons liberated as the biological body of the organism dies.
 - (b) Could this storage of photons have preceded chemical storage of energy in living matter? And could this energy reserve explain some rather mysterious findings about the ability of some people to survive without ordinary metabolic energy feed (usually saints and this kind of people telling that light is enough for them to survive. Also animals are capable to these metabolic miracles [I21] : see the article “Researchers Seek to Demystify the Metabolic Magic of Sled Dogs” in Science. Of course, the storage of energy to that of dark matter or dark photons confined to the net defined by magnetic flux tubes could be the eventual manner to avoid energy waste and associated entropy growth inducing environmental problems. Hierarchy of Planck constants would allow the storage in arbitrary long length scales for given energy of photon so that even a community of organisms could have collective metabolic energy resources: maybe synergy has something to do with this.

The first article summarizing the Pollack-Zheng effect gives quantitative support for this picture. I have formatted the text as comments to the summary represented in the article of Mae-Wan Ho [D12].

7.3.1 Exclusion zones

The article summarizes the sequence of events initiated by the discovery of Gerald Pollack and his student Jian-ming Zheng [D15, D13]. As a matter fact, the fascinating findings described in detail by Gerald Pollack in his book were absolutely crucial for the recent TGD based view about quantum biology in which dark matter plays key role.

1. Pollack and his student discovered that suspensions of colloids and dissolved substances are excluded from a region extending some hundreds of micrometres from the surfaces of hydrophilic gels. An “exclusion zone” (EZ) of this magnitude conflicts the belief that interfacial water forming at liquid-solid, or liquid-air interfaces can be no more than a few layers of molecules thick. What’s observed is a million layers or more! “Exclusion” means that the water suspension of micro-spheres moved away from the surface of gel with constant velocity and behaving like single structural unit.

Comment: The sizes of cells vary up to hundreds of micrometers and cells are by definition structures which are isolated from the environment. Maybe EZs represent protocells or their predecessors. Pollack and coauthors have indeed proposed that their finding might relate to the origin of life [D13]. That the surface was that of gel might be important. In TGD based model of living matter gels have magnetic bodies and their presence might relate to the formation of the thick water layer in non-standard phase.

2. Similar exclusion zones were found next to any hydrophilic surface including surfaces coated with a monolayer of hydrophilic molecules, and around ion exchange resin beads. Electric charge appears to be important, as EZ failed to form around charge-exhausted resin beads. Although EZ can form in pure water, it is enhanced and stabilized by low concentrations of buffer (2 to 10 mM at pH 7).

Comment: Hydrophily could correspond to the formation of magnetic flux tubes connecting the hydrophilic surface to water molecules as assumed in the model of protein folding and bio-catalysis [K5].

3. The EZ phase is very different from the bulk water. An unusually ordered crystalline phase where the molecules are less free to move is suggestive. The UV and visible absorption spectrum gave a single absorption peak at $\lambda \simeq 270$ nm in the UV region completely absent in the bulk phase. The infrared emission record showed that the EZ radiates very little compared with bulk water, as would be expected on account of the reduced mobility of water molecules. The magnetic resonance imaging mapping similarly gave a transverse relaxation time (T2) of 25.4 ± 1 ms, which is shorter than the 27.1 ± 0.4 ms recorded for the bulk water phase, again indicative of restricted motion.

Comment: The reduced radiation might mean that part of photons are dark and bound inside magnetic flux tubes defining a structure responsible for the formation of gel like phases inside cell and perhaps also inside EZ. The interpretation as bio-photons is suggestive. This phase of water could be predecessor of the water in cell interior since in the crystalline phase long bio polymers like DNA and amino-acid sequences would be stable against hydration.

4. EZ had a different electrical potential from the bulk phase, by as much as 100–200 mV, depending on the hydrophilic surface. With a negatively charged surface such as polyacrylic acid or Nafion (widely used as a proton exchange membrane), the potential is negative compared with the bulk water away from the EZ. Simultaneously, the hydrogen ion (proton, H^+) concentration is high just outside the EZ, decreasing in a gradient away from it. This indicates that the formation of the EZ is accompanied by a separation of positive and negative electrical charges, which led to the build up of electrical potential between the EZ and the bulk water. In effect, the water has become an electrical battery, and can provide electricity through an external circuit.

Comment: Cell membrane is also a battery and the potential is around 50-80 mV to be compared with 100–200 mV, and the size scale of cell varies from 5 micrometer to hundreds of micrometers so that EZs could be involved with the formation of cell and cell membranes. The kicking of electrons or protons to smaller space-time sheet could be the mechanism inducing electric potential at a given space-time sheet. The formation of battery would mean that water could some day used to store very effectively the energy of solar radiation.

7.3.2 A connection with photosynthesis

Separating H^+ from e^- (electron) is the first step of photosynthesis in green plants which provides energy for most of the biosphere. In this case the energy comes from solar radiation. The separation

of charges requires energy also in the case of EZ and the question is where this energy comes from in the case of EZ.

1. A clue came after having inadvertently left the experimental chamber with the EZ on the microscope overnight. Next morning, the EZ had shrunk considerably. But after turning on the microscope lamp, it began to immediately grow again, restoring itself within minutes to its former size. The energy for EZ formation comes from light, as in photosynthesis, but it can use the low energy part of the solar spectrum that photosynthesis cannot.

Comment: Could one consider the possibility that photosynthesis involves unknown step and this step is just the kicking of electrons or protons to a smaller space-time sheet. This step would also induce the separation of charges and the generation of electric potential.

2. Although the entire spectrum of visible light appeared effective in making the EZ grow, the most effective part is in the infrared region, peaking at $\lambda \simeq 3100$ nm. A 10 minute exposure at that wavelength expanded the width of an EZ 3.7 times, and after an hour of exposure, the expansion was more than 6 times. After the light was turned off, the EZ remained constant for about 30 minutes before beginning to shrink, reaching halfway to its baseline level in about 15 minutes.

Comment: $\lambda = 3100$ nm corresponds to .4 eV. The nominal value of the fundamental metabolic energy quantum is around $E_0 = .5$ eV and one has $E(k = 0, n = 3) = 0.4375$ eV for this value of E_0 . Perhaps the photons indeed kick electrons or protons to a smaller space-time sheet.

- (a) In the case of protons the smaller space-time sheet would correspond to atomic space-time sheets characterized by $p \simeq 2^{137}$: the larger one would correspond to $k = 141$.
- (b) For electrons the size of the smaller space-time sheet would be by a factor $m_p/m_e = 940/.5 = 1880 \simeq 2^{11}$ larger and would correspond to $k = 137 + 11 = 148$. This served as one motivation for the original $\hbar/\hbar_0 = 2^{11k}$ hypothesis for the preferred values of Planck constant. This is one half of the thickness of the lipid layer of cell membrane. The larger space-time sheet would correspond to cell membrane thickness $L(151) = 10$ nm and perhaps the dark space-time sheet serving as a template for the formation of the cell membrane! If $E = .4$ eV corresponds to electron, then proton would correspond to $E(0, 3) = .44$ eV giving for the metabolic energy quantum the value $E_0(p) = 0.5029$ eV in the case of proton and $E_0(e) = 0.4616$ eV in the case of electron.

3. When the UV and visible range was tested, a peak in the degree of EZ expansion was detected at $\lambda = 270$ nm in the UV region, corresponding to the characteristic absorption peak of EZ that was identified before. However, as the optical power used in the UV and visible region was 600 times that in the IR, the most profound effect was identified in the IR region, particularly at 3 100 nm.

Comment: $\lambda = 270$ nm corresponds to the energy 4.5926 eV. $E=4$ eV is the nearest metabolic energy quantum. This energy does not correspond directly to any metabolic energy quantum assignable to .4 eV or .43 eV. One must be however cautious with conclusions since the model is very rough.

4. The mechanism of EZ formation is still unknown. But the two wavelengths that expand the EZ most effectively may offer some hint. The UV wavelength 270 nm is close to the 250 nm ($\simeq 5$ eV) required to ionize water under standard state conditions and taking into account the hydration of the resulting ions. The 3 100 nm peak, on the other hand is close to the OH stretch of the ring hexamer identified as the most abundant species in infrared predissociation spectroscopy of large water clusters, and also in neon matrices by infrared spectroscopy. These results suggest that photoexcitation of ring hexamers and photoionisation followed by ejection of protons play synergistic roles in the assembly of the EZ phase. Pollack and colleagues believe that the infrared radiation, though normally insufficient to break OH bonds, can nevertheless work via resonance induced dissociation of large hydrogen-bonded networks.

Comment: Ring hexamers bring in mind the crucial role of aromatic cycles in TGD inspired model of DNA as topological quantum computer which leads also to a model of $ADP \leftrightarrow ATP$

transition involving reconnection of magnetic flux tubes and having also information theoretic interpretation as a change of the topology of the braid structure defining topological quantum computer program [K3]. Magnetic flux tubes carrying dark electrons begin from these and can end up to other bio-molecules or water. Just a guess: could they end on ring hexamers?

7.3.3 Summary

The findings suggest additional details to the TGD based view about living matter.

1. The kicking of electrons or protons or both of them to a larger space-time sheet would be the first step in photosynthesis as I indeed suggested for years ago. The energy of 3100 nm photons indeed corresponds to that for the fundamental metabolic energy quantum. I have also proposed this process to be a fundamental step also in bio-catalysis: the temporary dropping of electron or proton of the catalyst molecule could provide the energy helping the reacting molecules to overcome the potential wall preventing the reaction from running. This metabolic coin could be returned to catalyst with high enough probability or the photons exchanged could be virtual.

In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated.

2. The findings suggest also a mechanism for how solar radiation generates proto cells or their predecessors. The resulting phases of water have size extending to those for largest cells and the water could involve a gel like phase in which magnetic flux tubes containing dark matter could play a key role and eventually lead to quantum computer like behavior [K3]. The kicking of electrons (or protons) to smaller space-time sheet would induce ionization at given space-time sheet so that electric potential difference would result. The magnitude of the potential difference is of a correct order of magnitude. Cell membrane scale is present as a p-adic length scale for the space-time sheet of electrons before the kicking to the smaller space-time sheet and these space-time sheets could act as templates for the formation of cell membrane.
3. Interestingly, TGD based model of high T_c super conductivity predicts that both cell membrane length scale and size scale of cell are involved with the super-conductivity [K15]. Cell membrane acts as a Josephson junction in TGD based model of cell membrane, nerve pulse, and EEG.

7.4 A Model For Chiral Selection

Chiral selection of bio-molecules is one of the basic mysteries of biology and it is interesting to see whether the existing bits of data combined with vision about quantum TGD could help to build a coherent picture about the situation. Let us first try to identify the most important pieces of the puzzle.

1. Chiral selection requires parity breaking in the scale of biomolecules. Standard model predicts parity breaking interactions but the effects are extremely small above intermediate boson length scale which is by a factor 10^{-7} shorter than atomic length scale. The proposed solution of the problem is that dark variants of intermediate gauge bosons are in question so that the Compton lengths of intermediate gauge bosons are scaled up by a factor $r = \hbar/\hbar_0$. Below the dark Compton length weak gauge bosons would be effectively massless and above it possess ordinary masses. Large parity breaking effects induced by dark intermediate gauge bosons would be possible.
2. For instance, for $r = 2^{44}$ for which EEG photons have energies just above thermal threshold at room temperature, the effective p-adic length scale would correspond to $L(k)$, $k = 89 + 44 =$

133 of about .2 Angstrom. This scale in turn would scale up to $L(133 + 44 = 177)$. Secondary p-adic length scale assignable to $k = 89$ which is important in zero energy ontology would correspond to $k = 2 \times 89 = 178$ which corresponds to about $L(178) \simeq 100 \mu\text{m}$, the length scale assignable to large cells and the thickness of water layers in the experiment of Pollack.

3. Parity breaking interaction is associated with spin and the interaction energy of form $ks \cdot E_Z$, where s is the spin of particle and E_Z is Z^0 electric field. Classical induced gauge fields are very strongly correlated in TGD since they are expressible in terms of four CP_2 coordinates and their gradients. Hence classical electromagnetic field E is in the generic case accompanied by classical Z^0 field $E_Z = aE$. This means that if there is classical electromagnetic field and charge density at the dark space-time sheet, large parity breaking effect is possible at the level of spin. The induced Z^0 electric field could force the spins to become parallel and in this manner induce also magnetization.

The crucial finding about which I learned three years ago is that L glutamate is more stable than R glutamate in water and that heavy water does not induce this effect [I66]. This suggests a connection with Pollack-Zheng effect [D15]. Heavy water nuclei have vanishing spin whereas hydrogen nuclei have spin 1/2 so that H_2 in water molecules can be in spin singlet or triplet states (para and orto configurations). Could the nuclear spin of water molecules somehow induce parity breaking and the magnetic interaction distinguishing between these molecules?

1. Suppose that bio-molecules in question have magnetic moment and water carries magnetic field, most naturally at dark magnetic flux tubes. The parity breaking interaction energy $-p \cdot E$ with dark electric field remains invariant under reflection and rotation of π changing the orientation of the mirror image of the molecule with respect to electric field. The interaction energy with magnetic field however changes its sign since magnetic moment is not affected by the reflection but changes direction under rotation. The angular momentum of the molecule responsible for the magnetic moment can of course change sign but since the transformation involves acts on angular momenta only, it is not a symmetry of entire system. Indeed, if there is interaction between angular momentum degrees of freedom and geometric degrees of freedom the magnetic interaction energy for the mirror image is different. Suppose that the breaking of reflection symmetry induced by the chirality of the molecule induces internal electric field E_{int} . The parity breaking interaction energy $ks \cdot E_{int}$ would indeed break the symmetry in the transformation changing the directions of angular momenta and spins.
2. It deserves to be emphasize that the parity breaking of the molecule itself would induce the symmetry breaking if molecule possesses dark magnetic body. One can actually imagine a cascade of parity breakings proceeding from shorter to longer length scales in this manner.
3. The mechanism creating electric field could be the charging of water, perhaps by the Pollack-Zheng mechanism and having in TGD framework an interpretation as a basic mechanism storing the energy of sunlight to metabolic energy (kicking of electrons and/or protons to a smaller space-time sheet so that oppositely charge space-time sheets emerge as a consequence). A direct connection with metabolism would be admittedly a highly satisfactory feature of the mechanism.
4. Parity breaking energy $ks \cdot E$ for say dark protons assignable to hydrogen nuclei of bio-molecules in the internal electric field of the molecule or dark protons of water molecules in the electric field induced by Pollack-Zheng effect [D15] does not change sign under the reflection of the molecule so that spin polarization independent of chirality could result from both water molecules in crystal like phase and for bio-molecules possessing dark protons (and dark hydrogen atoms). This could in turn serve as a seed for magnetization essential for the existence of dark magnetic flux tubes.

If water is replaced with heavy water there is no difference between L and R. What distinction H and D could explain this difference?

1. The basic difference between water and heavy water nuclei is that for water nucleus is just proton having spin 1/2 so that H_2 in water molecule can be in spin triplet and singlet states. Fractions of the two states are 3/4 and 1/4 in the absence of external magnetic field.

2. On the other hand, in atto-second time scale (corresponding length scale is 3 Angstroms) water is known to behave effectively as $H_{1.5}O$. A possible explanation is that 1/4: th of H nuclei/atoms are effectively dark having large Planck constant. The dark protons cannot correspond to H_2 in spin singlet state since the interaction energy $ks \cdot E$ would be small in this case. Dark spin triplet states of H_2 could however induce parity breaking in water and make crystal like water phase both electret and magnet. If the spin $s_z = 1$ with negative interaction energy with E becomes dark then 1/4 of hydrogen atoms would be dark and $H_{1.5}O$ formula would hold true. For D_2O this mechanism would not work.
3. The model for homeopathy led to the idea that dark nuclei consisting of scale up variants of nucleons possibly having size of order atomic length scale could be crucial for understanding living matter. The states of nucleons correspond naturally to those DNA, RNA, and aminocids and vertebrate genetic code emerges naturally with DNA code word replaced with 3 quark state with entanglement between the quarks representing the information. Could it be that dark protons of water combine to form dark nuclei providing a fundamental representation of the genetic code and could the spin of protons induce electro-weak chiral symmetry breaking. Also now this mechanism fails for D_2O .

8 New findings related to the chiral selection

I learned of very interesting empirical findings related to the chiral selection of biomolecules (see the popular article). The article "Enantioselective Adsorption on Magnetic Surfaces" of Mohammad Reza Safari et al [?] is published in the journal Advanced Materials (2023).

8.1 The findings

Consider first the experimental arrangement and findings.

1. There is a copper conductor with a strong electric field in the normal direction of the conductor. Cu is not a magnetic substance. There are very thin Cobalt islands at the surface of the conductor. Cobalt is a magnetic metal. There are two options: magnetization direction is North or South and it corresponds to either up or down. North up and South down are the options and these could correspond to different chiralities somehow.
2. The molecules drift to the Cobalt islands and, depending on their chirality, prefer to bind to either south-up or north-up Cobalt islands. Are the magnetic fields of islands helical and possess a definite chirality? Does the magnetic chirality tend to be the same or opposite to that of the enantiomer that binds to it?
3. The effect is reported to occur already before the Cobalt islands in the drifting of molecules to the Cobalt islands. What does this mean? Counterparts of magnetic fields are not present.
4. It is also found that electrons with a given spin direction prefer to tunnel through the molecules in a direction which correlates with the chirality.

8.2 TGD view of the findings

These are highly interesting findings providing new empirical hints about the nature of chiral selection in living matter. Weak interactions are really weak and parity violation effects should be extremely small above weak scale so that the standard model fails to explain chiral selection.

8.2.1 TGD view of dark matter and chiral selection

The TGD view of dark matter would make possible chiral selection.

1. Chiral selection is one of the key empirical facts supporting the TGD prediction of a hierarchy of phases of ordinary matter predicted by the number theoretical vision of TGD [L25, L17, L34, L27, L28, L30]. These phases are labelled by effective Planck constant h_{eff} , which is essentially the dimension of an algebraic extension of rationals.

2. The predicted huge values of h_{eff} assignable to classical gravitational and electric fields of astrophysical objects [L30] mean that weak interactions become as strong as em interactions below the scale up Compton length of weak bosons, which, being proportional to h_{eff} , can be as large as cell size. This amplifies parity violation effects visible for instance in hydrodynamics [K2].
3. Large h_{eff} phases behave like dark matter: they do not however explain galactic dark matter, which in the TGD framework is dark energy assignable to cosmic strings (no halo and an automatic prediction of the flat velocity spectrum). Instead, large h_{eff} phases solve the missing baryon problem [L32]. The density of baryons has decreased in cosmic evolution (having biological evolution as a particular aspect) and the explanation is that evolution as unavoidable increase of algebraic complexity measured by h_{eff} has transformed them to $h_{eff} \geq h$ phases at the magnetic bodies (thickened cosmic string world sheets, 4-D objects), in particular those involved with living matter.
4. The large value of h_{eff} has, besides number theoretical interpretation [L31], a geometric interpretation. Space-time surface can be regarded as many-sheeted over both M^4 and CP_2 . In the first case the CP_2 coordinates are many-valued functions of M^4 coordinates. In the latter case M^4 coordinates are many-valued functions of CP_2 coordinates. This case is highly interesting in the case of quantum biology. Since a connected space-time surface defines the quantum coherence region, an ensemble of, say, monopole flux tubes can define a quantum coherent region in the latter case: one simply has an analog of Bose-Einstein condensate of monopole flux tubes.

The flux tube condensate as a covering of CP_2 means a dramatic deviation from the QFT picture and is a central notion in the applications of quantum TGD to biology. Therefore some examples are in order.

1. Fermi liquid description of electrons relies on the notion of a quasiparticle as an electron plus excitations of various kinds created by its propagation in the lattice. In some systems this description fails and these systems would have a natural description in terms of space-time surfaces which are multiple coverings of CP_2 , say flux tube condensates.
2. In high Tc superconductors and bio-superconductors [K44, K45] the space-time surface could correspond to this kind of flux tube condensates and Cooper pairs would be fermion pairs with members at separate flux tubes. The connectedness of the space-time surface having about $h_{eff}/h = n$ flux tubes would correlate the fermions.
3. Bogoliubov quasiparticles related to superconductors are regarded as superpositions of electron excitation and hole. The problem is that they have an ill-defined fermion number. In TGD, they would correspond to superpositions of a dark electron accompanied by a hole which it has left behind and therefore having a well-defined fermion number. Bogoliubov quasiparticle is indeed what can be seen using the existing experimental tools and physical understanding.
4. Strange metals would be an example of a system having no description using quasiparticles, as the linear dependence of the resistance at low temperatures demonstrates. I have considered a description of them in terms of Cooper pairs at short closed flux tubes [K44, K54]: this would however suggest a vanishing resistance in an ideal situation. Something seems to go wrong.

An alternative description could be in terms of superpositions of dark electrons and holes assignable to the flux tube condensate. Strange metal is between Fermi liquid and superconductor: this conforms with the fact that strange metals are quantum critical systems. The transition to high Tc superconductivity is preceded by a transition to a phase in which something resembling Cooper pairs is present.

A natural looking interpretation would be in terms of a flux tube condensate and pairs of dark and ordinary electrons. Also now the flux tubes could be short. In [K17], I have considered the possibility that high Tc superconductors could be this kind of "half-superconductors" but this option seems to be wrong.

The phase transitions between "half-superconductivity" and superconductivity could play a central role also in living matter.

8.2.2 A more detailed view of chiral selection in the TGD framework

Before proceeding to a detailed model, one must understand how the large parity violation required by the chiral selection could emerge in the TGD framework.

1. Since the Kähler action does not contain the induced $SU(2)_L$ weak fields, there should be no direct parity violation at the space-time level. The geometric parity violation as a chiral selection of bio-molecules could be however induced from the fermionic dynamics induced by the modified Dirac action determined completely by the bosonic action. The twistor lift of TGD [K61, K51, K11] suggest that this action is a sum of volume term and Kähler action.

Holography realized as generalized holomorphy implies that solutions are minimal surfaces irrespective of action and only the conditions at boundaries and singularities distinguish between different general coordinate invariant actions constructible using the induced geometry.

2. In the standard physics framework one could argue that Chern-Simons term relates to the parity violation. Now the situation is not so straightforward since parity violation for the weak interactions basically occurs at the level of $M^4 \times CP_2$ and is induced to the space-time level.

Chern-Simons-Kähler (CSK) action emerges from the topological instanton term $J \wedge J$ in the exponent defining vacuum functional [K26, K50, K52, K65]. The CSK term is naturally imaginary whereas the non-topological term defining the Kähler function as Kähler action would be real. The CSK term contains two parts corresponding to M^4 and CP_2 parts of the Kähler form. Neither Kähler action nor CSK action contain the induced $SU(2)_L$ gauge potentials so that parity violation directly induced by weak interactions is not present. CSK action is associated with partonic orbits carrying fermion lines identified as the light-like boundaries of the space-time surface and the interfaces of Euclidean and Minkowskian regions of the space-time surface.

3. CSK term contributes also a term to the modified Dirac action [K65] [L33], which is fixed completely by the bosonic action defining the space-time surfaces as a Bohr orbit-like preferred extremals satisfying holography, which reduces to a generalized holomorphy [K52].

What is crucial is that the covariant derivative acting on the induced spinor fields, obtained by restricting the second quantized H spinor fields to the space-time surface, contains the parity violation weak interaction term so that the parity violation at the level of elementary fermions emerges through it. This parity violation must induce the geometric parity violation at the level of the geometry of space-time surfaces distinguishing between different chiralities in dark weak scales.

4. The model of anomalous electron-positron pairs produced in heavy nucleus collisions [K63] assigns dark leptopion condensate to the non-vanishing of the Chern-Simons term requiring that the induced Kähler and electric fields are not orthogonal. The condition that the dark leptopion Compton wavelength, which is 1/2 of dark electron Compton length, should be of the order of the thickness of the electric flux tube. One must assume that the leptopions are dark in the sense that they have $h_{eff} \neq h$ since otherwise they would be produced in the decays of weak bosons.

It will be found that the model provides further support for a generalization of the Pollack effect [I40, L15, I67, I58]: instead of protons of water molecules, electrons at the conductor surface would be transformed to dark electrons at the magnetic monopole flux tubes. This suggests also a generalization [L28] of the dark genetic code [L23, ?, L26, L29]. For this generalization dark proton triplets as a representation of codons would be replaced with dark electron triplets. The universality of the realization of the dark genetic code in terms of the completely unique icosahedral tessellation of hyperbolic space H^3 supports this idea.

8.3 A TGD based model for the findings

Consider now a concrete model for the findings in the TGD framework.

1. A good guess is that the molecular monopole flux tubes of the molecules and of the magnetic fields assignable with the Cobalt islands tend to have the same chirality. This would generalize the chiral selection from the level of biomolecules to the level of dark monopole flux tubes. Some kind of condensate of flux tubes of the same chirality as a long scale parity violation would be in question.
2. In the TGD framework, the North up and South up magnetic fields could correspond to helical monopole flux tubes of opposite chiralities. The helical structure is essential and could relate directly to the requirement that the flux tube is closed: one could have a shape of flattened square for which the long sides form a double helix. This would be the case also for DNA.
3. Parity violation requires a large value of h_{eff} . Dark Z (and W) bosons could generate a large parity violation. Dark Z boson Compton length of order biological scale. The very large value of h_{eff} would give the needed large energy splitting between generalized cyclotron energies at the dark flux tube and induce chiral selection.

Gravitational flux tubes of the Earth's gravitational field or solar gravitational field would do the job. By the Equivalence Principle, the gravitational Compton length $\Lambda_{gr,E} = .5$ cm for Earth does not depend on the particle mass and looks like a promising scale. Also the cyclotron energies are independent of the mass of the charged particle since \hbar_{gr} is proportional to particle mass m and cyclotron frequency to $1/m$.

4. Also the electric field of the Copper surface should have an important role. The electric field orthogonal to Cu conductor would correspond to electric flux tubes. The consistency condition for the electric flux tube thickness with charged at the bottom (conductor) reads as $\Lambda_{em}(d) \sim d$. $\hbar_{em} = Ne^2/\beta_0$, N the number of electrons at the bottom. There is roughly one electron per atom. $N \sim 10^4$ per flux tube area of 100 nm^2 having radius about 10 nm. $\Lambda_{em} = Ne^2/\beta_0\lambda_e$ is about 1 nm for $\beta_0 = 1$. The value of \hbar_{em} are rather small and it seems that it cannot contribute to the chiral selection. One can however consider also the electric field of Earth, and in this case the situation could be different.

The effect occurs already before the Cobalt islands. Furthermore, electrons with a given spin direction prefer to tunnel through the molecules in a direction dictated by the chirality. What could this mean?

1. The counterparts of magnetic fields are present as dark magnetic fields inside the magnetic bodies of the drifting molecules. Suppose that dark molecular gravitational monopole tubes are indeed present and give rise to closed spin current loops with a direction determined by the chirality of the molecule. This would give rise to the large parity violation but how to understand the occurrence of the effect already before the Cobalt islands?
2. Could one assign a definite chirality also to the electric flux tubes assignable to the Cu surface and assume that the molecular chirality tends to be the same (or opposite) to this chirality? Do also these closed monopole flux tubes carry dark electric current?

The spin direction of the current carrying electrons would correlate with the magnetization direction so that the magnetic body of the molecule would prefer a pairing with the electric body with a preferred spin direction. The preferred pairing would explain the drift to a correct Cobalt island: the paths leading to the Cobalt island would be more probable.

3. In the case of water, the Pollack effect [I40, L15, I67, I58] transfers part of the protons of water molecules to dark protons at monopole flux tubes. Now there are no protons available. Does this require a generalization of the Pollack effect? Could the electric flux tubes be gravitational flux tubes carrying electrons instead of protons? Gravitational Compton length would be the same. Could electronic Pollack effect for conductors as a dual of Pollack effect for water be in question.

4. In the TGD inspired quantum biology, one assigns genetic code with dark proton triplets. Could one assign a dark realization of the genetic code to dark electron triplets? Could the electric counterparts of gravitational flux tubes carrying dark realization of the genetic code define dark genetic code? Codons would correspond to dark electron triplets instead of dark proton triplets. Could the analogs of the ordinary genetic codons correspond to the triplets of electron holes at the conductor surface?

The TGD based vision about universal genetic code suggests the existence of a 2-D analog of DNA realized in terms of mathematically completely unique hyperbolic icosahedral tessellation. Could this genetic code be associated with the metal surfaces? The implications of this hidden genetic code for computers might be rather dramatic.

8.4 Burning Water And Photosynthesis

For a physicist liberated from the blind belief in reductionism, biology transforms to a single gigantic anomaly about which recent day physics cannot say much. During years I have constructed several models for these anomalies helping to develop a more detailed view about how the new physics predicted by quantum TGD could allow to understand biology and consciousness.

The basic problem is of course the absence of systematic experimentation so that it is possible to imagine many new physics scenarios. For this reason the article series of Mae-Wan Ho [D12, D10, D8, D11] in ISIS was a very pleasant surprise, and already now has helped considerably in the attempts to develop the ideas further.

The first article “Water electric” [D12] told about the formation of exclusion zones around hydrophilic surfaces, typically gels in the experiments considered [D15]. The zones were in potential of about 100 meV with respect to surroundings (same order of magnitude as membrane potential) and had thickness ranging to hundreds of micrometers (the size of a large cell): the standard physics would suggest only few molecular layers instead of millions. Sunlight induced the effect. This finding allow to develop TGD based vision about how proto cells emerged and also the model for chiral selection in living matter by combining the finding with the anomalies of water about which I had learned earlier.

The article “Can water burn?” [D8] tells about the discovery of John Kanzius - a retired broadcast engineer and inventor. Kanzius found that water literally burns if subjected to a radio frequency radiation at frequency of 13.56 MHz [D1]. The mystery is of course how so low frequency can induce burning. The article “The body does burn water” [D11] notices that plant cells burn water routinely in photosynthesis and that also animal cells burn water but the purpose is now to generate hydrogen peroxide which kills bacteria (some readers might recall from childhood how hydrogen peroxide was used to sterilize wounds!). Hence the understanding of how water burns is very relevant for the understanding of photosynthesis and even workings of the immune system.

8.4.1 Living matter burns water routinely

Photosynthesis burns water by decomposing water to hydrogen and oxygen and liberating oxygen. Oxygen from CO_2 in atmosphere combines with the oxygen of H_2O to form O_2 molecules whereas H from H_2O combines with carbon to form hydrocarbons serving as energy sources for animals which in turn produce CO_2 . This process is fundamental for aerobic life. There is also a simpler variant of photosynthesis in which oxygen is not produced and applied by an-aerobic life forms. The article “Living with Oxygen” by Mae-Wan Ho gives a nice overall view about the role of oxygen [D9]. As a matter fact, also animals burn water but they do this to produce hydrogen peroxide H_2O_2 which kills very effectively bacteria.

