

TGD View about Language

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Abstract

Human languages differ dramatically from their analogos for animals. Animal languages consist mainly of simple signals, warnings and threats for instance. The emotional expression dominates. There seems to be no grammar. 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 saying the word describing 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

This chapter has been written together with Reza Rastmanesh, who proposed the topics of the article leading to this chapter. Human languages differ dramatically from their analogs 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 saying the word describing 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 [J7, J9, J8, J12]. The article of Kempe and Brooks [J11] and the review article "From Molecule to Metaphor: A neural theory of language" about the language theory of Jerome A. Feldman by Stefan Frank [J10] 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 [J3]. In addition to FOXP2 a limited number of genes are involved in speaking [J5]. 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 [J7]. 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 [J5] 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 almost 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.

Note: This chapter was prepared in collaboration with Dr Reza Rastmanesh who provided a lot of biological and neuroscientific knowhow and made inspiring questions.

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. 1 summarises the role of number theory in the TGD inspired vision concerning consciousness, cognition, and quantum biology and **Fig. 2** the role of dark matter in TGD inspired quantum biology.

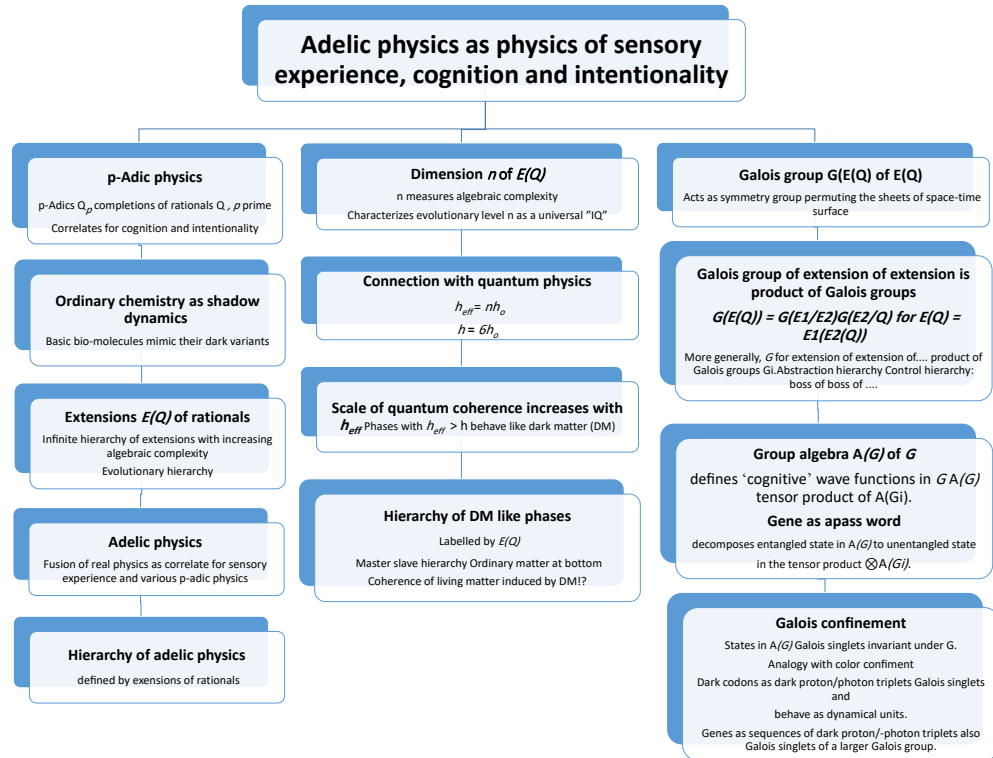


Figure 1: Adelic physics as physics of sensory experience, cognition and intentionality

2.1 Dark proton representation of genetic code

Fig. 3 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 [?] The outcome was a totally unexpected finding [?] 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 codons in turn would be connected by color flux tubes having quantum numbers of pion or η .

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.

