

# TGD view about language: part I

immediate

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## Contents

<b>1</b>	<b>Introduction</b>	<b>3</b>
1.1	About language genes . . . . .	4
1.2	How the mutation of only a few genes led to cultural evolution? . . .	4
<b>2</b>	<b>Number theoretical aspects of quantum biology</b>	<b>5</b>
2.1	Dark protons and genetic code . . . . .	5
2.1.1	Codons as dark nucleons? . . . . .	5
2.1.2	Codons as dark proton triplets? . . . . .	7
2.2	Bio-harmony as a realization of genetic code . . . . .	8
2.2.1	About the details of the genetic code based on bio-harmony .	9
2.2.2	Cell membrane and microtubules as a higher level representa- tion of genetic code? . . . . .	10
2.3	Galois group of space-time surface as new discrete degrees of freedom	12
2.3.1	Galois confinement . . . . .	12
2.3.2	Cognitive measurement cascades . . . . .	12
2.4	Energy and frequency resonance as basic elements of dark photon communications . . . . .	12
2.4.1	Selection of basic biomolecules by energy resonance . . . . .	13
2.4.2	What happens in the cyclotron resonance? . . . . .	14
<b>3</b>	<b>TGD based view about brain</b>	<b>15</b>
3.1	A new view about the role of nerve pulses in sensory perception . . .	15
3.2	Binaural beat as a support for TGD view about brain . . . . .	17
3.3	The roles of nerve pulses and oscillations of neuronal membrane in the TGD picture . . . . .	17
3.4	Memories . . . . .	18
3.5	Associations at quantum level . . . . .	19
<b>4</b>	<b>Appendix: Living matter, biochemistry, and consciousness</b>	<b>20</b>
4.1	ZEO based quantum measurement theory extends to a theory of con- sciousness . . . . .	20
4.2	p-Adic physics as a correlate of intention and cognition . . . . .	21
4.3	The notion of magnetic body . . . . .	25
4.4	Life is not mere chemistry . . . . .	27

### Abstract

Human languages differ dramatically from their analogos for animals. Animal languages consist mainly of simple signals, warnings and threats for instance; emotional expression dominates and grammar is lacking. Birds can have repertoire of different song patterns and monkeys have gesture language. There is a huge variety of human languages. One can also regard music as a kind language expressing emotions and creating them. Also pictures define linguistic representations. Children and animals learn speech by mimicry and the grammar and syntax without conscious efforts. Human language is also special in that it involves conceptualization, metaphors, and analogies representing abstract concepts in terms of objects and actions of the external world.

One might understand the semantic aspect of language in terms of association and conditioning. Language acquisition involves showing the object and uttering the word(s) describing it or assigned to it. This suggests conditioning and association so that a mere word generates an imagined percept of the object. Conditioning and formation of associations is a very general form of learning assumed to relate to the increase of synaptic strengths leading to a generation of association pathways. In computer science pattern recognition and completion models it mathematically.

Amazingly, only a few point mutations for relatively few genes seems so have led to human languages and transformed biological evolution to cultural evolution? What happened for these genes? In the biochemistry framework it is difficult to imagine an answer to this question. Here TGD could come in rescue.

Number theoretic physics is part of quantum TGD and essential for understanding evolution as an increase of algebraic complexity. Evolutionary hierarchies would correspond to hierarchies of algebraic extensions of rationals. The dimension  $n$  of extension defines effective Planck constant  $h_{eff}/h_0 = n$ . The larger the dimension, the larger the scale of quantum coherence at corresponding layer of magnetic body (MB) associated with the system:  $n$  would be analogous to IQ. One can assign a value of  $h_{eff}$  characterizing the evolutionary level also to genes. The genes with larger  $h_{eff}$  would serve as control genes and the increase of  $h_{eff}$  would mean an evolutionary step. Perhaps a dramatic increase of  $h_{eff}$  occurred to FOXP2 and some other genes as human language emerged.

## 1 Introduction

Human languages differ dramatically from their analogos for animals. Animal languages consist mainly of simple signals, warnings and threats for instance; emotional expression dominates and grammar is lacking. Birds can have impressive repertoire of different song patterns and monkeys have gesture language.

There is a huge variety of human languages: speech and written language, sign languages based on gestures, the language of mathematics and computer languages in which emotional expression is absent. One can also regard music as a kind language expressing emotions and creating them. Also pictures define linguistic representations. Children and animals learn language by mimicry and also learn the grammar and syntax without conscious efforts. Adults can learn a foreign language by learning the vocabulary and the rules of grammar. Human language is also special in that it involves conceptualization, metaphors, and analogies representing abstract concepts in terms of objects and actions of the external world.

One might understand the semantic aspect of language in terms of association and conditioning. Language acquisition involves showing the object and uttering the word(s) describing it or assigned to it. This suggests that conditioning and association happens so that mere word generates an imagined percept of the object. Conditioning and formation of associations is a very general form of learning assumed to relate to the increase of synaptic strengths leading to a generation of association pathways. In computer science pattern recognition and completion models it mathematically. One one can ask whether the learning of language and language

understanding is something more than this.

For more detailed approaches of language theories, interested readers may be referred to references [J6, J8, J7, J11]. The article of Kempe and Brooks [J10] and the review article "From Molecule to Metaphor: A neural theory of language" about the language theory of Jerome A. Feldman by Stefan Frank [J9] gives a deeper perspective to language theories. The notion of embodiment is in key role in these theories and will be in a key role also in the proposal to be discussed.

## 1.1 About language genes

Forkhead box protein P2 (FOXP2) encodes a transcription factor involved in language acquisition and speech [J2]. In addition to FOXP2 a limited number of genes are involved in speaking [J4]. All vertebrates possess FOXP2, however it is estimated that some 120,000-200,000 thousand years ago, some mutations occurred only in humans which aided humans to start initial forms of speaking [J6]. Animals have their own primitive language; both voices and gestures with meaning make communications possible. They mainly recognize each other and communicate with pheromones. As for vocabulary, a short review of the Old Testament, cuneiform writings, glossary of old books, and hieroglyphs clearly shows that the number of entries was quite limited in the past. Therefore, a further progression of language could be almost a matter of cultural communications and technological advances.

However, today it is clear that crucial mutations occurred in the non-coding part of the genome controlling the expression of genes coding for proteins [J4] which lead to language evolution. Therefore, the evolutionary step was associated with control of existing genes. Humans are also distinguished from animals by their learning abilities.

Language acquisition must rely on conditioning/associations between language expressions and experiences. It seems that embodiment is the mechanism, which associates to a linguistic expression an imagined sensory percept and/or motor action making the emergence of meaning. What is needed is long term memory and also some kind of standardization of percepts so that they consist of standardized mental images. Pattern recognition and completion could give this standardization.

Since sensory and motor imagination could be seen as almost sensory experiences and motor actions, this suggests that new communications between auditory organs and sensory and motor areas emerged. Even more generally, this kind of communication could have emerged quite generally. This would be essentially a new form of conditioning and the same mechanism could apply to all kinds of conditionings.

## 1.2 How the mutation of only a few genes led to cultural evolution?

Amazingly, only a few mutations for relatively few genes seems so have led to human languages. Why few point mutations of relatively few genes could have transformed biological evolution to cultural evolution? What happened for these genes? In the biochemistry framework it is difficult to imagine an answer to this question. Here TGD could come in rescue.

Number theoretic physics is part of quantum TGD and essential for understanding evolution as an increase of algebraic complexity. Evolutionary hierarchies would correspond to hierarchies of algebraic extensions of rationals. The dimension  $n$  of extension defines effective Planck constant  $h_{eff}/h_0 = n$ , the larger the dimension, the larger the scale of quantum coherence at corresponding level of magnetic body (MB) associated with the system. One can also say that  $n$  is analog of IQ. One can assign a value of  $h_{eff}$  characterizing their evolutionary level also to genes. The genes with larger  $h_{eff}$  would serve as control genes. The increase of  $h_{eff}$  for genes would mean an evolutionary step. Perhaps a dramatic increase of  $h_{eff}$  occurred to FOXP2 and some other genes as human language emerged.

Second mechanism could be energy resonance in the coupling of the analogs of DNA, RNA, tRNA, and amino acids consisting of dark proton triplet with their chemical counterparts. The coupling would be between the entire gene and its dark analog and codon sequence would play a role of address. In both cases small changes of the gene could spoil or produce an energy resonance. This sensitivity would make genes an ideal control tool but would also serve as a general mechanism also for genetic diseases. The increase of  $h_{eff}$  accompanied by a small mutation to guarantee energy resonance could be the mechanism explaining the importance of FOXP2 and similar control genes.

## 2 Number theoretical aspects of quantum biology

The basic ideas about consciousness and life are discussed in Appendix. Here the aspects relevant for the recent work are discussed.

**Fig. 4** summarises the role of number theory in the TGD inspired vision concerning consciousness, cognition, and quantum biology and **Fig. 5** the role of dark matter in TGD inspired quantum biology.