Burning of water has been studied as a potential solution for how to utilize the solar energy to produce hydrogen serving as a natural fuel [D10]. The reaction $O_2 + H_2 \rightarrow 2H_2O$ occurs spontaneously and liberates energy of about 1.23 eV. The reverse process $2H_2 \rightarrow H_2O_2 + H_2$ in the presence of sunlight means burning of water, and could provide the manner to store solar energy. The basic reaction $2H_2O + 4h\nu \leftrightarrow H_2O_2 + H_2$ stores the energy of four photons. What really happens in this process is far from being completely understood. Quite generally, the mechanisms making possible extreme efficiency of bio-catalysis remain poorly understood. Here new physics might be involved. I have discussed models for photosynthesis and $ADP \leftrightarrow ATP$ process involved with the utilization of the biochemical energy already earlier [K28].

8.4.2 How water could burn in TGD Universe?

The new results could help to develop a more detailed model about what happens in photosynthesis. The simplest TGD inspired sketch for what might happen in the burning of water goes as follows.

1. Assume that 1/4 of water molecules are partially dark (in sense of nonstandard value of Planck constant) or at least at larger space-time sheets in atto-second scale [D7, D6, D14, D5]. This would explain the $H_{1.5}O$ formula explaining the results of neutron diffraction and electron scattering.
2. The question is what this exotic fraction of water precisely is. The models for water electret, exclusion zones and chiral selection lead to concrete ideas about this. Electrons assignable to the H atoms of (partially) dark H_2O reside at space-time sheet $k_e = 151$ (this p-adic length scale corresponds to 10 nm, the thickness of cell membrane). At least the hydrogen atom for this fraction of water molecules is exotic and findings from neutron and electron scattering suggest that both proton and electron are at non-standard space-time sheets but not necessarily at the same space-time sheet. The model for the burning requires that electron and proton are at different space-time sheets in the initial situation.
3. Suppose all four electrons are kicked to the space-time sheet of protons of the exotic hydrogen atoms labeled by k_p . This requires the energy $E_\gamma = (1 - 2^{-n})E_0(k_p)$ (the formula involves idealizations). At this space-time sheet protons and electrons are assumed to combine spontaneously to form two H_2 atoms. Oxygen atoms in turn are assumed to combine spontaneously to form O_2 .
4. For $k_f = 148$ and $n = 3$ minimum energy needed would be $4E_\gamma = 4 \times .4 = 1.6$ eV. For $k_p = 149$ (thickness of lipid layer) and $n = 2$ one would have $4E_\gamma = 4 \times .3462 = 1.385$ eV whereas $H_2O_2 + H_2 \rightarrow 2H_2O$ liberates energy 1.23 eV. Therefore the model in which electrons are at cell membrane space-time sheet and protons at the space-time sheet assignable to single lipid layer of cell membrane suggests itself. This would also mean that the basic length scales of cell are already present in the structure of water. Notice that there is no need to assume that Planck constant differs from its standard value.

There is no need to add, that the model is an unashamed oversimplification of the reality. It might however catch the core mechanism of photosynthesis.

8.4.3 Burning of salt water induced by RF radiation

Engineer John Kanzius has made a strange discovery [D1]: salt water in the test tube radiated by radio waves at harmonics of a frequency $f=13.56$ MHz burns. Temperatures about 1500 K, which correspond to 15 eV energy have been reported. One can irradiate also hand but nothing happens. The original discovery of Kanzius was the finding that radio waves could be used to cure cancer by destroying the cancer cells. The proposal is that this effect might provide new energy source by liberating chemical energy in an exceptionally effective manner. The power is about 200 W so that the power used could explain the effect if it is absorbed in resonance like manner by salt water.

Mae-Wan Ho's article "Can water Burn?" [D8] provides new information about burning salt water [D1], in particular reports that the experiments have been replicated. The water is irradiated using polarized radio frequency light at frequency 13.56 MHz. The energy of radio frequency quantum is $E_{rf} = .561 \times 10^{-7}$ eV and provides only a minor fraction $E_{rf}/E = .436 \times 10^{-7}$ of the needed energy which is $E = 1.23$ eV for single $2H_2O \rightarrow H_2O_2 + H_2$ event. The structure of water has been found to change, in particular something happens to O-H bonds. The Raman spectrum of the water has changed in the energy range [0.37, 0.43] eV. Recall that the range of metabolic energy quanta $E(k, n) = (1 - 2^{-n})E_0(k)$ varies for electron in the range [.35, .46] eV in the model for the formation of exclusion zone induced by light. Therefore the photons assigned to changes in Raman spectrum might be associated with the transfer of electrons between space-time sheets.

The energies of photons involved are very small, multiples of 5.6×10^{-8} eV and their effect should be very small since it is difficult to imagine what resonant molecular transition could cause the effect. This leads to the question whether the radio wave beam could contain a considerable fraction of dark photons for which Planck constant is larger so that the energy of photons is much larger.

The underlying mechanism would be phase transition of dark photons with large Planck constant to ordinary photons with shorter wavelength coupling resonantly to some molecular degrees of freedom and inducing the heating. Microwave oven of course comes in mind immediately.

As I made this proposal, I did not realize the connection with photosynthesis and actual burning of water. The recent experimental findings suggest that dark radio frequency photons transform to photons inducing splitting of water as in photosynthesis so that one should have $r = \hbar/\hbar_0 = E_{r,f}/4E$. One could say that large number of radio wave photons combine to form a single bundle of photons forming a structure analogous to what mathematician calls covering space. In the burning event the dark photon would transform to ordinary photon with the same energy. This process would thus transform low energy photons to high energy photons with the ratio $r = \hbar/\hbar_0$.

Therefore the mechanism for the burning of water in the experiment of Kanzius could be a simple modification of the mechanism behind burning of water in photosynthesis.

1. Some fraction of dark radio frequency photons are dark or are transformed to dark photons in water and have energies around the energy needed to kick electrons to smaller space-time sheets .4 eV. After this they are transformed to ordinary photons and induce the above process. Their in-elastic scattering from molecules (that is Raman scattering) explains the observation of Raman scattered photons. For a fixed value of \hbar the process would occur in resonant manner since only few metabolic quanta are allowed.
2. How dark radio frequency photons could be present or could be produced in water? Cyclotron radiation assignable to say electrons in magnetic field comes in mind. If the cyclotron radiation is associated with electrons it requires a magnetic field of 4.8 Gauss the cyclotron frequency is 13.56 MHz. This is roughly ten times the nominal value $B_E = .5$ Gauss of the Earth's magnetic field and 24 times the value of dark magnetic field $B_d = .4B_E = .2$ Gauss needed to explain the effects of ELF em fields on vertebrate brain. Maybe dark matter at flux tubes of Earth's magnetic field with Planck constant equal to $\hbar/\hbar_0 = \frac{1}{4} \frac{E}{E_{r,f}}$ transforms radio frequency photons to dark photons or induces resonantly the generation of cyclotron photons, which in turn leak out from magnetic flux tubes and form ordinary photons inducing the burning of water. $E_\gamma = .4$ eV would give $\hbar/\hbar_0 = 1.063 \times 2^{21}$ and $E_\gamma = .36$ eV would give $\hbar/\hbar_0 = .920 \times 2^{21}$.
3. Magnetic fields of magnitude .2 Gauss are in central role in TGD based model of living matter and there are excellent reasons to expect that this mechanism could be involved also with processes involved with living matter. There is indeed evidence for this. The experiments of Gariaev demonstrated that the irradiation of DNA with 2 eV laser photons (which correspond to one particular metabolic energy quantum) induced generation of radio wave photons having unexpected effects on living matter (enhanced metabolic activity) [I28], and that even a realization of genetic code in terms of the time variation of polarization direction could be involved. TGD based model [K13, K62] identifies radio-wave photons as dark photons with same energy as possessed by incoming visible photons so that a transformation of ordinary photons to dark photons would have been in question. The model assumed hierarchy of values of magnetic fields in accordance with the idea about onion like structure of the magnetic body.

There are several questions to be answered.

1. Is there some trivial explanation for why salt must be present or is new physics involved also here. What comes in mind are Cooper pairs dark Na^+ ions (or their exotic counterparts which are bosons) carrying Josephson currents through the cell membrane in the model of the cell membrane as a Josephson junction which is almost vacuum extremal of Kähler action. In the experimental arrangement leading to the generation of exclusion zones the pH of water was important control factor, and it might be that the presence of salt has an analogous role to that of protons.
2. Does this effect occur also for solutions of other molecules and other solutes than water? This can be tested since the rotational spectra are readily calculable from data which can be found at net.

3. Are the radio wave photons dark or does water - which is very special kind of liquid - induce the transformation of ordinary radio wave photons to dark photons by fusing $r = \hbar/\hbar_0$ radio wave massless extremals (MEs) to single ME. Does this transformation occur for all frequencies? This kind of transformation might play a key role in transforming ordinary EEG photons to dark photons and partially explain the special role of water in living systems.
4. Why the radiation does not induce spontaneous combustion of living matter which contains salt. And why cancer cells seem to burn: is salt concentration higher inside them? As a matter fact, there are reports about [D4]. One might hope that there is a mechanism inhibiting this since otherwise military would be soon developing new horror weapons unless it is doing this already now. Is it that most of salt is ionized to Na^+ and Cl^- ions so that spontaneous combustion can be avoided? And how this relates to the sensation of spontaneous burning [D3] - a very painful sensation that some part of body is burning?
5. Is the energy heating solely due to rotational excitations? It might be that also a “dropping” of ions to larger space-time sheets is induced by the process and liberates zero point kinetic energy. The dropping of proton from $k=137$ ($k=139$) atomic space-time sheet liberates about .5 eV (0.125 eV). The measured temperature corresponds to the energy.15 eV. This dropping is an essential element in the earlier of remote metabolism and provides universal metabolic energy quanta. It is also involved with TGD based models of “free energy” phenomena. No perpetuum mobile is predicted since there must be a mechanism driving the dropped ions back to the original space-time sheets.

In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated.

6. The electrolysis of water and also cavitation produces what is known as Brown’s gas which should consist of water vapour and there might be a connection to the burning of salt water. The properties of Brown’s gas [?] however do not support this interpretation: for instance, Brown’s gas has temperature of about 130 C but is able to melt metals so that some un-known mechanism liberating energy must be involved explaining also the claims about over-unity energy production in water splitting using electrolysis. TGD inspired model for Brown’s gas [K29] suggests that activated water and Brown’s gas correspond to same phase involving polymer sequences formed from exotic water molecules for which one hydrogen nucleus is dark and defining the analogs of basic biopolymers. The bond binding protons to a polymer like sequence would serve as the counterpart of covalent bond.

One also ends up with a more detailed TGD inspired view about basic mechanism of metabolism in living matter predicting a tight correlation between p-adic length scale hypothesis and hierarchy of Planck constants. The model differs in some aspects from the rough models considered hitherto assuming that metabolic energy is liberated as zero point kinetic energy when particle drops to a larger space-time sheet or as cyclotron energy when cyclotron quantum number decreases. Now a phase transition increasing the p-adic length scale of the space-time surface would liberate either kinetic energy of cyclotron energy. Quantum numbers would not change: rather, the scale appearing as a parameter in the expression of kinetic or cyclotron energy would change adiabatically and in this manner guarantee coherence. Also a phase transition in which the changes of scale due to a reduction of Planck constant and increase of the p-adic length scale compensate each other liberate metabolic energy.

Recall that one of the empirical motivations for the hierarchy of Planck constants came from the observed quantum like effects of ELF em fields at EEG frequencies on vertebrate brain and also from the correlation of EEG with brain function and contents of consciousness difficult to understand since the energies of EEG photons are ridiculously small and should be masked by thermal noise.

8.5 How Bio-Polymers Were Associated With Their Dark Counterparts?

The experiments of Pollack [L15] demonstrating what he calls fourth phase of water is characterized by negatively charged regions - exclusion zones (EZs). The stoichiometry of water inside EZ is $H_{1.5}O$. TGD based model assumes that part of protons in these regions have been transferred to magnetic flux tubes where they form sequences identifiable as dark nuclei. The surprising finding is that a simple model for dark proton allows to assign its states to multiplets for which numbers of states are those assignable to DNA, RNA, and tRNA codons, plus amino-acids. Also the vertebrate genetic code can be realized in a simple manner. This leads to a vision about prebiotic life as dark life evolved in water before the ordinary life. Dark life would be present also in ordinary life forms.

If one believes that dark proton sequences [K25] define the counterparts of DNA, RNA, tRNA, and amino-acids realized at magnetic flux tubes, the question is how this form of life was transformed to the bio-chemical life.

The article “Hydrogen cyanide polymers, comets and the origin of life” (<http://tinyurl.com/ybfuwneq>, thanks to Ulla for the link) helped me to discover a new big gap in my knowledge about biology and this in turn led to a more detailed vision about how the transition could have taken place. HCN is everywhere and Miller demonstrated in his classic experiments that 11 out of 20 amino-acids emerged in presence of HCN. It has been later found that well over 20 amino-acids were produced. (<http://tinyurl.com/y9at46fe>). In my own belief system amino-acids could have appeared first as concrete something “real” and DNA as symbolic representations of this something “real”. First at dark matter level and then biochemically.

In TGD Universe one can imagine - with inspiration coming partially from Pollack’s experiments [L15] (<http://tinyurl.com/oyhstc2>) - that dark variants DNA, RNA and amino-acids were realized first as dark proton sequences at flux tubes- dark nuclei - I call them just dark DNA, RNA and amino-acids although dark proton sequences are in question. The genetic machinery involving translation and transcription was realized as dark variant and dark DNA was a symbolic representation for dark amino-acids.

How did this dark life give rise to bio-chemical life as its image? This is the question! I can only imagine some further questions.

1. Was this process like master teaching to a student a skill? Master does it first, and then student mimics. If so, the emergence of amino-acids, mRNA and DNA polymers would *not* have been purely chemical process. Dark variants of these polymers would have served as templates for the formation of ordinary basic biopolymers, for transcription, and for translation. These templates might have been necessary in order to generate long RNA and DNA sequences: mere chemistry might have not been able to achieve this. Without dark polymers one obtains only bio-monomers, with dark polymers as template one obtains also bio-polymers. Dark polymers would have been the plan, biopolymers the stuff used to build.
2. Are dark DNA, RNA, amino-acids, etc indeed still there and form binary structures with their biochemical variants as I have indeed proposed?
3. Are dark translation and transcription processes still an essential part of ordinary translation and transcription? Master-student metaphor suggest that these dark processes actually induce them just like replication of magnetic body could induce the replication of DNA or cell. Visible chemistry would only make visible the deeper “dark chemistry”. Apologies for all biochemists who have done heroic work in revealing chemical reaction paths!

How the process assigning biochemical life to dark life could have proceeded? The minimalistic guess is that the only thing that happened was that dark life made itself gradually visible! As a consciousness theoretician I have a temptation to see religious statements as hidden metaphors, at least they provide an excellent manner to irritate skeptics: Dark matter - the “God” made us- the biological life - to its own image.

1. First dark amino-acid sequences were accompanied by ordinary amino-acid sequences so that the dark translation process had now a visible outcome. At this step the presence of HCN was crucial and made the step unavoidable. Also the presence of template was necessary.

2. Dark mRNA got a visible counterpart in the same manner: the presence of template made possible long RNA polymers. The translation remained basically dark process but made visible by mRNA.
3. Dark DNA got a visible companion: again the presence of the template was - and still is - crucial.

What about generation of DNA and RNA? It is known that in reducing atmosphere DNA and RNA nucleobasis are obtained in an environment believed to mimick prebiotic situation: the presence of HCN and ammonia are necessary (<http://tinyurl.com/y9at46fe>). Reducing atmosphere <http://tinyurl.com/yc62g22f> does not oxidize, in other worlds does not contain oxygen and other oxidizing agents and can contain also actively reducing agents such as hydrogen, carbon monoxide. There are however some problems.

1. There is evidence that early Earth atmosphere contained less reducing molecules than thought in times of Miller. If life emerged in the underground water reservoirs as TGD strongly suggests, the usual atmosphere was absent and there are good hopes about reducing atmosphere.
2. The experiments using reducing gases besides those used in Miller's experiments produce both left and right handed polymers so that chiral selection is missing. This is not a surprise since weak interactions generate extremely small parity breaking for visible matter. If dark proton strings or even dark nuclei are involved, the Compton length of weak gauge bosons can be of the order of atomic length scale or even longer and weak interactions would be as strong as electromagnetic interactions. Therefore chiral selection becomes possible. The simplest option is that chirality selection occurred already for the helical magnetic flux tubes and induced that of biopolymers.

9 Water Memory And Pre-Biotic Life

Pollack's findings [L15] discussed from TGD view point in [K45, K41] provide new insights to the mechanisms of water memory and homeopathy. Also the attempts to understand the dependence of h_{eff} on parameters of the system involved provide help. This picture also suggests a more detailed vision about prebiotic life forms as analogs of exclusion zones involving charge separation leading to large value of h_{eff} .

9.1 Exclusion Zones As Prebiotic Cells

TGD based model model [L15], [K42] for Pollack's findings [L15] provides further guidelines.

1. Pollack *et al* discovered what they call exclusion zones and fourth gel like phase of water. The phenomenon occurs when water is bounded by gel and is irradiated with say visible light. Exclusion zones are negatively charged regions of water with positively charged environment. They act like batteries and have rather exotic properties. For instance, various impurities are repelled from exclusion zone.
2. The observed $H_{1.5}O$ stoichiometry implies that every fourth proton or hydrogen atom is dark and is transferred to the region outside the negatively charged exclusion zone. If only protons are transferred, very high negative charge density is generated. The size of the exclusion zone varies up to 100 μm and is in the range of cell sizes.
3. Dark matter corresponds in TGD Universe to phases with nonstandard value of Planck constant: $h_{eff} = n \times h$ phases at the "magnetic body" of the system (negatively charged region now). Magnetic body corresponds in Maxwell's theory to the magnetic fields generated by the system. Magnetic body consists of flux quanta (flux tubes and sheets).
4. If dark protons with say size scale of atomic size reside at flux tubes, one can assume that they form strings giving rise to dark atomic nuclei. Also ordinary nuclei consist of strings of dark protons and strings of neutrons. Various impurities are transferred from exclusion zone to the exterior suggesting that they become dark particles at magnetic flux tubes.

5. The quantum states of dark protons consist of 3 quarks and a simple model involving rotational symmetry around the axis of dark proton string predicts that the states of dark proton can be arranged into groups which correspond to DNA, RNA, amino-acids and possibly also tRNA molecules. Vertebrate genetic code can be realized as a natural correspondence between DNA/ RNA and amino-acids [L2, K25].
6. Negatively charged EZ could define a pre-biotic cell so that water would be a primitive pre-biotic life form. The voltage would be the analog of the resting potential. The transformation of dark protons to ordinary ones would liberate metabolic energy so that primitive metabolism and photosynthesis would be realized. One can also consider a more general possibility that cyclotron energies are different at flux tube portions in the interior and exterior of the EZ analogous to cell membrane. This would increase the value of the metabolic energy currency by adding to Josephson energy ZeV the difference of dark cyclotron energies proportional to h_{eff} . One expects that dark counterparts of basic bio-polymers are still present in living matter and play a fundamental role.

9.2 TGD View About Homeopathy, Water Memory, And Evolution Of Immune System

The following gives an attempt to build a brief sketch of TGD based model of water memory and homeopathy as it is after the input from Pollack's findings and $h_{eff} = h_{gr} = h_{em}$ hypothesis.

9.2.1 Summary of the basic facts and overall view

A concise summary of the basic qualitative facts about homeopathy [K25] could be following.

1. The manufacture of the homeopathic remedies consists of repeated dilution and agitation of water sample containing the molecules causing the effect which the remedy is intended to heal. This paradoxical looking healing method is based on "Alike likes alike" rule. This rule brings in mind vaccination causing immune system to develop resistance. The procedure seems to somehow store information about the presence of the molecules and this information induces immune response. Usually it is the organisms or molecules causing the disease which induce immune response.
2. The ultra-naïve and simplistic objection of skeptic is that the repeated dilution involved with the preparation of homeopathic remedy implies that the density of molecules is so small that the molecules can have absolutely no effect. Despite the fact that we live in information society, this is still the standard reaction of a typical skeptic.
3. A lot of research is done by starting from the natural idea that the electro-magnetic fields associated with the invader molecules (or more complex objects) represent the needed information and that water somehow gets imprinted by these fields. This could for instance mean that water clusters learn to reproduce radiation at frequencies characterizing the invader molecule. Benveniste is one of the most outstanding pioneers in the field [I24]. Benveniste *et al* [I25] even managed to record the VLF frequency finger print of some bio-active molecules and record them in binary form allowing to yield the same effect as the real bio-active molecule induced. Benveniste was labelled as a fraud. The procedure used by the journal Nature to decide whether Benveniste is swindler or not brings in mind the times of inquisition. It tells a lot about attitudes of skeptics that magician Randi was one member of the jury!
4. Benveniste's work has been continued and recently HIV Nobelist Montagnier produced what might be regarded as remote replication of DNA using method very similar to that used in manufacturing homeopathic remedy [I32, I33].

The general conclusion is that the em frequencies possibly providing a representation of the molecules are rather low - in VLF region - so that frequencies assignable to molecular transitions are not in question. Cyclotron frequencies assignable to the molecules are the most natural candidates concerning physical interpretation. The corresponding photon energies are extremely low

if calculated from $E = hf$ formula of standard quantum mechanics so that quantal effects in the framework of standard quantum theory do not seem to be possible.

My personal interest on water memory was sparked by the work of Cyril Smith [I19]. What I learned was what might be called scaling law of homeopathy [K25]. Somehow low frequency radiation seems to be transformed to high frequency radiation and the ratio $f_h/f_l \simeq 2 \times 10^{11}$ seems to be favored frequency ratio.

These two basic findings suggest what looks now a rather obvious approach to homeopathy in TGD framework. The basic physical objects are the magnetic bodies of the invader molecule and water molecule cluster or whatever it is what mimics the invader molecule. The information about magnetic body is represented by dark cyclotron radiation generated by the invader with frequency f_l . This dark radiation is transformed to ordinary photons with frequency f_h and energy $h_{eff}f_l = hf_h$, which is above thermal energy, most naturally in the range of bio-photon energies so that the radiation can directly induce transitions of bio-molecules. The analogs for the EZs discovered by Pollack are obvious candidates for “water molecule clusters”.

The following summarizes this overall picture in more detail.

9.2.2 Dark photon-bio-photon connection

The idea that bio-photons are decay product of dark photons emerged from the model of EEG [K19] in terms of dark photons with energies above thermal energy. Dark photons in question would be emitted as cyclotron radiation by various particles and molecules, perhaps even macromolecules like DNA sequences. Also cell membrane would emit dark photons with frequencies, which correspond in good approximation to differences of cyclotron energies for large value of $h_{eff} = nh$ [K45, K19].

1. Bio-photons have spectrum in the visible and UV would decay products of dark cyclotron photons. If the h_{eff} of particle is proportional to its mass then the cyclotron energy spectrum is universal and does not depend on the mass of the particle at all. The original model of EEG achieved this by assuming that h_{eff} is proportional to the mass number of the atomic nucleus associated with the ion.
2. The ideas about dark matter involve two threads: $h_{eff} = n \times h$ thread motivated by biology and the thread based on the notion of gravitational Planck constant and inspired by the observation that planetary orbits seem to obey Bohr rules. $\hbar_{gr} = GMm/v_0$ is assigned to the pairs of gravimagnetic flux tubes and massless extremals making possible propagation of dark gravitons. The realization was the two threads can be combined to single thread: by Equivalence Principle h_{gr} hypothesis is needed only for microscopic objects and in this case $h_{eff} = h_{gr}$ makes sense and predicts that dark photon energies and dark particle Compton lengths do not depend on particle and that bio-photon energy spectrum is universal and in the desired range if one assumes that h_{gr} is associated with particle Earth par with v_0 the rotational velocity at the surface of Earth. Even $h_{eff} = h_{em} = h_{gr}$ hypothesis makes sense. $h_{em} = h_{gr}$ is also very natural assumption for ATP synthase which can be regarded as a molecular motor whose rotation velocity appears in the formula for h_{em} .
3. The prediction would be that any charged system connected to Earth by flux tubes generates cyclotron dark photons decaying to bio-photons. Bio-photons in turn induce transitions in biomolecules because the energy range is in visible and UV. Magnetic bodies can control biochemistry via resonant coupling with bio-photons.

9.2.3 Molecular recognition mechanism as basic building brick of primitive immune system

The reconnection of U-shaped magnetic flux tubes emanating from a system makes possible a recognition mechanism involving besides reconnection also resonant interaction via cyclotron radiation which can induced also biochemical transitions of $h_{eff} = h_{gr}$ hypothesis holds true.

1. Molecules have U-shaped flux tube loops with fluxes going in opposite directions. This makes possible also super-conductivity with members of Cooper pair at the parallel flux tubes carrying magnetic fluxes in opposite direction since magnetic fields now stabilize Cooper pairs rather than tend to destroy them.

2. The flux loops associated with systems - call them A and B - can reconnect and this leads to the formation of 2 parallel flux tubes connecting A and B. Stable reconnection suggests that magnetic field strengths must be same at the flux tube pairs associated with A and B. This implies same cyclotron frequencies and resonant interaction. This would define molecular mechanism of recognition and sensing the presence of invader molecules - even conscious directed attention might be involved.
3. Systems with magnetic body could be constantly varying the thicknesses of at least some of their flux tubes and in order to reconnect with the magnetic body of a possible invader. This activity could be behind the evolution of the immune system.

The question is how the system or its sub-system could stabilize itself so that it would receive signals only from one kind of molecule specified by its cyclotron frequency spectrum.

1. If the flux tubes carry monopole flux (this is possible in TGD framework and requires the flux tube cross section is closed 2-surface), stabilization of the flux tube thickness stabilizes the magnetic field strength. How the stabilization of the thickness of the flux tubes could have been achieved?

Pollack's negatively charged EZs with dark protons at magnetic flux tubes giving rise to dark nuclei identifiable as dark proton sequences suggests an answer. Maybe the presence of dark proton sequences could stabilize the flux tube thickness. Dark proton sequences have also interpretation as dark DNA/RNA/amino-acid sequences [L2].

A further question is whether the magnetic body of the prebiotic cell identified as EZ could use the information about invader molecule to represent its magnetic body either concretely and perhaps even symbolically and regenerate the concrete representation when needed.

1. The concrete representation could be in terms of dark proteins whose folding would represent the topology of the invader molecule and symbolic representation in terms of dark DNA transcribed to dark protein. If the dark protein has same topology of knotting it could more easily attach to the invader molecule and make it harmless. Note that the invaders are naturally other dark DNAs and proteins just as in living matter. The higher purpose behind this cold war would be stimulation of mimicry - emulation in computer science - leading to generation of cognitive representations and negentropic entanglement.
2. Not only the representation of the 3-D magnetic body - its behavior - is possible. In ZEO also the representation of the dynamical evolution of magnetic body becomes possible since basic objects are pairs of 3-surfaces at future and past boundaries of causal diamond. The challenge is to represent the topology time development of magnetic body - 2-braiding, first concretely by mimicking it and then symbolically in terms of DNA coding for proteins doing the mimicry. The obvious representation for the behavior of magnetic body of invader molecule would be in terms of folding and unfolding of protein representing it.
3. The question how the symbolic representation could have emerged leads to a vision about how genetic code emerged. The model for living system as topological quantum computer utilizing 2-braiding for string world sheets at 4-D space-time leads to the idea that 3-D coordinate grids formed by flux tubes are central for TQC: each node of grid is characterized by 6 bits telling about the topology of the node concerning 2-braiding. Could the 6 bits of dark DNA code for the local topology of the invader molecule and an the flux tube complex mimicking it?
4. This raises the possibility that DNA strands - one for each coordinate line in say z-direction could code for the 2-braiding of 3-D coordinate grid and in this manner code for the magnetic template of invader molecule and also that of the biological body. Therefore genetic code would code for both the basic building bricks of the biological body and 4-D magnetic body serving as template for the development of biological body.

One can imagine how the biochemical evolution after this stage might have taken place.

1. At the next step the chemical representation of genetic code would have emerged. Dark proteins learned to attach to real proteins and real proteins to other proteins and DNA and bio-catalysis became possible.
2. The transformation of the ordinary photons emitted in the transitions of biomolecules to dark photons made possible the recognition of invader molecules using ordinary photons emitted in their molecular transitions.
3. Magnetic bodies learned to control biochemical reactions by using dark cyclotron radiation transformed to bio-photons.
4. Gradually dark and ordinary proteins developed a rich repertoire of functions relying on reconnection, communication by dark photons, and attachment in invader molecule. Proteins began to serve as building bricks, as bio-catalysts, promote the replication of DNA, responding to stimuli, serve as receptors.

9.2.4 Possible mechanism of water memory and homeopathy

The general vision about prebiotic evolution described above suggests that the mechanisms of water memory and homeopathy are basically the same as those underlying the workings of the immune system.

1. Exclusion zones could define primordial life forms with genetic code. They are able to detect the presence of invader molecule from its cyclotron frequency spectrum.
2. Dark proteins can form concrete memory representations of the invader molecules in terms of dark proton sequences defining dark proteins. The folding of these dark proteins mimics the behavior of the magnetic bodies of the invaders. These dark proteins can attach to the magnetic body of the invader molecule to make it non-dangerous. Even symbolic representations in terms of dark DNA allowing transcription and translation to concrete dark protein representation could be involved. The procedure involved in the manufacture of homeopathic remedy could be seen as a series of “environmental catastrophes” driving the evolution of dark primordial life by feeding in metabolic energy and generating new EZs, which mimic the invader molecules and existing EZs mimicking them.
3. In organism the dark DNA representing the invader molecule would generate ordinary genes coding for ordinary proteins attaching to the invader molecules by the attachment of ordinary DNA nucleotides to them. The attachment would involve h_{eff} reducing phase transition reducing the length of connecting flux tube.
4. Later dark genetic code transformed to chemical genetic code as dark DNA strands were formed around dark double strands and large number of other biological functions emerged besides immune response.
5. The mechanical agitation in the manufacturing of homeopathic remedy generates exclusion zones and new primitive life forms by providing the needed energy. These in turn recognize and memorize invader molecules and their already existing representations as EZs.

9.3 Direct Empirical Evidence For Dark DNA?!

Sciencedaily tells about extremely interesting finding related to DNA (<http://tinyurl.com/pbzqx36>). The finding is just what breakthrough discovery should be: it must be something impossible in the existing world view.

What has been found [I35] (<http://tinyurl.com/y9849jkz>) is that knock-out (removing parts of gene to prevent transcription to mRNA) and knock-down of gene (prevent protein translation) seem to have different consequences. Removing parts of gene need not have the expected effect at the level of proteins! Does this mean that somehow DNA as a whole can compensate the effects caused by knock-out but not those by knock-down? This explanation is natural in the standard conceptual framework and is proposed in the article.

Could this be explained by assuming that genome is a hologram as Gariaev *et al* (<http://tinyurl.com/ycosxzen>) [I26, I1] have first suggested? Also TGD leads to a vision about living system as a conscious hologram [K13]. Small local changes of genes could be compensated. Somehow the entire genome would react like brain to a local brain damage: other regions of brain take the duties of the damaged region. Could the idea about DNA double strand as nano-brain having left and right strands instead of hemispheres"help here. Does DNA indeed act as a macroscopic quantum unit? The problem is that transcription is local rather than holistic process. Something very simple should lurk behind the compensation mechanism.