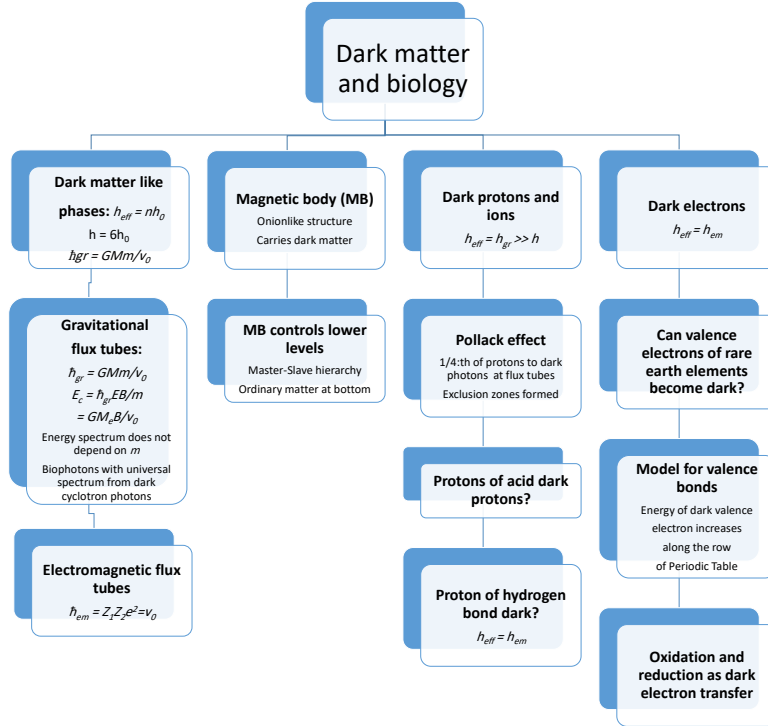


Figure 2: Dark matter in TGD inspired quantum biology

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 4×5 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 Δ 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 [?] means formation of negatively charged exclusion zones as protons are transferred to dark protons at magnetic flux

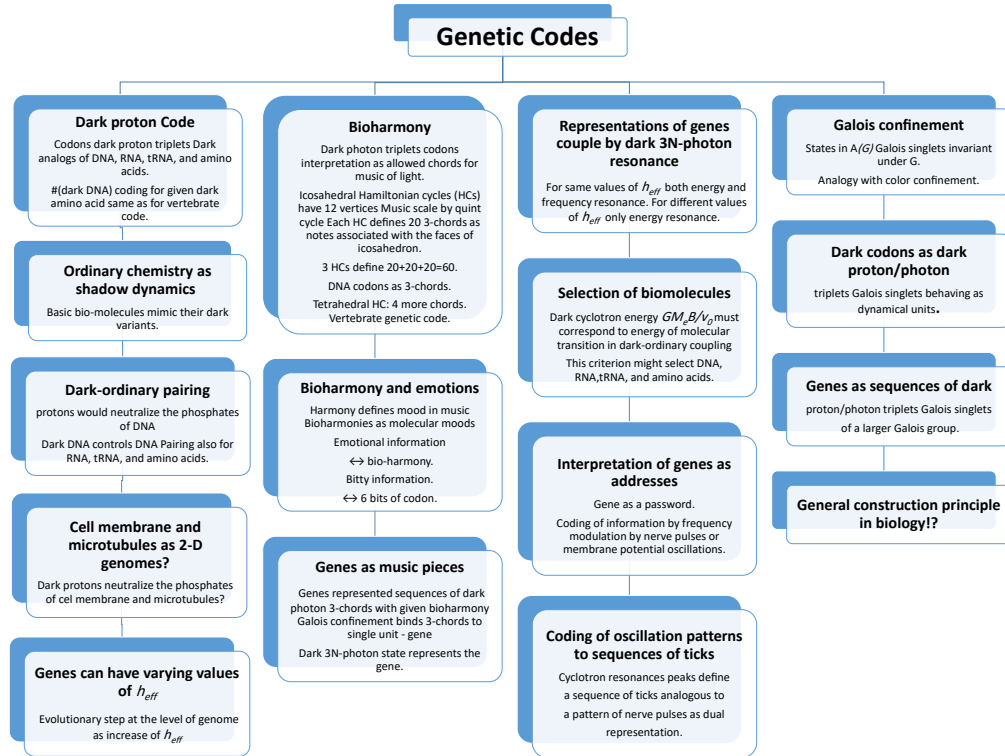


Figure 3: Genetic codes in TGD framework

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 ρ_0 meson-like bond connecting neighboring protons. Since ρ_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 ρ 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 [?]rings 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 [?]
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 [?]inding 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.