### 2.1 Dark protons and genetic code

**Fig. 1** summarizes the TGD based vision about genetic codes.

#### 2.1.1 Codons as dark nucleons?

The model for codons of genetic code emerged from the attempts to understand water memory [L1]. The outcome was a totally unexpected finding [L13]: the states of dark nucleons formed from three quarks connected by color bonds can be naturally grouped to multiplets in one-one correspondence with 64 DNAs, 64 RNAs, 20 amino acids, and tRNA and there is natural mapping of DNA and RNA type states to amino acid type states such that the numbers of DNAs/RNAs mapped to given amino acid are same as for the vertebrate genetic code.

The basic idea is simple. The basic difference from the model of free nucleon is that the nucleons in question - maybe also nuclear nucleons - consist of 3 linearly ordered quarks - just as DNA codons consist of three nucleotides. One might therefore ask whether codons could correspond to dark nucleons obtained as open strings with 3 quarks connected by two color flux tubes or as closed triangles connected by 3 color flux tubes. Only the first option works without additional assumptions. The

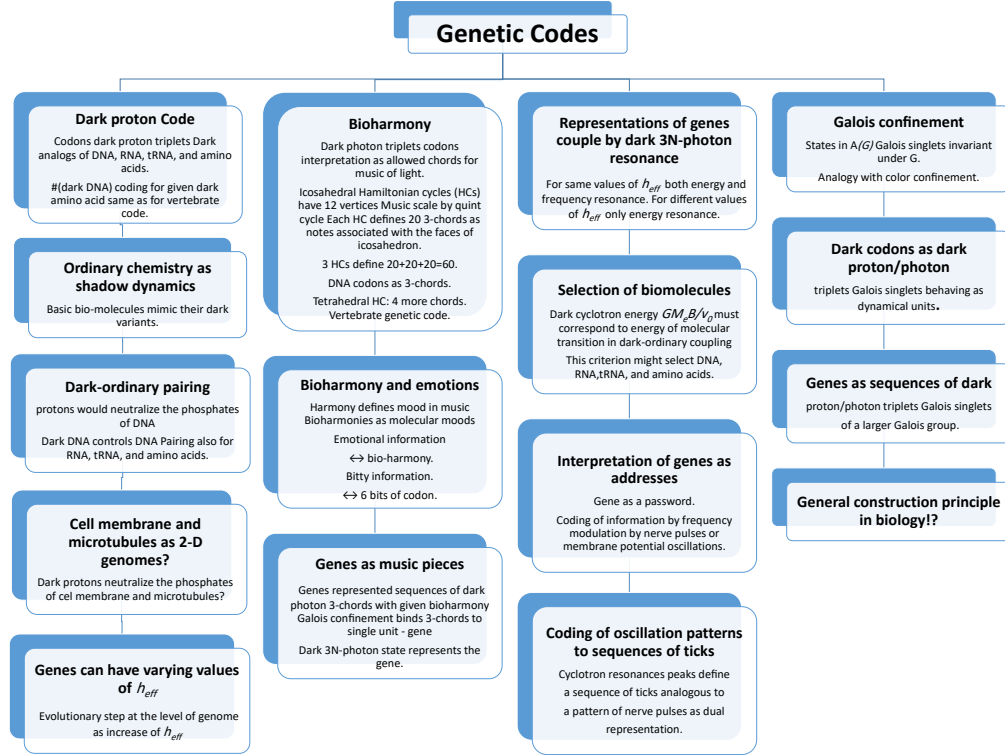


Figure 1: Genetic codes in TGD framework

codons in turn would be connected by color flux tubes having quantum numbers of pion or  $\eta$ .

This representation of the genetic would be based on entanglement rather than letter sequences. Could dark nucleons constructed as a string of 3 quarks using color flux tubes realize 64 DNA codons? Could 20 amino acids be identified as equivalence classes of some equivalence relation between 64 fundamental codons in a natural manner? The codons would not be separable to letters but entangled states of 3 quarks anymore.

Genetic code would be defined by projecting DNA codons with the same total quark and color bond spin projections to the amino acid with the same (or opposite) spin projections. The attractive force between parallel vortices rotating in opposite directions serves as a metaphor for the idea. This hypothesis allows immediately the calculation of the degeneracies of various spin states. The code projects the states in  $(4 \oplus 2 \oplus 2) \otimes (5 \oplus 3)$  to the states of  $4 \times 5$  with the same or opposite spin projection. This would give the degeneracies  $D(k)$  as products of numbers  $D_B \in \{1, 2, 3, 2\}$  and  $D_b \in \{1, 2, 2, 2, 1\}$ :  $D = D_B \times D_b$ . Only the observed degeneracies  $D = 1, 2, 3, 4, 6$  are predicted. The numbers  $N(k)$  of amino acids coded by  $D$  codons would be

$$[N(1), N(2), N(3), N(4), N(6)] = [2, 7, 2, 6, 3] .$$

The correct numbers for vertebrate nuclear code are  $(N(1), N(2), N(3), N(4), N(6)) = (2, 9, 1, 5, 3)$ . Some kind of symmetry breaking must take place and should relate to the emergence of stopping codons. If one codon in the second 3-plet becomes stopping codon, the 3-plet becomes doublet. If 2 codons in 4-plet become stopping codons it also becomes doublet and one obtains the correct result  $(2, 9, 1, 5, 3)!$

### 2.1.2 Codons as dark proton triplets?

The model of codon as dark nucleon predicts analogs  $\Delta$  resonances whose masses differ from those of nucleons.

The hint comes from the fact that DNA nucleotides have a negative charge, which is problematic from the point of view of DNA stability. This suggests that dark codons should have a charge of 3 units screening the charge of the ordinary DNA codon. Pollack effect [I4] means formation of negatively charged exclusion zones as protons are transferred to dark protons at magnetic flux tubes. Could DNA be formed by Pollack effect? Could codons be represented as dark proton triplets?

The problem is that protons however have only 2 spin states: 4 states would be needed as in the case of quarks having also color. Where could the counterparts of spin and color come from?

One could consider adding a neural pion-like and/or  $\rho_0$  meson-like bond connecting neighboring protons. Since  $\rho_0$  has spin 1, this would give  $1+3=4$  states per bond. However, 2 states are enough and one must get rid of 2 states. The string-like structure of the proton triplet suggests that the rotation group reduces to  $SO(2) \subset SO(3)$  so that  $\rho$  meson states split into singlets with helicities 0,1,-1. The doublet (-1,1) would serve as the analog of the isospin doublet (u,d) for baryons and enough to achieve a correct effective number  $N = 4$  of states per single DNA codon. Helicity would replace isospin and the tensor product states could be constructed effectively as tensor products of 3 representations  $2 \otimes 2$ .

There is also an issue related to the fermionic statistics. Protons are fermions and the total wave function for them must be antisymmetric. For baryons color singlet property allows this. Can one require statistics in the ordinary sense also now? Or could the effective 1-dimensionality of the magnetic flux tube allow braid statistics?

The following variant gives good hopes about the ordinary statistics.

1. Adelic physics [L9] brings in additional discrete degrees of freedom assignable to the group algebra of Galois group of extension of rationals inducing the extensions of p-adic number fields appearing in the adèle [L25].
2. Galois group acts on the space of space-time surfaces, and one can say that one has wave function at the orbit of the Galois group consisting of space-time sheets. At quantum level quantum states correspond to wave functions in the group algebra of Galois group of extension.
3. The role of color degrees of freedom in helping to achieve correct statistics in the case of baryon could be taken by Galois degrees of freedom. One can even consider the notion of Galois confinement as a generalization of color confinement [L23] binding codons as dark proton triplets to dynamical units.

Codons should be antisymmetric under exchange of dark protons in Galois degrees of freedom. Also genes as sequences of codons could be bound to dynamical units as Galois singlets. Could this allow ordinary statistics.

One can consider the replacement of u and d quarks with proton and neutron: color degrees of freedom would be missing but also now Galois confinement could come in rescue. Now however the charge screening of DNA by dark DNA would not be complete.

If this picture is correct, genetic code would be realized already at the level of dark nuclear physics or even at the level of ordinary nuclear physics if the nuclei of ordinary nuclear physics are nuclear strings. Chemical realization of genetic code would be induced from the fundamental realization in terms of dark nucleon sequences and vertebrate code would be the most perfect one. Chemistry would be a kind of shadow of the dynamics of positively charged dark nucleon strings accompanying the DNA strands and this could explain the stability of the DNA strand having 2 units of negative charge per nucleotide. Biochemistry might be controlled by the dark matter at flux tubes.

## 2.2 Bio-harmony as a realization of genetic code

TGD leads to a notion of bio-harmony in terms of icosahedral and tetrahedral geometries and 3-chords made of light assigned to the triangular faces of icosahedron and tetrahedron [L5, L6, L18]. The surprise was that vertebrate genetic code emerged as a prediction: the numbers of DNA codons coding for a given amino acid are predicted correctly. DNA codons correspond to triangular faces and the orbit of a given triangle under the symmetries of the bio-harmony in question corresponds to DNA codons coding for the amino acid assigned with the orbit.

Codon corresponds to 6 bits: this is information in the usual computational sense. bio-harmony codes for mood: emotional information related to emotional intelligence as ability to get to the same mood allowing to receive this information. bio-harmony would be a fundamental representation of information realized already at molecular level and speech, hearing and other expressions of information would be based on it. For emotional expression at RNA level possibly involved with conditioning at synaptic level see [L12].