9.3.1 Could transcription transform dark DNA to dark mRNA?

Also the TGD based notion of dark DNA comes in mind [K25, L2] (<http://tinyurl.com/ybp338x5>, <http://tinyurl.com/yag67j4p>). Dark DNA consists of dark proton sequences for which states of single DNA proton correspond to those of DNA, mRNA, aminoacids, and tRNA. Dark DNA is one of the speculative ideas of TGD inspired quantum biology getting support from Pollack's findings (<http://tinyurl.com/oyhstc2> [L15], [K40]). Ordinary biomolecules would only make their dark counterparts visible: dark biomolecules would serve as a template around which ordinary biomolecules such as DNA strands are formed in TGD Universe. All basic biomolecules of genetics would be pairs of ordinary biomolecule and its dark proton analog.

Although ordinary DNA is knocked out of ordinary gene, dark gene would still exist! If dark DNA actually serves as template for the transcription to mRNA, everything is still ok after knock-out! Could it be that we do not understand even transcription correctly? Could it actually occur at the level of dark DNA and mRNA?! Dark mRNA would attach to dark DNA after which ordinary mRNA would attach to the dark mRNA. One step more!

Damaged DNA could still do its job! DNA transcription would have very little to do with bio-chemistry! If this view about DNA transcription is correct, it would suggest a totally new manner to fix DNA damages. These damages could be actually at the level of dark DNA, and the challenge of dark genetic engineering would be to modify dark DNA to achieve a proper functioning.

9.3.2 Could dark genetics help to understand the non-uniqueness of the genetic code?

Also translation could be based on pairing of dark mRNA and dark tRNA. This suggests a fresh perspective to some strange and even ugly looking features of the genetic code. Are DNA and mRNA always paired with their dark variants? Do also amino-acids and anticodons of tRNA pair in this manner with their dark variants? Could the pairings at dark matter level be universal and determined by the pairing of dark amino-acids with the anticodons of dark RNA? Could the anomalies of the code be reduced to the non-uniqueness of the pairing of dark and ordinary variants of basic bio-molecules (pairings RNA–dark RNA, amino-acid– dark amino-acid, and amino-acid–ordinary amino-acid in tRNA).

1. There are several variants of the genetic code differing slightly from each other: correspondence between DNA/mRNA codons and amino-acids is not always the same. Could dark-dark pairings be universal? Could the variations in dark anticodon - anticodon pairing and dark amino-acid-amino-acid pairing in tRNA molecules explain the variations of the genetic code?
2. For some variants of the genetic code a stop codon can code for amino-acid. The explanation at the level of tRNA seems to be the same as in standard framework. For the standard code the stop codons do not have tRNA representatives. If stop codon codes for amino-acids, the stop codon has tRNA representation. But how the mRNA knows that the stop codon is indeed stop codon if the tRNA associated with it is present in the same cell?

Could it be that stop codon property is determined already at the level of DNA and mRNA? If the dark variant of genuine stop codon is missing in DNA and therefore also in mRNA the translation stops if it is induced from that at the level of dark mRNA. Could also the splicing of mRNA be due to the splitting of dark DNA and dark mRNA? If so genes would be separated from intronic portions of DNA in that they would pair with dark DNA. Could it be that the intronic regions do not pair with their dark counterparts. They would be specialized to topological quantum computations in the TGD inspired proposal [K3].

Start codon (usually AUG coding met) serves as a Start codon defining the reading frame (there are 3 possible reading frames). Dark DNA would naturally begin from this codon.

3. Also two additional amino-acids Pyl and Sec appear in Nature. Gariaev *et al* have proposed that the genetic code is context dependent so that the meaning of DNA codon is not always the same. This non-universality could be reduced to the non-uniqueness of dark amino-acid-amino-acid pairing in tRNA if genetic code is universal.

9.3.3 Could dark genetics help to understand wobble base pairing?

Wobble base pairing (<http://tinyurl.com/y73se8vs>) is second not-so-well understood phenomenon. In the standard variant of the code there are 61 mRNAs translated to amino-acids. The number of tRNA anticodons (formed by the pairs of amino-acid and RNA molecules) should be also 61 in order to have 1-1 pairing between tRNA and mRNA. The number of ordinary tRNAs is however smaller than 61 in the sense that the number of RNAs associated with them is smaller than 45. tRNA anticodons must be able to pair with several mRNA codons coding for given amino-acid. This is possible since tRNA anticodons can be chosen to be representative for the mRNA codons coding a given amino-acid in such that all mRNA codons coding for the same amino-acid pair with at least one tRNA anticodon.

1. This looks somewhat confusing but is actually very simple: genetic code can be seen as a composite of two codes: first 64 DNAs/mRNAs to are coded to $N < 45$ anticodons in tRNA, and then these N anticodons are coded to 20 amino-acids. One must select N anticodon representatives for the mRNAs in the 20 sets of mRNA codons coding for a given amino-acid such that each amino-acid has at least one anticodon representative. A large number of choices is possible and the wobble hypothesis of Crick pose reduce the number of options.
2. The wobble hypothesis of Crick states that the nucleotide in the third codon position of RNA codon of tRNA has the needed non-unique base pairing: this is clear from the high symmetries of the third basis. There is exact U-C symmetry and approximate A-G symmetry with respect to the third basis of RNA codon (note that the conjugates of RNA codons are obtained by $A \leftrightarrow U$ and $C \leftrightarrow G$ permutations).
3. The first two basis in the codon pair in 1-1 manner to the second and third basis of anticodon. The third basis of anticodon corresponds to the third letter of mRNA codon. If it is A or C the correspondence is assumed to be 1-to-1: this gives 32 tRNAs. If the first basis of anticodon is G or U the 2 mRNA basis can pair with it: they would be naturally A for G and C for U by symmetry. One would select A from A-G doublet and C from U-C double. This would give 16 anticodons: 48 anticodons altogether, which is however larger than 45. Furthermore, this would not give quite the correct code since A-G symmetry is not exact.

Smaller number of tRNAs is however enough since the code has almost symmetry also with respect to A and C exchange not yet utilized. The trick is to replace in some cases the first basis of anticodon with Inosine I, which pairs with 3 mRNA basis. This replacement is possible only for those amino-acids for which the number of RNAs coding the amino-acid is 3 or larger (the amino-acids coded by 4 or 6 codons).

4. It can be shown at least 32 different tRNAs are needed to realize genetic code by using wobble base pairing. Full A-C and G-U symmetry for the third basis of codon would give $16+16=32$ codons. One can ask whether tRNA somehow realizes this full symmetry?

How dark variants of could help to understand wobble base pairing? Suppose for a moment that the visible genetics be a shadow of the dark one and fails to represent it completely. Suppose the pairing of ordinary and dark variants of tRNA anticodons *resp.* amino-acids and that translation proceeds at the level of dark mRNA, dark anticodons, and dark amino-acids, and is made visible by its bio-chemical shadow. Could this allow to gain insights about wobble base pairing? Could the peculiarities of tRNA serve for some other - essentially bio-chemical - purposes?

The basic idea would be simple: chemistry does not determine the pairing but it occurs at the level of the dark mRNA codons and dark tRNA anticodons. There would be no need to reduce wobble phenomenon to biochemistry and the only assumption needed would be that chemistry does

not prevent the natural dark pairing producing standard genetic code apart from the modifications implied by non-standard dark amino-acid–amino-acid pairing explaining for different codes and the possibility that stop codon can in some situation pair with dark mRNA.

One can consider two options.

1. The number of dark RNAs is 64 and the pairings between dark mRNA and dark anticodons and dark anticodons and dark amino-acids are 1-to-1 and only the pairing between dark RNA codons and anticodons in tRNA is many-to-1.
2. The model of dark genetic code [K25] suggests that there are 40 dark proton states, which could serve as dark analogs of tRNA. This number is larger than 32 needed to realize the genetic code as a composite code. I have cautiously suggested that the proposed universal code could map dark mRNA states of the same total spin (there is breaking of rotational symmetry to that around the axis of dark proton sequences) to dark tRNA/dark amino-acid states with the same total spin projection. The geometric realization would in terms of color flux tubes connecting the dark protons of corresponding dark proton sequences. Also in ordinary nuclei the nucleons are proposed to be connected by color flux tubes so that they form nuclear strings [L2] and dark proton sequences would be essentially dark variants of nuclei.

One should understand the details of the dark mRNA–tRNA anticodon correspondence. One can also ask whether the dark genetic code and the code deduced from the icosahedral model for music harmony [K46] [L11] are mutually consistent. This model implies the decomposition of 60+4 DNA codons to 20+20+20+4 codons, where each “20” corresponds to one particular icosahedral Hamilton’s cycle with characteristic icosahedral symmetries. “4” can be assigned to tetrahedron regarded either disjoint from icosahedron or glued to it along one of its faces. This allows to understand both the standard code and the code with two stop codons in which exotic amino-acids Pyl and Sec appear. One should understand the compositeness $64 \rightarrow 40 \rightarrow 20$ of the dark genetic code and whether it relates to the icosatetrahedral realization of the code.

I have proposed [K29] (<http://tinyurl.com/ycm48w54>) that dark variants of transcription, translation, etc.. can occur and make possible kind of R&D laboratory so that organisms can test the consequences of variations of DNA. If ordinary translation and transcription are induced from their dark variants it would not be surprising and if dark biomolecules could also appear as unpaired variants, these processes could occur as purely dark variants. Organisms could indeed do experimentation in the virtual world model of biology and pairing with ordinary bio-molecules would make things real.

There is now evidence for this picture. It has been discovered [J14] (<http://tinyurl.com/oec3mff>) that brain cells have a mosaic like distribution of genomes (<http://tinyurl.com/odwajdq>). In standard framework this mosaic should be created by random mutations. The mechanism of mutation is reported to involve transcription rather than DNA replication. The mutation would take place for DNA when its is copied to RNA after opening of the DNA double strand. The mutations would have occurred during the period when neurons replicate and the mutation history can be read by studying the distributions of changes in the genome.

This brings in mind the finding that removing a part of gene does not affect transcription. In both cases it is dark DNA, which would serve as a template for transcription rather than ordinary DNA. This suggests that the dark DNA is not changed in these modifications and mRNA is determined by the dark DNA, which would serve as a template for transcription rather than ordinary DNA. If this were the case also for neurons, the mutations of neuronal genes should not affect the gene transcription at all, and there would be no negative (or positive) effects on brain function. This seems too conservative. The mutations should have some more active role.

One can consider also different interpretation. The mutations of DNA could be induced by the dark DNA. As dark DNA changes, ordinary DNA associated with it is forced to change too - sooner or later. Especially so when the genome is in a state in which mutations can take place easily. Neurons during to replication stage could have such quantum critical genomes.

Evolution would not be mere selection by a survival of random mutations by external environment in the time scale much longer than lifetime of individual - but a controlled process, which can occur in time scale shorter than lifetime and differently inside parts of say brain. This is what

the idea TGD inspired biology suggests. The modified DNA could be dark DNA and serve as template for transcription and also induce transformation of ordinary DNA associated with it.

Whether this change can be transferred to the germ cells to be transferred to the offspring remains of course an open question. For instance, one can imagine that dark DNA strands (magnetic flux tubes) can penetrate germ cell membranes and replace the earlier dark DNA sections and induce change of ordinary DNA. Or is a more delicate mechanism involving dark photons in question. With inspiration coming from the findings reported by Peter Gariaev [I26] I have proposed a model of remote DNA replication suggesting that DNA can be replicated remotely if the needed nucleotides are present [K67]: the information about DNA could be transferred as dark photons, which can be transformed to ordinary photons identified as bio-photons. Could Lysenko have been at least partially right despite that he was a swindler basing his views on ideology?

In any case, TGD inspired biology allows to imagine a controlled evolution of DNA in analogy to that what occurs in R&D departments of modern technological organizations. The notion of dark DNA suggests that biological systems indeed have a "R&D department" in which new variants of DNA studied as "dark DNA" sequences realised as dark proton sequences - same about dark RNA, and amino-acids and even tRNA. The possibility to transcribe RNA from dark DNA would mean that the testing can be carried in real life situations.

There indeed exists evidence that traumatic - and thus highly emotional - memories may be passed down through generations in genome [J6] (<http://tinyurl.com/oja8v94>). Could the modifications of brain DNA represent long term memories as the above described experiment suggests? Could the memories be transferred to the germ cells using the mechanism sketched above?

9.4 Is Replication Of Magnetic Body Behind Biological Replication?

The vision about exclusion zone (EZ) like regions as primordial life forms and facts about water memory and homeopathy lead to a vision about how primitive immune system might have developed and how the recent genetic code might have emerged.

Magnetic body and dark analogs of bio-polymers should still play key role in living matter. The basic idea is that the time evolution of the magnetic body is the template for the time evolution of the biological body. In [K43] [L13] various pieces of evidence for the role of magnetic body as "morphogenetic field" are discussed. For instance, the replication of DNA and cell would reduce basically to that for corresponding magnetic bodies.

Replication of magnetic body is analogous to what happens in 3-vertex of Feynman diagram. This occurs in several scales. This would make possible dark DNA (dDNA) replication and copying of dDNA to dDNA+dRNA as well as copying of dRNA to dRNA+dark protein.

Replication process should start from the higher levels of dark matter hierarchy and proceed to shorter scales. The basic constraint from ZEO is that the time evolutions of magnetic bodies at various levels of the hierarchy are highly unique as preferred extremals connecting initial and final 3-surfaces. For the maxima of vacuum functional only preferred pairs of 3-surfaces are possible. This gives rise to what might be called "standard behaviors". Also the replication would be this kind of behavioral pattern. In the context of the positive energy ontology it is extremely difficult to understand why the predictability of cell replication or the development of organism from single cell by repeated cell divisions.

Remote gene replication [K67] might be one application: the model described was actually developed before the idea that the replication of the magnetic body could be the fundamental mechanism. Its reversal could be basic mechanism of bio-catalysis and induce the attachment of bio-molecules together. Also ordinary DNA replication could be induced by the same electromagnetic signal as remote replication.

The sketch about replication of DNA would look roughly like following.

1. Assume that the portion of DNA promoting DNA replication is activated by dark radiation at some frequency and that the promoter region emits radiation with same frequency. This activates further promoter regions -also in other cell nuclei. The replication process is amplified exponentially. The negative feedback is necessary in the general case and is provided by attachment of the produced proteins (basically dark proteins) to the genes making them inactive.

2. This might occur during cell division which might involve irradiation by dark analog of white noise exciting all promoter regions. Certainly the coherence of this process is essential and here the higher levels of the dark matter hierarchy would be essential.
3. Remote replication becomes possible if the dark radiation exciting promoter region can leak to other cells or even other organisms. Large h_{eff} might make this possible.
4. Also remote transcription is possible by the same mechanism. Actually remote variants of very many basic processes seem to be possible.
5. The observations of Peter Gariaev's group about effects of laser light on genes [I28, I42] support this view as also the findings of group of HIV Nobelist Montagnier [I32, I33].

9.5 Quantum Model For Metabolism

First it is good to list some basic facts about energy metabolism.

1. $ADP \rightarrow ATP$ meaning the addition of phosphate to ADP is believed to be the fundamental step of metabolism. The process occurs when protons flow through the ATP synthase, which can be regarded as a nano-motor with a rotating shaft. During single turn three ADPs are phosphorylated and 3 protons flow through the "turbine" of the nano-motor and give up their Coulombic and chemical energy parameterized in terms of chemical potential difference. There is clearly a strong analogy with power plant. High energy phosphate bond is believed to receive the metabolic energy transferred from the flow of protons through the mitochondrial membrane.
2. The nominal value of metabolic energy quantum about .5 eV. The Coulomb energy associated with the mitochondrial membrane is 50-80 meV and by almost order of magnitude too small. The large chemical potential difference is believed to explain the large metabolic energy gain. This requires that the process is regarded as purely thermodynamical. This is a questionable assumption even in standard physics context and does not conform with the TGD based idea that transmembrane proteins such as ATP synthase act as large h_{eff} Josephson junctions. The square root of thermodynamics forced by zero energy ontology suggests itself as a proper description of cell membrane as macroscopically quantum coherent system.
3. The notion of high energy phosphate bond is not well understood. The storage of energy dark cyclotron energy at the magnetic body of phosphate suggests itself as TGD based description.

9.5.1 How to understand the value of h_{eff} ?

The basis problem is to understand how h_{eff} depends on the parameters characterizing the situation at the magnetic flux tube connecting two systems. I have considered several mechanisms for the generation of large h_{eff} phase.

1. The model for h_{eff} in systems involving charge separation stimulated by AC current was based on the identification of Josephson frequency with the frequency of AC current: $f_J = E_J/h_{eff} = f_{AC}$ predicting $h_{eff}/h = E_J/hf_{AC}$ [K7].

The findings of Pollack and the difficulties to understand metabolic energy quantum of nominal value .5 eV in the simplest model for cell membrane as Josephson junction as Josephson energy for Cooper pair equal to $ZeV = 10 - 10.6$ mV inspired the assumption that cyclotron energies at flux tubes traversing cell membrane can be different at the two sides of the cell membrane [K19, K45]. This would lead to a generalization of the notion of Josephson junction associated with the transmembrane protein and generalizes $f_J = f_{AC}$ to $\Delta f_c + f_J = f_{AC}$ predicting $h_{eff}/h = E_J/(h(\Delta f_c - f_{AC}))$ so that h_{eff}/h would get arbitrarily large values near resonance $f_{AC} = f_c$. Note that correct sign requires $\Delta f_c - f_{AC} > 0$.

2. The conjecture $\hbar_{eff} = \hbar_{gr} = GMm/v_0$ could make sense at microscopic level for particle-Earth pair and would predict a universal spectrum of bio-photons if identified as resulting from the decays of dark cyclotron photons to bio-photons. The first guess for the parameter

v_0 would be as a rotational velocity associated with the two systems such as Earth and electron rotating with it. In case of planetary orbits $v = v_0$ is not consistent with

$$\frac{v}{c} = \frac{\sqrt{\frac{v_0}{c}}}{4\pi n}$$

following from Bohr rules in $1/r$ potential (n denotes the principal quantum number).

3. $h_{eff} = h_{em} = Z_1 Z_2 e^2 / v_0$ hypothesis is a natural looking generalization in systems involve large charge separations, say the exclusion zones discovered by Pollack providing a model for prebiotic life forms. The philosophy would be that when the coupling strength between systems becomes so large that perturbation theory fails, the value of h_{eff} increases and makes perturbation theory in powers of $1/h_{eff}$ possible again. At space-time level this means emergence of non-determinism so that 3-surfaces at the future and past boundaries of causal diamond are connected by n-branched space-time surface for which branches fuse at the two ends. Dark matter would be Nature's manner to define what non-perturbative phases are. The strong hypothesis $h_{eff} = h_{em} = h_{gr}$ might make possible reconnection between em and gravimagnetic flux tubes and ATP synthase is here a candidate system.
4. Rotating magnetic systems with high negative charge are also good candidates for generating large h_{eff} at the magnetic flux tubes possibly contain dark proton sequences identifiable as dark nuclei. I have also proposed that a system subject to constant torque allowing description in terms of potential function which is multivalued as function of the angle coordinate ϕ leads rather naturally to generation of large h_{eff} [K29] when one requires internal consistency.

9.5.2 How metabolic energy is transferred?

The basic question concerns the mechanism of energy transfer from nutrients. It should be however emphasized that the transfer might not be the really important aspect. The transfer of negentropic entanglement from nutrient to the organism might be of equal importance.

1. Zero energy ontology (ZEO) suggests that magnetic bodies are carriers of the metabolic energy. What does this mean is not quite clear but cyclotron energies or ions or Cooper pairs of them proportional to h_{eff} are obvious candidates concerning energy storage. The value of $h_{eff} \simeq 10^{14}$ guaranteeing the energies of dark EEG photons are in the range of bio-photon energies would mean that storage as cyclotron energies is very effective and the liberated energy quanta can directly induce molecular transitions essential for bio-chemical reactions.
2. The liberation of metabolic energy could take place in a phase transition in which p-adic length scale increases and h_{eff} is reduced in such a way that the length of flux tubes is not changed. This induces a coherent quantum transition in the sense that large number of particles can liberate cyclotron energy as cyclotron energy scale is reduced in the reduction of magnetic field strength. As protons flow from thinner flux tube with smaller h_{eff} to thicker one, similar reduction of cyclotron energy takes place and the energy is liberated, and would be received by ATP synthase to form ATP from ADP. This mechanism could be universal and at work also in other situations.
3. At quantitative level the identification $h_{eff} = h_{gr}$ of gravitational Planck constant with $h_{eff} = n \times h$ at microscopic level at least is an attractive hypothesis [K56, K45]. Gravitational Planck constant can be expressed as $\hbar_{gr} = GMm/v_0$, where v_0 is taken to be the rotational velocity of Earth. Assuming this for Cooper pairs of rotating super-conductor explains the gravimagnetic anomaly claimed by Tajmar et al [?, ?]. It also predicts a universal energy spectrum of dark cyclotron photons in the range of bio-photon energies and gives thus support for the hypothesis that dark EEG photons decay to bio-photons. The metabolic energy quantum for proton of order .5 eV is consistent with the identification as cyclotron energy difference for proton over mitochondrial membrane. The hypothesis $h_{em} = h_{eff} = h_{gr}$ makes also sense for the nano-motor defined by ATP synthase transforming ADP to ATP. The interpretation would be that this condition makes possible the reconnection of electromagnetic and gravitational flux tubes.

One can imagine also different scenario involving phase transition changing the value of h_{eff} assignable to atoms. TGD indeed predicts also small values of h_{eff} . $h_{eff} = h_{em}$ would hold true when em interaction becomes non-perturbative. In this case NE would be short ranged and associated with atomic/molecular systems with nonstandard value of h_{eff} .

1. For dark atoms the scale of binding energy behaves like $1/h_{eff}^2$ and is thus reduced for dark atoms [?]. The creation of dark atoms would require metabolic energy. This metabolic energy could also be liberated as dark atoms transforms to ordinary atom. Metabolic electrons could be associated with dark atoms and also the dark atoms in nutrients could provide metabolic energy driving protons through the mitochondrial membrane against potential gradient and transforming ADP to ATP contains high energy phosphate bond, which would actually correspond to the presence of dark (say hydrogen -) atom. Phosphate containing the dark atom would carry the negentropic entanglement or be accompanied by dark magnetic flux tube.
2. Phosphorylation and de-phosphorylation could be interpreted in terms of reconnection of flux tubes so that the dark proton associated with phosphate is transferred to the acceptor molecule. I have proposed that the deeper meaning of metabolism is transfer of negentropic entanglement (NE). The reconnection of flux tubes would transfer NE between ATP and third party to NE between acceptor molecule and third party. There is a large number of alternative identifications for NE. It could be short range entanglement associated with $h_{eff} = h_{em}$ assignable to electron and nucleus of dark atoms, to pairs of atoms or molecules, or very long range entanglement between molecule and large scale structure with size scale of Earth or even galaxy and associated with $h_{eff} = h_{gr}$. Both forms of NE might be involved and distinguish between two evolutionary levels.
3. Short ranged NE could be associated with dark atoms for which the scale of binding energy behaves like $1/h_{eff}^2$ and is thus reduced for dark atoms [?]. The creation of dark atoms would require metabolic energy. This metabolic energy could also be liberated as dark atoms transforms to ordinary atom. The dark atoms in nutrients transforming to ordinary atoms could provide the metabolic energy driving protons through the mitochondrial membrane against potential gradient and transforming ADP to ATP contains high energy phosphate bond, which would actually correspond to the presence of dark (say hydrogen -) atom. Phosphate containing the dark atom would carry the NE or be accompanied by dark magnetic flux tube. The transfer of NE would mean its disappearance followed by reappearance and it could happen that $h_{eff}/h = n$ is reduced in the process.
4. The simplest view about photosynthesis would be that the absorption of solar photons excites some atoms to dark states and that nutrients contain these dark atoms as stable enough entities. The contamination of nutrients could mean the decay of these dark atoms to the normal states.

9.5.3 Exclusion zones as prebiotic cells

TGD based model model [L15], [K42] for Pollack's findings [L15] provides further guidelines.

1. Pollack *et al* discovered what they call exclusion zones and fourth gel like phase of water. The phenomenon occurs when water is bounded by gel and is irradiated with say visible light. Exclusion zones are negatively charged regions of water with positively charged environment. They act like batteries and have rather exotic properties. For instance, various impurities are repelled from exclusion zone.
2. The observed $H_{1.5}O$ stoichiometry implies that every fourth proton or hydrogen atom is dark and is transferred to the region outside the negatively charged exclusion zone. If only protons are transferred, very high negative charge density is generated. The size of the exclusion zone varies up to 100 μm and is in the range of cell sizes.
3. Dark matter corresponds in TGD Universe to phases with nonstandard value of Planck constant: $h_{eff} = n \times h$ phases at the "magnetic body" of the system (negatively charged

region now). Magnetic body corresponds in Maxwell's theory to the magnetic fields generated by the system. Magnetic body consists of flux quanta (flux tubes and sheets).

4. If dark protons with say size scale of atomic size reside at flux tubes, one can assume that they form strings giving rise to dark atomic nuclei. Also ordinary nuclei consist of strings of dark protons and strings of neutrons. Various impurities are transferred from exclusion zone to the exterior suggesting that they become dark particles at magnetic flux tubes.
5. The quantum states of dark protons consist of 3 quarks and a simple model involving rotational symmetry around the axis of dark proton string predicts that the states of dark proton can be arranged into groups which correspond to DNA, RNA, amino-acids and possibly also tRNA molecules. Vertebrate genetic code can be realized as a natural correspondence between DNA/ RNA and amino-acids [L2, K25].
6. Negatively charged EZ could define a pre-biotic cell so that water would be a primitive pre-biotic life form. The voltage would be the analog of the resting potential. The transformation of dark protons to ordinary ones would liberate metabolic energy so that primitive metabolism and photosynthesis would be realized. One can also consider a more general possibility that cyclotron energies are different at flux tube portions in the interior and exterior of the EZ analogous to cell membrane. This would increase the value of the metabolic energy currency by adding to Josephson energy ZeV the difference of dark cyclotron energies proportional to h_{eff} . One expects that dark counterparts of basic bio-polymers are still present in living matter and play a fundamental role.

9.5.4 What might happen in $ADP \rightarrow ATP$ process?

The identification of the exclusion zone with magnetic body as a basic structure allows to speculate about what might happen in $ADP \rightarrow ATP$ process and how ATP might store metabolic energy.

1. The strings of dark protons [K25] would be analogous to basic bio-polymers serving as the basic fuel of metabolics hydrolysed in metabolism. Basic biopolymers tend to be negatively charged and could therefore be accompanied by dark proton strings and the liberated metabolic energy might be stored by these strings as cyclotron energy and as Coulomb energy.
2. The simplest guess is that metabolism has developed from the transformation of dark protons to ordinary ones as the analog of EZ transforms back to ordinary water and potential difference disappears. One can also consider generalizations of this picture. A phase transition reducing h_{eff} and increasing p-adic scale such that the size scale of the flux tube remains fixed but cyclotron energy is reduced. This phase transition could also effectively accompany the flow of protons through the boundary of EZ if h_{eff} is smaller and p-adic scale longer at the other side. This mechanism could be still at work at the level of mitochondria for dark protons.
3. The notion of high energy phosphate bond is somewhat mysterious. ATP is negatively charged and one can wonder whether it could be accompanied by EZ assignable to the negatively charged phosphates. Also DNA strands and many other biomolecules carry negative charge due to the phosphates. Could the metabolic energy be stored to the magnetic body of ATP or of phosphate and eventually liberated by flow of protons to flux tubes with weaker magnetic field?

One can ask why the rotation of ATP synthase motor is necessary. Could the centrifugal acceleration drive dark particles to the magnetic body or keep them there thus stabilizing the dark phase? The dark protons at the magnetic body rotating with the system would remain to magnetic body and would avoid transition to ordinary protons if it is induced by the vicinity of ordinary protons serving as seeds for phase transition. If this interpretation is in the right direction, the rotating magnetic systems might provide a way to create dark matter [K10].

9.5.5 Energy metabolism as transfer of negentropic entanglement?

Negentropic entanglement (NE, see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig. ??** in the appendix of this book) is 2-particle property (or more generally $n > 1$ -particle property). One can argue that this is not consistent with the naïve idea about systems carrying NE as a resource analogous to metabolic energy. If negentropy transfer is behind metabolism and if one accepts this objection, one must ask whether metabolism actually corresponds to a transfer of NE between nutrient A and some fixed system B so that NE transforms to that between receiver R and same fixed system B? If so, could this could B correspond some higher collective level of consciousness perhaps identifiable as gravitational Mother Gaia (MG) as suggested by the success of $h_{gr} = h_{eff}$ hypothesis at microscopic level?

1. Negentropic entanglement (NE) would be transferred. Nutrients would be negentropically entangled with something very crucial for life. MG is a good candidate in this respect. Even Sun can be considered. Gravitational NE with MG would make possible dark EEG, etc... Basic formula is $\hbar_{gr} = GMm/v_0$, v_0 the rotational velocity at surface at the surface of Earth.
2. Formula generalizes to em case: $h_{em} = Z_1 Z_2 e^2 / v_0$ and would apply to ATP synthase being consistent with $h_{gr} = h_{em} = h_{eff}$. Em flux tubes could reconnect with gravitational flux tubes for $h_{gr} = h_{em}$.
3. Nutrient-MG NE can be transformed to molecule-MG NE by the sequence N-MG \rightarrow P-MG \rightarrow ATP-MG \rightarrow R-MG (N for nutrient, R for receiver).
4. The basic mechanism would be the reconnection of magnetic U-shaped loops associated with various molecules serving as kind of tentacles: N/P/ADP/R would have this kind of loops.

One can represent a critical comment. The notion of personal magnetic body (PMB) controlling biological body (BB) is central for TGD inspired theory of consciousness. The above argument does not involve it at all. Can the notion of PMB be therefore consistent with MG hypothesis? Or is PMB in some sense part of the magnetic body of MG - say in the sense that the flux tubes of PMB could be inside flux tubes of MG? Mystics would perhaps equate MG with PMB but this leads to paradoxes.

1. An attractive guess is that $h_{em} = h_{gr}$ holds true for PMB so that it can interact with MG by forming reconnections. Nutrients are dead but have NE with MG so that metabolism allows BB to have NE with MG.
2. How PMB could generate NE with BB? Could it reconnect with the flux tube pairs connecting MG with BB? Do both MG and PMB have NE with BB during life-time. What happens in biological death?: does the NE between PMB and BB transform to that between BB and MG again and only the NE between PMB and MG remains? This would conform with what spiritual teachings say.
3. If the answers to these questions are “yes”, the basic purpose of metabolism would be the transformation of gravitational NE between MG and nutrients to that between MG and biomolecules. Magnetic bodies would “steal” part of this NE by reconnecting between MG and BB to that between PMB and BB: note that this process would be something new besides molecular metabolism and could be interpreted as a higher level metabolism. All this would be basically transfer of information from collective level of consciousness to lower levels to be processed and further enriched and to be returned back to MG in biological death: nothing would be lost! Biological death itself would be reconnection transforming flux tube bonds to PMB to bonds to MG.