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, L20]. 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 [L25] 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 embedding 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 [L3] (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 π .
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 [I4]. 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 [I3] (<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 β 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 $L(151) \approx 10^{-8}$ 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 [L26]. 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 [L24] 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.

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 valued of the magnetic field strength dictated by the quantization of the monopole flux quantization by the thickness of the flux tube which can be do 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, L20] 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 [L3, 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 [L24] 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 transforming to ordinary photon (or 3-photon) and absorbed by the ordinary codon or amino acid excitation to hither 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 [K2, K1].

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 [K4], 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 [K3].

The view about sensory perception and function of nerve pulse transmission differs from the standard view. Nerve pulse transition 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] [K6].

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 [K3]. 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 . muscles but virtual sensory organs inside brain for which a good candidates are basal ganglia - ganglions are also associated a 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 [L28] [L17].

3.2 Binaural beat as a support for TGD view about brain

The phenomenon known as binaural beat [J4] 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 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 [L22], this picture can be made precise.

The moments "Now" would correspond to "special moments in the life of self" [L22, L27] 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 subelves 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 [J6] (see also the popular article "*The human brain works backwards to retrieve memories*" at <http://tinyurl.com/y7hbqumug>).

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 naïve expectations, in ZEO the memory mental images would be subelves 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 naïve 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 A TGD inspired vision about language

4.1 The role of MB

The proposal is that new layer of MB assignable to larger part of MB outside body was involved with the emergence of language. There are several arguments in favor of this proposal.

1. The model for how mutation of few genes like FOXP2 lead the evolution of human languages to be discussed relies on the idea that the value of h_{eff} assignable to dark variants of language genes increases. This means the emergence of new layer of MB having onion-like structure. What emerged was grammatics and syntax as hierarchical structures represented as many-sheeted space-time structures distinguishing humans from other animals could have emerged: these structures can be assigned to MB and they have also interpretation in terms of extension of rationals leading to n-sheeted structures. The new level of hierarchy would have emerged at the level of the MB including also dark gene first: flux tubes inside flux tubes inside labelled by values of h_{eff} .
2. The development of language led to a cultural evolution and could have been a quantum leap in the evolution of collective levels of consciousness: emergence of new levels in the hierarchy of extensions of rationals. Maybe the emergence of gene with large h_{eff} meant that it receives control commands from this collective level of consciousness possibly assignable to communications, social group, or even larger structure. Recall that the size scale of MB assignable to EEG frequencies is of order Earth size. The basic structure of language are indeed very "social". Subjects, objects, verbs expressing what they do to each other, relations between these entities, attributes (adjectives) characterizing their states. Also the notions of plural and singular.
3. One can also ask how it is possible to distinguish between sensory input created by living beings and having meaning from that produced to dead matter. Also humans give emotional meaning to bird's song and vocal signals and gestures of animals but not to the sounds of dead Nature. For autists this ability might be very weakly developed. The natural answer to the question is that all communications are also communications between magnetic bodies, quite concrete touching, makes it possible to distinguish natural sounds from speech and signals with represent communications. Communications require attention and the flux tube connections between communicators would be correlates for the attention.

Mere mimicry does not require interpretation of the signal as communications. Some birds can mimic the sound of even a car. I remember my astonishment when Finnish bird "talitiainen" mimicked the fate motif of Beethoven's symphony No. 5. My neighbours listened to classical music!

There should be also a fundamental difference between the communications of ordinary sounds and speech to brain. The communications of speech could be via the large part of MB outside body whereas ordinary sensory data would be communicated via small part of MB to brain.

4. In language acquisition the role of parents, in particular mother, is crucial. One might of course argue that just mimicry and rewards are enough. But how the child knows that mother is trying to teach her that the word "apple" corresponds to the object that the mother is holding at her hand. Is the fusion and entanglement of MBs needed?

The acquisition of language by child might also involve the MBs of child and Mother at least fusing to a larger structure. This might help the child to understand that the purpose is to learn to reproduce the word associated with the object that word describes. It could also make possible to learn the grammatics and syntax by becoming a part of larger self already learned these notions.

5. Speech communications happen magically in a good company when people are friendly and benevolent. As a young man I was extremely shy in a company of people who were not my friends. When I had intention to say something, I tried to form sentences in my mind as internal speech before possibly getting courage to talk but found it extremely difficult and I remained usually silent. In a company of good friends I realized that it was not so difficult at all: someone talked through me using me as an instrument.