Does the generation of nerve pulse patterns by a gene mean at the cell membrane from dark DNA to dark protein map to dark protein (it could be also dark RNA or dark DNA even) associated with the cell membrane. What about communications with RNA and enzymes involved with transcription and translation. Do all basic biocatalytic processes involve them.

What about a generalization of Josephson currents? Dark ions certainly define them but could also dark proton triplets and their sequences associated with proteins give rise to oscillating Josephson currents through cell membrane and therefore to dark Josephson radiation with  $3N$  dark photon units! Proteins themselves need not move much!

The universal language could be restricted to the genetic code which would be realized by dark proton triplets. The 64 codons are formed from 3 20-chord harmonies associated with icosahedron and the unique 4-chord harmony associated with tetrahedron. Bio-harmonies are associated with the so-called Hamiltonian cycles ,which



go through every vertex of Platonic solid once. For icosahedron the number of vertices is 12, the number of notes in 12-note scale.

Also tetrahedron, cube, octahedron and dodecahedron are possible and one can consider the possibility that they also define harmonies in terms of Hamiltonian cycles. Dodecahedron would have 5-chords (pentagons as faces) as basic chords and there is only single harmony. Same mood always, very eastern and enlightened as also the fact that scale would have 20 notes.

Also octahedron gives 3-chords (triangular faces) whereas cube gives 4-chords (squares as faces). One can of course speculate with the idea that DNA could also represent this kind of harmonies: sometimes the 3N rule is indeed broken, for instance for introns.

Galois confinement [L23] allows the possibility to interpret dark genes as sequences of  $N$  dark proton triplets as higher level structures behaving like a single quantal unit. This would be true also for the corresponding dark photon sequences consisting of  $3N$  dark photons representing the gene in bio-harmony as an analog of a music piece consisting of 3-chords and played by transcribing it to mRNA.

The picture can be viewed even more generally. Any discrete structure, defining graph, in particular cognitive representation providing a unique finite discretization of space-time surface as points with the coordinates of the 8-D imbedding space coordinates in the extension of rationals, defines harmonies in terms of Hamiltonian cycles. Could also these harmonies make sense? The restrictions of the cognitive representations to 2-D partonic 2-surfaces would define something analogous to bio-harmony as Hamiltonian cycle of 2-D graph (Platonic surfaces solids can be regarded as 2-D graphs). The interpretation as representations of Galois groups and the notion of Galois confinement is possible although one loses the symmetries of the Platonic solids allowing to identify genetic code.

### 2.2.1 About the details of the genetic code based on bio-harmony

TGD suggests several realizations of music harmonies in terms of Hamiltonian cycles representing the notes of music scale, most naturally 12-note scale represented as vertices of the graph used. The most plausible realization of the harmony is as icosahedral harmony [L4] (see <http://tinyurl.com/yad4tqwl> and <http://tinyurl.com/yyjpm25r>).

1. Icosahedron [?](see <http://tinyurl.com/15sphzz>) has 12 vertices and Hamiltonian cycle as a representation of 12-note scale would go through all vertices such that two nearest vertices along the cycle would differ by quint (frequency scaling by factor  $3/2$  modulo octave equivalence). Icosahedron allows a large number of inequivalent Hamiltonian cycles and thus harmonies characterized by the subgroup of the icosahedral group leaving the cycle invariant. This group can be  $Z_6$ ,  $Z_4$ , or  $Z_2$  which acts either as a reflection group or corresponds to a rotation by  $\pi$ .
2. The fusion of 3 icosahedral harmonies with symmetry groups  $Z_6$ ,  $Z_4$  and  $Z_2$  gives  $20+20+20=60$  3-chords and  $3+1 + 5 + 10 =19$  orbits of these under symmetry group and almost vertebrate genetic code when 3-chords are identified as analogs of DNA codons and their orbits as amino acids. One obtains

counterparts of 60 DNA codons and  $3+1 + 5 + 10 = 19$  amino acids so that 4 DNA codons and 1 amino acid are missing.

3. The problem disappears if one adds tetrahedral harmony with 4 codons as faces of tetrahedron and 1 amino acid as the orbit of the face of tetrahedron. One obtains 64 analogs of DNA codons and 20 analogs of amino acids: this harmony was coined as bio-harmony in [L5, L6]. The predicted number of DNA codons coding for given amino acid is the number of triangles at the orbit of a given triangle and the numbers are those for genetic code.

4. How to realize the fusion of harmonies? Perhaps the simplest realization found hitherto is based on the union of a tetrahedron [?] of 3 icosahedrons obtained by gluing tetrahedron to icosahedron along its face which is a triangle. The precise geometric interpretation of this realization has been however missing and some possibilities have been considered. The model could explain the two additional amino acids Pyl and Sec appearing in Nature [L5, L6] as being related to different variant for the chemical counterparts of the bio-harmony.

There is also a slight breaking of symmetries: ile 4-plet breaks into ile triplet and met singlet and trp double breaks into stop and trp also leu 4-plet can break in leu triplet and ser singlet (see <http://tinyurl.com/puw82x8>). This symmetry breaking should be understood.

### 2.2.2 Cell membrane and microtubules as a higher level representation of genetic code?

Also the representation of genetic code at the level of cell membrane can be considered [L13]. This kind of proposal have been made with different motivations by Okecukwu Nwamba [I3]. The motivation for the current proposal is that the lipids have at their ends negatively charged phosphates just as DNA nucleotides have. The generalization of DNA as a 1-D lattice like structure to a 2-D cylindrical lattice containing nucleotide like units - letters - possibly assignable to lipids and realized as dark protons. Single lipid could be in the role of ribose+nucleotide unit and accompanied by a neutralizing and stabilizing dark proton. For axons one would have cylindrical lattice dark DNA lattice. The two lipid layers could correspond to two DNA strands: the analogs of the passive and active strand.

The finding is that membrane affects protein's behavior. This would be understandable in the proposed pictures 2-D analog of 1-D nucleotides sequences with codons replaced with counterparts of genes as basic units. That lipids are accompanied by phosphates with charge -1 gives the hint. Phosphate charge is neutralized by a dark proton as an analog of a nucleotide.

The notion of Galois confinement identifying genes as units consisting of  $N$  dark proton triplets representing genetic codons suggests that genes possibly assignable to the lipid layers of the cell membrane could communicate using dark  $3N$ -photon sequences with the proteins, genome, RNA and DNA. Dark variants of the control genes could initiate a nerve pulse pattern. An interesting possibility is that ganglions, nucleus like structures assignable to sensory organs and appearing as basal ganglia in brain [I2] (<https://cutt.ly/zfWoBFt>) could communicate with genes.

Also microtubules have GTPs with charge -3 bound to tubulins. In dynamical instability known as treadmilling the transformation of  $GTP \rightarrow GDP$  bound to  $\beta$  tubulin by hydrolysis induces the shortening of the microtubule at minus end whereas the addition of tubulins bound to GTP induces the growth at plus end. Also actin molecules bound to ATP show a similar behavior. Could they be accompanied by dark DNA codons? Are all codons allowed or does the absence of XTP, X=T,C,G mean that only codons of type GGG would be present?

For the dark codons for the cell membrane the p-adic length scale  $L(151) \simeq 10^{-8}$  m would correspond to the lipid's transversal size scale and would be the distance between the dark protons. The scale of dark nuclear energy would be proportional to  $1/L(151)$  and scaled down by factor  $\sim 10^{-3}$  from that for DNA. The energy scale should be above the thermal energy at room temperature about .025 eV. If the energy scale is 2.5 eV (energy of visible photon) for DNA, the condition is satisfied. Note that 2.5 eV is in the bio-photon energy range. For p-adic large scales longer than  $L(151)$  thermal instability becomes a problem.

It is interesting to compare the number of codons per unit length for ordinary genetic code (and its dark variant) and for various membranes and microtubules.

- For the ordinary genetic code there are 10 codons per 10 nm defining p-adic length scale  $L(151)$ . This gives a codon density  $dn/dl = 10^3/\mu m$  in absence of coiling. The total number of codons in human DNA with a total length  $L \sim 1$  meter is of order  $N \sim 10^9$  codons. The packing fraction of DNA due to coiling is therefore huge: of order  $10^6$ .
- If each lipid phosphate is accompanied by a dark proton and if lipid correspond to square at axonal cylinder with side of length  $d = L(151)$  and the radius  $R$  of axon corresponds to the p-adic length scale  $L(167) = 2.5\mu m$  (also of the same order as nucleus size), there are about  $dn/dl = 2\pi(R/d)^2 \sim (2\pi/3) \times 10^4 \sim 1.3 \times 10^5/\mu m$ . Axon should have length  $L \sim 1$  cm to contain the entire genome.

The same rough estimate applies to microtubules except that there would be one codon per GTP so that the estimate would be 3 times higher if GTP corresponds to length scale  $L(151)$  of tubulin molecule. It has been proposed that genetic code is realized at the microtubular level.

- The nuclear membrane assumed to have a radius about  $L(167) = 2.5\mu m$  could represent  $N \sim (4/3)R^2/d^2 \sim .8 \times 10^5$  codons. This is a fraction  $10^{-5}$  about the total number of codons. For a neuronal membrane with radius  $R \sim 10^{-4}$  meters assignable to a large neuron the fraction would be roughly  $10^{-1}$ . The fraction of dark codons associated with membranes could correspond to genes involved with the control and communication with genome and other cell membranes. Note that the non-coding intronic portion dominates in the genome of higher vertebrates. One can ask whether the chromosome structure is somehow visible in the membrane genome and microtubular genome.