9.5.6 Could electrons serve as nutrients?

The New Scientist article (see <http://tinyurl.com/ybd4g2k1>) about bacteria using electrons as nutrients is very interesting reading since the reported phenomenon might serve as a test for the TGD inspired idea about metabolism as a transfer of negentropic entanglement (NE, see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig. ??** in the appendix of this book) at fundamental level discussed in [K45] (see <http://tinyurl.com/yat9bx9j>).

1. NE is always between two systems: nutrient and something, call it X . The proposal inspired by a numerical co-incidence was that X could be what I have called Mother Gaia. X could be also something else, say personal magnetic body. The starting point was the claim that the anomalously high mass of electronic Cooper pair in rotating superconductor (slightly larger than the sum of electron masses!) could be due to a gravimagnetic effects which is however too strong by a factor 10^{28} . This claim was made by a respected group of scientists. Since the effect is proportional to the gravimagnetic Thomson field proportional to the square of Planck constant, the obvious TGD inspired explanation would be $h_{eff} \simeq 10^{14}$ (see <http://tinyurl.com/yb7rsct5> and <http://tinyurl.com/yat9bx9>).
2. Gravitational Planck constant $\hbar_{gr} = GMm/v_0$, v_0 typical velocity in system consisting of masses $M \gg m$ and m was introduced originally by Nottale and I proposed that it is genuine Planck constant assignable to flux tubes mediating gravitational interaction between M and m . In the recent case v_0 could be the rotating velocity of Earth around its axis at the surface of Earth.
3. For electron, ions, molecules, .. the value of h_{gr} would of the order of 10^{14} required by the gravimagnetic anomaly and is also of the same order as $h_{eff} = n \times \hbar$ needed by the hypothesis that cyclotron energies for these particles are universal (no mass dependence) and in the visible and UV range assigned to biophotons. Biophotons would result from dark photons via phase transition. This leads to the hypothesis $h_{eff} = h_{gr}$ unifying the two proposals for the hierarchy of Planck constants at least in microscopic scales.

Thanks to Equivalence Principle implying that gravitational Compton length does not depend on particle's mass, Nottale's findings can be understood if h_{gr} hypothesis holds true only in microscopic scales. This would mean that gravitation in planetary system is mediated by flux tubes attached to particles. One non-trivial implication is that graviton radiation is dark so that single graviton carries much larger energy than in GRT based theory. The decay of dark gravitons to ordinary gravitons would produce bunches of ordinary gravitons rather than continuous stream: maybe this could serve as an experimental signature. Gravitational radiation from pulsars is just at the verge of detection if it is what GRT predicts. TGD would predict pulsed character and this might prevent its identification if based on GRT based belief system.

4. In the recent case the model would say that the electrons serving as nutrients have this kind of negentropic entanglement with Mother Gaia. $h_{gr} = h_{eff}$ would be of order 10^8 . Also in nutrients electrons would be the negentropically entangled entities. If the model is correct, nutrient electrons would be dark and could also form Cooper pairs. This might serve as the eventual test.

This is not the only model that one can imagine. TGD predicts also small values of h_{eff} . $h_{eff} = h_{em}$ would hold true when em interaction becomes non-perturbative. In this case NE would be short ranged and associated with atomic/molecular systems. At this moment one cannot exclude the possibility that only short range NE is involved with living matter.

Short ranged NE could be associated with dark atoms for which the scale of binding energy behaves like $1/h_{eff}^2$ and is thus reduced for dark atoms [?]. The creation of dark atoms would require metabolic energy. This metabolic energy could also be liberated as dark atoms transforms to ordinary atom. Metabolic electrons could be associated with dark atoms and also the dark atoms in nutrients could provide metabolic energy driving protons through the mitochondrial membrane against potential gradient and transforming ADP to ATP contains high energy phosphate bond, which would actually correspond to the presence of dark (say hydrogen -) atom. Phosphate containing the dark atom would carry the negentropic entanglement or be accompanied by dark magnetic flux tube.

Electrons are certainly fundamental for living matter in TGD Universe.

1. Cell membrane is high T_c electronic super-conductor [K45]. Members of Cooper pairs are at flux tubes carrying opposite magnetic fields so that the magnetic interaction energy produces very large binding energy for the large values of h_{eff} involved: of the order of electron volts! This is also the TGD based general mechanism of high T_c superconductivity: it is

now accepted that anti ferromagnetism is crucial and flux tubes carrying fluxes at opposite directions is indeed very antiferromagnetic kind of thing.

2. Josephson energy is proportional to membrane voltage ($E_J = 2eV$) is just above the thermal energy at room temperature meaning minimal metabolic costs.
3. Electron's secondary p-adic time scale is 1 seconds, the fundamental biorhythm which corresponds to 10 Hz alpha resonance.

9.6 Humble Origins Of DNA As Nutrient - Really Humble?

I received an interesting link (<http://tinyurl.com/ybv8xu9u> DNA_May_Have_Had_Humble_Beginnings_As_Nutrient_Carrier_999.html) about the indications that DNA may have had rather humble beginnings: it would have served as a nutrient carrier [136]. Each nucleotide in the phosphate-deoxyribose backbone corresponds to a phosphate and nutrient refers to phosphate assumed to carry metabolic energy in high energy phosphate bond.

In AXP, X=M, D, T the number of phosphates is 1, 2, 3. When ATP transforms to ADP, it gives away one phosphate to the acceptor molecule which receives thus metabolic energy. For DNA there is one phosphate per nucleotide and besides A also T, G, and C are possible.

The attribute "humble" reflects of course the recent view about the role of nutrients and metabolic energy. It is just ordered energy what they are carrying. TGD view about life suggest that "humble" is quite too humble an attribute.

1. The basic notion is potentially conscious information. This is realized as negentropic entanglement for which entanglement probabilities must be rational numbers (or possibly also algebraic numbers in some algebraic extension of rationals) so that their p-adic norms make sense. The entanglement entropy associated with the density matrix characterizing entanglement is defined by a modification of Shannon formula by replacing the probabilities in the argument of the logarithm with their p-adic norms and finding the prime for which the entropy is smallest. The entanglement entropy defined in this manner can be and is negative unlike the usual Shannon entropy. The interpretation is as information associated with entanglement. Second law is not violated since the information is 2-particle property whereas as Shannon entropy is single particle property characterizing average particle.

The interpretation of negentropic entanglement is as potentially conscious information: the superposition of pairs of states would represent abstraction or rule whose instances would be the pairs of states. The large the number of pairs, the higher the abstraction level.

2. The consistency with standard quantum measurement theory gives strong constraints on the form of the negentropic entanglement. The key notion is that if density matrix is proportional to unit matrix, standard measurement theory says nothing about the outcome of measurement and entanglement can be preserved. Otherwise the reduction occurs to one of the states involved. This situation could correspond to negentropic 2-particle entanglement. For several subsystems each subsystem-complement pair would have similar density matrix. There is also a connection with dark matter identified as phases with non-standard value $h_{eff} = n \times h$ of Planck constant. n defines the dimension of the density matrix. Thus dark matter at magnetic flux quanta would make living matter living.

In 2-particle case the entanglement coefficients form a unitary matrix typically involved with quantum computing systems. DNA-cell membrane system is indeed assumed to form a topological quantum computer in TGD framework. The braiding of magnetic flux tubes connecting nucleotides with lipids of the cell membrane defines topological quantum computer program and its time evolution is induced by the flow of lipids forming a 2-D liquid crystal. This flow can be induced by nearby events and also by nerve pulses.

Side-step: Actually pairs of flux tubes are involved to make high temperature superconductivity possible with members of Cooper pairs at flux tubes with same or opposite directions of spins depending on the direction of magnetic field and thus in spin $S = 0$ or $S = 1$ state. For large value of Planck constant $h_{eff} = n \times h$ the spin-spin interaction energy is large and could correspond in living matter to energies of visible light.

3. Negentropy Maximization Principle (NMP, [K33]) is the basic variational principle of TGD inspired theory of consciousness. NMP states that the gain of negentropic entanglement is maximal in state function reduction so that negentropic entanglement can be stable.
4. NMP guarantees that during evolution by quantum jumps recreating the Universe (and sub-Universes assignable to causal diamonds (CDs)) the information resources of Universe increase. Just to irritate skeptics and also to give respect for the ancient thinkers I have spoken about “Akashic records”. Akashic records can be said to form books in a universal library and could be read by interaction free quantum measurement preserving entanglement but generating secondary state function reductions providing conscious information about Akashic records defining also a model of self.

Side-step: Self can be identified as a sequence of state function for which only first quantum is non-trivial at second boundary of CD whereas other quantum jumps induce change of superposition of CDs at the opposite boundary and states at them). Essentially a discretized counterpart of unitary time development would be in question. This allows to understand how the arrow of psychological time emerges and why the contents of sensory experience is about so narrow a time interval. Act of free will corresponds to the first state function reduction at opposite boundary and thus involves change of the arrow of psychological time at some level of self hierarchy: this prediction is consistent with the Libet’s findings that conscious decision implies neural activity initiated before the decision (“before” with respect to geometric time, not subjective time).

In this framework the phosphates could be seen as ends of magnetic flux tubes connecting DNA to cell membrane and mediating negentropic entanglement with the cell membrane. DNA as topological quantum computer vision conforms with the interpretation DNA-cell membrane system as “Akashic records”. This role of DNA-cell membrane system would have emerged already before the metabolic machinery, whose function would be to transfer the entanglement of nutrient molecules with some bigger system X to that between biomolecules and X . Some intriguing numerical co-incidences suggest that X could be gravitational Mother Gaia and flux tubes mediating gravitational interaction with nutrient molecules and gravitational Mother Gaia could be in question [K40]. This brings in mind Penrose’s proposal about the role of quantum gravity. TGD is indeed a theory of quantum gravity predicting that gravitation is quantal in astrophysical length scales.

10 More Precise View About Remote DNA Replication

Both Luc Montagnier [I32, I33] and Peter Gariaev [I38] have found strong evidence for what might be called remote replication of DNA. I have developed a TGD inspired model for remote replication using the data from Peter Gariaev [K67], who has developed the notion of wave DNA [I26] supported by Montagnier’s findings.

Polymer chain reaction (PCR) [I9] provides a way to build copies of piece of DNA serving as template. Once single copy is produced, it serves as a template for a further copy so that exponential amplification is achieved. Montagnier’s and Gariaev’s works suggest however that the synthesis of DNA could also occur without a real matrix DNA as remote replication. According to the proposal of Gariaev [I26, I57] DNA template would be remotely represented as what he calls wave DNA. Montagnier [I33] uses 7 Hz ELF radiation to obtain the effect whereas Gariaev [I38] uses scattering of laser light into large interval of frequencies to achieve the effect.

In TGD approach magnetic body containing dark matter with large Planck constant, the associated cyclotron radiation for which energy scale is proportional to effective Planck constant $h_{eff} = n \times h$ having large values implying conjectured macroscopic quantum coherence of living matter, dark analog of DNA represented as dark proton sequences at magnetic flux tubes and accompanying ordinary DNA, plus reconnection of U-shaped magnetic flux tubes assignable to the magnetic bodies of biomolecules and allowing them to recognize each other, are the basic elements. The model has evolved from the attempts to understand water memory and homeopathy in TGD framework [K25].

Both 7 Hz ELF radiation and scattering of laser light would both generate dark photon (large Planck constant) spectrum with a wide spectrum of frequencies but with the same energy which

in Gariaev's experiments would naturally be the energy of scatter laser light. The dark photons would provide representation for DNA codons. If 7 Hz frequency radiation involves dark photons with energies of visible photons transforming to ordinary photons before scattering from DNA the outcome would be same as in Gariaev's experiments.

This picture conforms with Gariaev's hologram idea and also with TGD based vision about living matter as a conscious hologram [K13]. The laser beam that Gariaev has used and the 7 Hz irradiation (involving dark ELF photons at bio-photon energies) would act as a reference beam allowing to read a biohologram coded by DNA and its magnetic body. The outcome is dark photons with same energy but with varying values of Planck constant and thus with varying frequencies propagating along magnetic flux tubes to the target, which could be exclusion zone (EZ). Flux tubes are characterised by h_{eff} and magnetic field strength B_{end} determining cyclotron frequency (coded by the transversal area by flux quantization if monopole flux is in question). Metabolic energy is needed to create EZ and could be provided either by the radiation itself or by the repeated heating. Negentropic entanglement is generated and creates the correlation between dark (phantom) DNA codons and ordinary DNA codons.

The following involves same elements as the model discussed in [K67] but there are also new elements due to the developments in the model of dark DNA allowing to imagine a detailed mechanism for how water can represent DNA and how DNA could be transcribed to dark DNA. The transcription/association represents a rule and rules are represented in terms of negentropic entanglement in TGD framework with pairs of states in superposition representing the instances of the rule. Transition energy serves as a characterizer of a molecule - say DNA codon - and the entangled state is a superposition of pairs in which either molecule is excited or dark DNA codon is excited to higher cyclotron state with same energy: this requires tuning of the magnetic field and sufficiently large value of h_{eff} at the flux tube. Negentropic entanglement is due to the exchange of dark photons: this corresponds to wave DNA aspect. Dark cyclotron photons also generate negatively charged exclusion zones (EZs) discovered by Pollack and in this process transform part of protons to dark ones residing at the magnetic flux tubes associated with EZs and forming dark proton sequences.

10.1 Some Background

The model for remote replication involves the following basic building bricks.

1. Dark variant of DNA realized as dark proton strings representing dark nuclei.
2. The identification of bio-photons as decay products of dark cyclotron photons with large value of h_{eff} having universal energy spectrum due to the condition $h_{eff} = h_{gr}$.
3. TGD explanation for the fourth phase of water discovered by Pollack [L15] and characterized by negatively charged exclusion zones EZs generated by radiation.
4. A model for the radiative coding of DNA creating 1-1 correlation between ordinary and dark DNA codons and between two dark DNA codons.

10.1.1 Dark DNA as dark proton strings

TGD leads to a model of nuclei as nucleons strings [L2]. The model generalizes to the dark matter sector [L2, K25].

1. I have proposed the notion of dark DNA realized as dark proton sequences (3 quark states), which I have argued on basis of a simple model to form representations for DNA, RNA, amino-acids and even tRNA is central for TGD inspired biology. Biochemistry would define only a secondary representation for more fundamental realization of genetic code and analogs of basic biomolecules in terms of dark nuclear physics.

I have conjectured that translations, transcription, etc generalize and apply to pairs of ordinary and dark and dark and dark DNA and amino-acids. One could even consider that dark DNA would make possible induction of genetic changes: transfer dark DNA inside germ cells and transform them to ordinary DNA and attach to existing DNA. If dark DNA can

be generated by radiation as wave DNA notion suggests then radiation from other cells to germ cells could induced genetic changes. Living systems would have kind of Research and Discovery apartment developing new candidates for genes. Evolution would be the opposite for blind random trials.

2. I have also proposed that immune system could have developed from what is basic mechanism of homeopathy and water memory. The magnetic bodies of water clusters mimic invader molecules - or rather their magnetic bodies. What is needed is a representation for cyclotron frequencies so that radiation would emerge in this phase. Cyclotron frequency spectrum would represent the invader and the simplest mimicry of invader molecule would be water structure with magnetic body characterized by same cyclotron frequency spectrum: water memory in short. Also the braiding of the magnetic body of the invader might be mimicked.

Protein folding might be a chemical representation for this braiding and the proteins of immune system might mimic the braidings of the magnetic bodies of the invader molecules. DNA in turn would give a symbolic representation of proteins allowing to construct them when needed. Ordinary DNA and proteins would have been preceded by dark DNA and dark proteins. I have even proposed an interpretation of genetic code based on the idea that it represents the dynamical evolution of braiding of the magnetic body - or 2-braiding [K43].

The basic mechanism of directed attention or sensing the presence of the invader molecule would be reconnection of U shape flux tubes of the magnetic bodies of the two system. Also resonant interaction by cyclotron radiation inducing cyclotron transitions is expected to be an essential piece of the mechanism. Magnetic body of water cluster could tune the thickness of flux tube so that the magnetic field is same as that in the flux tube of invader molecule so that primitive consciousness and act of free will would be involved.

3. Suppose that DNA codes for proteins, their cyclotron frequency spectrum and their braiding and knotting in protein folding in turn representing invader molecule. Is the frequency spectrum all that is needed to represent DNA and construct its dark variant? The experiments of Benveniste and followers [I24, I25] suggest that invader molecules are indeed represented by the cyclotron frequency spectrum alone. This would suggest connection with wave DNA concept.

10.1.2 Universality of cyclotron energy spectrum and bio-photons as decay products of dark photons

There are good empirical motivations [K40] to expect that the cyclotron energy spectrum is universal and in the range of bio-photon energy spectrum. This is achieved if h_{eff} is proportional to the mass m of the charged particle so that cyclotron energy $\hbar_{eff}eB/m$ is independent of mass and same for all charged particles.

Universality follows also from the condition that gravitational and biological Planck constants are identical: $h_{gr} = h_{eff}$, where $\hbar_{gr} = GMm/v_0$ is the gravitational Planck constant introduced by Nottale and assigned with the flux tubes mediating gravitational interaction in TGD Universe. The condition states that electromagnetic and gravitational flux tubes have same the value of effective Planck constant meaning that also gravitation would become a key player in biology.

10.1.3 Fourth phase of water, EZs, and metabolic role of cyclotron radiation

The experiments of Pollack [L15] suggest a partial answer to the question. in terms of what he calls fourth phase of water containing negatively charged regions, exclusion zones (EZ) of size up to 200 micrometers.

1. Irradiation of water by visible light generates negatively charged regions which he calls exclusion zones (EZs). The energy goes to the formation of electric voltage between exterior and interior and is analogous to cell membrane potential. Predecessor of cell could be in question. Some fraction of protons must go outside the system and my proposal is that it goes to magnetic flux tubes and forms dark proton sequences defining the analogs of basic bio-molecules. The $H_{1.5}O$ stoichiometry of EZs [L15] characterizing also earlier findings suggesting that one fourth of protons of water are dark in attosecond time scale (not visible

in electron scattering and neutron diffraction) suggests that every fourth proton disappears from EZ. This anomaly was one of the strong motivations for taking the idea about dark matter as large h_{eff} phases seriously [K21].

These structures would be involved also with water memory and homeopathy and immune system would have emerged from these. Free energy researchers know these regions quite well [?] (no-one of course takes them seriously!) and they can be generated by just feeding energy to system used as metabolic energy. In homeopathy the mechanical agitation would do this and induce replication and perhaps even evolution of the resulting primitive lifeforms. Cavitation, use of strong electric field, maybe even heating used in PRC, etc... are possible mechanisms of energy feed.

2. The cyclotron radiation at cyclotron frequencies associated with flux tubes emanating from DNA codons could provide the energy needed to induce the formation of EZs. This would be the first function for the radiation.
3. If the DNA end of flux tube contains dark proton in state which corresponds to the DNA in one-one manner then the mass of the dark proton state would assign to it a unique cyclotron frequency distinguishing between DNA codons. The challenge is to understand the mechanism of DNA dark DNA pairing and dark DNA-dark DNA pairing and one expects resonant binding by exchange of dark cyclotron photons.

10.1.4 Pairing ordinary and dark DNA codons and two identical dark DNA codons by negentropic entanglement

One should understand the pairing of ordinary and dark DNA. As a matter fact, this pairing defines a realization of the genetic code as a physical 1-1 correlation of DNA codons with some physical states. I have consider this kind of realizations also in the model of DNA as topological quantum computer. The following realization relies on resonant interaction by exchange of dark cyclotron photons and can be seen as radiation based.

1. The most natural association between ordinary and dark DNA would via energy resonance. The energy for some molecular transition of DNA (in bio-photon energy range by argument below) would be same as cyclotron energy for the codon with large value of $h_{eff} = n \times h$ making cyclotron energy large.
2. By suitably tuning the value of the magnetic field B associated with the flux tube accompanying ordinary DNA codon the dark cyclotron energy can be tuned to be equal to the value of some biochemical transition energy of DNA, which is in visible and UV range typically - that is in the energy range of bio-photons.
3. Classically DNA codon and its dark variant can be thought of as exchanging forth and back dark photon at resonance frequency and become strongly correlated in this manner like tennis players during game. Quantum mechanically one has quantum entangled Schrödinger cat like state in which state pairs have same total energy but individual states do not have well-defined energy.
4. The correlation between dark proton states at two ends of flux tube would be realized as formation of bound state via resonant exchange of dark cyclotron photons. Negentropically entangled [K33] superposition for which simplest the possible form is $|n\rangle|n+1\rangle + |n+1\rangle|n\rangle$ of paired cyclotron states would be generated. DNA and dark DNA codons would pair to a negentropically entangled state in similar manner. Recall that in TGD framework negentropic entanglement (NE) carries potentially conscious information: the state represents a rule whose instances correspond to the state pairs in the superposition [K33].
5. One can consider also 3-particle NE of DNA codon and 2 dark DNA codons which is superposition of three 3-particle states with one particle excited to higher energy state with the same energy. DNA codon would be excited chemically and dark codons excited to cyclotron state ($n \rightarrow n+1$). 3-dimensional permutation symbol defines this kind of state. Also NE for larger number of particles is possible.

The tuning of the flux tube magnetic field to make cyclotron energy equal to chemical transition energy is possible for arbitrary biochemical transition energies and the association of dark proton states to arbitrary biomolecules is in principle possible via same mechanism. This would be essentially a symbolic representation of biomolecule, a name for molecule. If one has some number of different molecules able to form sequences, these sequences can be remotely reconstructed by using the cyclotron frequencies and transversal flux tubes associated with the template to generate the EZs and the name of the polymer to which the building bricks bind resonantly.

If the condition $h_{eff} = h_{gr}$ holds true, one can use instead of dark proton sequences sequences of *any* dark charged particles - say electrons and ions. Hence almost an unlimited repertoire of representations arises. These correspondences need not to be one-one. For instance, DNA-amino-acid 64-to-20 correspondence is possible to realize with the help of dark variants of DNA codons and amino-acids and also the partially or totally dark variants of this correspondence are possible.

This pairing mechanism would allow resonant interactions of the ordinary DNA codons in water and dark DNA codons induced by the dark cyclotron radiation and could play key role also in ordinary DNA replication and also in the remote replication reported by Montagnier [I33] and Gariaev [K67]. A phase transition reducing h_{eff} would bring ordinary and dark codon together and ordinary biochemistry would take care of the rest. Clearly, this mechanism would also allow biomolecules connected by magnetic flux tubes to find each other in molecular soup with pairing following by a phase transition reducing h_{eff} .

10.2 Does Remote Replication Apply Same Mechanism As MimicryOf Invader Molecules In The Case Of Water Memory?

Somehow the irradiation of water sample with the cyclotron radiation generated by real DNA should induce or be involved with the generation of dark DNA representing the ordinary DNA and the PCR process would use this dark DNA as template and involves pairing of ordinary and dark DNA nucleotides. How this could happen in TGD Universe?

The mechanism of remote DNA replication without chemical template would be essentially the same as in the TGD based model of water memory [K25] underlying also the model of homeopathy circumventing the ultra-naïve skeptic argument that homeopathy is not possible because the density of molecules dissolved in water is practically zero.

The cyclotron frequency spectrum allows to create EZ whose magnetic body mimics the invader molecule. Resonant formation of negentropically entangled pairs would define a realization of genetic code based on radiation and dark cyclotron radiation would give rise to the formation of EZs and accompanying dark proton sequences.

In the recent case invader molecule would be replaced with DNA expressing its presence using dark cyclotron radiation propagating along the flux tubes transversal to codons and forming part of the magnetic body of DNA. The magnetic flux tube of ordinary DNA codon realizing dark proton sequence as dark variant of DNA codon would generate its own representation by generating EZs in water.

The rules would be following.

1. Magnetic fields at U-shaped flux tubes associated with codons and dark codons must be equal so that also cyclotron frequencies coding for dark proton masses and therefore for dark proton states would be equal so that frequency and energy resonance is possible and negentropically entangled state is formed. This assigns by resonance mechanism to the second end of flux tube same dark proton state as to the end near ordinary DNA. Recall that U-shape is essential for bio-super-conductivity based on large value of h_{eff} making possible large and negative spin-spin interaction energy for electrons of pair located at parallel flux tubes [K15, K44].

As described, binding is generated by resonant exchange of dark cyclotron photons between the ends which are in superposition of different cyclotron states. Magnetic field value in turn corresponds directly to ordinary DNA codon - or rather its transition in bio-photon energy range. It is essential that the value of magnetic field codes for ordinary DNA codon via a biochemical transition energy associated with it. One can imagine that magnetic body can tune the value of field by changing the transversal area of the flux tube carrying monopole flux (possible in TGD due to the CP_2 topology). Similar tuning would be involved when

the magnetic bodies assignable to EZs detect possible invader molecules. Interestingly, the impurity molecules inside EZs are removed by unknown mechanism citebbioPollackYoutube.

2. Dark DNA codons associated with DNA would have U-shaped flux tubes which for large h_{eff} would extend to the water sample containing building bricks of DNA and catalyst. The flux tubes associated with dark DNA and building bricks of ordinary DNA would reconnect resonantly and lead to remote replication of DNA strand.

This option is definitely not the only possibility one can imagine but represents the general principle. For instance, one can consider using only DNA-dark DNA complex and inducing h_{eff} increasing phase transition transferring the dark DNA strand to the volume of the water sample. The mechanism allows also to consider remote translation of genes to proteins. The possible medical applications of this in a situation in which the DNA of the patient has suffered a mutation causing a disease are obvious.

11 Remote replication again

In TGD inspired vision about quantum biology relying on the notion of magnetic body (MB) carrying dark matter as phases of ordinary matter with effective Planck constant $h_{eff} = n \times h_0$ one ends up with the notion of dark DNA realized as sequences of dark protons and to the surprising finding that dark proton triplets realize vertebrate genetic code and basic biomolecules DNA, RNA, tRNA, and amino-acids [L16, L19].

The objection against dark photon 3-chords (3-photon states) is that the simultaneous emission of 3 dark photons used in communications as 6-bit unit is extremely non-probable. A possible solution of the problem is that dark photons carry number theoretic color associated with Z_3 subgroup of Galois group. Number theoretic color confinement would imply that only 3-chords can appear as asymptotic states analogous to baryons. If dark protons are also number theoretic color triplet, dark codons must consist of 3 protons and therefore also ordinary codons have 3 letters.

The findings of Montagnier *et al* [I33] (<http://arxiv.org/abs/1012.5166>) raise the possibility of remote replication of DNA. Montagnier's experiment involves two chambers A and B. A contained water and genes and B water and DNA nucleotides. There were channels between the chambers but so thin that DNA could not get through. Besides this there was present em field with 7 Hz frequency. Same genes as in A appeared also in B. As if remote replication of genes in A had happened in B. I have written an article about Montagnier's findings [L7, L12]. Gariaev has reported similar phenomenon already before Montagnier *et al*: we wrote together an article discussing TGD based model for the finding [K67].

How did the genetic information pass to B and how the remote replication took place? Somehow the radiation made the remote replication possible or at least more probable. Clearly the information about gene - not only about codons but also about their order and relative positions - should have been communicated from A to B. I have already earlier considered this problem but found no satisfactory solution to it.

Concerning the role of the 7 Hz frequency, there are two hints.

1. The nominal value of the lowest Schumann frequency is 7.8 Hz, not far from 7 Hz. Could one think that macroscopic quantum coherence in the scale of Earth was involved. 7.8 Hz correspond to wavelength equal to circumference of Earth.

“Endogenous” magnetic field $B_{end} = .2$ Gauss identifiable as the monopole flux part of the Earth's magnetic field $B_E = .5$ Gauss explains the findings of Blackman [J8] and others about quantal looking effects of radiation at frequencies seem to be multiples of cyclotron frequencies of biologically important ions.

The problem is that the energies of cyclotron photons are ridiculously small for ordinary value of Planck constant. This was one of the motivations for the hypothesis that dark matter corresponds to phases of ordinary matter with effective Planck constant $h_{eff} = n \times h_0$ [K43, K44, K45]. The cyclotron frequency of K ion is $f_c(K^+) = 7.1$ Hz. The flux tubes with length of corresponding cyclotron frequency are also of the order of Earth circumference.

This raises several questions.

1. Did water generate flux tubes with magnetic field with frequency equal to $f_c(K^+) = 7.1$ Hz and strengthening coupling to a radiation with Schumann frequency or K cyclotron frequency or both so that the communications with the MB of Earth or/and layer of MB corresponding to K cyclotron was strengthened? The TGD based mechanism of water memory [K25] would be involved.
2. Did this make the remote replication more probable? How?
3. What DNA actually looks like in TGD Universe? What actually happens in DNA replication? What could happen in remote DNA replication?

In the sequel the questions whether cyclotron frequency or Schumann frequency or both were involved and how their presence made possible remote replication remain without detailed answer although it is clear that the presence of dark photons with this frequency should make possible the control by MB generating coherence of ordinary matter in the scale determined by the sizes of the chambers. These questions however led to a considerable increase in the understanding of dark variants of genetic code predicted by TGD [L16, L11, L23].

1. To understand remote replication one must understand replication. Dark codons do not decompose into letters like chemical codons: this poses strong constraints on the replication and transcription if one assumes DDNA-DNA-pairing. These constraints strongly suggests that the nucleotides in the water environment of DNA are not actually free but form loosely bound triplets representing codons and bound with DDNAs. This means a new variant of genetic code realizing codons as loose triplets of nucleotides in the water environment.
2. This proposal brings in mind TGD based model for viruses, which can decompose into pieces shared between several host cells and re-combine later as also the observation that the dense states of bacteria population have resemblance to multi-cellular embryos. The common TGD inspired explanation [L24] would be that the pieces of virus and cells of bacterial population are connected by magnetic flux tubes and form a single loosely bound unit at the level of MB. The prediction is that replication occurs in codon-wise manner: this has been observed to be possible for RNA [L20]. It might be that the loose nature of exotic DNA codons allows this to occur quite generally.
3. Remote replication in this framework reduces to ordinary replication in TGD sense if also dark genes are formed by attaching flux tubes characterizing dark codons to a long flux tube associated with gene. Remote replication requires that the portion of dark gene accompanying ordinary gene is transferred from chamber A to chamber B in the experiment of Montagnier.

11.1 Three variants of genetic code

The notions of MB and view about dark matter leads to 3 variants of genetic code.