4.2 Genes and language

4.2.1 What is the role of FOXP2 and other control genes?

The question that led to the writing of this article was whether the mutation of the genome leading to FOXP2 gene and other similar genes responsible for control of the genome did lead to the evolution of human language. How? The above mechanism does not distinguish in no manner between linguistic and ordinary associations. What happened?

Evolution in TGD framework means the increase of number the increase of the complexity of extension of rationals and thus increase of its dimension $h_{eff}/h_0 = n$ defining a universal measure of intelligence and also a measure for the temporal and spatial scale of quantum coherence. A possibly dramatic increase of h_{eff} for FOXP2 gene and other key genes is a natural hypothesis explaining why the complexity of the language evolved and led from signals to sentences requiring longer time scale of quantum coherence and also the emergence of complex hierarchical structures naturally assignable to the new extension as extension of the original one.

The larger the value of h_{eff} , the larger the scale of the layer of MB. This suggests that a new level of collective consciousness essential for communications emerged. This layer would be associated with the system formed by the systems communicating using language. This would explain the ability to distinguish between sounds produced by inanimate systems and sounds produced by living systems and having meaning.

The emergence of this new level would have meant emergence of many new things: of speech, of longer time scales of memory and planned action, of a new level of cognition, of imagination in longer time scales, and of cultural evolution.

Second mechanism related to the emergence of FOXP2 and other similar control genes could be energy resonance in the coupling of the analogs of DNA, RNA, tRNA, and amino acids. The coupling would be between the entire gene and its dark analog. Whether the energy resonance occurs for all cyclotron energies of codons separately or for their sum remains an open question. For both scenarios small changes of the gene can 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 genes.

4.2.2 What about the development of speech organs and brain areas related to speech?

The development of speech required development of speech organs and brain areas for understanding of language and language production. How important was their role or was the mutation of certain genes responsible for language control enough to initiate the evolution leading to the development of speech organs and needed brain areas?

One can consider the emerge of a layer of MB with a considerably longer scale perhaps assignable to some collective level of consciousness - perhaps even the entire species. MB as a TGD counterpart for magnetic fields in Maxwellian theory indeed has layers or order of Earth size and even much larger. The proposed emergence of a big layer of MB with a large value of h_{eff} could relate closely to Sheldrake's proposal [I6] about learning at the level of species. How this new layer could have affected the evolution of speech organs and new brain regions.

1. MB is the key player in TGD. The TGD Universe allows conscious entities and they tend to have ideas as we know. Did MB at some level of hierarchy get an idea about expression of information using temporal sound patterns coupling to dark photons with specific frequencies? That would be a representation of bio-harmony in a new much longer spatial and time scale: did this evolutionary step correspond to the emergence of a new even larger value of h_{eff} to the dark matter hierarchy. Maybe the realization of this new faculty would have been a fractally scaled up variant of earlier realizations making this easier. Did MB make a plan which was eventually realized after a lot of trials and errors?

2. What this plan could correspond to? Here p-adic physics enters into the game. p-Adic dynamics for p-adic variants of space-time sheets obeys the same field equations as real space-time sheets. It however allows breaking of a strict determinism of real number based field equations: this non-determinism would correspond to the freedom of imagination.

p-Adic data could give rise to full space-time surface as dynamical patterns but they could correspond only to a piece of its real counterpart. Imagination would be non-realistic. Imagined motor actions and sensory inputs would correspond to this kind of partially fulfilled entions: signals would not reach sensory organs or muscles.

3. How this would apply to MB's plan to create sound producing organs? This plan could proceed by trial and error to become more realistic and gradually find a complete realization. The reduction of the planning to trial and error at dark gene level - would be an enormous simplification and could have meant mutations increasing the value of h_{eff} bringing in larger layers of MB related to the brain areas and speech organs.

4.3 Meaning from embodiment in the TGD framework

The notion of embodiment is central for the understanding of how speech gets its meaning. The simplest sentences represent sensory inputs or motor actions. But also very abstract expressions have metaphoric representations in terms of subject and objects and verbs representing actions. Embodiment means that language expressions are transformed to virtual sensory inputs and virtual motor actions creating imaginations of the real ones. This requires formation of associations as generation of sensory and motor mental images.