## 2.3 Galois group of space-time surface as new discrete degrees of freedom

### 2.3.1 Galois confinement

The problem is to understand how dark photon triplets occur as asymptotic states - one would expect many-photon states with a single photon as a basic unit. The explanation would be completely analogous to that for the appearance of 3-quark states as asymptotic states in hadron physics - the analog of color confinement [L24]. Dark photons would form  $Z_3$  triplets under the  $Z_3$  subgroup of the Galois group associated with corresponding space-time surface, and only  $Z_3$  singlets realized as 3-photon states would be possible.

The invariance under  $Gal(F)$  would correspond to a special case of Galois confinement, a notion introduced in [L22] with physical motivations coming partially from the TGD based model of genetic code based on dark photon triplets.

### 2.3.2 Cognitive measurement cascades

Quantum states form Galois group algebra - wave functions in Galois group of extension  $E$ .  $E$  has in general decomposition of extension  $E_1$  as extension of  $E_2$  as extension of ... to a series . Galois group of  $E$  has decomposition to product of  $Gal(E) = Gal(E/E_1)Gal(E_1)$  and same decomposition holds true for  $Gal(E_1)$  so that one has hierarchy of normal subgroups corresponding extension of extension of...hierarchy defined by a composite polynomial  $P(x) == P_1(P_2(x))$  with  $P_2$  having similar representation.  $P$  defines in  $M^8$  picture the space-time surface. This maps a tensor product composition for group algebra and the factors of group algebra entangle. SSFR corresponds to a quantum measurement cascade: SSFR in  $Gal(E/E_1)$ , SSFR in  $Gal(E_1/E_2)$  etc.

Could this cascade relate to the parsing of a linguistic expression? It would certainly correspond to a sentence  $S_1$  about a sentence  $S_2$  about ... such that one substitutes a concrete sentence for  $S_1$  first, then to  $S_2$ , etc.... The sentences in the sequence indeed have  $h_{eff}$  which decreases. This is the case in the cascade of SSFRs since  $h_{eff}/h_0 = n$  is the dimension of  $E_n$ .

I also mentioned the number theoretic measurement cascades for purely number theoretic Galois degrees of freedom. [http://tgdtheory.fi/public\\_html/articles/SSFRGalois.pdf](http://tgdtheory.fi/public_html/articles/SSFRGalois.pdf).

Could cascade of flux tubes decaying to smaller flux tubes with smaller value of  $h_{eff}$  should correspond to this hierarchy. Certainly this is linguistics but the sentence as argument could correspond to several sub-sentences - different flux tubes. Could a neural pathway defined by the branching axon correspond to a concretization of this kind statement about statement (or multistatement, perhaps nerve pulse pattern generated by nerve pulse patterns arriving to a given neuron) about...

## 2.4 Energy and frequency resonance as basic elements of dark photon communications

Dark photon realization of genetic code leads to a view about fundamental linguistic communication based on resonance and we will write a separate paper connecting

TGD with language soon. Two systems can be in communication when there is resonance.  $E = h_{eff}f$  and energy conservation implies

$$h_{eff,1}f_1 = h_{eff,2}f_2 .$$

For  $h_{eff,1} = h_{eff,2}$ , energy conservation implies that both energies and frequencies are identical:  $E_1 = E_2$  and  $f_1 = f_2$ . Both energy and frequency resonances in question.

In the general case one has  $f_1/f_2 = h_{eff,2}/h_{eff,1}$  and frequency scaling takes place. The studies of water memory lead to the observation that this kind of phenomenon indeed occurs [I1]. The communications of dark matter with ordinary matter and those between different values of  $h_{eff}$  involve only energy resonance. Frequency and wavelength scaling makes it possible for long scales to control short scales. Dark photons with EEG frequencies associated with the big part of MB transform to bio photons with a wavelength of say cell size scale and control dynamics in these short scales: for instance, induce molecular transitions. This is impossible in standard physics.

The resonance condition becomes even stronger if it is required there is a large number of biomolecules in resonance with dark matter realized as dark variants of biomolecules and dark ions. Cyclotron resonance energies are proportional to  $\hbar_{eff}$  characterizing magnetic flux tubes and to the value of the magnetic field strength dictated by the quantization of the monopole flux quantization by the thickness of the flux tube which can be to some degree varied by varying the thickness of the flux tube giving rise to frequency modulation.

The findings of Blackman et al [J1] suggest that  $B_{end} = 0.2$  Gauss defines an important value in the spectrum of  $B_{end}$  values. It could correspond to the field strength for the monopole flux part of the Earth's magnetic field: besides this there would be a non-monopole flux part allowed also in the Maxwellian theory.

There are however indications that the value  $B_{end}$  is quantized and is proportional to the inverse of a biologically important p-adic length scale and thus would be quantized in octaves. This could relate directly to the octave equivalence phenomenon in music experience. The model of bio-harmony [L5, L6, L18] suggests a further quantization of the octave to Pythagorean 12-note scale of music. This would not be only essential for the music experience but communications of emotions and molecular level using the music of light.

### 2.4.1 Selection of basic biomolecules by energy resonance

The dark particles must have energy resonance with bio-molecules in order to induce their transitions. This seems to pose extremely strong conditions possibly selecting the bio-molecules able to form interacting networks with dark matter and with each other. One expects that only some amino acids and DNA type molecules survive.

Nottale's hypothesis provides a partial solution to these conditions. Nottale proposed the notion of gravitational Planck constant

$$\hbar_{gr} = GMm/v_0$$

assignable in TGD to gravitational flux tubes connecting large mass  $M$  and small

mass  $m$  and  $v_0$  is velocity parameter. The gravitational flux tube presumably carries no monopole flux. The TGD based additional hypothesis that one has equals to

$$hbar_{gr} = h_{eff} = nh_0 .$$

This implies that the cyclotron energy spectrum

$$E_c = n\hbar_{gr} \frac{eB}{m} = n \frac{GM}{v_0} eB$$

of the charged particle does not depend at all on its  $m$ . Therefore in a given magnetic field, say  $B_{end}$ , the cyclotron resonance spectrum is independent of the particle.

The energy resonance condition reduces to the condition that the charged ion or molecule has some cyclotron energy coming as a multiple of fundamental in its spectrum in the spectrum of its transition energies. Even this condition is very strong since the energy scale for cyclotron energy in  $B_{end}$  is in the bio-photon energy range containing energies in visible and UV. The fact that bio-photons have a quasi-continuous spectrum strongly suggests that  $B_{end}$  has a spectrum. The model of bio-harmony [L4, L16] suggests that the values of  $B_{end}$  correspond to Pythagorean scaling constructible by quint cycle.

The above simplified picture is formulated for single dark photon communications. The dark proton and dark photon realizations of the genetic code requires 3-resonance that is a simultaneous energy resonance for the 3 members of dark photon triplet. In dark-dark pairing also frequency resonance is possible. In dark-ordinary pairing frequency increases and couples long scales with short scales. Also resonant communications between genes with  $N$  codons involving  $3N$  dark photon frequencies must be possible. This requires new physics provided by number theoretical vision.

### 2.4.2 What happens in the cyclotron resonance?

3 cyclotron energies for flux tubes characterize dark 3-proton triplet and Nottale's hypothesis predicts that they depend on the values of  $B_{end}$  for the flux tubes only. bio-harmony suggests that the spectrum of frequencies and thus  $B_{end}$  corresponds to Pythagorean 12-note scale for a given octave. The allowed chords of bioharmony would characterize the emotional state at the molecular level and correspond to the holistic emotional aspects of the communication beside the binary information.

The resonance would require that the dark cyclotron energy changes are equal to corresponding energies in molecular transitions. Galois confinement [L22] makes possible also 3-N resonance. The resonance condition would select basic biomolecules and the ability of dark analogs of biomolecules to simultaneously resonate with several biomolecules would give additional conditions. In particular this would select DNAs and amino acids.

An open question is whether the coupling to ordinary biomolecules involves a transformation of a dark photon triplet or an N-plet to a single ordinary photon. For instance, does the sum of the 3 cyclotron excitation energies appear in the coupling of dark 3-proton state to amino acid in protein? This would have an analog as 4-wave coupling in laser physics allowing in biology the transformation of dark photon triplet to single biophoton/or 3 bio-photons or vice versa. 6-wave coupling of laser

physics would be analogous to the coupling of ordinary 3-photon state to dark 3-photon and back to ordinary 3-photon state.

The resonance itself would mean a process in which dark 3-proton cyclotron excitation returns to the ground state and generates dark 3-photon transforming to ordinary photon (or 3-photon) and absorbed by the ordinary codon or amino acid excitation to higher energy state. This state would in turn emit an ordinary photon transforming to dark 3-photon absorbed by dark codon. This mechanism generalizes to  $3N$ -proton states representing genes or dark proteins.

### 3 TGD based view about brain

#### 3.1 A new view about the role of nerve pulses in sensory perception

Sensory perception would in TGD generate sensory mental images at sensory organs: this would solve a basic problem of neuroscience due to the similarity of neural tissue in various sensory areas. The new view about time and memory implied by ZEO solves the problem caused by the phantom limb. The pain in the phantom limb is a sensory memory of pain.