1. The notion of MB suggests that dark proton sequences assumed to explain Pollack effect (<http://tinyurl.com/gwasd8o>) [L15] realize dark genetic code. Dark DNA (DDNA) codon would correspond to 3-proton triplet assignable to closed flux tubes attached to a long flux tube by U-shaped flux tube appendix giving rise to dark gene (<http://tinyurl.com/jgfj1be>). Attaching means formation of U-shaped appendices from long flux tube and DDNA codon which reconnect to a pair of flux tubes. 3-proton states define dark analogs of DNA, RNA, tRNA, and amino-acids (DDNA, DRNA, DtRNA, DAA) [L16, L19]. The numbers of DDNAs coding for given DAA are same as for vertebrate genetic code.
2. Second dark code is needed for communications and realizes genetic codons as dark 3-photon states - 3-chords of bio-harmony [L11, L22, L23] (<http://tinyurl.com/yad4tqw1>). The model emerged from a model of musical harmony based on icosahedron and tetrahedron. 12-note scale is identified as a Hamiltonian cycle - a path going through all 12 vertices of icosahedron - such that going from vertex to neighbor corresponds to quint. Hamiltonian cycles have cyclic group Z_n , where $n = 0, 2, 4, 6$ is the order of the group, as symmetries. $n = 0$ corresponds to chaotic orbit and disharmony. Each of the 20 faces - triangles - corresponds to a chord of given harmony.

One identifies the orbit of given face as DAA coded by faces (DDNAs) at the orbit. By combining 3 harmonies with $n = 6$, $n = 4$ and $n = 2$ one obtains 20+20+20 chords and the numbers of DNA coding given AA are essentially those in vertebrate code. By gluing tetrahedron to one face one obtains 4 additional chords (DDNAs) and 1 additional note very near to one of the notes of Pythagorean scale, whose problem is that it does not quite close. The numbers for analogs of DNA codons coding for for given DAA are same as for vertebrate code.

The chords would be represented as “music of light” as states of 3 dark photons. Music expresses and creates emotions and bio-harmony would provide a physical correlate for emotional states at molecular level [L21].

3. Dark codes would be fundamental and chemical code would be their mimicry. One expects DDNA-DNA pairing with DDNA codons represented as dark proton triplets. DDNA codons and dark photon chords have no decomposition to letters (chinese and western languages provide an analog). This suggests that DNA replication and transcription cannot take letter-wise but but codon-wise. Amazingly, there is evidence that DNA replicates in codon-wise manner during RNA era: I have commented this in [L20].

Nucleotides/letters in the water environment of DNA double strand should appear as loosely bound but correlated triplets of nucleotides associated with closed flux tubes containing dark DNA codon. They would represent exotic DNA codons. This would force fixed order of nucleotides essential for the code. By absence of valence bonds between nucleotides they would be effectively free but strongly correlated. This representation of the code would be crucial for replication and transcription.

These 3 codes allow to understand replication and transcription of DNA replaced in TGD with DDNA-DNA pair. The prediction is that the replication takes place codon by codon and might kill the model.

A model of replication based on this picture generalizes to remote replication suggested by the findings of Montagnier [I33]. The DDNA codons of ordinary DNA strand would be attached with a long side of closed flux tube as dark gene. In remote replication h_{eff} of dark gene would change and dark gene would be transferred to chamber B from A. After that the replication would proceed as usual.

11.2 An objection against bio-harmony

There is a serious objection against the realization of dark genetic code in terms of bio-harmony. The emission of 3 dark photons simultaneously looks extremely non-probable process.

Number theoretical physics suggests a solution of the problem. Number theoretical physics [L18] (<http://tinyurl.com/zy1rd7w>) is a central part of quantum TGD and quantum biology and provides physical correlates for cognition. It explains dark matter as $h_{eff} = nh_0$ phases of ordinary matter with n identified as order of Galois group of extension of rationals and as dimension of extension. This picture predicts automatically evolution as increase of n in quantum jumps.

1. There is analogy with color confinement. Baryons consist of 3 quarks. Color symmetry is a symmetry of strong interactions and quarks form color triplets. Free quarks do not appear in the final states, which gives rise to color confinement: only color singlets, in particular baryons consisting of 3 quarks and mesons consisting of quark and antiquark are possible.

This suggests that also now there must be a symmetry such that dark photons have new quantum numbers, which vanish for physical states such as dark photon triplets.

2. What these quantum numbers could be? The only candidate, which comes in mind are discrete quantum numbers related to the Galois group of extension of rationals defining number theoretic symmetry. For ordinary $h = 6h_0$ Galois group has $n = 6$ elements and equals to $Z_6 = Z_2 \times Z_3$.

It appears as subgroup of higher Galois groups for which $h_{eff} = n \times h = 6nh_0$ one would have extension of extension. Z_3 confinement would require 3-photon states, which are Z_3 singlets with number theoretic colors summing up to zero. One would obtain only 3-chords. Ordinary photons would be Z_3 singlets.

3. Also the 3 protons of DDNA codon could form Z_3 triplet. Number theoretic color confinement would allow only 3-proton triplets. Genetic code is predicted correctly and the number letters in the codons is predicted to be 3.

This raises two interesting questions.

1. Quantum-classical correspondence (QCC) is a exact part of TGD. Therefore I have considered the possibility that all physical symmetries could have number theoretical space-time correlates. However, at space-time level one cannot have representations of color group with non-vanishing triality $t = 0, \pm 1$. Same applies to spin half-odd integer representations of rotation group. Could $SU(2) \times SU(3)$ representations with triality $t = \pm 1$ and spin half-odd integer have triplet representation of Z_3 and double representation of Z_2 as space-time correlates? Z_6 would be the minimal Galois group allowing to realize spin and color for quarks.
2. Number theoretical physics predicts that Galois group for any extension of rationals acts as new hidden discrete symmetry. Could number theoretical confinement implying new selection rules be true quite generally? The larger the degree n of extension (h_{eff}), the larger the scale in which confinement holds true, is. For instance, genes could be analogs of color singlet many particle states for a larger subgroup.

This is not the only option. I have already earlier considered with Peter Gariaev [K67] a proposal in which dark photons would communicate the genetic information from A to B. The problem is how the massless extremals (MEs) [K9] associated with them can be parallel and of same length: this would require that they form a quantum coherent entity. Could one consider a modification of the above proposal assuming that gene is an entity of N codons confined number theoretically? Could one can speak about dark photon genes as composites of N dark photon 3-chords? The information would be sent by dark photon gene representing entire music piece, as one might say. In chamber B energy-frequency resonance would generate a linear configuration of exotic codons, which would reduce to DDNA-DNA pair when h_{eff} is reduced.

11.3 DDNA-DNA, DDNA-DDNA, DDNA-exotic DNA pairings

The idea about MB as boss of BB suggests that DNA is accompanied by DDNA. DDNA would be the fundamental DNA and ordinary DNA emerged later as a kind of mimicry and there would be DDNA-DNA pairing.

The basic problem problem is that DDNA codons do not allow decomposition into letters like DNA codons. It seems that replication and transcription must occur codon by codon rather than letter by letter. For translation of mRNA this is indeed the case: tRNA are the basic objects. Could this be true in modified sense also for replication and transcription? In fact, RNA can replicate in codon-wise manner [L20]. Could this occur quite generally, and could the codons for replication believed to occur letter-wise be present in a latent manner?

11.3.1 DNA and DDNA codons

At least 3 new kind of codons are predicted (<http://tinyurl.com/yygqen5g>).

1. Also ordinary DNA codons involve flux tubes. Valence bonds between nucleotides of DNA strand and hydrogen bonds in double strand involve flux tubes or pairs of them.
2. DDNA codons are paired with ordinary DNA codons of DNA strand. DDNA codons would correspond to dark proton triplets at flux loops being analogous to tritium and ^3He . The model for remote replication requires that DDNA codon loops are connected to long closed dark gene flux loop by U-shaped appendages - attached to dark gene.

If DDNA and DNA codons are paired with ordinary DNA by energy resonance there is no need for flux tube contacts between the triplets.

3. Dark codons as dark photon 3-chords are predicted. Couple to DDNA by energy-frequency resonance and to DNA by energy-resonance.

4. Exotic DNA codons are required by the model of replication. DNA nucleotides in environment would combine to exotic codons paired with DDNA codons.

11.3.2 What various pairings do look like?

There would be 3 kinds of pairings. This would predict that nucleotides appear as apparently free entities in the water environment.

1. DDNA-DNA pairing in DNA strand. Different values of h_{eff} do not allow flux tubes contacts. Energy resonance only.
2. DDNA-DDNA pairing in DNA double strand is not necessary in geometric sense as flux tube connections because hydrogen bonds pair DNA codons and energy resonance pairs DDNA strands to DNA codons. DDNA codons could be however located along dark gene flux tube and attached to it by flux tube pairs.
3. DDNA-exotic DNA pairing would take place in environment. Nucleotides of exotic DNA would be attached to closed DDNA codon flux tubes. h_{eff} would be larger than for DDNA codon in double strand. There would be no valence bonds between nucleotides. The ordering of letters would be forced by flux tube containing the dark codon and energy resonance. One obtains correct codon if the orientation of the flux tube matters (ABC and BCA correspond to different energies in energy resonance). Strong parity breaking allowed by TGD and realized in living matter would imply it.

This would solve the basic problem. Codon would be secretly present since there would be no valence bonds, which together with small string tension would mean that nucleotides are effectively free.

4. It is of course not clear whether this is enough to explain experimental findings. If one can demonstrate experimentally that the build-up of DNA strand in replication really occurs in letter-wise manner, the proposed model must be modified (not of course clear whether this is possible). The codon-wise coding, which can occur for RNA [L20] could be understood if the value of h_{eff} for DRNA strand can be same or nearly the same as in RNA strand.

12 TGD Inspired Model For The Formation Of Exclusion Zones From Coherence Regions

There is a talk of Mae-Wan Ho (<http://tinyurl.com/ybbyn4pc>) in Conference on the Physics, Chemistry and Biology of Water 2014. It is a very nice representation and I learned new facts highly relevant for my own work.

Some background articles might be helpful. Mae-Wan Ho [I46] has proposed that there exists superconducting liquid crystal water aligned with collage fibres. Giudice *et al* [I23] have proposed that water dynamics is at the root of metamorphosis in living matter: this involves the notion of water coherent region (CD) with size scale of 1 micrometer. I have not considered this notion in TGD framework earlier but TGD strongly suggests that the four Gaussian Mersennes $M_{G,k}$, $k = 151, 157, 164, 167$ with corresponding p-adic length scales coming as $L(k) = 2^{(k-151)/2} \text{times } L(151)$, $L(151)=10$ nm are important in biology: $k = 167$ corresponds to 2.5 micrometers. Pollack and *et al* [I67, I58] have introduced the concept of exclusion zone (EZ) with size scale of 200 nm and related notion fourth phase of water. TGD inspired model of EZ involves in essential manner dark protons at magnetic flux tubes assignable to EZ [K40, K43].

The main points of Mae-Wan Ho's talk are following.

1. Protons make water a conductor, maybe even superconductor. In TGD framework the statement would be that dark protons flowing along magnetic flux tubes make this possible. Personally I believe that electronic and even ionic Cooper pairs are involved and TGD based model of cell membrane [K55] assumes these super-conductivities relying on the notion of dark matter realizes as $h_{eff} = n \times h$ phases.

2. The water associated with collagen networks appears as superconductor and superfluid in nano-scales. Also this is very attractive idea and if the $h_{eff} = h_{gr}$ condition holds as some arguments suggest, then superfluidity allowing macroscopic quantum coherence with gravitational Compton length having no dependence on the mass of particle becomes possible [K40]. This is due to two facts. First, one has $\hbar_{gr} = GMm/v_0$, where M can be identified as dark part of the Earth's mass, m is the mass of the particle and v_0 is velocity parameter. Secondly, Compton length is inversely proportional to the mass. One of the strange effects involved with superfluidity is fountain effect explained elegantly by macroscopic quantum gravitational coherence: water would effectively defy gravitation: this effect might allow testing of the hypothesis.

12.1 CDs And Ezs

Mae Wan-Ho talked about and compared two notions: CDs (coherent domains of water with size of about micrometer postulated by quantum field theoreticians, in particular Emilio del Giudice) and EZs (exclusion domains with size about 200 micrometers discovered by Gerald Pollack and collaborators experimentally). Note that in Zero Energy Ontology (ZEO) I talk about causal diamonds (CDs), which are typically much larger than CDs of Giudice *et al.*

1. Inside EZ the water forms layered structure consisting of hexagonal layers and the stoichiometry is $H_{1.5}O$ so that every fourth proton must be outside EZ (proton is not accompanied by electron if charge separation takes place: EZ is indeed negatively charged so that one obtains different pHs inside EZ and in its exterior). This state is experimentally heavier than ordinary water.
2. So called tetrahedral or 4-coordinated water is assigned with CDs. CDs and EZs could correspond to two different p-adic length scales in TGD framework. This state would be less dense than ordinary water. Both CD and EZ contain plasma of almost free electrons. CDs are excited to 12.06 eV just .5 eV below the ionizing potential 12.56 eV..5 eV which is the nominal value of metabolic energy quantum - probably not an accident.

12.2 TGD Inspired Model For CDs And Ezs

I try my best to summarise some very interesting points of the talk and develop in more detail TGD inspired model for EZs and their formation, and the TGD view of metabolism leading to a prediction of new form of metabolism involving dark UV photons from Sun.

1. The splitting of ordinary water H_2O to $2H^+ + 2e^- + O$ is a key step in photosynthesis. In particular, it produces oxygen without which we cannot survive. The splitting process involves two ionizations. The ionisation energy of the first electron 12.56 eV and in ultraviolet much above the metabolic energy quantum around .5 eV. How the splitting of water can be achieved at all? This looks like a very real problem!
2. CDs/EZs could be the solution to the problem. Inside CD the energy for the splitting of water is much smaller due to the fact that electrons are almost free as already mentioned: if the splitting energy equals to the so called formation energy, it is about .41 eV for CD: nothing but the metabolic energy quantum! Also at the interace of EZ just above the boundary of EZ the electronic states are excited and only an energy of .51 eV - known as formation energy - is needed for the splitting. This suggests that metabolic energy quanta are used to generate EZs and/or CDs in the fundamental step metabolism. Also irradiation at these energies generates CDs/EZs.
3. My layman logic says that formation energy for EZ must correspond to the energy needed to increase the size of /EZ by a minimum amount. In TGD model this would mean creating one proton-electron pair such that electron remains inside the EZ, whose size thus increases and proton becomes dark proton at dark magnetic flux tube. This step would be also a key step in the splitting of water. Splitting of water and growth of EZ would be essentially the same process. In the case of CD it would seem that charge separation takes place inside CD in the splitting and proton can go outside.

What comes in mind that the formation of CDs requiring large excitation UV energy of 12.06 eV precedes that of EZs. After the formation of CD and almost free electrons only metabolic energy quantum per proton is required to kick single proton to dark magnetic flux tube. This would conform with the fact that CD radius is about 200 times larger than that of CD meaning that volumes are related by a factor $8 \times 10^6 \simeq 2^{23}$. The formation of EZ would transform tetrahedral water to the hexagonal $H_{1.5}O$ and suck protons to dark protons at magnetic flux tubes. If this picture is correct, the proper identification of formation energy for CD would be as absorption energy for CD equal to 12.06 eV and in UV. Recall that bio-photon spectrum extends to UV and dark photons with this energy could be responsible for the formation of CDs. This would add dark photons transforming to bio-photons to the picture.

The formation of EZ can be seen as pulling out one ordinary proton from ordinary water just above the surface of the EZ and making it dark proton at a magnetic flux tube assignable to the EZ and perhaps connecting it to neighboring EZ for form a quantum coherent network. Dark proton would serve as a current carrier and make water a conductor and perhaps even super-conductor. Even superfluidity can be considered.

4. The metabolic energy quantum.5 eV can be also assigned with hydrogen bond. Could the process of generating dark proton and increasing the size of EZ by one electron involve cutting of the hydrogen bond binding the proton to the water outside. If so then the only thing keeping the excited water inside CD as a coherent phase would be the bond energy of hydrogen bonds! Maybe this is too simplistic.

I have proposed earlier that hydrogen bonds are short magnetic flux flux tubes, which can suffer h_{eff} increasing phase transition. These flux tubes could in turn experience reconnections with U shaped large h_{eff} flux tubes and get connected to the dark web. Mae-Wan Ho also tells that the transfer of proton from covalent OH bond to the middle of hydrogen bond happens with a considerable probability. Could this step precede the increase of h_{eff} and reconnection? This would give a connection with hydrogen bonding about which Mae Wan-Ho also talked about. These naïve models of course cannot be correct in detail but give hopes about fusion of existing chemical thinking and new quantal notions.

5. A process bringing in mind the formation of EZs occurs as one perturbs molecular bio-systems - that is feeds energy into it. The system "wakes up" from "winter sleep", the globular proteins, which are in resting state with hydrogen bonds at their surface forming kind of ice layer unfold and protein aggregates are formed. Molecular summer begins and ceases when the energy feed is over. Cellular winter begins again. Maybe cellular summer is just temporary formation of EZ layers around the protein involving melting of hydrogen bonds and generation of dark protons making system conscious!

12.3 Is A New Source Of Metabolic Energy Needed?

What remains to be understood is the process generating CDs: where could the UV photons with energy 12.06 eV come? Clearly a new form of metabolism is involved and the only source of energy seems to be the Sun!

1. Solar radiation cannot however provide UV photons as ordinary photons since UV radiation at these wavelengths is absorbed by the atmosphere. In TGD framework a reasonable candidate for dark radiation with energies in UV range is dark cyclotron radiation with energy $E = h_{eff} \times f$: biophotons would be produced in the transformation of dark cyclotron photons to ordinary photons.
2. Could part of solar UV radiation transform to dark UV photons at magnetic flux tubes of even size scales larger than that of Earth predicted by the model of EEG and arrive along them through the atmosphere? The presence of a new source of metabolic energy is in principle a testable prediction: is the energy feed from the visible part of solar radiation really enough to cover the metabolic energy needs? Here one must however take into account the fact that the UV energy would be received by water. The water from which CDs are eliminated would not allow photosynthesis.

To sum up, if the proposed picture is correct photosynthesis involves formation of EZs and cellular respiration the inverse of this process. As discussed earlier, the purpose of metabolic processes would be basically generation and transfer of negentropic entanglement assignable to large h_{eff} states.

13 Connections To The Work Of Other Researchers In The Forefront

Many connections with the workers in the field have emerged. In the following I list some articles in chronological order. Some of the people included have not worked with remote mental interactions but in TGD world order their work relates rather closely to this field so that I have included them.

13.1 Mae Wan-Ho

Mae Wan-Ho is one of the pioneers of the new biology. She emphasizes the fact that genetic code is not enough to understand inheritance (see article *Mystery of Missing Heritability Solved* (see <http://tinyurl.com/y7f4b5rz> [I53]), that genes alone do not determine body patterns (see article *it Genes don't Generate Body Patterns* (see <http://tinyurl.com/y9tyslww>) [I52]), that there are no genes for intelligence (see article *No Genes for Intelligence in the Human Genome* (see <http://tinyurl.com/yxdoz3h>) [I54]). In TGD framework the notion of magnetic body could provide the umbrella concept suggesting braiding as a universal mechanism to encode interactions with environment to braiding.

Ho realizes the importance of water-protein interaction (see article *Proteins secret water music in nanospace* at <http://tinyurl.com/ybdrftft>) [I55]. Ho dares also to speak about homeopathy and water memory (see *Quantum Coherent Water Homeopathy* at <http://tinyurl.com/ydhwlbz7>) [I55]. The TGD counterpart is the vision about cellular and molecular “seasons”. External energy feed melts the “ice” formed by ordered water around globular proteins. This leads to new conformations and protein aggregation. This process also updates topological quantum programs by inducing time-like braiding changing space-like braidings of the perturbed part of the system with its complement.

Ho also emphasizes the importance of liquid crystal phases in biology. Liquid crystals are associated with cell membranes, cytoskeletal and muscle proteins, collagen and other connective tissue macromolecules, and also DNA in chromosomes [?] Ho assigns morphogenic fields with them (see *Liquid Crystalline Morphogenetic Field* at <http://tinyurl.com/c4udjism> [I56]). Ho has introduced “Quantum Jazz” as a wonderful metaphor for what Bohm would have called active information and I call negentropic entanglement making possible highly correlated states in which particles are effectively free. Ho has proposed that these liquid crystals act as a holographic medium and based the proposal on the effects of polarized light [?] In TGD framework also magnetic flux tubes would be involved. Flux tubes would connect the basic units of liquid crystals to those of other liquid crystals. DNA nucleotides to lipids of nuclear or cell membrane [K3] (see <http://tinyurl.com/ybyscdpt>).

Space-like braiding is modified by liquid crystal fluid flows defining time-like braidings (dance metaphor). Liquid crystals plus magnetic flux tubes could serve as the holographic medium storing dynamical patterns to spatial patterns and therefore defining also fundamental memory representations. The sensitivity of liquid crystal state and therefore of braiding to various parameters such as em fields, temperature and pressures changes, hydration, pH, concentrations of various ions makes braiding an ideal mechanism for making living matter a hologram substrate.

Also topological quantum computation like processes would become possible. The fractality crucial for holography would correspond to the possibility of having flux tubes within flux tubes within.... In other words, one would have hierarchical braiding. Braids would decompose to braids which are braided in turn. As a matter fact, this braiding is central element of the dynamics of TGD Universe, not only of TGD inspired biology.

I have commented some of the articles of Mae Wan-Ho in the chapter *TGD inspired model for nerve pulse* (see <http://tinyurl.com/y8e5oqkm>) of [?] see the article *Can Water Burn?* at <http://tinyurl.com/y7pju6eh> [D8]) and in the chapter *Quantum gravity, dark matter, and prebiotic evolution* (see <http://tinyurl.com/y8gr9enm>) of [K55].

13.2 Peter Gariaev

Peter Gariaev and his group have done a lot of pioneering work in bio-electromagnetism and the notion of wave DNA is due to him. The findings of Gariaev's group include the rotation of polarization plane of laser light by DNA [I26], phantom DNA effect [I27], the transformation of laser light to radio wave photons having biological effects [I28], the coding of DNA sequences to the modulated polarization plane of laser light and the ability of this kind of light to induce gene expression in another organisms provided the modulated polarization pattern corresponds to an "address" characterizing the organism [I26], and the formation of images of what is believed to be DNA sample itself and of the objects of environment by DNA sample in a cell irradiated by ordinary light in UV-IR range [I42]. The chapter "Model for the findings about hologram generatg properties of DNA" (see <http://tinyurl.com/y9ughr5f>) [K1] of book "Genes and Memes" represent an article written in collaboration with Peter Gariaev and published in DNADJ (DNA Decipher Journal) in January 2011. If the interpretation of the experimental data is correspond then dark matter at magnetic flux body assignable to DNA sample has been photographed. What would happen that incoming photons leak to the dark flux tubes in a phase transition changing the value of Planck constant, are reflected from the dark matter and transform back to ordinary photons generating the picture in the film.

"Quantum Model for remote replication" (see <http://tinyurl.com/ybvsoy7h>) [K67] is second article written together with Peter Gariaev. There are three experimental guidelines: the phantom DNA [I27] identified as dark nucleon sequences in TGD framework and the evidence for remote activation of DNA transcription [I26] - both discovered by Gariaev's group - are assumed as the first two key elements of the model. The remote replication of DNA suggested by the experimental findings of Montagnier's group serves as a further guideline in the development of the model. Also the results of the latest experiment of Gariaev's group in many respects similar to that of Montagnier's experiment but differing in certain crucial aspects from it are used as input.

Polymerase chain reaction (see <http://tinyurl.com/ybv6mn51>) (PCR) is the technique used in the experiments of Montagnier's group [I9] and later in somewhat modified experiment by Gariaev's group involving irradiation of the second test tube by laser light. DNA polymerase catalyzes the formation of DNA from existing DNA sequences serving as a template. Since the catalytic interaction of DNA polymerase takes place with already existing DNA sequence, the only possibility is that first some conjugate DNA sequences are generated by remote replication after which DNA polymerase uses these sequences as templates to amplify them to original DNA sequences. Whether the product consists of original DNA or its conjugate can be tested.

In TGD inspired quantum biology the representations of genes in terms of temporal patterns of em radiation could be in central role. TGD suggest concrete model for water memory in terms of the magnetic body of biomolecule whose cyclotron frequency pattern codes for the biological effects of the molecule. Water memory would mean that water can build magnetic bodies mimicking those of biomolecules or perhaps steal them in the process of dilution which involves the shaking of the solution. The basic problem of the model is how to the gene coded as a temporal field pattern could activate corresponding gene. It seems that the solution of this problem requires that also linear spatial pattern matters. A possible realization would be as planar sheets of magnetic flux tubes emerging from sender DNA and attaching to the target DNA and carrying the radiation. Remote replication would take place only if resonance condition for the frequencies depending on nucleotides is satisfied for each flux tube. Note that DNA as topological quantum computer relies on similar flux tube structure.

TGD suggest also another representation of the genetic code in terms of dark nucleons [L2], [L2], which could be highly relevant for the realization of water memory in terms of a dark portion of water for which there exist empirical evidence [K20]. This dark portion would also explain the numerous anomalies of water. It became as a total surprise that the states of dark nucleons correspond in natural manner to DNA, RNA, tRNA, and amino-acids. DNA would define only one particular representation of the genetic code, which in the primary form would be realized at elementary particle level and that there could exists many representations of DNA. Also the model for DNA as topological quantum computer [K3] proposes a non-standard representation of the code.

The model inspires the proposal that the magnetic body of a polar molecule codes for it using dark nucleon sequences assignable to the hydrogen bonds between the molecule and surrounding

ordered water layer. Quantum antenna mechanism would allow the immune system to modify itself by developing ordinary DNA coding for amino-acids attaching to and thus “catching” the polar molecule. The mechanism could be behind water memory and homeopathic healing. Every polar molecule in living matter would have dark nucleon sequence or several of them (as in the case of amino-acids) serving as its name. This would also associate unique dark nucleon sequence also with the magnetic body of DNA so that “DNA-dark DNA” association would be automatic. Same applies to mRNA and tRNA and amino-acids. The general idea is therefore that symbolic dynamics emerges already at the molecular level: the dark DNA sequence serving as a “name” of the molecule to high extent determines the dynamics just as in human society.

The existence of a multitude of representations of the code would not be too surprising when one realizes that the information processing performed by computers involves endless variety of different representations of various codes. The problem is about attitudes: the dogma that biology is nothing but chemistry is what is being challenged and we love dogmas because they liberate us from the burden of using our own brains.

13.3 Luc Montagnier

The article “DNA waves and water” by L. Montagnier, J. Aissa, E. Del Giudice, C. Lavallee, A. Tedeschi, and G. Vitiello [I33] has created quite a furor even before its publication. The article was preceded by article [I32], whose results led to my own proposal about the existence of new kind of representation of DNA in water [L3] and the recent article indeed suggests the existence of a new kind nano-scale representation of DNA besides electromagnetic representation of the code, which was also suggested for years ago by the group of Peter Gariaev [I26] and also in TGD framework [K24]. The article “DNA waves and water” (see <http://tinyurl.com/y8buy89k>) [L5] discusses TGD based explanation of the findings.

The claim of Montagnier’s team is that the radiation generated by DNA affects water in such a way that it behaves as if it contained the actual DNA. A brief summary of experiment of Montagnier and collaborators is in order.

1. Two test tubes containing 100 bases long DNA fragments were studied. Both tubes were subjected to 7 Hz electromagnetic radiation. Earth’s magnetic field was eliminated to prevent its possible interference (the cyclotron frequencies of Earth’s magnetic field are in EEG range and one of the family secrets of biology and neuroscience since seventies is that cyclotron frequencies in magnetic fields have biological effects on vertebrate brain). The frequencies around 7 Hz correspond to cyclotron frequencies of some biologically important ions in the endogenous magnetic field of 2 Tesla explaining the findings. This field is 2/5 of the nominal value of the Earth’s magnetic field.
2. What makes the situation so irritating for skeptics who have been laughing for decades for homeopathy and water memory is that the repeated dilution process used for the homeopathic remedies was applied to DNA in the recent case. The dilution containing no detectable amounts DNA (dilution factor was 10^{-12}) was placed in second test tube whereas the first test tube contained 100 bases long DNA in the original concentration.
3. After 16 to 18 hours both tubes were subjected to polymerase chain reaction (PCR), which builds DNA from its basic building bricks using DNA polymerase enzyme. What is so irritating that DNA was generated also in the test tube containing the highly diluted water. Water seems to be able to cheat the polymerase by mimicking the presence of the actual DNA serving in the usual situation as a template for building copies of DNA. One could also speak about the analog quantum teleportation.

The model explaining remote replication would apply also to the findings of Montagnier. The essential elements would be sheets formed by flux tubes emerging from DNA crucial also in the model of DNA as quantum computer and nucleotide dependent resonance condition satisfied for each flux tube allowing DNA portion to active only similar DNA portion.

The findings of Montagnier demand that the genetic code is represented somehow by dark photons, presumably dark photon frequencies. How genetic code could be represented in terms of frequencies? The TGD based model of music harmony [L11] [K46] (see <http://tinyurl.com/>

zg3aaaj7) relies on the idea that 12-note scale is representable as a closed non-self-intersecting curve (Hamilton's cycle) at icosahedron having 12 vertices. The harmony assignable to a given Hamilton's cycle is characterized in terms of 3-chords assignable to the 20 faces (triangles) of the icosahedron once the 12-note scale is represented as a particular Hamilton's cycle.

Remarkably, the number of amino-acids is also 20! One indeed ends up with a model in which $20+20+20=60$ DNA codons are represented by 3-chords for a triplet of harmonies defined by Hamilton's cycles predicting correctly the numbers of DNAs coding for a given amino-acid for vertebrate code. One must however assume that also tetrahedral harmony is present to get 64 DNA codons rather than only 60. TActually two variants of the code are predicted and altogether one obtains the standard 20 amino-acids plus two additional ones identified as Pyl and Sec known to be realized in living matter.

In music realization DNA codons can be represented as 3 dark photons or phonons with appropriate frequency ratios. This representation could explain the findings of Montagnier and Gariaev. There is also a connection with TGD inspired theory of consciousness. Music both expresses and induces emotions. The proposal is that the representation of DNA codons in terms of triplets of sounds or dark photons defines molecular level representation of emotions. There is large number of different harmonies and they could represent different moods.

13.4 Rupert Shelldrake

Rupert Shelldrake is very interesting thinker whose basic idea is that even genetic expression is more like a habit. Even the manner how crystallization takes place could be a habit. In TGD framework the 4-dimensional character of geometric existence and zero energy ontology in which quantum states are pairs of positive energy states assignable to the two light-like boundaries of causal diamonds conforms with Sheldrakes views (see the article "Sheldrake's Morphic Fields and TGD View about Quantum Biology" at <http://tinyurl.com/y79kxbua>).

The basic idea of Shelldrake that Nature would have habits just as we do is probably one of those aspects which generate most irritation in physicalists believing that Nature is governed by deterministic laws with classical determinism replaced with quantum statistical determinism. Shelldrake is one of those very few scientists able to see the reality rather than only the model of reality. Morphic resonance would make possible to establish the habits of Nature and the past would determine to high extent the present but on organic manner and in totally different sense as in the world of physicalist.