For instance, the sentence "A does something to B" creates virtual sensory and motor mental images in which A indeed does something to B. Mental images representing A and B and "does something" are generated and could correspond to interaction between two mental images. Basically remembering sensory percept in which A does something to B is enough to provide the meaning and the linguistic decomposition is a model. For instance, the heard speech generates internal speech helping in understanding.

The experience or imagined experience as virtual almost experience with input from MB rather than environment is associated with the expression of language. When the language has been learned, a mere language expression generates memory mental images about the experience associated with the expression. The mechanism is naturally pattern recognition and completion as a general mechanism of association and conditioning also in neuroscience and artificial pattern recognition.

4.3.1 Questions

In the TGD framework the questions are the following ones.

1. How memories are represented and how they give rise to conscious memory mental images? ZEO leads to a general proposal for how memory mental images are represented. First communication of sensory input to the part of MB containing a subself representing memory mental image, call it M. M receives the signals and experiences BSFR analogous to motor action involving a signal to the direction of geometric past to subself representing "Me Now". This signal is transformed to a nerve pulse pattern generating a virtual almost sensory mental image.

The general proposal is that in biology at cellular level motor actions are generated as time reversed signals from MB to dark genome inducing neural activity by a signal to cell membrane. The signal from MB to genome would take place by dark photon representation of genetic code and induce BSFR. This mechanism would be quite general.

Genes with N codons must be represented as a dark $3N$ -photon signal behaving like a single particle like entity. This is not possible in standard physics but adelic physics relying on number theory makes this possible. The notion of Galois confinement [L26] allows dark photon $3N$ -plets representing genes as sequences of N 3-chords of bio-harmony - kind of music pieces - serving as dynamical units analogous to baryons as color confined units formed from 3 quarks and thus behaving as dynamical units.

The signal would generate a sequence cyclotron resonance peaks at the genome giving rise to a sequence of ticks at dark genome. They must in turn generate a signal to the cell membrane received as a sequence of ticks inducing the sequence of nerve pulses. This seems to require realization of genetic code at the level of the cell membrane level proposed [L11]. The general principle would be the same as in computer language LISP manipulating lists: only identical genes serving as addresses can be in communications by cyclotron resonance. Not only the notion of cyclotron radiation but also the notion of generalized Josephson radiation [L4] must be further generalized: dark Josephson photons are replaced with dark $3N$ -photons.

2. Where the sensory signal to MB is generated? Its generation at neuronal or cell membranes as generalized Josephson radiation is not plausible since the time scales do not fit together. The modulation of Josephson radiation by nerve pulses patterns produces ripples rather than slow frequency modulation. A more plausible proposal is that the sensory signal to MB is generated at the basal ganglia of sensory organs as a generalized Josephson radiation with frequency modulation generated by the sensory input.
3. What is the basic quantum mechanism of association of the memory mental image B to a sensory input A? In the neuroscience framework it would happen in the associative regions of the brain by new pulse patterns and by learning based on changes in synaptic contacts. Now this would take place at analogous regions of MB to which sensory input is sent as a signal and induced cyclotron resonance for $3N$ -chords.

A pattern recognition at the level of MB would be in question. This involves a completion of the sinput pattern - sensory mental image - to a pattern representing memory mental image associated with it. This requires a generalization of the existing view about pattern recognition to quantum level. Also this step could involve resonance leading to a fusion of the associated mental images by entanglement. This fused pair of mental images would generate a dark $3N$ -photon signal propagating to the brain as a generalized cyclotron radiation.

4.3.2 Association to memory mental images gives meaning to linguistic expressions

Association of the auditory input to memory mental images would provide linguistic expressions with meaning.

1. Association is a way to assign meaning to linguistic expressions by embodiment. Language expression is associated with an imagined sensory experience or motor activity. Also internal speech is imagined speech as imagined motor activity and generated by written text.

Association requires wake-up of memory mental image by the speech signal, which in turn generates a virtual sensory brain or lower level of layers of MB. In ZEO memory mental images are in the geometric future of "me Now" so that BSFR must take place: the memory self "dies" when it sends the message as a dark photon signal. The signal eventually arrives in the brain and generates a nerve pulse pattern needed by dark photon communications generating the virtual sensory to virtual sensory organs.