The stimulation of temporal lobes indeed generates sensory memories, and people with a cognitive impairment are known for memory feats such as being able to draw a building seen in the past with every detail or to learn music pieces with single listening. These feats can be understood if the memories correspond to “seeing” in time direction with a beam of dark photons travelling to the past reflected back. ZEO allows this.

Since perception involves a lot of processing this would require forth-and back signaling between brain and sensory organs. There would be virtual sensory input from the brain or via the brain. Sensory percept would be an artwork, standardized mental image, resulting as pattern recognition assigning to sensory input standardized mental image nearest to the input.

1. Nerve pulses would not mediate information inside the brain. They would only build short connections between existing flux tube connections parallel to axons. Same happens in an old fashioned telephone network by relays: it would be energy consuming to keep the connections on all the time.

The velocity of nerve pulse conduction is quite too slow to realize the iteration leading to a standardized sensory mental image. If the signal velocity is light velocity, duration of order 1 ms for nerve pulse also for 10 cm neural pathway about  $10^6$  forth and back travels between sensory cortex and retina.

Communications would occur by dark photons signals with  $h_{eff}/h = n$  and with maximal signal velocity allowing for an iteration leading to standardized perceptions as near as possible to the sensory input and representing only the essential features. Dark photons could transform in an energy conserving manner to biophotons with energies in visible and UV range (at least) and thus above thermal energy and therefore having effects not masked by thermal

radiation. Brain is known to emit biophotons and they are also associated with axons [K6, K5].

2. All information molecules (neural transmitters, hormones, messengers) would be connection builders so that the view of neuroscience would be badly wrong here. I have discussed this idea earlier but in a slightly different form: the proposal was that information molecules are attached to the end of a flux tube getting longer as the molecule travels to its target. This is possible but unnecessary since it is enough to build just the bridge between existing connections. **Remark:** The view of neuroscience might be very different if information technologies would have been known for a century ago. Same applies to homeopathy and water memory [K2], which still remains curse words in mainstream science, although a lot about the mechanisms involved is known.

The standard view about learning as strengthening of synaptic connections would translate to a gradual build-up of permanent flux tube connections so that communications with dark photon signals would be possible all the time. This would lead to fusion of sender and receiver to a single quantum entangled system.

If the meridians of acupuncture network correspond to this kind of permanent network, they would not require nerve pulses, transmitters, nor information molecules.

3. Nerve pulse patterns would however generate Josephson radiation at EEG frequencies propagating from the brain to its MB from axonal membranes serving as Josephson junctions. EEG would code the nerve pulse patterns as frequency modulated Josephson radiation [K1].

The view about sensory perception and function of nerve pulse transmission differs from the standard view. Nerve pulse transmission would not be communication between parts of CNS but building of the communication line for dark photons making possible communications with maximal signal velocity [L8] [K4].

1. This would allow generation of sensory mental images at sensory organs by an iteration involving virtual sensory input from brain to sensory organs. Pattern recognition would be realized as a build-up of an artwork representing standardized mental image as near as possible to the original sensory input.
2. Neurotransmitters and all information molecules would be bridges needed to construct connected communication lines. Learning as formation of permanent synaptic connections would be generation of permanent bridges of this kind.
3. Cell membrane and perhaps also other structures serve as generalized Josephson junctions [K1]. The (generalized) Josephson radiation generated by nerve pulses would give rise to EEG (and perhaps also to its fractal counterparts) as communication of neural information from brain to MB via Josephson frequency modulation. The size scale of the layer of MB would be rather large, of the order  $1/f_c$ , of the order Earth size in alpha band ( $f_c \simeq 10$  Hz).



This view allows to understand imagination as virtual sensory inputs *resp.* motor actions from MB via brain which do not reach actual sensory organs *resp.* muscles but virtual sensory organs inside brain for which a good candidates are basal ganglia - ganglions are also associated with sensory receptors. Dreams (REM), hallucinations, and psychedelic experiences (motor activities during sleep) could be understood as virtual sensory input reaching the sensory organs (muscles).

Also memory recall could involve virtual (real in the case of sensory memories) sensory input from MB at which memory mental images are realized [L27] [L20].

### 3.2 Binaural beat as a support for TGD view about brain

The phenomenon known as binaural beat [J3] provides support for the TGD view about the brain. Binaural beat occurs when sound waves with slightly different frequencies arrive in both ears. The beat can be understood as interference due to the time-varying phase difference of the waves. What is heard is the difference frequency, even when it is below 20 Hz - for instance 10 Hz-, and therefore not audible. The amplitude modulation with 10 Hz would be perceived, not the 10 Hz frequency. Strangely, the binaural beat occurs also when the signals arrive only to separated ears so that interference is not possible.

The TGD based explanation could be that the sound waves generate dark photon signals propagating along flux tubes and having classical em waves as correlates. The waves from different ears would interfere if the flux tubes meet at some point in the brain located at auditory areas perhaps. The first option is that this interference gives rise to the experience of the binaural beat and superposes with the sensory input assigned to ears (one cannot exclude the possibility that the sensory qualia are assigned to virtual sensory organs in the brain). Second option is that the virtual sensory input as feedback sent back to ears as dark photons superpose to the sensory input from ears.

### 3.3 The roles of nerve pulses and oscillations of neuronal membrane in the TGD picture

1. Nerve pulses - or more precisely, the transmitters emitted at synaptics contacts - connect flux tubes to longer pathways along which dark photons signals travel. Biophotons are dark photons transformed to ordinary so that there is empirical basis for this. Dark photons are an optimal tool for communications: light velocity and coherence.

This allows the build of percepts as standardized sensory mental images by feedback. Nanosecond is the time scale for a single feedback loop so that there is a lot of time for this. This also explains dreams as virtual sensory input from the brain of MB to sensory organs in particular eyes (REM).

Imagination can be understood as virtual sensory input which does not reach sensory organs or muscles but stops before it. Imagination is almost sensory experience with input from MB or brain. The notion of virtual sensory input is central for understanding speech comprehension and also inner speech.

2. Nerve pulses patterns modulate generalized Josephson frequencies for the membrane proteins (ion channels and pumps, etc...) and Josephson radiation to big part of MB codes for the sensory input.

Motor output is from MB in reverse time direction induced by BSFRs. A good guess is that it is via genes and induces gene expression by producing proteins but possible are also other forms of gene expression such as dark photon signals to cell/neuronal membrane inducing nerve pulse patterns building connected wave guides for motor output as dark photons signals to propagate

### 3.4 Memories

To understand what memories and memory recall could be in ZEO one must specify what the geometrical correlate of subjective "Now" have?

1. The first proposal was that it corresponds to the active boundary of causal diamond (CD). It however turned out that the subjective "Now" could more naturally correspond to the  $t = T$  slice of CD with maximal size located in the middle of the CD. Here  $t$  corresponds to a linear Minkowski time axis connecting the tips of the CD. If one accepts  $M^8 - H$  duality [L20], this picture can be made precise.

The moments "Now" would correspond to "special moments in the life of self" [L20, L26] identifiable as intersections of 6-spheres, which are brane-like entities (branes are encountered in M-theory) appearing as universal special solutions of algebraic equations determining the space-time surfaces in  $M_c^8$ . The values of  $T$  correspond to the roots of the real polynomial defining the space-time surface so that the values of "Now" are quantized.

2. During the sequence of state function reductions the active boundary of CD would shift towards the geometric future and the size of CD would increase (in statistical sense). The sub-CDs accompanying sensory and other mental images would shift to the direction of geometric future as CD increases and become potential memory mental images suffering BSFRs in a shorter time scale.

The self would experience a memory mental image as a sub-self in memory recall to be discussed below. The time=constant snap-shots at the upper half of CD assignable to the memory mental images are ordered with respect to the Minkowski time  $t$  but the order is opposite to that for the subjective experiences. This was a great surprise to me. They would correspond to subselves to which memory recall builds a connection by entanglement quantally or by sending a signal, which is reflected back in BSFR for the memory mental images.

What about recall of episodic memories in ZEO?

1. Spontaneous memory recall could correspond to a death of a memory mental image with an opposite arrow of time and re-incarnation with the same arrow

of time as self. This could be accompanied by emission of a past directed "negative energy" signal received by self associated with the moment "Now". The interpretation would be in terms of extraction of metabolic energy: memory recall indeed requires metabolic energy. Active memory recall could correspond to a receipt of future directed "positive energy" signal coming from "Now" having interpretation as metabolic energy feed. Energy conservation would force the memory mental image to change the arrow of time.

2. The prediction would be that in active memory recall by a "positive energy" signal received by the memory sub-CDs, the order of recalled memories is opposite to that for the real experiences. There is evidence for this kind of change [J5] (see also the popular article "*The human brain works backwards to retrieve memories*" at <http://tinyurl.com/y7hbqumg>).

### 3.5 Associations at quantum level

How associations could be formed at quantum level? Certainly memories and memory recall are involved and ZEO provides a universal model of memories.

1. In contrast to the naive expectations, in ZEO the memory mental images would be sub-selves and would comove with the active boundary of causal diamond (CD identified as an intersection of future and past directed light-cones) and shift to the direction of the geometric future after their creation at  $t = T$  hyper-plane of CD at which upper and lower light-cones of CD are glued to together. This is the largest time slice of CD and assumed to define the geometric correlate for the subjective moment "Now".