13.5 Seth Lloyd On Quantum Life

The notion of quantum biology is becoming accepted notion although Wikipedia contains still nothing about its most important application (photosynthesis). I can be proud that I have been a pioneer of quantum biology for about two decades. TGD remains still one of the very few theories leaving the realm of standard quantum theory and suggesting besides the new view about space-time a generalization of quantum theory involving in an essential manner quantum theory of consciousness based on the identification of quantum jump as moment of consciousness. The new view about quantum theory involves a refined view about quantum measurement based on Negentropy Maximization Principle (NMP) [K33] identified as the basic variational principle and zero energy ontology (ZEO) replacing ordinary standard energy ontology. The new view providing new vision about the relationship between subjective time and geometric time, about the arrow of time, and about second law.

The hierarchy of Planck constants having as space-time correlate effective (or real -depending on interpretation) n -sheeted coverings of 8-D embedding space (or space-time) with $h_{eff} = nh$ defining the value of (effective) Planck constant. p-Adic physics as physics of cognition is essential part of theory and together with the hierarchy of Planck constants closely related to the notion of negentropic entanglement characterizing living matter. Negentropic entanglement is maximal involving two-particle case tge entanglement of n states characterized by $n \times n$ unit matrix with n identified in terms of h_{eff} . Also maximal m -particle entanglement with $1 < m \leq n$ is possible and one can write explicit formulas for the entangled states relating closely to the notion of exotic atom introduced earlier. The hierarchy of Planck constants as associated with dark matter so that dark matter is what makes living matter living in TGD Universe.

The concepts of many-sheeted space-time and topological field quantization imply that the concept of field body (magnetic body) becomes a crucial element in the understanding of living matter. Non-locality in even astrophysical scales becomes an essential piece of the description of living matter. Remote mental interactions making possible communication between biological and magnetic bodies become standard phenomena in living matter. The reconnection of magnetic flux tubes and phase transitions changing the value of h_{eff} and thus changing the length of magnetic flux tubes become a basic piece of biochemistry. Various macroscopic quantum phases such as dark electronic Cooper pairs and of protons and even ions as well as Bose-Einstein condensate of various dark bosonic objects with large value of h_{eff} are also central. They are associated with magnetic flux bodies (magnetic flux tubes).

TGD implies a new, still developing, view about metabolism. Magnetic body as a carrier of metabolic energy and negentropic entanglement (see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig. ??** in the appendix of this book) allows to understand the deeper role of metabolism in a unified manner. The notion of high energy phosphate bond assigned to ATP is one of the poorly understood notions of biochemistry. As a matter fact, all basic biomolecules are carriers of metabolic energy liberated as they are broken down in catabolism. It is usually thought that the covalent bonds containing shared valence electron pair between atoms involved carries this energy and that covalent bond reduces to standard quantum theory. TGD challenges this belief: covalent bond could in TGD framework correspond to magnetic flux tube associated with the bond having considerably larger size than the distance between atoms: similar picture has already earlier emerged in the model of nuclei as strings with colored flux tubes connecting nucleons and having length scale much longer than nuclei [L2]: this model also explains [K34] the puzzling observation that protonic charge radius seems to be somewhat larger than predicted [?].

The metabolic energy quantum would be associated with large h_{eff} valence electron pair being identifiable as cyclotron energy in endogenous magnetic field for which the pioneering experiments of Blackman [J8] suggests value $B_{end} = .2$ Gauss as the first guess. Of course, entire spectrum of values coming as power of two multiples of this field strength can be considered. This would require rather high value of h_{eff}/h of order 10^8 . Reconnection of flux tubes would make possible to transfer these electron pairs between molecules: actually a piece of flux tube containing the electron pair would be transferred in the process. This view allows to unify the model of metabolism with the view of DNA-cell membrane system as topological quantum computer with DNA nucleotides and lipids (or molecules assigned with them) by flux tubes.

Seth Lloyd represents three examples about situations in which quantum biology seems to be a “must”: photosynthesis, navigation of birds, and odour perception. Photosynthesis represents the strongest and most quantitative support for quantum biology. Navigation and odour perception suggest strongly quantum theory model but leave the details of the model open.

I have applied TGD to numerous situations during years and also discussed simple TGD inspired models for all these three phenomena. The following represents briefly the core of Lloyd’s talk and comparison with TGD based views. I do not of course have access to the data basis and can represent only a general vision rather than detailed numerical models. I share Lloyd’s belief that quantum models provide the only manner to understand the data although models as such are not final. The authors of course want to publish their work and therefore cannot introduce explicitly notions like high temperature super-conductivity, which I believe are crucial besides purely TGD based concepts. What is however good that the models start from data and just look how to explain the data in quantum approach. Data lead to assumptions, which are not easy to defend in the framework of standard quantum theory. For instance, the presence of long-lived entangled pairs of electrons and electron and hole with wave functions possessing rather long coherence length and somehow isolated from entanglement destroying interactions with the external world emerge from the data. In TGD large value of h_{eff}/h and associated negentropic entanglement justifies these assumptions.

13.5.1 Photosynthesis

The incredible effectiveness of the first step of the photosynthesis after photon absorption [J20] is one of the key points of Lloyd in this talk (<http://tinyurl.com/yadbjx2x>). The organisms living deep under the surface of ocean are able to gather their metabolic energy using only the visible photons of black body radiation, whose typical photon energy is much lower than that of

metabolic energy. In human eyes there is even mechanism preventing the detection of less than five photons at time.

The first step of photosynthesis after the capture of photon by harvesting antenna proteins has been a long standing mystery and here only quantum mechanical approach seems to provide the needed understanding. The light harvesting antenna proteins can be visualized as small disk like objects and are associated with a membrane like structure - so called thylakoid membrane similar to cell membrane. The absorption creates what is known as exciton - electron-hole pair, which is most naturally singlet. Photon has spin so that the exciton must have unit angular momentum. After its creation the electron of the exciton reaches by a random walk like process the reaction centre. From the reaction centre the process continues as a stepwise electron transfer process leading eventually to the chemical storage of the photon energy.

The capture of photon occurs with some probability and also the process continues from reaction centre only with probability of about 5 per cent. The process with which the electrons reaches the reaction centre is however amazingly effective: effectiveness is above 95 per cent. This is mysterious since for the classical random walk for exciton between the chromophores the time is proportional to the square root of distance measured as number of neighboring chromophores along the path.

The quantum proposal is that exciton is spin singlet state - this minimizes the interactions with photons - and performs quantum (random) walk to the reaction centre. The model assumes only experimental data as input and all parameters are fixed. Temperature remains the variable parameter. One can consider two extreme situations. At low energy limit the random walks tends to be stuck since external perturbations (mostly thermal photons) inducing the random walk process are not effective enough and quantum walk becomes so slow so that the exciton decays before it reaches the reaction centre. At high energy limit the thermal perturbations destroy quantum coherence and classical random walk results so that the efficiency becomes essentially zero. There is a temperature range where the transfer efficiency is near unity and time for reaching the reaction centre relatively short. This range has as midpoint room temperature.

If I have understood correctly, the model accepts as experimental facts the rather long lifetime of the exciton - few nanoseconds. In quantum-computerish this assumption translates to the statement that exciton belongs to a de-coherence-free subspace so that external perturbations are not able to destroy the exciton too fast. Second assumption is that the exciton is de-localized over a ring like structure of size scale of 7 Angstroms (actually there are two rings of this kind, inner and outer and the wave function is assumed to be rotationally symmetric for the inner ring). This de-localization increases the probability of transfer to neighboring chromophore so that it is proportional to the square N^2 of the number N of chromophores rather than N . The technical term expressing this is concatenated quantum code.

Skeptic would probably claim that coherence and stability of coherence are the weak points of the model. In TGD framework the assumption that electron-hole pair is negentropically entangled would guarantee its long life time. The reason is that NMP [K33] favors negentropic entanglement. Negentropic entanglement corresponds to entanglement associated with n -sheeted effective covering of embedding space and n has interpretation in terms of effective Planck constant $\hbar_{eff} = n\hbar$. The naïve guess is that coherence scale for the wave function of exciton scales up by factor n or \sqrt{n} . This entanglement need not have anything to do with spin but could relate to large \hbar .

I have earlier considered a slightly different proposal [K29]. Instead of exciton the negentropically entangled system would be Cooper pair of dark electrons. Note that the negentropic entanglement need not relate to the spin but to the n -fold covering although it could be assigned with spin too in which case the state would be spin singlet. The motivation came from the fact that the transfer of electrons to the reaction centre takes as pairs (<http://tinyurl.com/yocrj3zqe>). The TGD inspired interpretation of electron pair would be as dark Cooper pair. Two electron pairs would come from the splitting of two water molecules to O_2 , 4 protons and two electron pairs, and they would end up to P680 part of photosystem II (680 refers to maximally absorbed wavelength in nanometers) and from here to P680* as two pairs. This mechanism would require that the Cooper pairs absorbs the photon as single particle. In the case of dark Cooper pairs this might be naturally true. If this requires exchange of photon between the members of the pair, the rate for this process is of the order α^2 lower.

13.5.2 Avian navigation

Second topic discussed by Seth Lloyd is avian navigation (<http://tinyurl.com/zwdso>). The challenge is to understand how birds (and also fishes) are able to utilize Earth's magnetic field in order to find their way during migration. In some cases the magnetite in the beak of the bird guides the way along magnetic field lines by inducing magnetic force, and the process can be understood at least partially. Consciousness theorist could of course wonder why these animals find year after year their exact birth place.

Robins however represent an example not so easy to understand. There are three input facts:

1. Robins are able to detect the orientation of B_E but not its direction. They can also detect the angle between orientation and vertical to the Earth's surface and from this to deduce also the direction of B_E .
2. Blue or green light is necessary for the successful detection of the orientation.
3. Oscillating em field with frequency of order MHz makes the robins totally disoriented.

The only model that seems to be able to explain the findings is that long-lived entangled pairs of electrons are created by the photon provided their energy is high enough. For red light the energy is 2 eV and is not yet quite enough. This suggests that the electrons originate from a pair of molecules or atoms of single molecule. It is not known what the molecules in question could be. The electrons of the pair are spinning in the magnetic field and this is suggested to cause the decay of the pair and second member (why not both?) of the pair would contribute to a current giving eventually rise to nerve pulse pattern.

Entangled long-lived electron pair should be created. Long lifetime is the problem. The proposed mechanism brings in mind the TGD based variant for the light harvesting mechanism of photosynthesis. Universality suggests that long lived dark negentropically entangled Cooper pairs are generated in both cases so that light harvesting is in question in both cases. These pairs assignable to membrane structures in both cases in turn would generate a supra current giving eventually rise to a generation of nerve pulses in the case of navigation and to electron transfer process in the case of photosynthesis. If the same mechanism is involved in both cases, the extreme effectiveness of this light harvesting process could make it possible for the birds to navigate even in dark. Electron has cyclotron frequency of about 1.5 MHz in the Earth's magnetic field and this makes easy to understand why oscillation with this frequency (resonance) induces disorientation by forcing the spinning of the dark Cooper pairs.

Why the energy of photon creating the dark electron Cooper pair should correspond to visible light? Cyclotron energy scale for the ordinary value of Planck constant is extremely small and corresponds to frequency in MHz range. For visible photons the frequency by order of magnitude 10^8 higher. Does this correspond to the value of h_{eff} ? Similar order of magnitude estimate follows from several premises. If the scaling of h by n corresponds roughly to the scaling of p-adic scale by \sqrt{n} , one would have roughly 10^{15} -fold (effective) covering of embedding space which looks rather science-fiction! For electrons this would imply size of order cell size if dark scale corresponds to the p-adic scale. If the electrons are originally in bound states with binding energy of order eV, the value of h_{eff} could be much lower.

13.5.3 I smell the quantum

Quantum detection of odours was the third topic in Lloyd's talk. For decades it was believed that odor perception is based on lock and key mechanism. Human has 387 odour receptors and this would be the number of smells too. It has however turned out that humans can discriminate between about 10^4 smells and Luca Turin and his wife have written a book giving a catalogue of all these smells. It is clear that lock key mechanism is correct but something else is needed in order to understand the spectrum of odors.

The key observation of Turin is that the smells seems to be not purely chemically determined but is different for molecules consisting of atoms differing only by the weight of nucleus and thus being chemically identical. Therefore the vibrational spectrum of the molecule, which is typically in infrared, seems to be important. The proposal of Turin is that the process of odour perception involves the tunnelling of the vibrating electron from odour molecule. This tunnelling can be

assisted by absorption of phonon coming from the receptor with frequency which corresponds to fundamental vibrational frequency or its multiple. The model has been tested in several cases. The latest test described by Lloyd is the one in which hydrogen in some molecule is replaced with deuterium, which is twice as heavy so that the vibrational frequency is reduced by a factor $1/\sqrt{2}$. Fruit flies took the role of odour perceivers and it turned out that they easily discriminate between the molecules.

I have considered earlier a somewhat different quantum model for odour perception by starting from the pioneering experimental work of Callahan [I59], which led him to conclude that in the case of insects odour perception is “seeing” at infrared wavelengths. Infrared wavelengths correspond to vibrational energies for molecules so that this brings in the dependence on the square root of the inverse of the mass of the odorant and predicts that chemically identical molecules containing only different isotopes of atoms smell differently. Frequencies are same as in the model of Turin. Instead of phonons IR photons would play the key role serving as passwords exciting particular cyclotron state at particular magnetic tube. Similar mechanism could be at work in the case of ordinary vision.

13.6 Orch-Or Theory Of Penrose And Hameroff And New Experimental Findings About Microtubules

The latest news in quantum biology is the claim about corroboration of the Orch OR theory of Penrose Hameroff (see <http://tinyurl.com/ybga0e0u>) [J1]. To my humble opinion the news suffer from rather heavy hyping. If the observation of the group lead by Anirban Bandyopadhyay about detection of quantum vibration in microtubule scale (their lengths vary up to 50 μm) can be replicated, one can speak about breakthrough in quantum consciousness. The results do not however prove Orch OR, which involves poorly defined vision about quantum gravitational description of state function reduction so that most predictions are just order of magnitude estimates relying on Uncertainty Principle.

The biological half of the theory relies on microtubules and for this side of the theory the claimed finding would of course be a victory. Indeed, there is a meeting in Amsterdam devoted to Orch OR theory of consciousness motivated by this finding (<http://tinyurl.com/zwayv12>). Unfortunately, I could not find any article about the findings of Bandyopadhyay in web. I managed however to find two years old Youtube talk of Bandyopadhyay summarizing earlier experimental results supporting the vision about microtubules as macroscopic quantum systems (<http://tinyurl.com/ze366ny>) [J5] to be discussed below.

The findings reported in the talk give support for the general TGD inspired view about TQC and allow rather detailed model in the case of microtubules. The idea is that flux tubes form a 2-D coordinate grid consisting of parallel flux tubes in two different directions: the guess that they could consist of helical Fibonacci flux tubes and their mirror images is not however convincing. Crossing points would be associated with tubulins and the conformational state of tubulin could define a bit coding whether the braid strands defining coordinate lines are braided or not (swap or not). In this manner any bit pattern at microtubule defines a particular TQC program. If also conformations are quantum superposed, one has “quantum-quantum computation”. It however seems that conformation change is irreversible chemical reaction [J16] so that this option is not feasible.

The TGD inspired modification of the proposal in terms of flux tube coordinate grids making possible TQC architectures with tubulin dimers defining bits defining in turn TQC program looks more plausible to me. Coordinate grids can be fixed on the basis of the experimental findings and there are 8 of them. The interpretation is in terms of different resolutions. The grids for A and B type lattices are related by 2π twist for the second end of the basic 13-unit for microtubule. An attractive interpretation for the resonance frequencies is in terms of phase transitions between A and B type lattices. If A type lattices can be generated only in phase transitions induced by AC stimulus at resonance frequencies, one could understand their experimental absence, which is strong objection against the Penrose-Hameroff model.

This would fit very nicely with the general vision about frequencies as passwords inducing not only directed attention but activities in target - also TQCs! The increase of Planck constant could be associated with the phase transition to A-phase making possible high T_c dark superconductivity for which evidence is observed! One can even deduce estimates for $h_{eff}/h = n$ if one

requires that AC photons have energy above thermal threshold: $n = h_{eff}/h = f_{visible}/f_{AC}$ would be the estimate. For bio-photon energies one would obtain something like $n \simeq 10^8 - 10^9$, which pops up in different contexts in TGD framework.

This picture generalizes in the fractal universe of TGD. One can form layers of 2-D coordinate grids and connect them by vertical flux tubes to obtain 3-D grid defining TQC. The brain is known to have grid-like architecture and neurons could by quantum computation produce bit/qubit defining swap or not/superposition of swap and not-swap for a larger scale TQC. One would have fractal of TQCs. One can even think 4-D grids in Euclidian space-time regions with 6 bits defining the swaps at each crossing point: could this have something to do with the genetic code?

A further idea is that 1-braid TQC generalize in a natural manner to 2-braid TQC in TGD framework (for 2-braids see [K27]). The knotting occurs for string world sheets defining the orbits of braid strands - say magnetic flux tubes idealized to strings. In the case of microtubules this option suggests itself: the emergence of MTs could have meant emergence of 2-braid TQC and the increase of abstraction level in the information processing. Note that 2-braiding is possible only if string worlds sheets "live" in 4-D space-time: for super strings living in higher-D space-time this is not possible.

In TGD Universe one could look at the situation also from the point of view of metabolism.

1. Dark particles quite generally have higher energies than ordinary particles. For instance, atomic bindings energies are scaled down like $1/h_{eff}^2$ and cyclotron energies scale like h_{eff} . The generation of dark particles with increased value of h_{eff} requires therefore energy identifiable as metabolic energy. The increase of h_{eff} creates quantum coherence in longer length scale in turn inducing coherence of living matter. $h_{eff}/h = n$ also serves as a kind of IQ for the system. The larger n is, the better ability the system has to generate negentropic entanglement.
2. In Bandyophyay's experiments AC voltage feeds metabolic energy. Microtubules of type A generated in the process are ordered in longer scale than microtubules of type B. In living matter this energy feed is due to the radiation generated by other parts of living system. Note that the basic objection abgainst Penrose-Hameroff theory is that in vitro only microbutules of type B are possible.

13.6.1 Penrose-Hameroff theory

Approximately two decades ago Penrose and Hameroff proposed a model that they called Orchestrated Objective Reduction (Orch OR) [J28]. Besides the highly speculative quantum gravity related ideas, the model assumes that microtubules are quantum coherent systems essential for consciousness. For the importance of microtubules one can find a lot of qualitative support. A I believe that microtubules are important for consciousness and I have developed ideas about the role of microtubules [K37]. Personally, however, I find it difficult to believe in the reduction of consciousness to microtubular level, but see microtubules as one particular layer in the hierarchy of conscious entities. Personally, I would prefer fractality over the naïve length scale reductionism.

Many objections [J16] against the biological feasibility of Orch OR (<http://tinyurl.com/nx4vevv>) [J28] have been raised. For the latest response of the authors to the criticism see [J27]. There are two basic challenges: one should formulate precisely what Orch OR really means and be able to identify the qubit.

1. The basic vision about quantum superposition of space-time geometries gives rise to consciousness as something analogous to quantum computation. State function reduction would thus reduce to a mechanism rather than being something irreducible. Most quantum physicists would disagree about this. The quantum superposed geometries would be protein conformations. Since there is no theory of quantum gravity, the proposal boils down to the ad hoc estimate for the time τ for Orch OR to take place claimed to be $\tau = \hbar/E_G$, where E_G is the difference of gravitational energies for the superposed geometries. The estimates favor nuclear scale 5 fm and one needs a coupling between nano-scale physics of electrons and physics nuclei and London forces are suggested to be responsible for this coupling. It deserved to be mentioned that the gravitational energy for a blob of water with radius around 10^{-4} meters - the size scale of large neuron - is about Planck mass so that gravitation and

biology might relate. In my own proposal involving large gravitational Planck constant assigned to space-time sheets mediating gravitational interaction, Planck mass might serve as a threshold above which large values of Planck constant would emerge [K53, K39].

- Concerning the identification of qubit there is a long list of suggestions. The superposition of tubulin conformations was one of the first proposals. Reimers [J16], who has criticized heavily Orch-OR proposal, reports that irreversible chemical reaction is responsible for selecting conformation so that quantum superpositions would not make sense. Conformational switching could however be involved with classical computational aspects of biological information processing and Hameroff has proposed before Orch OR that microtubules could act as classical cellular automatons.

Also other proposals for qubit have been made. Quantum fluctuations generating London force between electric dipoles could somehow give rise to qubits. Also magnetic dipoles, nuclear spin, AC current flow, and synergistic modes have been mentioned. Also the identification of qubit as a helical conduction pathway has been proposed (“Oscillating London force dipoles in resonance rings in helical pathways through microtubule lattices”). It is difficult to imagine what the two superposed states defining qubit would be. For instance, could qubit correspond to electron current running in two different directions and is quantum superposition possible at criticality for a phase transition inducing the change of the current direction? For this option the information storage capacity of microtubule would be rather modest. It is also difficult to see the claimed connection with topological quantum computation since braiding gives rise to entanglement between states at the ends of the braids.

Orch OR proposal involves several interesting ideas probably relevant for quantum consciousness.

- Aromatic rings have probably some deep role in quantum consciousness. For instance, most psychoactive biomolecules and also DNA and three amino-acids contain them. Hameroff and Penrose trace this role to London force between aromatic rings and quantum fluctuations making them qubits. I am unable to imagine what the exact proposal is. In any case, what is known is that electrons at aromatic rings are de-localized.

Comment: My own humble proposal is that electrons could be further de-localised at magnetic flux tubes in longer scales and make cyclotron BE condensates of dark electrons or their Cooper pairs possible. They would make possible the coupling between receptor-information molecule complex and magnetic bodies at various levels of hierarchy. Hierarchy of Planck constants and negentropic entanglement suggests the existence of a new kind of state consisting of electrons (that is fermions) but analogous to Bose-Einstein condensate.

- The idea about insulation provided by hydrophobic pockets of proteins against fluctuations destroying quantum coherence is nice and it would be natural to put aromatic rings into these pockets.
- The needed long value of Orch OR de-coherence time τ (originally assumed to correspond to 40 Hz thalamocortical resonance frequency) is one of the problems of Orch OR and the recent discovery of EEG like oscillations in kHz range [J22] is claimed to make the situation more tolerable.

Comment: Fractal hierarchy of EEGs mediating communications between parts of biological body and corresponding magnetic body is basic prediction of TGD and the observation seems to provide evidence for this prediction.

- Reimers *et al* challenges [J17] also Fröhlich Bose-Einstein condensation [J26] and claims that according to his own simulations the resulting state is extremely incoherent [J17]. There are however models which give Bose-Einstein condensation [J4] and the in [J5] the experimental findings about assembly of microtubules are interpreted as Fröhlich condensation. The frequency inducing the condensation would be however 3 orders of magnitude lower than predicted by Fröhlich.

There is a further puzzling result (<http://tinyurl.com/y7f2r93o>) [J15] in conflict with the assumption of Orch OR that brain microtubules are dominantly so-called A-type tubules. Brain microtubules re-assembled in vitro form lattices of type B and for them the lattice must have surface discontinuities. This makes sense for microtubules which are partially fused together as in the structures consisting of cylinder whose surface is formed by 9 units consisting of 3 microtubules glued together along their sides. This would not allow Fibonacci helices proposed by Penrose and Hameroff to serve as conducting pathways defining the analogs of braid strands in their model for microtubule as topological quantum computer (TQC) unless one is ready to give up helical symmetry. One way out of the difficulty would be that vitro results do not hold in vivo but Kikkawa *et al* has shown that all in vivo microtubules have lattice of type B (<http://tinyurl.com/ybnxymuw>) [J11].

The above mentioned article concludes that only the lattice B is realized in nature. This lattice does not possess helical symmetry. After each full turn along sequence α or β tubulin sequence there is a shift as the figure 2 of the article demonstrates: this discontinuity is called seam in the article. Furthermore, these helices can be said to have periodicity 5. The helix-like curve satisfies the condition $z = 4a\phi/2\pi$ and the n^{th} tubulins along vertical is located at $z(n) = na$, a the size of the tubulin. For $\phi = 2\pi$ one has $\Delta z = a$ rather $\Delta z = 0$ as figure 2 of the article shows. This discontinuity could have some important biological meaning.

Hameroff, Nip, Porter, and Tuszynski have an article about microtubules as topological quantum computation written in 2002 [J10]. They do not give any justification for why the conduction pathways should correspond to Fibonacci numbers but the article by Hameroff represents evidence that the important certain amino-acids crucial for consciousness inside tubulin molecules are located along the Fibonacci conduction pathways (<http://tinyurl.com/yb5od1mn>) [J10].

2011 Hameroff and Penrose considered the possibility that microtubules could perform topological quantum computation. The proposal of Penrose and Hameroff (<http://tinyurl.com/yb5od1mn>) [J10] assumes realization of braiding in terms of helical braids strands assignable to A-type microtubules (which according to experimenters do not exist in brain and - as it seems - in living matter in general). In the simplest realization the strands are parallel to each other and have horizontal periodicity characterized by 13 tubules. Also Fibonacci pathways with horizontal periodicity of 3, 5, and 8 are Fibonacci pathways. The strands with different periodicities can intersect and can therefore be braided. One can also construct left- and right handed variants of the strands and left- and right-handed strands intersect periodically with a period of 13. The experiments discussed in [J5] however suggest a different kind of braidings.

In the intersection points braiding (swap) operation could be realized meaning that first strand goes either over or below the second one. Gupta and Hameroff suggests that MAPs are responsible for this kind of swap and thus define the fundamental quantum gates for TQC (<http://tinyurl.com/ycohz259>) [J25]. Of course, also more complex gates can be imagined but swap is enough to build universal TQC. Official biology assigns to MAP many other functions associated with MAPs but also this function can be imagined. Penrose and Hameroff have also considered the possibility that topological qubits are represented in terms of quantum superpositions of helical pathways with 13-periodicity characterized by the gap between neighboring pathways.

13.6.2 The identification of Bandyopadhyay for conduction pathways

In his Youtube talk Anirban Bandyopadhyay (<http://tinyurl.com/ze366ny>) [J5] discussed an identification of conduction pathways different from that of Penrose and Hameroff. In [J23] Gosh, Sahu, and Bandyopadhyay argue for evidence for massive global synchronization in brain and claim that experimental findings support the Penrose-Hameroff theory. In the article "Atomic water channel controlling remarkable properties of a single brain microtubule: correlating single protein to its supramolecular assembly" [J18] it is reported that ordered water inside microtubule is necessary for the conduction inside microtubule. According to the same article the tubulins inside microtubule has same energy levels in chemical energy range as isolated tubulins which suggests that the mechanism binding tubulins to form MT is not chemical. In the article "Multi-level memory-switching properties of a single brain microtubule" [J19] it is reported that the hysteresis curve for current along MT as function of voltage is ideal square curve meaning that there is no dissipation involved with the change of the current direction. This would make MT as an ideal memory device. Whether Penrose/Hameroff have in mind the use of current direction as qubit

remains unclear. In video talk Bandyopadhyay refers also to these results.

I consider only the general proposal discussed in video lecture here: the Youtube representation gives concrete illustrations of conduction pathways.

1. It is assumed that there are two kinds of hexagonal tubulin lattices labelled as A and B. As found there is strong evidence that A-type tubules do not exist stably. For both types the tubulin dimers defining dipoles are nearly axial and define candidates for conduction paths with winding periodicity of 13 tubulin dimers. For B type one has rows made of α or β type tubulins along with α and β have effective periodicity of five if one accepts discontinuity at after 2π rotation. One might think that this dictates the choice of the candidates for the conduction paths to consist of sequences of α - β dimers: for these sequences are along the microtubule. If hops occur between α and β this assumption is natural. The proposed pathways are however more general and - as it seems to me - based on rather ad hoc mathematical rule.
2. The notion of helical conduction pathway is the starting point. For B-type tubules this notion must be modified. Presumably the criterion for what it is to be a helical pathway is that they are straight-lines connecting nearest neighbors to each other- this is natural if conduction is identified as hopping between neighboring tubulin molecules. The position of each pathway represented by a value of discrete dynamical variable replacing spin as representation of qubit -essentially the angle $\phi = n \times 2\pi/13$ is in question. There are 13 different values for ϕ . For A-type conducting pathways the condition that one has $\alpha - \beta$ sequence very probably gives the claimed pathways with periodicity 13. One can ask whether the pathways of type A are obtained by twisting the pathways of type B at the second end by 2π and whether living systems could be able to perform this twist to achieve phase transition between two states of the microtubule.
3. Instead of single pathway one considers groups of parallel pathways consisting of translates of a fixed pathway with a fixed gap $\Delta\Phi_{gap} = n_{gap}2\pi/13$ along the circumference of microtubule. I failed to understand the motivation for this: maybe the idea is that the additional degree of freedom makes possible the analog of spin degree of freedom as angular position of the pathway. One could also consider the possibility that the translates of a pathway define a braid: this braid would be however trivial since the pathways are parallel. If I have understood correctly, topological qubits would be represented as quantum superpositions of helical conduction pathways with same gap $\Delta\phi = n_{gap} \times 2\pi/13$ between neighboring pathways. This is not what TGD suggests.
4. By $n = 13$ modulo arithmetics it can that the series of pathways with $n = kn_{gap} \bmod 13$, $k = 1, 2, \dots$ generates additional gaps. One says that the decomposition occurs. The addition of translated parallel pathways can also lead to a pair of pathways with $n_{gap} = 0$ or $n_{gap} = 1$ in which case pathways overlap or touch. This is not allowed. What this means physically is unclear to me. One could also avoid touching simply by allowing only the translates to be such that $kn_{gap} \leq 13$ holds true: even weaker condition can guarantee this.

Consider first what one obtains for A-type microtubules.

1. The construction rule gives for $n_{gap} \in 1, 2, 3, 4, 6, 12$ many secondary gaps, in particular $n_{gap, new} = 1$ so that “don’t touch” rule is violated. For $n_{gap} \in \{5, 7, 8, 9, 10, 11, 13\}$ only 1 or one secondary gap or no secondary gap is obtained. The decompositions of primary gaps are

$$5 \rightarrow (5, 3) , \quad 7 \rightarrow (7, 6) , \quad 8 \rightarrow (8, 5) , \quad 9 \rightarrow (9, 4) , \quad 10 \rightarrow (10, 3) , \quad 11 \rightarrow (11, 2) , \quad 13 \rightarrow 13 .$$

2. One can form from these collections of parallel pathways more complex collections as unions. Only unions for which “don’t touch” rule is satisfied. This leaves for A-type microtubules 4 groups of pathways characterized by four values of n_{gap} each. The 4 groups of 4 of n_{gap} values which can co-exist without breaking the basic rule are

$$\begin{aligned}
 &(8, 5, 10, 13) \\
 &(7, 9, 11, 13) \\
 &(5, 7, 10, 13) \\
 &(5, 7, 9, 13)
 \end{aligned}
 \tag{13.1}$$

Here only the generating gaps are listed. For instance, the $(8, 5, 10, 13)$ decomposes to $(8, 5, 3, 10, 13)$.