Memory mental images at MB are woken up in ordinary memory recall presumably taking place at the hippocampus [J2]. The frequencies involved are theta frequencies suggesting that the layers involved of MB have the size scale of Earth. In the case of speech the frequencies are in the range 150-300 Hz which suggests that layers corresponding to these frequencies are involved. Also longer time scales such as minute time scale are involved and much bigger layers of MB could be involved.

2. The signals could be sent to the MB from sensory organs:

- (a) Ganglions associated with sensory organs are analogous to brain nuclei and would be the primary receivers of the sensory input. Nerve pulses are generated by neurons above them. Ganglions must play an important role in the generation of sensory experience and motor activities. Ganglions in the brain are called basal ganglia. They could serve as receivers of virtual sensory input and motor output from the brain.

The neuron structures above ganglions also generate nerve pulses and these give rise to communications to the brain along flux tubes associated with neural pathways by dark photons signals. These communications would represent ordinary sensory communications, in particular sounds as mere sounds without meaning. They would also give rise to language acquisition via association.

- (b) The view about communications to MB as Josephson radiation modulated by membrane voltage variations suggests that the frequency modulations of membrane potential at frequencies of speech are involved. The earlier proposal that nerve pulse patterns could induce this modulation. They however would correspond to ripples of long wavelength waves. Of course, also axonal membranes involve oscillations of the membrane potential inducing the modulation but this modulation of generalized Josephson energy involving also difference of cyclotron energies is much smaller than that caused by nerve pulses.

The oscillations ganglion membrane potential induced by sound waves could be involved. Frequency modulated Josephson radiation modulated by sounds would propagate to some part of MB. One can consider even the possibility that dark genes such as FOXP2 generate dark 3N-photon radiation. These dark genes could be also realized at the level of cell membrane.

What could be the radiation in the case of dark genes. Could it be generalized Josephson radiation assignable to an array of Josephson junctions defined by dark genes and their conjugates. Sound waves could induce frequency modulations of oscillations of the voltage between the dark genes just by putting them into motion. Does the distance matter.

- (c) The signals would be received by frequency resonance by some layer of MB responsible for memories representing word-sensory/motor associations. What this layer of MB is and where it is located? The flux tubes should allow 3-N dark photon sequences. Their realization outside the biological body does not look realistic. This suggests that the part of MB can be assigned with the brain of the geometric future. Magnetic loops would return back to the brain of the geometric future. The longer the time scale of the memory, the longer the loop. The realization of sensory or in part of MB analogous to associative cortex. What happens in the part of the MB of the future brain representing the memory about association. The analogy of pattern completion of incoming sound signal to sensory input should take place and generate a virtual sensory input to the geometric past as a response along flux loops arriving at the virtual basal ganglia defining virtual sensory organs. Two long loops would be involved. From sensory basal ganglia to the highest motor and sensory areas? And from these to virtual sensory and motor organs.

- (d) The branching of axons suggests a branching of corresponding flux tubes. What could happen in this process? In branching the value of h_{eff} could be reduced for dark photons - for instance by frequency doubling. Frequency doubling would transform audible frequencies to patterns of nerve pulses with much higher frequencies. From long to short scales. h_{eff} hierarchy would be essential.

A possible interpretation as a cognitive quantum measurement is possible. Cognitive quantum measurement as a cascade of measurements in the group algebra of the Galois group of extension would give rise to a gradual reduction of effective Planck constants for the factors of the tensor product.

This cascade could correspond to the branching of axons leading to the reduction of biophoton energy in visible or UV to energy above thermal energy and assignable to cell membrane. What happens in branching of the flux tube? Is energy shared to that of n dark photons with the same frequency and smaller h_{eff} . Or does a localization to a single branch occur. h_{eff} would be reduced and f would increase. E would be conserved. Also both processes can occur. Division into n dark photons with $h_{eff} \rightarrow h_{eff}/n$ with f preserved plus a reduction $h_{eff}/n \rightarrow h_{eff}/nm$ and increase $f \rightarrow mf$ increasing by factor m .

- (e) The communication via long flux loops to the small part of MB at the brain cannot correspond to this kind of process since the value of h_{eff} assignable to FOXP2 genes should be preserved. The communication could be to dark control genes such as dark FOXP2 generating signal to neuronal membrane - perhaps dark control gene also there - giving rise to nerve pulse pattern generating virtual almost sensory experience at the virtual sensory organs defined by basal ganglia.