Memory mental image (associated with sub-CD) continues its Karma's cycle having as basic unit a birth in BSFR, a life consisting of a sequence of analogs of unitary time evolutions followed by SSFRs, death in BSFR and living a life with opposite arrow of time. Memory mental images can live in the brain of the geometry future being connected to the brain "Now" by long flux tubes.

2. Memory recall wakes up the memory mental images by sending a message using dark photons received by the memory mental image. The universal model of language suggests that the signal is biological system coded genes serving also as addresses.
3. Conditioning in its simplest form should associate two mental images. The classical example about conditioning is a dog, which learns to expect food after it hears the sound of a bell. The primary experience involves both the sound of the bell and getting the food. After the conditioning the mere sound of the bell stimulates activities like salivation. Positive or negative emotions facilitate conditioning. In ZEO framework the learning of the conditioned response would involve two mental images: imagined experience about obtaining the food and the sound of a bell.

They should fuse to a composite mental image, perhaps by entanglement. These primary memory mental images and their almost copies produced later and involving only the bell and the imagined food would form a population of

memory mental images in the geometric future shifting farther away. As the dog hears the sound of the bell, a message to the memory mental images in the geometric future is sent. It is realized as frequency modulated dark Josephson radiation from say basal ganglia of sensory organs.

4. A naive guess is that the modulated Josephson frequencies correspond to a period larger than the temporal distance of the memory mental image from "Now" and defining its age. Rather low frequencies are involved for long term memories and the values of  $h_{eff}$  must be scaled correspondingly. The longer the time span of the memory, the larger the value of  $h_{eff}$ . The emergence of language is therefore accompanied by the emergence of long term memory. The memory mental images about expectation of food +sound of bell have however a shorter time span. These signals wake-up the memory mental images but they are however not conscious to self - and as they die they send a signal back to the brain inducing an imagined mental image involving also the promise of food.
5. In some cases the signal can reach the sensory organs and a sensory memory mental image is generated. This picture applies also to the acquisition of the language. The larger value of  $h_{eff}$  associated with language genes (the value of  $h_{eff}$  could vary for a given language gene) meaning larger layers of MBs and a possible fusion of MBs of the communicators, and therefore the ability to remember the associations of the words to sensory mental images for a long time. Hearing of the linguistic expression would also generate internal speech as a particular virtual motor action.

## 4 Appendix: Living matter, biochemistry, and consciousness

The model for living matter relies heavily on the notions of MB carrying  $h_{eff} > h$  phases behaving like dark matter and ZEO.

### 4.1 ZEO based quantum measurement theory extends to a theory of consciousness

ZEO based quantum measurement theory [L27] leads to a quantum theory of consciousness (see **Fig. 2**) by lifting the observer from an outsider to part of physical system. In particular, the theory predicts that the arrow of time changes in "big" (ordinary) state function reductions (BSFRs) as opposed to "small" SFRs (SSFRs) as the counterparts of weak measurements (see **Fig. 3**).

This suggests that self-organization in all scales reduces to dissipation with reversed arrow of time. The energies of states increase with  $h_{eff}$  and  $h_{eff}$  tends to be reduced spontaneously. This means that energy feed is needed to preserve the distribution for  $h_{eff}$ : in biology this corresponds to metabolic energy feed. The energy feed necessary for self-organization would reduce to dissipation of self-organizing system in reversed time direction. Dark matter at MB of the system would serve

as a master controlling the ordinary matter serving in the role of slave. Note that there would be master-slave hierarchy of MBs ordered by  $h_{eff}$ .

This would happen at magnetic and have dramatic implications. Time reversed dissipation looks like energy feed from the environment to system. Self-organization involves always energy feed and generation of structures rather than their disappearance in apparent conflict with second law. Self-organization would correspond to dissipation in reversed time direction implied by generalized second law. No specific mechanisms would be required and only metabolic energy storages- systems able to receive the energy dissipated in reversed time direction - are enough. Obviously this provides a totally new vision about energy technology.

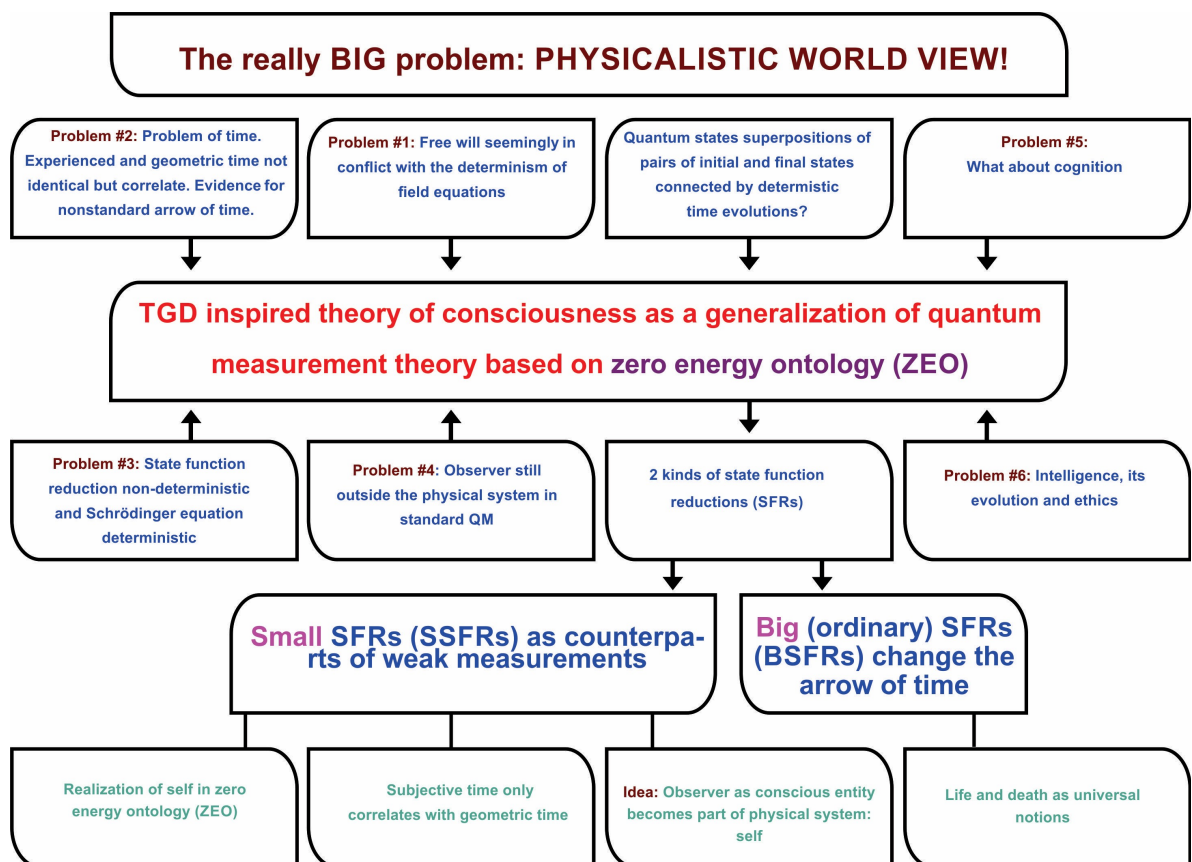
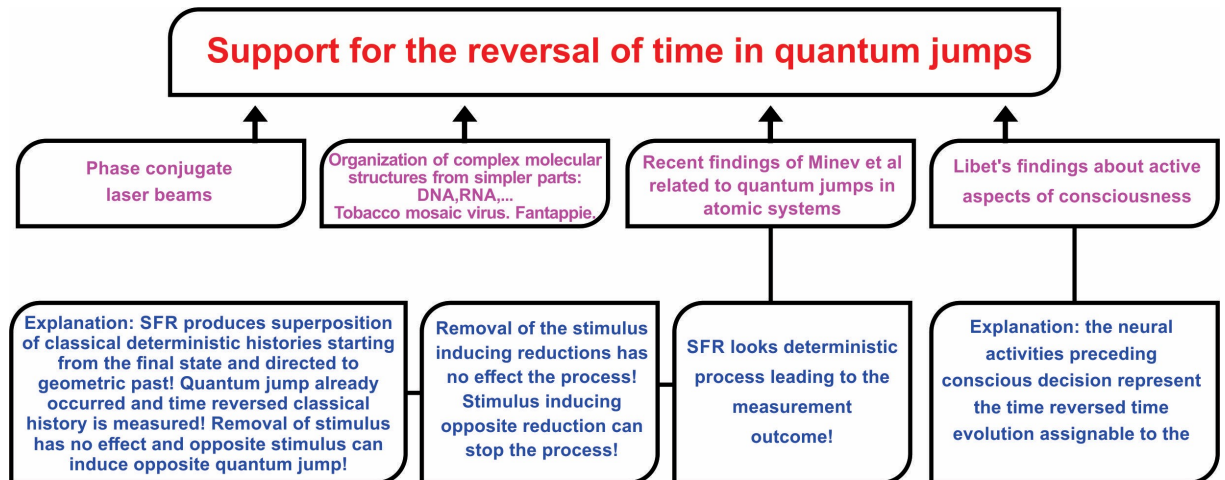


Figure 2: Consciousness theory from quantum measurement theory

## 4.2 p-Adic physics as a correlate of intention and cognition

One of the earlier ideas about the arrow of subjective time was that it corresponds to a phase transition front representing a transformation of intentions to actions and propagating towards the geometric future quantum jump by quantum jump. The assumption about this front is unnecessary in the recent view inspired by ZEO. Intentions should relate to active aspects of conscious experience. The question is what the quantum physical correlates of intentions are and what happens in the transformation of intention to action.