3. There is a problem: these parallel pathways do not have intersections and therefore cannot form braids unless also their mirror images are allowed or one introduces additional group of pathways, which could be called transversal.
4. One does not obtain Fibonacci conduction pathways with periodicities 3, 5, 8 for A-types microtubules suggested by Penrose and Hameroff. One could argue that since the periodicity as winding number is a topological characteristics, the correct identification should give all winding numbers or at least those which are Fibonacci numbers in case A-type microtubules.

What about B-type microtubules?

1. For B-type microtubules one obtains 4 pathways, one of them parallel to the microtubule and the remaining three with periodicity 7. Only the gaps 2, 3, 4 are allowed by the “don’t touch” rule. 2 and 3 do not decompose and 4 decomposes to $(4, 2)$ so that 2 and 4 can co-exist.
2. For the axial pathway X there is no restriction to the values of n_{gap} unless one just assumes $n_{gap} = 2$ as in the illustration of slides. It is argued that together A and B-type pathways cover the entire series. I failed to understand what this means: in any case, the primary gap number $n_{gap} = 12$ is missing and I find difficult to understand what complementarity could mean.
3. The 3 pathways 2, 3, 4 are parallel and cannot intersect each other but they can intersect the axial pathways called X so that braiding is possible. For X type pathways conduction would take place along sequence of $\alpha - \beta$ pairs.
4. For A-option one obtains only periodicity 13 and for B option periodicity 7 for primary gaps 2, 3, 4 and periodicity 1 for the line parallel to microtubule with periodicity 1.

Bandyopahyay emphasizes that A-type pathways are ideal for TQC whereas B-type pathways are ideal for communications. I did not understand the argument. Certainly this requires that a phase transition from B to A can take place.

The transitions reported to occur as the microtubule is excited at certain resonance frequencies, would in this picture correspond to transitions between different groups rather than excitation of single pathway. The number of resonance frequencies is reported to be 8. If there are n pathways all possible transitions would give $n(n + 1)/2$ resonance frequencies: this number cannot be equal to 8 unless some frequencies are degenerate. It would seem that more plausible interpretation is in terms of excitation of a physical state assignable to given pathway or group of its parallel translates rather than between groups of them.

13.6.3 Microtubules from TGD point of view

In TGD framework microtubules are especially interesting from the point of view of TQC - both for 1- and 2-braids and MTs might represent an evolutionary step in which 1-braid TQCs were extended to 2-braid TQCs.

1. *What does one mean with TQC?*

I ended up with my own proposal about TGD Universe as topological quantum computer (TQC) around 2002 [K4] with inspiration coming from New Scientist article [?] - at the same time

Hameroff has proposed the idea about conducting pathways as braids. By looking at old blog articles I learned that I have developed the vision about DNA as TQC during 2007 [K3, K64].

The proposal is that the braiding of magnetic flux tubes associated with the magnetic bodies of biomolecules - and probably also much larger structures - makes possible TQC like activities basic aspect of living systems. For instance, braids connecting DNA and nuclear and cellular membranes could make possible automatic construction of memories as space-like braidings of magnetic flux tubes induced by time like braiding generated by the liquid flow around cell and nuclear membrane [K3]. Also microtubules could be connected to axons by flux tubes and similar mechanism could be at work. A universal representation of memories could be in question and couple microtubules directly to the neural activities.

It is essential that the second of each braid is free to move so that temporal braiding patterns are generated and induce spatial braiding patterns (dance metaphor helps to visualize this [K3]). Second essential point is that the qubits reside at the ends of braid strands. This is why the statement of Penrose and Hameroff that conduction pathway defines a qubit in some manner - say in terms of current direction - does not make sense in standard TQC paradigm. In the following I shall propose that the statement can be made to make sense if one considers generalization of TQC involving 2-braids instead of 1-braids so that 2-D objects get “knotted” instead of 1-D objects [K27].

The braiding induced by say 2-D flow of lipids would still be passive generation of memories but one could consider also genuine quantum computation like activities in which the braiding defining the TQC program is constructed in a controlled manner. For instance, one could associate to microtubular surface highly regular “pre-braidings” involving crossings of magnetic flux tubes for which basic braiding operation (swap) between neighboring braid strands could be controlled by the tubulin molecule associated with the crossing. Swap could be determined by the tubulin conformation in the crossing defining a classical bit so that classical computer program expressible as cylindrical surface decorated with bits would code TQC program. In this manner coupling of the events at cell membrane to microtubular quantum cognition would be achieved.

What one exactly means with topological quantum computation (TQC) is not at all obvious and one can consider several variants of it in TGD framework.

1. Zero energy ontology (ZEO) leads to the notion of unitary U-matrix and orthonormal basis of M-matrices which are “square roots” of density matrices expressible as products of hermitian matrix and unitary S-matrix depending on the size scale n of CD in very simple manner: $S(n) = S^n$, where S is the S-matrix for the minimal sized CD.

M-matrices define time-like entanglement coefficients between the positive and negative energy states at the opposite boundaries of causal diamond (CD). For braid strands along light-like 3-surfaces defining string ends one obtains entanglement between fermions at the ends of strands. Since the entanglement matrix is unitary it defines density matrix which is sum over projection operator acting as identity matrices and state function reduction yields a negentropically entangled state carrying information. One can pose additional conditions on space-time like negentropic entanglement (NE) (see **Fig. <http://tgdtheory.fi/appfigures/cat.jpg>** or **Fig. ??** in the appendix of this book) and ends up with a highly unique form of entanglement coefficients from the condition that any splitting of the system to two parts defines negentropic entanglement [K33].

Under rather natural assumptions S-matrix reduces to a unitary representation of scaling of causal diamond (CD) [K36]. U-matrix elements between M-matrices for various CDs are proportional to the inner products $Tr[S^{-n_1} \circ H^i H^j \circ S^{n_2} \lambda]$, where λ represents unitarily the discrete Lorentz boost relating the moduli of the active boundary of CD and H^i form an orthonormal basis of Hermitian square roots of density matrices. \circ tells that S acts at the active boundary of CD only. It turns out possible to construct a general representation for the U-matrix reducing its construction to that of S-matrix.

2. In absence of degeneracy giving rise to negentropic entanglement one would have ordinary entanglement and ordinary quantum measurement theory applies. The outcome of TQC would be statistically determined from state function reductions for large enough number of sub-CDs of given CD. It would be coded by quantum classical correspondence (QCC) to the

parameters characterizing classical fields inside CD (frequencies, wave numbers, ...). EEG patterns would be one particular representation of this kind.

3. The sequence of state function reductions defining sub-self as mental image would correspond to the reading of Akashic records as kind of TQC. TQC would represent "Akashic records" and by NMP Universe would be building increasing library of Akashic records. This might provide a general mechanism of term memory.
4. Also a generalization of ordinary 1-braid TQC to 2-braid TQC is suggestive. 1-D braid strands define braiding of orbits of point like particles in 3-D space space-time - say light-like 3-surface. In TGD framework the 1-D braid strands correspond to the boundaries of 2-D string world sheets and the evolution of string world sheets corresponds to 2-braid in space-time. One obtains a generalization of 1-braid TQC to 2-braid TQC in which knotting occurs for 2-D string world sheets of 4-D space-time rather than 1-D strings of 3-D space.

Qubits at the ends of time-like braid strand are replaced with quantum states at space-like braid strands defining ends of string world sheet and TQC corresponds to a time evolution in which the 2-knotting of braid strands changes. The first basic operation is what Alexander the Great did for the knot - the breaking of 1-knot temporarily. What happens is following: if braid strand A goes over B before the moment of breaking, it goes below B after it. This is however not the only possible operation: also reconnection - basic operation for magnetic flux tubes - can take place: the braids strands AB and CD are replaced with AD and CB. These operations define standard vertices in closed string model. The sequence of these operations defines 2-braiding and one can assign to it a generalization of 1-braid TQC to 2-braid TQC. 2-braid TQC is not possible in super string models since strings are embedding in space-time having dimension higher than $D = 4$.

The quantum states of braids strand would define qudits. In TGD qudits representable as superposition of p^N states, p prime, are of special interest in TGD framework.

2. *Could MTs lead from 1-braid TQCs to 2-braid TQCs?*

What can one say about the situation concerning microtubules in TGD framework? Since I am not a professional biologist, I can imagine rather freely.

Consider first TQC in the standard sense, that is for 1-braids.

1. The obvious question concerns the nature of the braid strands (conduction pathways in the terminology of Penrose and Hameroff) and here standard physics cannot provide much insight. A natural TGD based identification would be in terms of magnetic flux tubes carrying dark electrons or even better, their Cooper pairs forming currents running along the microtubule. This would predict that microtubules act as super-conductor like systems. The basic aspect of this kind of system is resistance which does not depend on the length of the wire since the resistance is determined by what happens at the ends of the wire where electron current enters or leaves the wire - now flux tube. For ordinary superconductors the resistance involves term which does not depend on temperature. Also now one might expect that the resistance has similar behavior.

The states of Bose-Einstein condensate at the braid strand cannot defined the qubits in ordinary 1-braid TQC for which the states reside at the ends of braid matter. The flux tubes should have ends - at least effectively. The ends should carry quantum numbers defining the qubits. The effective end would correspond to wormhole throat of a wormhole contact at which the magnetic flux flows to another space-time sheet. Quite generally, the flux tubes would be closed structures: for instance, elementary particles correspond to two-sheeted flux tubes having two wormhole contacts as "ends".

2. Maybe the tubulin at the crossing point could induce swap or not depending on its state. Tubulin dimers possess two different configurations and the original proposal of Hameroff was that these configurations correspond to two values of bit. The bit represented as a tubulin conformation would tell whether the left-handed strand runs above or below the right-handed strand at the crossing. The braiding would have representation as a 2-dimensional

cylinder with points representing classical bits determining the TQC program. Classical computing and quantum computing would couple together. If tubulin conformations could form quantum superpositions, one would have “quantum-quantum-computation”. According to [J16], the process inducing the change of tubulin conformation is chemical irreversible process so that this option does not seem to be possible.

3. The swap at the crossing point for certain value of time would be determined by the state of the tubulin at the crossing at particular moment. At each moment the braiding pattern for braids connecting microtubule ends would determine the TQC program in terms of entanglement matrices proportional to unitary matrices. What is important is that unitary matrix between the states at the ends of braid gives rise to NE with entanglement probabilities forming a matrix proportional to unit matrix. The NE alone could be in principle source of conscious information obtained during sequence of state function reductions at a fixed boundary of CD defining self. These states or selves would define what I have called “Akashic records” responsible for memory storage as quantum invariants.

What is new that a generalization of TQC based on 2-braids defined by string world sheets can be imagined. The idealization of time evolutions of magnetic flux tubes can be idealized as string world sheets so that magnetic flux tubes would become key players also in 2-braid TQC. The transition from DNA as TQC to MT as TQC could correspond to the replacement of 1-braids with 2-braids. The quantum states of 2-braid TQC would correspond to unhalting 1-braid TQCs. This would represent a step leading to a higher abstraction level and could play a fundamental role in evolution in accordance with the role of emergence of microtubules in ontology.

1. The states of braid strands could define qubits for TQC based on 2-braids defined by string world sheets assignable to time evolutions of flux tubes idealized as strings.

The spin direction of cyclotron Bose-Einstein condensate defines one candidate for qubit. The direction of DC current along braid strand could also define qubit. If the system is ideal Josephson junction then a constant voltage should however give rise to an oscillating current. The presence of resistances at the ends of the flux tubes is expected to give rise to the standard form of Ohm’s law in average sense.

2. The hysteresis curve for the micro tubular current I as function of voltage V between the ends of microtubule is reported to be square [J19] so that the phase transition changing the current direction could be quantum phase transition at criticality and make possible qubits as superpositions of both current directions near criticality for the current flip. TQC would halt when the voltage is changed so that it is not in the critical region anymore.
3. For magnetic flux tubes the vertex changing swap for 1-braid corresponds to reconnection, which would therefore find a new application in TGD inspired biology. I have earlier proposed that the ATP-ADP transformation generates reconnection but failed to realize that the interpretation could be in terms of 2-braid TQC. Energy metabolism as a continual occurrence $ADP \rightarrow ATP$ and its reversal could be also a direct signature of 2-braid TQC. The spatio-temporal pattern of $ADP \leftrightarrow ATP$ transformations would reveal the TQC program code.
4. The change of the conformation of tubulin molecule would induce a swap. The reconnection of flux tubes -perhaps also induced by a change in the conformation of tubulin molecule - is also possible. The TQC program for 2-braids would be coded by the temporal history of changes of tubulin conformations represented in terms of bits. Chemistry would be used to write TQC programs. 2-braid TQC could be seen as sequence of 1-braid TQCs, which need not halt.

Admittedly, the model involves several new physics elements, which skeptic with Occam’s razor could use to debunk the approach: dark matter hierarchy represented as hierarchy of effective Planck constants, the motion of magnetic body implied by the TGD based geometrization of classical fields and new view about space-time, and the notion of NE and Negentropy Maximization Principle [K33] defining the variational principle of TGD inspired theory of consciousness. These new elements are not however ad hoc assumptions but basic pillars of quantum TGD.

3. *Identification of conduction pathways*

Consider next the detailed identification of the conduction pathways assumed to correspond to a grid formed by flux tubes.

The interpretation of Bandyopadhyay has some problematic aspects. The proposed parallel strands do not intersect and cannot therefore define braid. The transitions to which the resonance frequencies are assigned, are not identified. No comment is represented concerning the problem that A-type microtubules have not been observed experimentally. From these problematic aspects it takes some time to end up with TGD based vision about the situation.

1. In TGD framework it is natural to regard the pathways of A-type microtubules as obtained by 2π twist for the “upper” end of B-type pathways which are of type X and possess the primary gap numbers allowed for A-type groups: recall that this gives 4 groups of four primary gaps. The pathways obtained from the transversal pathways of B-type microtubules by 2π twist define an excellent candidate for the complementary pathways needed to obtain crossings and braiding.

What looks like a problem is that the twist for the 3 groups of 7-periodic pathways would produce two 7-periodic pathways per 13-unit, which corresponds to 14 rather than 13 tubulins rather per basic unit. The only explanation is that the discontinuity disappears and implies that there one has 13 tubulins per single structural unit of Q-type tubule.

2. If one excludes the decomposable pathways with $n_{gap} = 4$, the twists of 2 and 3 groups would define transverse pathways for A-type microtubules. Altogether 8 different coordinate grids formed by the pathways - now magnetic flux tubes - would be obtained. The 8 resonance frequencies would correspond to the phase transitions $A \leftrightarrow B$ induced by $\pm 2\pi$ twist for the “upper” end of the basic unit.
3. In TGD framework the most natural explanation for why A type tubules are ideal for TQC is that they correspond to a large value of h_{eff} , and the phase transition increases the value of h_{eff} and makes superconductivity and TQC possible for A type tubules. Unitary S-matrix characterizing TQC defines entanglement probabilities which are identical so that NE is in question. NE is very closely related to large value of $h_{eff}/b = n$: n corresponds to the number of entangled states in the simplest situation.
4. One can estimate the value of h_{eff} if the AC radiation inducing the phase transition corresponds to dark photons with energy which is above thermal energy. For the energy $E \simeq 2$ eV of visible photons this would give for 8 MHz frequency $n = h_{eff}/h \simeq 6 \times 10^7$. For IR frequencies above thermal threshold which corresponds to the energy $E \simeq .05eV$ assignable to resting potential, one would have $n = h_{eff}/h = 10^5 - 10^6$.

Corresponding p-adic length scales giving estimates for the length scales of flux tubes would scale like $n^{1/2}$. For B-type microtubules the p-adic length scale would be naturally 5×4 nm corresponding to 5-periodicity and 4 nm length diameter for single tubulin. For A-type microtubules corresponding scale would be by factor 10^3 longer for IR frequencies: upper bound would give $20 \mu m$. The length of microtubules obtained in experiments ranges from 2μ to $25 \mu m$ so that the estimate seems to make sense.

4. *Could frequency hierarchy correspond to a p-adic hierarchy of magnetic flux tubes?*

The hierarchy of frequency scales kHz, MHz, and GHz could correspond to cyclotron frequencies for electron and perhaps also proton. In particular, the crucial role of water in making conductivity possible suggests that protonic cyclotron B-E condensate is important in the water core of MT at least but possibly also in longer length scales.

1. TGD allows magnetic monopole fluxes for flux tubes: in this case the cross section of the flux tube would be closed 2-D surface (sphere) rather than disk, and no current rotating around the tube would be needed to create the magnetic flux. This kind of flux tubes could explain the presence of magnetic fields in cosmic scales: in Maxwellian cosmology they are impossible in early cosmology because the needed currents are too possible. This kind of fluxes might be

associated with super-conductors and even permanent magnets. The unit of magnetic flux $\Phi = \int eBdS$ is $h/2$ for a disk cross section. For spherical cross section of monopole flux tube the flux is $\Phi = \oint eBdS$ and unit is $2h$ that is 4 times larger. This could serve as a test for whether one has monopole flux or standard flux.

2. I have proposed that constant endogenous magnetic field $B_{end} = .2 \text{ Gauss} = .2 \times 10^{-4} \text{ Tesla}$ could explain the effects of ELF radiation to vertebrate brain as resulting from cyclotron transitions of large h_{eff} B-E condensate. The recently updated model replaces cyclotron transitions with phase transitions scaling the value of p-adic prime and thus the value of the magnetic field. The model yields essentially the same predictions as the earlier model. The phase transition scales down the radius of the flux tube characterized by p-adic length scale $L(k) \simeq 2^{(k-151)/2} \times L(151)$, $L(151) \simeq 10 \text{ nm}$ by a power of two: the increase in cyclotron energy due to the reduction of flux tube radius is in good approximation $ne(B_f - B_i)/m = neB_f(1 - 2^k) \simeq neB_f$, where B_f is the field strength for the compressed magnetic flux tube.
3. For electron in endogenous magnetic field of .2 Gauss cyclotron frequency is $f_e \simeq .5 \text{ MHz}$: for proton one has $f_p \simeq 300 \text{ Hz}$ (note that the ratio of cyclotron frequencies of electron and proton is given by the mass ratio $m_p/me \simeq 1843 \sim 2^{11}$). The reported resonance frequency is $f \simeq 8 \text{ MHz}$, which is 2^4 times higher than f_e . This suggests that the irradiation induces p-adic phase transition of flux tubes contracting them by a factor 1/2 and increasing field strength by a factor 4. This would mean that the p-adic length scale is reduced from $L(k)$ to $L(k - 4)$. The possibility of this interpretation yields support for the p-adic length scale hypothesis.
4. Purely number theoretic considerations predict that in biologically interesting length scale range ranging from 10 nm to $2.5 \mu\text{m}$ there are four p-adic length scales which correspond to Gaussian Mersenne primes $M_{G,n} = (1 + i)^n - 1$, $n = 151, 157, 163, 167$. One could speak of a number theoretic miracle. It is easy to see that the transition induced by 8 MHz radiation could correspond to the transition $k = 167 \rightarrow 163$ for electron. This gives strong support for the fundamental role of these Mersenne scales.

First, B_{end} corresponds to magnetic length of $L_B = \sqrt{\hbar/eB} = 5.7 \mu\text{m}$ not far from the p-adic length scale $L(169)$ is $L(169) \simeq 5.1 \mu\text{m}$. L_B would give flux quantum $h/2$. The problem is that this scale is by a factor 2 longer than the Mersenne scale $L(167)$. Situation changes if the flux is monopole flux for flux tube with spherical rather than disk-like cross section. By previous argument the flux quantization would be obtained for a sphere with radius given by the p-adic length scale $L(167)$. One would obtain Mersenne scale and the transition $L(k) \rightarrow L(k - 4)$ would correspond to $k = 167 \rightarrow k = 163$. Proton cyclotron frequency would be scaled up in this transition to 4.8 kHz and it would be natural to identify frequencies in kHz frequencies as harmonics of f_p .

5. The scaling $k \rightarrow k - 11$ would transform $f_e = .5 \text{ MHz}$ to $f_e = 1 \text{ GHz}$. The p-adic scale would become $k = 156$. $k = 157$ would have been more attractive outcome. $L(156) \simeq 57.6 \text{ nm}$ looks too large to be radius for a magnetic flux tube assignable to the MT strand of thickness of order 4 nm. I would more naturally correspond to the length scale defined by a strand of 13 tubulins.
6. Microtubule strand corresponds to length scale 4 nm which suggests that p-adic length scale $L(149)$ assignable to lipid layer of cell membrane characterizes the flux tubes defining the coordinate grid at MT surface. GHz frequency is assigned with the order water in the interior of MT $L(145) \simeq 1.25 \text{ nm}$ seems to be a good candidate for the corresponding p-adic length scale. $f_p = 1.35 \text{ GHz}$ frequency is obtained if flux the transition is $k = 167 \rightarrow 145$.
7. An attractive possibility is that the flux tubes in the interior of MT contain dark proton sequences defining the dark nuclei with single dark proton with large value of Planck constant h_{eff} with size scale of single DNA codon. The amazing prediction of the model of dark nucleon is that the counterparts for the DNA, RNA, amino-acids and even tRNA are obtained and vertebrate genetic code can be realized as a natural correspondence between these states [K25, L2]. One can imagine the possibility that the dark genetic codes inside MT and

connected by radial magnetic flux tubes to the codons at the braid strands at the surface of MT.

5. About B-type lattice

Some TGD- and computer science inspired comments on B-type lattice are in order.

1. B-type lattice is discontinuous along vertical line. There is a horizontal pair of α and β tubulin monomers at discontinuity and here α (β) tubulins have 3 instead of 2 nearest neighbour β (α) tubulins. Could the possible flux tubes connecting microtubule to the axonal membrane and making possible to receive sensory input begin here? The flux tube pair parallel to this line brings in mind DNA double strand. The α - or β -sequences with vertical 5-periodicity would be discontinuous after full turn: the shift in vertical direction would be 5 tubulin units but single turn of the helical path would correspond to a vertical shift of 4 tubulin units only.
2. The discontinuity suggests that the tubulin consists of pieces of 13-units maybe defining a sequences of 13 binary digits as code words - kind of bytes - in turn defining the classical computer code giving rise to TQC code.
3. A second interesting aspect is the 7-periodicity of transversal pathways in axial direction. One of the TGD inspired models for genetic code [K24] interprets 64 genetic codons as a subset of 127 element space consisting of $2^7 - 1$ elements identified as a subset set of mutually consistent logical statements of 7-bit algebra so that the negation of the statement cannot belong to the set.

Statements would be analogous to axioms of mathematical system being identically true. One statement is non-realizable: in case of set theoretic realization it would be naturally empty set. If statements are realized as spin excitations of ferromagnet then absence of spin excitations would correspond to the non-realizable statement. One could also argue that only communicable statements are possible. Communication of the state could be defined as radiation generated by the transition from the ground state to a multiply excited state. If there is no change (ground state goes to ground state), the statement is not communicable. Could 7-bit sequences be restricted by the condition that they represent identically true statements? This condition would make possible error correction mechanism analogous to parity bit.

6. Could DNA sequences code for TQC programs?

One also ends up with a rather crazy idea about possible interpretation of genetic code.

1. If one piles up 2-D TQC: s one obtains 3-D 1-braid TQC. In crossings one must have 3 bits to specify whether to swap or not since there are three planes for TQC and 3 pairs of crossing strands (12, 13, 23).
2. For 2-braid TQC one obtains 6 bits at each crossing of 3-D grid. The first bit tells whether reconnection occurs and second tells which of the resulting strands goes over the other. One can imagine even a concrete realization. DNA strand which is a coil with radius of 10 nm could be accompanied by a flux tube and there would be for each codon to flux tubes crossing this flux tubes so that 6 bits would be needed to characterized the 2-braid locally. DNA as TQC model suggests that second flux tube connects DNA codons to a helical flux tube at lipid layer of nuclear or cell membrane. Second strand could connect it to similar tube at cell membrane.
3. Just for fun one can imagine also a second, even more science fictive realization. If one further piles 3D TQC: s in 4-D one obtains 4-D one making sense in zero energy ontology because failure of strict non-determinism is basic element of TGD. Single crossing would in 4-D would involve crossings of four lines in orthogonal dimensions. TGD predicts also space-time regions with Euclidian signature in all scales (lines of generalised Feynman diagrams). I have proposed that any system corresponds to an Euclidian space-time sheet having its size and shape and behaving like quantum system. In these regions the fourth piling might really make sense!

This would make 6 crossing pairs corresponding to 6 planes in which particular TQC takes place - for which one must tell whether to swap or not (12, 13, 14, 23, 24, 34). This makes 6 bits. DNA codons correspond to 6 bits! Could codons define crossing points of magnetic flux tubes arriving from 4 coordinate directions- perhaps at Euclidian space-time sheets? Could the planes correspond to 3 components of magnetic field and 3 components electric field. Magnetic flux tubes and electric flux tubes in 3 directions? In Euclidian regions magnetic and electric do not differ intrinsically. It is however difficult to concretize this proposal.

In the following I try to understand the observations reported by Anirban Bandyopadhyay (<http://tinyurl.com/ze366ny>) in TGD framework.

13.6.4 The observations of the group of Anirban Bandyopadhyay from TGD point of view

The observations of Anirban Bandyopadhyay are briefly summarized by Massimo Pregolato. At this stage one can of course several models for the findings and in the following one option is selected.

1. The most plausible model is based on the notion of coordinate grid formed by longitudinal and transversal magnetic flux tubes whose crossing points are the points at which swap occurs or does not occur depending on the state of tubulin dimer. The grids associated with A and B tubules are obtained by a 2π twist for the upper end of the tubulin.
2. There is a large number of options for grids and they are identified on basis of the experimental findings. Transversal coordinate lines would correspond to the 7-periodic parallel lines with either gap 2 or 3 (gap 4 lines decompose to gap 4 and gap 2 lines) and longitudinal coordinate lines to one of 4 line groups involving four gaps so that 8 coordinate grids are obtained and related by a 2π twist for A and B tubules respectively. Gaps could characterize measurement resolution.
3. For A-type microtubule one can consider also Fibonacci grids constructed from helical curves and their mirror images with periodicities 3, 5, 8, 13 and arbitrary gaps but it is difficult to interpret the resonance frequencies and understand their number for this option.

1. Fröhlich B-E condensation or something else?

Excitation at the resonance frequencies cause microtubules to assemble extremely rapidly. This is proposed to be due to Fröhlich condensation. The resonance frequency of AC stimulation leading to a rapid generation of microtubules in the length scale range $[.2 - 22.5] \mu\text{m}$ is around 8 MHz. There is correlation between resonance frequencies and lengths of microtubules and qubit sets that are possible.

Comment: The identification as formation of Fröhlich B-E condensate can be criticized. The frequency at which this would take place was predicted by Fröhlich to be around GHz rather than in MHz range.

In TGD framework AC stimulation could generate flux tube grid or activate existing magnetic flux tube grid forming a braid like structure serving as a template for the formation of microtubule around it. If the formation of grid corresponds to quantum criticality, the resonance frequencies could also generate phase transitions between A and B type states of the microtubuli. AC signal could also generate contacts to these flux tubes making possible supra currents. The formation of microtubules is known to proceed by the formation of vertical nucleotide polymers which are then glued together horizontally: flux tube could serve as a template for the formation of the nucleotide polymer. The magnetic fields at flux tubes can be accompanied by helical electric fields (in this case both magnetic and electric fields are helical) and these fields could be responsible for the polarization of microtubule and induce the growth of microtubules in such a way that the polarized alpha-beta tubulin always attaches in the same manner to the growing polymer. Fröhlich condensation would be a consequence of generation of flux tube coordinate grids defining microtubule skeleton- growth of the magnetic body would precede that of biological body.

The length of the tubule increases with resonance frequency which suggests that single tubulin dimer is added to the polymer during each cycle. MHz range and formation time around few

seconds. This would mean something like 10^6 giving MT with length of order 10^{-4} meters. The order of magnitude is correct.

2. 8 resonance frequencies in AC stimulation and 8 distinct interference patterns

Microtubules are reported to have 8 resonance peaks for AC stimulation (kilohertz to 10 megahertz), which appear to correlate with various helical conductance pathways around the geometric microtubule lattice. The explanation is proposed in terms of current pathways which are identified topological qubits.

Comment: To me this terminology looks strange and confusing. Why not to speak about braid strands or specify what topological qubit means if one is speaking about TQC? I am unable to understand why groups of parallel pathways are considered as topological qubits (TQs). The idea about parallel translates might however make sense.

As already explained, the notion of coordinate grid in the sense discussed is consistent with the findings. The resonance frequencies could correspond to phase transitions changing A-type coordinate grids to B-type or vice versa. Coordinate grid would define the basic architecture of TQC.

The second claim is that there are altogether eight distinct quantum interference patterns from a single microtubule, each correlating with one of the 8 resonance frequencies and pathways. According to the interpretation discussed in the talk 4 sets of four pathways representing quantum TQ each can exist simultaneously for type A microtubules claimed to be ideal for quantum computation. Lattices of type B exhibit 4 different pathways and are claimed to be ideal for communications. The lattices A and B are complementary in the sense that together they allow all possible pathways (this is not quite true: $n_{gap} = 12$ is lacking). The set of possible pathways depends on the length of MT.

Comment: Also this would conform with the TGD inspired model in which one has 8 coordinate grids for tubules of B and their deformations by twist to A type tubules. The 8 interference patterns would correspond to different coordinate grids. What coordinate grids are physically allowed coordinate grids are depends the length of the microtubule.

3. Observations about conductivity

There are also several observations about conductivity suggesting quantum coherence.

1. In assembled microtubules AC excitation at the resonant frequencies causes electronic conductance to become lossless, or “ballistic”, essentially quantum conductance, presumably along these helical quantum channels. Resonance in the range of kilohertz demonstrates microtubule de-coherence times of at least 0.1 millisecond. Does this mean that AC signals at resonance frequencies are able to create these channels or groups of them?

Or does this mean, that the resonance signal transforms the microtubule to A (or B) type lattice which is highly conducting or even super-conducting (via magnetic flux tubes). The claim that A type lattice does not exist in vivo reduces to the statement that it does not exist stably in vivo. The AC signal at resonance frequency induces the twist taking lattice B into lattice A in which TQC is possible.

2. There are three frequency scales corresponding to kHz Hz, MHz and GHz ranges. The natural identification for these rather low frequency scales is in terms of cyclotron frequencies of dark electrons and possibly also various ions at magnetic flux tubes. The simplest identification would be in terms of three ranges for the strengths of magnetic field. I have proposed that 2 Gauss magnetic field define endogenous magnetic field explaining the effects of ELF em radiation on brain in terms of cyclotron transitions of biologically important ions, in particular Calcium ions for which cyclotron frequency would be 15 Hz (later an alternative explanation making essentially the same predictions has emerged). For electron the cyclotron frequency would be 5 MHz so that for 16 times strong field would correspond to cyclotron frequency of 8 MHz appearing as resonance frequency. GHz frequency would require a magnetic field of 0.4 Tesla.
3. It is stated that the system cannot be classified as insulator, semiconductor, or conductor. The reason would be that the two bands involved do not overlap as in conductors, are not

completely separate with large gap as in insulators, nor separate with a small gap. Instead the bands touch each other in pointwise manner.