This feedback should have been present already before the emergence of language but in shorter scales and leading to lower layers in the hierarchical structure of the brain ordered by evolution. They would correspond to a hierarchy of increasing values of h_{eff} realized at the level of genome.

These long feedback loops could end also at lower layers inside the brain and also the hierarchy of cortical layers could relate to this kind of feedback hierarchy. The virtual sensory input to the basal ganglia inside the brain would give rise to imagined sensory perceptions and motor actions.

- (f) The interpretation as analog of Fourier transform [?] is suggestive. The cyclotron resonance peaks would generate a sequence of ticks analogous to a Fourier transform of the incoming waves. Music-speech dichotomy suggests itself strongly. Speech could be analogous to a sequence of SFRs - ticks - and singing to superpositions of classical time evolutions connecting them. It is said that the right brain sings and the left brain talks. Could some brain regions sing in the sense that they receive or send the signal as dark cyclotron radiation and could some brain regions talk in the sense that this radiation would induce or be induced by internal speech as virtual motor action.

A holistic representation in terms of frequencies would be transformed to "reductionistic" representation as time series. The correlation function for ticks would have the frequencies in its Fourier transform: stochastic resonance or its analog. Eventually this association to a sequence of ticks could generate a nerve pulse pattern creating a neural pathway making possible virtual sensory input in various sensory areas.

Given language expression corresponds to a huge number sensory percepts and one could argue that this requires a huge number of associations. In the computationalistic framework this would mean a huge amount of computer storage. The model for the generation of mental images predicts that the sensory mental images are standardized mental images generated by a feedback loop giving rise to a pattern recognition. Standard mental images allow also abstraction and conceptualization. One can even consider a quantum counterpart of the classical notion of concept. Concept as the set of its instances would be replaced by wave function in the set of instances giving a large number of different views about the concept.

4.4 Bio-harmony as a universal language

Bio-harmony [L3, L16] realizing genetic code for communications is an ideal candidate for a universal language: codon would represent 6 bits and the allowed 64 chords would represent mood at molecular level. There is quite a large number of fundamental moods. Both dark codons and 3-chords bound to units by Galois confinement [L24] can be combined to dark genes by Galois confinement. This language would be minimal. The contents of the message would be minimal - the address of the receiver same as that of sender - so that LISP like language would be in question. The communications would be based on 3N-resonance. U-shaped flux tubes from receiver and sender forming bridges by reconnection would be the topological aspect of the communications.

The space-time surface associated with n :th order polynomial in M^8 defining the extension of rationals has n sheets corresponding to the roots of the polynomial [L18, L17]. These many-sheeted structures would give rise to a geometric representation of hierarchical linguistic structures.

There is also an abstraction hierarchy defined by the functional composition of polynomials giving rise to representation of the Galois group of extension in terms of inclusion hierarchy of normal subgroups. Flux tubes within flux tubes within.... are possible. For extension of extension of ... with extensions having dimensions n_1, n_2, \dots one would have n_1 -sheeted structure with sheets replaced with n_2 sheeted structures replaced with..... Substitution of x in $P_{n_1}(x)$ with $P_{n_2}(x)$ with x replaced with....would correspond to this replacement.

Cascades of quantum measurements for the states of the Galois group algebra to a product state in the tensor product of Galois group algebras of the hierarchy of normal subgroups would define cognitive measurements which could be crucial for understanding of language by analysis [L25].

4.4.1 Speech is only one form of communication of binary and emotional information

Concerning production and understanding of speech, one must see the situation more generally in TGD framework.

1. Speech is only one form to communicate information and emotions. Also gestures define a language being based on motor expression. An interesting test is how complex gestures developed before speech and whether FoxP2 has anything to do with sign language. Does sign language have grammatics and syntax characterizing formal languages?
2. Music and singing is the second form of language and expresses emotions rather than bits. Here harmony is an essential notion. Some basic chords define the harmony expressing the mood. Bits/words do not matter, only the chords used.

This leads in TGD to the model of bioharmony in terms of icosahedral and tetrahedral geometries and 3-chords made of light assigned to the triangular faces of icosahedron and tetrahedron. The surprise was that vertebrate genetic code emerged as a prediction: the numbers of DNA codons coding for a given amino-acid is predicted correctly. DNA codons correspond to triangular faces and the orbit of a given triangle under the symmetries of the bioharmony 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. Bioharmony codes for mood: emotional information related to emotional intelligence as ability to get to the same mood allowing to receive this information. Bioharmony 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.