**Figure 3:** Time reversal occurs in BSFR

1. The old proposal is that p-adic-to-real transition could correspond to a realization of intention as action. One can even consider the possibility that the sequence of state function reductions decomposes to pairs real-to-padic and p-adic-to-real transitions. This picture does not explain why and how intention gradually evolves increasingly stronger, and is finally realized. The identification of p-adic space-time sheets as correlates of cognition is however natural.
2. The newer proposal, which might be called adelic, is that real and p-adic space-time sheets form a larger sensory-cognitive structure: cognitive and sensory aspects would be simultaneously present. Real and p-adic space-time surfaces would form a single coherent whole which could be called adelic space-time. All p-adic manifolds could be present and define kind of chart maps about real preferred extremals so that they would not be independent entities as for the first option. The first objection is that the separate assignment of fermions to every Cartesian factor of the adelic space-time does not make sense. This objection is circumvented if fermions belong to the intersection of realities and p-adicities.

This makes sense if string world sheets carrying the induced spinor fields- define seats of cognitive representations in the intersection of reality and p-adicities.

Cognition would be still associated with the p-adic space- time sheets and sensory experience with real ones. What can be sensed and cognized would be represented by the intersection.

Intention would be however something different for the adelic option. The intention to perform quantum jump at the opposite boundary would develop during the sequence of state function reductions at fixed boundary and eventually Negentropy Maximization Principle (NMP) [K3] [L7] (stating that in given state function reduction negentropy gain is in some sense maximized) would force the transformation of intention to action as first state function reduction at opposite boundary. NMP would guarantee that the urge to do something develops so strong that eventually something is done.

Intention involves two aspects: The plan for achieving something which corresponds to cognition and the will to achieve something which corresponds to emotional state. These aspects could correspond to p-adic andreal aspects of intentionality.

The recent view relying strongly on  $M^8 - H$  duality lead to ask whether the picture could be made more precise. This picture forces also to challenge the above picture.

1. The basic idea is that p-adic integration constants of the differential equation are pseudo-constants having a vanishing derivative but depending on finite number of binary digits- rational numbers satisfy this condition. In  $M^8$  picture a real polynomial with rational (or possibly algebraic) coefficients determines the space-time surface. The roots of this polynomial as a function of radial light-coordinate  $r$  at light-like boundary of CD determine this polynomial. When pseudo constant are allowed, the coefficients become pseudo constants, which are constants at the the interval  $[0; T]$  divided to sub-intervals  $I_1 = [0; t_1]$ ,  $I_2 = [t_1; t_2]$ , ...,  $I_N = [t_{N-1}; t_N]$  by the division  $0 < t_1 < t_2 < ... t_N = T$ .
2. Could the division to the intervals be unique by some argument? The roots of  $P$  are identified as moments for which SSFRs occur. Could  $t_k$  correspond to a root of the polynomial  $P_k$  defined in the interval  $I_k$ . Could the "very special moments in the life of self" as roots of a polynomial correspond to introduction of new pseudo constants as a p-adic correlate for the state function reduction? Each interval has its own polynomial  $P_k$  and the allowed roots  $r_{k_i}$  become to the interval  $[t_k; t_{k+1}]$  and their number is usually smaller than the degree  $n$  of the polynomial. Assume that each polynomial restricted to its own range defines a 4-surface inside the same CD. One would have  $m$  separate p-adic space-time surfaces. These surfaces would serve as correlates for intentions or dreams.

How could the real space-time surface as a realized intention relate to these surfaces?

1. Each of the 4-surfaces with genuinely constant coefficients of  $P_k$  has its own cognitive representation as points common to real and all p-adic variants. If the number of points  $t_k$  is finite one indeed has p-adic pseudo-constants for any prime  $p$ .

2. The realization of intention should be a quantum jump, state function reduction, or action of free will. Does this state function reduction have the selection of one of the polynomials  $P_k$  as a real polynomial defining the real space-time surface as a geometric correlate.
3. Could one generalize this to fermionic degrees of freedom. In [L17] it is proposed that one could super-symmetrize TGD and quark spinors as imbedding space spinors by replacing imbedding space coordinates with super fields with components expressible as hermitian composites of second quantized quark and antiquark oscillator operators. Analogous generalization would be made for the second quantized quark field.

In the  $M^8$  picture the real polynomial would be replaced with a polynomial of super coordinate algebraically continued to super-octonionic coordinate. Solutions of the algebraic equations defining space-time surface would be now super-space-time surfaces which are unions of components assignable with the fermionic super coefficients of the super-polynomial.

The rational coefficients of this polynomial could be replaced with pseudo-constants and the above picture seems to generalize. The spinor super-field would be a restriction of the  $M^8$  spinor super-field to the p-adic branches of the p-adic space-time surface. Could the above picture about intentional act as a choice of the real branch generalize.

The next important step is to understand intentional action at quantum level.

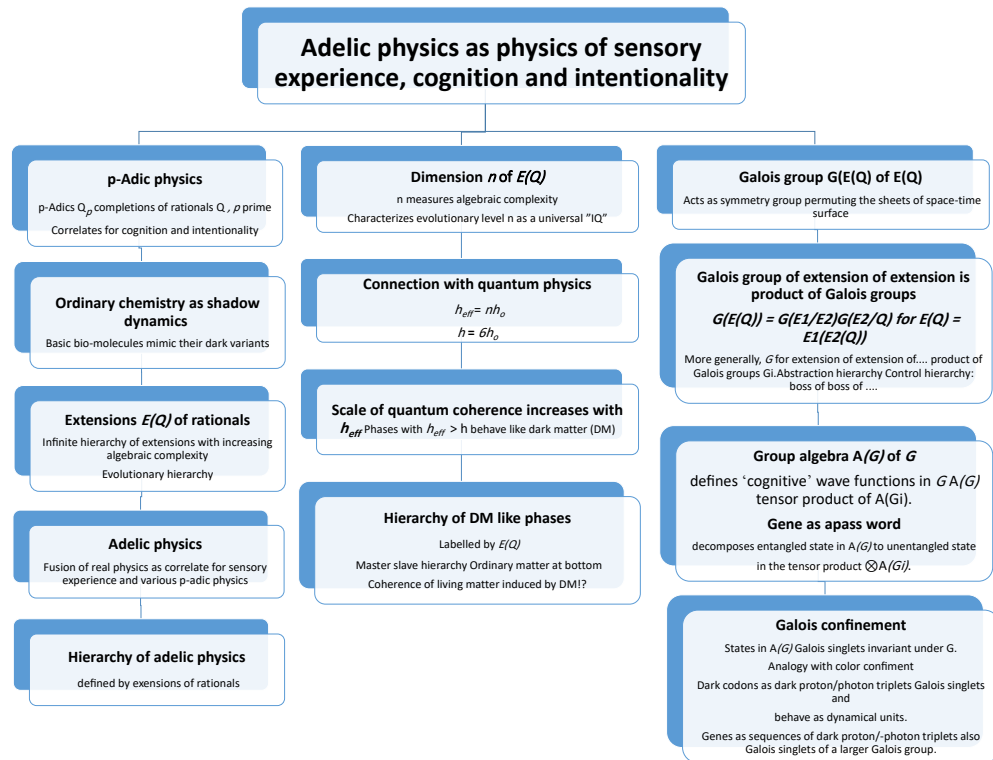
1. The most general vision is that intention corresponds to a superposition of p-adic spacetime surfaces with coefficients of polynomials which are genuine pseudo constants and by number theoretic universality same in all p-adic sectors. These superpositions would represent intentions and dreams. One could also speak of a dreamy CD containing a dreamy quantum Universe. Since cognitive representations are considered, everything would reduce to an extension of rationals, and the quantum dynamics by SSFRs and BSFRs would not formally differ from that for the real space-time surface and one could speak about transition amplitudes between dreams.
2. The realization of an intentional action would correspond to an SFR in which the pseudo constants become genuine constants. The simplest model is that one of the polynomials  $P_k$  is selected and be extended to a polynomial in the entire CD associated with  $P$ . The origin of CD is in a unique role in  $M^8$  picture and  $P(0) = 0$  makes possible hierarchies of extensions and conservation of number theoretical data as roots of  $P$  in the composition of polynomials realized for space-time surfaces.

If  $P_k(0)$  is required also for  $k > 1$ , any  $P_k$  can be selected. One can however challenge the idea that intentional action involves a selection. If  $P_k(0) = 0$  for  $k > 1$  is not assumed,  $P_1$  associated with the interval  $[0, t_1]$  must be chosen and CD corresponds to its size scale. One can talk about a partial realization of the intention in accordance with the intuitive expectations. For instance, imagined sensory percepts and motor actions could correspond to this kind of partial realizations.