Comment: Stimulus with the resonance frequency could regenerate the flux tubes or bridges to the flux tubes allowing the transfer of electrons to them. The ballistic resistance temperature independent resistance would be due to a very long free path or due to super-conductivity at the magnetic flux tubes - the latter is the TGD inspired hypothesis. This kind of behavior could result if the electrons can leak to the flux tube only if they have same momentum as the Cooper Bose-Einstein condensate at the flux tube. Resonance condition would mean that the magnitude of the wave vector of electron is quantized in magnitude: this would also support the proposed interpretation.

4. It is claimed that conductance does not depend on microtubule length, is temperature independent, and has discrete values. Also ohmic dissipation is claimed to be negligible.

Comment: The interpretation could be in terms of superconducting current pathways defined by magnetic flux tubes looks natural as already found.

The observation that water is necessary for MT conductivity [J18] suggests that the presence of water is essential for large h_{eff} . One of the many possibilities is that the flux tubes (which are closed) return through the interior of MT containing the ordered water. Also dark variants of genes realized as dark proton sequences dark nuclei could be involved.

4. Ferroelectric hysteresis

What is interpreted as ferroelectric hysteresis is claimed to demonstrate memory capacity in microtubules [J19]. Current viz. voltage over the microtubule exhibits square hysteresis. Suddenly all-in one jump changing the direction of current at critical voltage. This is analog of ferromagnetic or ferroelectric behavior but in completely quantal manner.

One can ask whether the quantum superpositions of two current directions might represent qubit. If so, the information processing capacity of microtubule would be rather modest unless one considers seriously 2-braid TQC. (recall however that in neuroscience single neuron is assumed to represent bit).

It is not at all obvious that ferroelectric hysteresis is in question and TGD suggests different interpretation for the hysteresis curve. The current as function of voltage could reflect quantum coherent current in Bose-Einstein condensate of electronic Cooper pairs with all Cooper pairs having the same momentum. Macroscopic quantum coherence would make the state stable against perturbations defined by the external voltage and only when the voltage exceeds critical magnitude the state would change its momentum to opposite values instantaneously. If the interpretation as cyclotron BE-condensate is correct one would have Cooper pairs with spin 1 in same state and effectively only single particle representing memory.

The assumption of Bose-Einstein condensate might be unnecessary strong: negentropic entanglement might be enough. Dark electrons are negentropically entangled and the entanglement stores potentially conscious information. The degeneracy of the ground state essential for achieving stable enough entanglement also in standard approach to TQC. The NE would not be in spin degrees of freedom but in those labeling sheets of the covering of M^4 and CP_2 defined by the space-time sheet of electron. Anti-symmetry in these exotic degrees of freedom would make electrons bosons if seen from the perspective of standard physics and allow them to effectively B-E condense to the same state with respect to standard quantum numbers. Note that this proposal resembles somewhat the proposal of Hameroff and Penrose for topological qubits in terms of parallel current pathways with same gap. In this case the NE could perhaps stabilize the state in the sense that NMP [K33] would not allow the quantum jump leading to opposite direction of electron current to take place.

5. Dynamical instability of MTs

MTs are dynamic instable and the length of MT changes in jumps. The conjecture is that some kind of language is involved. On basis of few second time scales one can wonder whether the correspondence with language production could be rather direct. Could regions of type A contain the information communicated in speech, say the information needed to form words or sentences? If microtubules of type B are indeed responsible for communications, one can ask whether $A \rightarrow B$

phase transitions generate the signal in turn inducing the nerve pulse patterns correlating with internal speech. The connection with language could be realized also at gene level [K24].

I have proposed that microtubule acts as quantum antenna emitting radiation with frequencies $f_n = nc/L$, where L is the length of MT. The variation of the length of microtubule would predict frequency modulation of the radiation coding for potentially conscious information. The model for nerve pulse and EEG makes similar prediction [K47, K19]. Josephson frequency for cell membrane as Josephson junction is proportional to membrane voltage and the variations of membrane voltages due to oscillations and nerve pulse activity are coded to EEG via frequency modulation. Even ordinary speech involves frequency modulation as is clear by listening recorded speech with abnormally slow speed. If microtubules talk, the most natural language would be based on frequency modulation.

The system seems to be critical, maybe it is quantum critical in TGD sense. At quantum criticality the dynamics involves a large number of length scales. In TGD framework quantum criticality would mean that the hierarchy of Planck constants is involved such that given length scales is proportional to the effective value of Planck constant. Maybe different lengths for flux tubes correspond to values of effective Planck constant $h_{eff} = nh$.

13.6.5 Conclusion

The important conclusion suggested by the experiments is that microtubules - in particular, brain microtubules - are macroscopic quantum systems. Already this would be enormously important conclusion. To my personal opinion, the interpretation in the talk is not convincing at the level of details and TGD inspired modification of the proposal in terms of flux tube coordinate grids making possible TQC architectures with tubulin dimers defining bits defining in turn TQC program looks more plausible to me. A natural generalization of of 1-braid TQC to 2-braid TQC is also highly suggestive in TGD framework and could be seen as evolutionary step assignable to the emergence of microtubules. The interpretation based in Fibonacci conduction paths fails to predict correctly the number of resonances. An attractive interpretation for the resonance frequencies is in terms of phase transitions between A and B type lattices. If A type lattices can be generated only in h_{eff} increasing phase transitions induced by AC stimulus at resonance frequencies, one could understand their experimental absence and why super-conductivity like state is generated.

13.7 Morphogenesis, Morphostasis, And Learning In TGD Framework

Michael Levin and his collaborators have been working with fascinating topics including fundamentals of long term memory and morphogenesis and morphostasis [I49, I50, I64]. I am grateful for Lian Sidorov for bringing these articles to my attention.

There are two articles about morphogenesis and morphostasis. The first article [I49] (<http://tinyurl.com/y91e7wme>) seems to be directed to general audience and has the title "The wisdom of the body: future techniques and approaches to morphogenetic fields in regenerative medicine, developmental biology and cancer". Second article [I50] titled "Morphogenetic fields in embryogenesis, regeneration, and cancer: Non-local control of complex patterning" (<http://tinyurl.com/ydfq28cb>) is more technical. The basic notion is morphogenetic field, an old notion, which has not captured the attention of main stream biologists who have worked mainly with the attempt to reduce biology to genetic code. Sheldrake's work [I61] with the notion has drawn special attention but there are many other workers in the field.

The third article [I64] by Levin and Shomrat has title "An Automated Training Paradigm Reveals Long-term Memory in Planaria and Its Persistence Through Head Regeneration" (<http://tinyurl.com/ycsfs6zc>) challenging the belief that brain is the only seat of memories.

According to Levin, the basic challenge of morphogenetics and morphostasis is to understand how the shape of the organism is generated and how it is preserved [I50]. The standard local approach based on belief on genetic determinism does not allow answer these questions satisfactorily. There is paradigm based on self-organization in which the local dynamics of cells leads to large scale structures as self-organization patterns. The game of life is an elegant example about how simple cellular automaton can lead to surprisingly complex behaviors: actually the game of life is universal Turing computer. The problem of this approach is that it is very difficult to deduce the

local rules governing the behavior of basic units (whatever they are) in practice- especially so if they are also dynamical.

Second approach could be seen as computational with basic idea being that the process is guided by a template of the target state. Morphogenetic fields would define this template. The assumption about final goal can be argued to be too strong: much weaker principle defining a local direction of dynamics and leading automatically to the final state as something analogous to free energy minimum in thermodynamics might be enough. Unfortunately, second law is the only principle that standard physics can offer.

These problems are very relevant also for medicine [I49] since morphogenesis, morphostasis, and cancer all involve actively replicating cells: the difference is that in cancer the control and long scale coordination of the process fails and it becomes purely local process. Levin refers to cancer as geometric disease and it seems that this correction contains seed of truth.

These topics are also interesting from the point of view of TGD inspired quantum biology and consciousness. There are several new notions to be tested.

1. The new view about time and quantum implied by zero energy ontology (ZEO). In TGD framework the notion of preferred extremals as 4-D space-time sheet analogous to Bohr orbit, for which strict determinism of dynamics fails, replaces 3-space as basic unit. One can understand self-organization process in 4-D sense rather than 3-D sense: geometric time evolution would be replaced by subjective time evolution by quantum jumps. This could resolve the basic difficulty of the ordinary self-organization paradigm. Geometro-temporal pattern approaches to asymptotic quantum jump by quantum jump one rather than 3-D pattern.
2. The new view about information relying on the notion of negentropic entanglement and Negentropy Maximization Principle (NMP). NMP could be the principle guaranteeing local positive goal making healing and evolution basic processes of Nature. In particular, the development of shape and shape preservation of organisms could involve NMP in essential manner. Also the approach of WCW spinor field to the maximum of vacuum functional (or equivalently that of Kähler function) gives a goal for the dynamics after the perturbation of the organism causing “trauma”. If Kähler function is classical space-time correlate for entanglement negentropy, these two views are equivalent.
3. The notion of magnetic body (MB) carrying dark matter as phases with large value h_{eff} of Planck constant making living matter a macroscopic quantum system and providing a tool kit of quantum mechanisms (phase transitions changing the value of h_{eff} and thus the length of flux tube, reconstructions changing the topology of magnetic Indra’s net, and 1-braiding of flux tubes 3-space and 2-braiding of their orbits in 4-D space-time). Magnetic body defining a kind of coordinate grid is a good candidate for the TGD counterpart of morphogenetic field serving as a template for the developing organism. It would also give rise to topological quantum computation (TQC) type activities.
The coordinate grid formed by flux tubes defines 3-D topological quantum computer program and the natural assumption is that learned behaviors are coded by the magnetic body as TQC programs. If replication of magnetic body accompanies the replication of DNA, cell, and even planaria (say), the learned behaviors are also replicated.
4. There are additional mechanisms: super-conductivity made possible by large values of h_{eff} , Josephson radiation from Josephson junctions transforming voltages to frequencies inducing resonant transitions, and radiation consisting of dark photons and inducing cyclotron transitions serving as a basic control and coordination tools. The radiation could be generated as analog of cyclotron radiation by quantum phase transitions at magnetic flux tubes, by Josephson junctions, and by microtubules serving as quantum antennas. Frequency modulation is an excellent candidate for the representation of information: kind of whale song would be in question.

All these new notions seem to be highly relevant for the understanding the findings challenging the standard intuition discussed in the articles. It would seem that both computational aspects (TQC), self-organization but in 4-D sense, the idea about template identified in terms of flux

quanta of topologically quantized classical em fields, and the local direction of quantum dynamics defined by NMP are involved rather than single principle.

13.7.1 The notion of time in TGD framework

The TGD based notion of time is very relevant in attempts to understand the findings about the memory of planaria and metamorphosis and metastasis challenging the standard thinking.

1. *The general picture based on zero energy ontology*

1. In TGD framework one must make a distinction between subjective time and geometric time: usually these times are identified. Subjective time has state function reduction/quantum jump as chronon. Geometric time is the time of physicists and corresponds to one coordinate for space-time surface or embedding space. General Coordinate Invariance implies that it is not unique but that there are very natural choices of it dictated by symmetries.
2. In zero energy ontology (ZEO) physical state is replaced with a pair of positive and negative energy states at opposite boundaries of $CD \times CP_2$, where CD is causal diamond identified as the intersection of future and past directed light-cones. I will talk about CD in the sequel without bothering to write " $\times CP_2$ ". In ordinary positive energy ontology zero energy states correspond to initial and final states of physical events. The space-time surfaces having their ends at the boundaries of $CD \times CP_2$ are space-time correlate for the physical time evolution between the initial and final states. CD: s form a fractal hierarchy since the distance between the tips of CD is assumed to be integer multiple of CP_2 time. Also Lorentz transforms and translates of CD are allowed so that it makes sense to speak about moduli space of CD: s and also have "wave functions" in this moduli space. This is very relevant for understanding what the flow of time corresponds physically.

One can say, that due to the failure of strict determinism the 4-D space-time surface connecting boundaries of CD becomes the basic dynamical unit as far as subjective time development is considered. The superposition of space-time sheets is recreated again and again in quantum jump so that "quantum average" space-time - also its past - changes.

One can speak about 4-D body, brain, even society and there is continual 4-D interactions. For instance, the recall of long term memories could be communications with the geometric past using time reversed signals reflecting back from the brain of the geometric past: essentially seeing in time direction would be in question. One can even consider healing process in which the healthy state result also in the geometric past!

A new view about long term memories emerges: the brain of geometric past can serve as the seat of memories. This applies to genuine conscious memories such as episodal memories but not to learned behaviors.

3. Zero energy ontology (ZEO) implies a new view about state function reduction and about how the experience about flow of time and its arrow emerge. The state function reductions can occur at either boundary of CD but also repeatedly at same boundary. The wave function in the moduli space of CD: s with fixed "lower boundary" changes although in each repetition of state function reduction although the positive energy state at "lower" boundary remains unchanged. In ordinary quantum measurement theory nothing would change. This change gives rise to the experience about flow of time. The change is that the average temporal distance between the fixed tip of "lower" boundary and the tip of the "upper boundary" increases: essentially dispersion leading to the decay of wave packet is in question. It is analogous to diffusion in which distance of the diffusing particle from the initial position gradually increases. One can quantify this by introducing the average increase of average geometric time in single state function reduction highly relevant for understanding time experience.
4. Couplings between several widely different length and time scales - say molecular length scale and the scale of biological body - seems to be needed in order to understand morphogenesis - at least as something implied by cell level events. TGD assigns to each particle its CD. The

scale of the smallest CD assignable with the particle characterized by given p-adic prime p corresponds to its secondary p-adic length/time scale. For electron this time scale is .1 seconds defining a fundamental biorhythm: as a length scale it corresponds to the circumference of Earth.

5. One of the basic predictions of TGD is the failure of strict determinism of the time evolution for space-time surfaces. The interpretation is as a space-time correlate of quantum non-determinism. The reason is the huge vacuum degeneracy of Kähler action. Any space-time surface with vanishing induced Kähler form which is essentially Maxwell field, is vacuum extremals. Mathematically this huge degeneracy is like gauge degeneracy but implies 4-D (very essential distinction from standard view) spin glass degeneracy: there is huge number of different preferred extremals obtained as deformations of the vacuum extremals. This means non-determinism.

So called vacuum functional tells the probability of one particular preferred extremal and one can imagine plotting it as a functional of the extremal. The graph would be a fractal analogous to free energy landscape of spin glass: there are minima inside minima inside.... - now only the minima are replaced with maxima.

2. *What healing in 4-D sense could mean?*

The TGD view about time allows to imagine what 4-D healing could mean.

1. Suppose that one performs a deformation of the space-time sheet representing healthy organism. The system suffers “traumatic injury” in 4-D sense but only inside the CD in question. Classical non-determinism makes also possible that the localization of 4-D deformation to a finite region of space-time rather than extending to infinite future. State functions repeatedly replace the zero energy state with a new one and it can gradually end up back to the maximum of Kähler function unless the deformation was not too large or unless it stuck to a different local maximum. If it ends up with a original maximum, one can say that 4-D healing took place. Also the biological body of geometric past is healthy! In geometric sense the system was never sick! This mechanism requires no knowledge about healthy state and no algorithm for getting back into healthy state. Nature takes care of healing.
2. The sticking to a local maximum of vacuum functional can prevent getting to the ideal healthy state. This can be avoided by the same mechanism as in annealing, which serves as a metaphor in numerics for a process in which one finds deep minimum of function by “kicking” the system now and then to get out of local minimum. Now the “kicking” would be stimulus deforming the system but not too much.
3. One expects that also Negentropy Maximization Principle (NMP) is closely involved with healing since healing should involve regain of the lost information. NMP states that the total negentropy increases in state function reductions and is apparently the opposite of second law: the negentropies in question are however not the same thing and NMP implies second law for ordinary entanglement. The implication is that the potentially conscious information associated with the negentropic entanglement (with identical entanglement probabilities for entangled states) tends to increase and negentropic entanglement (see **Fig. <http://tgdtheory.fi/appfigures/cat.jpg>** or **Fig. ??** in the appendix of this book) can be only transferred to another system or transformed to a new form, but cannot disappear. Negentropically entangled systems would define kind of Akashic records storing potentially conscious information transformed to conscious information in interaction of free quantum measurement. The approach towards maximum of negentropic and maximum of vacuum functional should closely to each other. Quite concretely, NMP could help to understand why the pieces of planaria split into two parts develop head and tail.
4. Clearly, NMP and the approach to the maximum of Kähler function both define candidates for the principles giving rise to same outcome as morphogenetic field is hoped to give. A possible interpretation is that the approach to the maximum of Kähler function is the space-time correlate for NMP: Kähler function defined as Kähler action for preferred extremal could be regarded as classical negentropy.

3. The flow and arrow of time in ZEO

The TGD based vision about how the arrow of geometric time has developed slowly and I do not dare claim it be fully developed and final [K8].

1. What seems clear now is the decisive role of ZEO and hierarchy of CDs, and the fact that the quantum arrow of geometric time is coded into the structure of zero energy states to a high extent. The still questionable but attractively simple hypothesis is that U matrix relates two zero energy state basis with opposite quantum arrows of geometric time: is this assumption really consistent with what we know about the arrow of time? The second basis is always state function reduced.

If this is the case, the question is how the relatively well-defined quantum arrow of geometric time implies the experienced arrow of geometric time. Should one assume the arrow of geometric time separately as a basic property of the state function reduction cascade or more economically- does it follow from the arrow of time for zero energy states?

2. The state function reductions occurs at either of the two boundaries of CD. If the reduction occurs at given boundary is immediately followed by a reduction at the opposite boundary, the arrow of time alternates: this does not conform with intuitive expectations: for instance, this would imply that there are two selves assignable to the opposite boundaries!

It took time to realize that zero energy states must be de-localized in the moduli space CDs (the size of CD plus discrete subgroup of Lorentz group defining boosts of CD leaving second tip invariant). One has quantum superposition of CDs with difference scales but with fixed upper or lower boundary belonging to the same light-cone boundary after state function reduction. In standard quantum measurement theory the repetition of state function reduction does not change the state but now it would give rise to the experienced flow of time. Zeno effect indeed requires that state function reductions can occur repeatedly at the same boundary. In these reductions the wave function in moduli degrees of freedom of CD changes. This implies “dispersion” in the moduli space of CDs experienced as flow of time with definite arrow.

3. This approach codes also the arrow of time at the space-time level: the average space-time sheet in quantum superposition increases in size as the average position of the “upper boundary” of CDs drifts towards future state function reduction by state function reduction.
4. In principle the arrow of time can temporarily change but it would seem that this can occur in very special circumstances and probably takes place in living matter. Phase conjugate laser beam is a non-biological example in this respect. Memory recall [K49] would involve the change of arrow of geometric time for a subsystem corresponding to the signal propagating to the geometric past and reflecting back.

This vision involves minimal number of assumptions and is the most convincing one found hitherto and the challenge is to invent objections in order to develop it in more detail.

13.7.2 The notions of magnetic body and dark matter hierarchy

The notion of magnetic body is central in TGD. The TGD inspired model trying to explain the findings about microtubules by Indian research group led by Anirban Bandyopadhyay lead to rather interesting speculations about the role of magnetic flux tubes and a more precise speculative view about how living system could act as topological quantum computer [K43] [L14].

Remark: Magnetic body is somewhat misleading term since a simple deformation implies that magnetic flux quanta carry helical magnetic and electric fields along the flux tube axis.

1. *Could magnetic body define coordinate grids making possible topological quantum computation?*

If the claims of Indian research group led by Anirban Bandyopadhyay are true, one can say that microtubules are macroscopically quantum coherent systems at physiological temperatures. In his Youtube talk Anirban Bandyopadhyay (<http://tinyurl.com/ze366ny>) [J5] discussed an identification of conduction pathways different from that of Penrose and Hameroff. In [J23] Gosh,

Sahu, and Bandyopadhyay argue for evidence for massive global synchronization in brain and claim that experimental findings support the Penrose-Hameroff theory. In the article “Atomic water channel controlling remarkable properties of a single brain microtubule: correlating single protein to its supramolecular assembly” [J18] it is reported that ordered water inside microtubule is necessary for the conduction inside microtubule.

According to the same article the tubulins inside microtubule has same energy levels in chemical energy range as isolated tubulins, which suggests that the mechanism binding tubulins to form MT is not chemical. In the article “Multi-level memory-switching properties of a single brain microtubule” [J19] it is reported that the hysteresis curve for current along MT as function of voltage is ideal square curve meaning that there is no dissipation involved with the change of the current direction. This would make MT as an ideal memory device. Whether Penrose/Hameroff have in mind the use of current direction as qubit remains unclear. In video talk Bandyopadhyay refers also to these results.

I have considered the general proposal discussed in video lecture in the article [K43] [L14]. The findings reported in the talk give support for the general TGD inspired view about TQC and allow rather detailed model in the case of microtubules. The idea is that flux tubes form a 2-D coordinate grid consisting of parallel flux tubes in two different directions: the guess that they could consist of helical Fibonacci flux tubes and their mirror images is not however convincing. Crossing points would be associated with tubulins and the conformational state of tubulin could define a bit coding whether the braid strands defining coordinate lines are braided or not (swap or not). In this manner any bit pattern at microtubule defines a particular TQC program. If also conformations are quantum superposed, one has “quantum-quantum computation”. It however seems that conformation change is irreversible chemical reaction [J16] so that this option is not feasible.

The TGD inspired modification of the proposal in terms of flux tube coordinate grids making possible TQC architectures with tubulin dimers defining bits defining in turn TQC program looks more plausible to me. Coordinate grids can be fixed on the basis of the experimental findings and there are 8 of them. The interpretation is in terms of different resolutions. The grids for A and B type lattices are related by 2π twist for the second end of the basic 13-unit for microtubule. An attractive interpretation for the resonance frequencies is in terms of phase transitions between A and B type lattices. If A type lattices can be generated only in phase transitions induced by AC stimulus at resonance frequencies, one could understand their experimental absence, which is strong objection against the Penrose-Hameroff model.

This would fit very nicely with the general vision about frequencies as passwords inducing not only directed attention but activities in target - also TQCs! The increase of Planck constant could be associated with the phase transition to A-phase making possible high T_c dark superconductivity for which evidence is observed! One can even deduce estimates for $h_{eff}/h = n$ if one requires that AC photons have energy above thermal threshold: $n = h_{eff}/h = f_{visible}/f_{AC}$ would be the estimate. For bio-photon energies one would obtain something like $n \simeq 10^8 - 10^9$, which pops up in different contexts in TGD framework.

This picture generalizes in the fractal universe of TGD. One can form layers of 2-D coordinate grids and connect them by vertical flux tubes to obtain 3-D grid defining TQC. The brain is known to have grid-like architecture and neurons could by quantum computation produce bit/qubit defining swap or not/superposition of swap and not-swap for a larger scale TQC. One would have fractal of TQCs.

A further idea is that the TQC based on 1-braids generalizes in a natural manner to 2-braid TQC in TGD framework (for 2-braids in 4-D space-time see [K27]. The knotting occurs for string world sheets defining the orbits of braid strands - say magnetic flux tubes idealized to strings. In the case of microtubules this option suggests itself: the emergence of MTs could have meant emergence of 2-braid TQC and the increase of abstraction level in the information processing.

In the node of 3-D coordinate grid either reconnection of two flux tubes can occur or not: this is coded by one bit. Second bit tells which tube goes over which tube in the plane defined by two tubes. There are three planes of this kind corresponding to xy , xz , and yz planes, and therefore 6 bits altogether. Could genetic codon containing 6 bits of information code for what happens in the node of the grid. Note that 2-braiding is possible only if string worlds sheets “live” in 4-D space-time: for super strings living in higher-D space-time this is not possible.

This kind of 3-D TQC could be responsible for the those aspects which are nearest to computa-

tion. One must be however very cautious with the word “computation”. Space-like braiding seems to be very natural for storing memories [K3] in braiding patterns and bit patterns would characterize the 2-braiding associated with the coordinate grid but from this it is long way to computation in the usual sense of the word.

2. Flux tube grids and coding of position information

In metamorphosis and metastasis the basic problem is how the information about position is coded. How cell does know its position in organism? This is necessary for the cell to express its genome in appropriate manner: for instance, gene expression of neuron is quite different from that of muscle cell? According to the article of Levin [I50] organisms seem to have developed kind of coordinate grids to realize this purpose. For instance, simple coordinate transformations seem to related the grids of nearby species to each other. Magnetic flux tubes could be basic building bricks of these grids and at the same time the realization of morphogenetic fields. The coordinate value could be coded by the value of local magnetic field strength varying along the flux tube. By flux conservation this would correspond to the thickness of the flux tube or equivalently to cyclotron frequency. Radiation at cyclotron frequencies would act resonantly only at points at which the resonance condition is satisfied.

Voltages associated with Josephson junctions define Josephson frequencies which could be essential for bio-control and coordination via the resonance mechanism allowing selective activation of biological programs. According to [I50], the values of transmembrane potentials in frog embryo correlate with the formation of the face of *Zenopus laevis* embryos. The lipid layers of cell membrane are proposed to form Josephson junction (at microscopic level the ionic channels and pumps associated with them).

Fractality suggests that nearby cell membranes - say those associated with epithelial sheets - could also form Josephson junctions as fractal considerations. Gap junctions could provide a microscopic realization of these Josephson junctions. If so, then the large h_{eff} Josephson photons with frequencies determined by transmembrane potential ($f = ZeV/h_{eff}$) could induce in resonant manner activities in precisely defined positions of the magnetic coordinate grid. The radiation at correct frequency would serve as kind of password allowing to initiate a biological program. For instance, in the case considered above they could initiate the generation of the face. The errors in development could be due to various birth defects could be due to external electric perturbations. Maybe, some day even the correction of these errors might be possible by using properly tuned electric voltages.

3. What happens to the magnetic body of planaria cut into two pieces?

When planaria is cut to two pieces, second pieces regenerates head and second regenerates tail. Also when one takes second cell away from 2-cell embryo, the remaining cell becomes a full organism rather than only half of it. If there is a template for the formation of organism, then also this template must split in two. As a matter of fact, I have proposed that the magnetic body of the cell decomposes to two in cell division and that this splitting actually guides the cell division.

The fractality of TGD Universe suggests similar splitting in all scales. The vertex of Feynman diagram representing the decay of photon to electron-positron pairs provides an ultra-simplified version of the replication. In TGD framework the lines of Feynman diagrams are replaced with 4-D orbits of 3-D surfaces (or by holography 3-D orbits of 2-D partonic surfaces) and this is true in all scales. Therefore the idea that magnetic body replicates would reduce one of the most mysterious processes of living matter to generalization of fundamental physics. Note that string models do not allow analogs for the vertices of Feynman diagrams, they are possible only in TGD framework.

The idea about magnetic body defining a coordinate grid serving as a counterpart of morphogenetic field or as template able to guide the development of the organism becomes central. It seems that even individual cell - perhaps even DNA - should contain microscopic representation of some topological aspects of the adult organism. This conforms with the notion of holography and is consistent with the central role of genes. Magnetic body with large h_{eff} being very multi-sheeted structure analogous to covering space could provide this representation. With inspiration coming from Hox genes and from deep ignorance about genetics I proposed that the magnetic body of DNA and even DNA in some rough sense could be homologous to the biological body [K31].

Can one test this hypothesis? It is also possible to isolate the cells of planaria during the development of new head by closing gap junction connections between them for about 48 hours [I50].

The outcome is planaria with two heads. As if the isolation of two cells which should have belong to the head of planaria had induced splitting of the magnetic body assignable to the head to two so that the outcome was two separate heads. One can however split the two-headed planaria again and the headless part develops now two heads! If the two headed magnetic body replicates, the outcome follows as a prediction.

13.7.3 Is brain really the seat of memories?

Levin and Shomrat tell about experiments demonstrating that brain is not necessarily the seat of memories as usually assumed. Planaria have brains and they are able to learn and remember. When planaria is split, the pieces develop head and tail. In the experiments planaria are taught some skill and after that split into two pieces. According to [I64], there is evidence that the part of planaria with new head remembers the skill. From this one can conclude that brain is not the only possible seat of memories.

Before continuing, it should be emphasized that memories are now defined as learned behaviors - assumed to reduce basically to conditionings of neurons at the motor areas of brain so that they generate certain motor response to sensory input. In TGD framework memories are understood as genuine conscious memories about events of past and involve communication with the geometric past.

One can imagine several explanations for the findings about the memory preservation. The computationalist possibility is that memories are transferred at least temporarily to the body of planaria and then back to the new head. This does not look biologically feasible.

Three TGD inspired explanations - corresponding to the identification of the brain of the geometric past, biological body, or magnetic body as the seat of memories - are considered.

1. Memories - identified as conscious experiences analogous to episodal memories rather than learned skills - could reside in the old brain or biological body or even magnetic body of the planaria with new head in the geometric past and accessed by negative energy signals which are time reflected from it. This explanation is not natural when memories are identified as learned skills, which in the ideal case are un-conscious behaviors.
2. In TGD Universe entire body and brains could form a hologram like structure [K13] and the information about body is transferred to the new brain. This would be like hologram completion. TGD indeed suggests strongly that entire body is conscious. For instance, the sensory organs carry the primary sensory qualia, one could circumvent the problem caused by the fact that neural circuits seem the same in all sensory areas. Cortex - maybe entire brain - would build standardized cognitive mental images, give them names, and entangle them with sensory qualia at sensory organs.

Phantom leg is the basic objection against this view but new view about time allows to circumvent it: the seat for the experience about pain in phantom leg is in geometric past when the leg still existed. Note that here memories are not learned skills but memories about genuine events in geometric past. The memory feats of idiot savants and people with left brain damage would be most naturally also due to sensory (visual or auditory) memories. Also ordinary people can have sensory memories when neurons in temporal lobes are stimulated electrically.

Second TGD inspired explanation for phantom leg would be it is that phantom leg corresponds to the magnetic body part: it is however not clear whether the sensation of pain even other bodily sensations can be located at magnetic body.

3. The long term memories of planaria restricted to learned behaviors could be represented also at the magnetic rather than biological body. Quantum computationalist would agree with this idea since learned skills would be very naturally TQC programs realized at the coordinate grid formed by the magnetic flux tubes. If magnetic body is replicated as planaria is cut to two pieces, also the TQC programs are replicated. DNA as TQC proposal [K3] assigns these programs to the braids defined by flux tubes assumed to connect DNA nucleotides or codons with the lipids of the lipid layers of the nuclear or cell membranes.

4. Could the state function reduction sequence implying 4-D self-organization driven by NMP lead to and asymptotic state in which also the skills learned in possession of old brain are possessed. As a matter fact, this aspect is certainly present since the replica of the magnetic body of planaria brain must give rise to original biological brain. TQC programs for the skills would be however present from the beginning.
5. In Zero Energy Ontology the space-time surface connecting 3-surfaces at the opposite light-like boundaries of causal diamond are the basic objects. The maxima of Kähler function correspond to very special pairs of 3-surfaces connected by space-time surfaces. One can say that 4-D dynamical patterns, “behaviors” are fundamental objects. In ordinary ontology they would 3-D patterns perhaps interpreted as asymptotic states resulting in self-organization.

The second option looks like the most plausible explanation since allows to understand the replication of not only organism but also the TQC programs defining behavior repertoire.

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