3. If motor action corresponds to BSFR, intentional action can be realized only for BSFR. SSFR could not allow a realization of intention if the sequence of SSFRs corresponds to a functional composition of polynomials or even iteration of a single polynomial: I have considered these options for the sequence of SSFRs in [L21].
4. This picture is in accordance with the conservation laws in ZEO and allows the creation of Universes as from nothing. CDs do not pop up from vacuum but dream-CDs transform to real ones.

It is difficult to avoid the question of whether the notion of state function reduction could be reduced to a classical choice selecting one  $P_k$ : quantum jump as choice between dreams to be realized. This option would lead to purely classical probability theory and it would be however very difficult to understand what determines the transition probabilities.



**Figure 4:** Adelic physics as physics of sensory experience, cognition and intentionality

### 4.3 The notion of magnetic body

Magnetic body (MB) would carrying dark matter would serve as the boss controlling ordinary matter at flux tubes.

1. MB has as building bricks magnetic flux quanta. Typically flux tubes and flux sheets. It consists of two kinds of flux quanta. Flux can be vanishing, which corresponds to Maxwellian case. The flux can be also non-vanishing and quantized and corresponds to monopole flux. In monopole case magnetic field requires no current to create it. This option is not possible in Maxwellian world. These flux tubes play a key role in TGD Universe in all scales.
2. Also Earth's magnetic field with nominal value  $B_E = .5$  Gauss would have these two parts. Monopole part corresponds to the "endogenous" magnetic field  $B_{end} = .2$  Gauss explaining strange effects of ELF em radiation to the physiology and behavior of vertebrates [J1]. The presence of this part identifiable as monopole flux explains why Earth has magnetic field: this field should have decayed long time ago in Maxwellian world since it requires currents to generate it and they disappear. Magnetic fields of permanent magnets could have a monopole part consisting of flux quanta. Electromagnets would not have it.
3. MB would carry dark matter as  $h_{eff} = n \times h_0$  phases and act as a "boss" controlling ordinary matter [L19]. Communication to and control of biological body (ordinary matter) would be based on dark photons, which can transform to ordinary photons and vice versa. Molecular transitions would be one form of control.
4. Dark photons with large  $h_{eff}$  serve as as communication and control tools. Josephson frequencies would be involved with the communication of sensory data to MB and cyclotron frequencies with control by MB. Dark photons are assumed to transform to bio-photons [L3, L2] with energies covering visible and UV associated with the transitions of bio-molecules. The control by MB which layers having size even larger than that of Earth means that remote mental interactions are routine in living matter. EEG would be a particular example of these communications: without MB it is difficult to understand why brain would use such large amounts of energy to send signals to outer space.
5. The experiments of Blackman and others led originally to the notion of  $h_{eff}$  hierarchy. The large effects of radiation at ELF frequencies could be understood in terms of cyclotron transitions in  $B_{end} = .2$  Gauss if the value of  $h$  in  $E = hf$  is replaced with  $h_{eff}$ , which would be rather large and possibly assignable to gravitational flux tubes with  $h_{eff} = \hbar_{gr} = GMm/v_0$ .

MB would control BB by cyclotron radiation - possibly via genome accompanied by dark genome at flux tubes parallel to the DNA strands. Cyclotron Bose-Einstein condensates of bosonic ions, Cooper pairs of fermionic ions, and Cooper pairs of protons and electrons would appear in living matter and  $h_{eff} = \hbar_{gr}$  hypothesis predicts universal energy spectrum in the range of bio-photon energies.

Cell membrane could act as generalized Josephson junction generating dark Josephson radiation with energies given by the sum for ordinary Josephson energy and of the difference of cyclotron energies for flux tubes at the two sides

of the membrane. The variation of the membrane potential would induce variation of the Josephson frequency and code the sensory information at cell membrane to a dark photon signal sent to MB.

6. In ZEO field body and MB correspond to 4-D rather than 3-D field patterns. Quantum states are replaced by quantum counterparts of behaviors and biological functions. The basic mechanism used by MB would be generation of conscious holograms by using dark photon reference beams from MB and their reading. In ZEO also the time reversals of these processes are possible and make possible to understand memory as communications with geometric past. Sensory perception and memory recall would be time reversals of each other and correspond to sequences of SSRs. Motor action would correspond to BSRs.

#### 4.4 Life is not mere chemistry

The dogma about biology as mere bio-chemistry is given up in TGD framework.

1. Bio-catalysis remains a mystery in bio-chemical approach. MB carrying dark matter could provide the needed mechanisms.

According to TGD view about catalysis, the U-shaped flux tubes associated with the MBs of reactants reconnect to a pair of flux tubes connecting the molecules [L15]. This happens if there is cyclotron resonance for dark cyclotron radiation assignable to massless extremals (MEs) associated with U-shaped flux tubes. This requires that the flux tubes have same strength of magnetic field and therefore same thickness by flux quantization. The same value of  $h_{eff}$  guarantees resonance. The next step is the shortening of the flux tubes by a reduction of  $h_{eff}$  and liberating energy kicking the reactants over the potential wall making the process extremely slow otherwise.

2. Also valence bonds and hydrogen bonds could correspond to magnetic flux tubes characterized by  $h_{eff} = h_{em} = n \times h_0$ , where  $n$  is now rather small number ( $h = 6h_0$ ). This leads to a model for valence bond energies of atom with  $n$  increasing as one moves to right along the row of the periodic table providing insights to the biological roles of various molecules in biology [L10]. For instance, the molecules involving atoms towards right end of the periodic table would be natural carriers of metabolic energy whereas at the left end of row would be naturally involved with biocontrol via cyclotron frequencies.
3. The physics of water is full of anomalies [15]. TGD suggests an explanation [L11] in terms of flux tubes assignable to hydrogen bonds [L11, L14]. These flux tubes could correspond also to values of  $h_{eff} > h$  so that these flux tube could be long and give rise to long range quantal correlations. Water could be seen as a manyphase system. The MBs assignable to water molecule clusters could mimick the cyclotron frequency spectrum of invader molecules and make possible water memory and primitive immune system based on reconnections of U-shaped flux tubes of water cluster and invader molecule [L24]. In this framework water would represent a primitive life form.

In Pollack effect [I4] exclusion zones (EZs) are induced at the boundary between gel phase and water by energy feed such as IR radiation. The negative charge of EZs is explained as a formation of flux tubes carrying dark protons having interpretation as dark nuclei. A simple model for linear dark proton triplets predicts their states to be in 1-1 correspondence with DNA, RNA, tRNA, and amino-acids and the numbers of codons coding for given amino-acid are predicted to be same as for vertebrate genetic code [L13, L18]. The model thus predicts deep connections between nuclear physics, condensed matter physics, chemistry, and biology usually thought to be rather disjoint disciplines.

EZs are able remove impurities from interior in conflict with second law. TGD based explanation of the mystery is change of the arrow of time induced by TGD counterpart of ordinary state function reduction in ZEO) [L27]: self-organization would be dissipation with reversed arrow of time at the magnetic body (MB) of system acting as master and forcing time reversed evolution at the level of ordinary bio-matter serving as a slave.

DNA has one negative charge per nucleotide, microtubules are negatively charged, also cell is negatively charged, ATP carries 3 units of negative charge. This together with ZEO suggests that Pollack effect plays a key role in bio-control and macroscopic SFRs play a key role in living matter.

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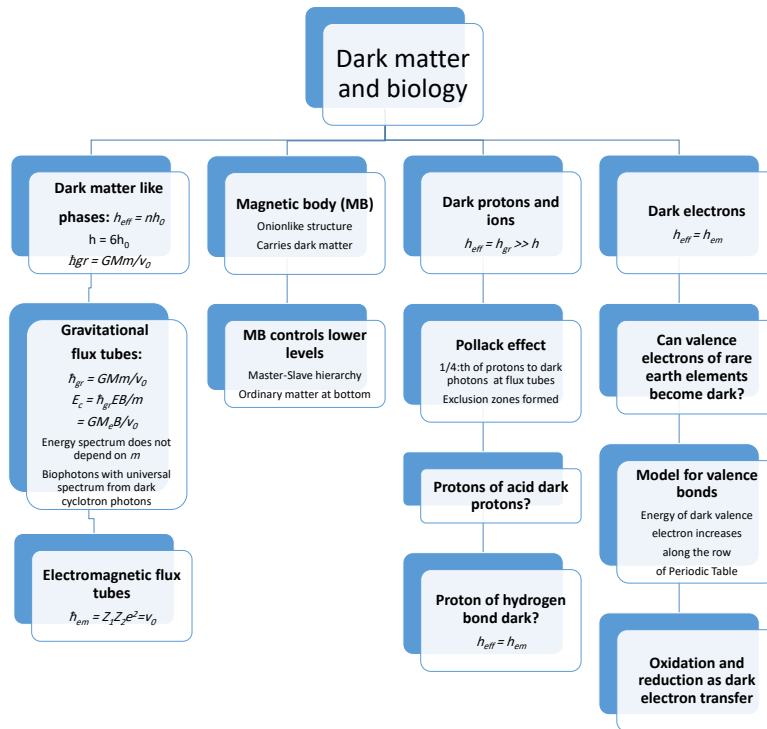


Figure 5: Dark matter in TGD inspired quantum biology

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