The surprising findings that RNA is central in conditioning [?] suggest that RNA somehow represents emotions crucial for conditioning [?] Dark DNA and bioharmony for which emotions would be realized at molecular level would make it possible.

4.4.2 What does Universality mean?

There are two views about language: Universality (or computationalism involving only grammar and syntax) concentrates on the formal aspects whereas connectionism concentrates language as a conditioning. For the first option one speaks of language learning as learning of formal rules and

this applies to written language and language of mathematics. For the latter option one speaks of language acquisition as an almost unconscious process of imitation. These two views would be fused together in TGD view.

1. There would be only one universal language at the fundamental level. For communications it would be defined by genetic code realized as 3-chords of dark photons forming in turn 3N-frequency composites serving also as units. This code has both the bitty aspect: codon corresponds to 6 bits and the emotional aspect defined by given bio-harmony characterizing that is by the 3-chords defining the bio-harmony and in this manner mood. Genome would define genotype of language and specific languages would be phenotypes.

This code is used in communications between various levels of the hierarchy. At least in control commands arriving from MB to genome. The analog of Josephson radiation from cell membrane mediating sensory data to MB would consist of a sequence of notes but if cell membrane realizes genetic code, also Josephson radiation could consist of 3N-frequency dark photon composites representing genes. Note that the notion of tick makes sense also for 3N-chords. The message would be sent as Josephson radiation or cyclotron radiation and received as ticks corresponding to state function reductions.

Of course, one cannot exclude the single note option - mere temporal pattern of ticks with varying time separations - for the messages to the genome could be the case of speech having constant pitch. For singing and speech mediating emotions the situation melody or sequence of 3-chords would be needed.

Since the language would be realized at DNA level, even plants could communicate using it. Plants are known to communicate and there is evidence that plants can cognize and even count [I2](<https://cutt.ly/ffRYXH8>). In TGD framework also hormonal communications thought to be chemical would take place by biophotons: the hormones connected by flux tube to molecule in say hypothalamus would build the waveguides to second molecule in body for dark photons to propagate.

The basic new physics building bricks in this picture would be 3N-frequency cyclotron resonance transforming the oscillating signal from basal ganglia membranes to a sequence of ticks in turn inducing a sequence of nerve pulses generating the virtual sensory experience using stochastic resonance coding the frequencies of original signal to peaks in the frequency spectrum of the correlation function for the sequences of nerve pulses. Also dark 3N-photon Josephson radiation assignable to genes represented also at cell membrane level would emerge as a new concept.

2. The universal aspects of the language would be realized as a basic expression of dark genes realized in terms of 3N dark photon composites propagating along flux tubes. The content of the packet is the address to which it sent! This would be just like in computer language LISP. This would be the genotype of language, the universal language based on 3N-frequency-resonance between sender and receiver genes.

This would completely separate the meaning of language expressions from the basic communication mechanism. This is of course true also for kinds of communications. The sender and receiver provide the meaning for language expressions by sensory perceiving them. Understanding of how the meaning is generated is the key problem. This requires theory of consciousness and a new view about the conscious brain.

3. TGD view is based on dark 3N-photon resonance communications between genomes and possibly also the genomes associated with the cell membranes and microtubules realizing the genetic code. The sensory input together with the language expression would provide the primary sensory percept - just as in learning by example. When communicated to the brain and even MB a secondary virtual almost sensory percept and virtual almost motor action would be generated as imagined sensory inputs.

This would be the fundamental association giving meaning to the language. Conditioning would occur and when the mere linguistic input is received, the virtual sensory percept and motor output are generated. Does this require anything new: for instance, does it require

that the associations are remembered in some sense or are the associations realized as in neuroscience in terms of synaptic strengths? One would have memory as a learned behavior. First the sensory input generated by linguistic expression is communicated from the basal ganglia of sensory organ or virtual sensory organ to the sensory and motor cortices by using dark 3N-photon resonance. After this the virtual sensory input and almost imagined) perception is generated. How?: as dark 3N-photon signals propagating in opposite spatial direction to sensory organs. The fact that nerve pulse conduction is in a single direction only suggests that also time reversal occurs in BSFR.

4. This general picture applies to the formation of associations and conditioning quite generally. This would be also the mechanism of imagination, which also sharply distinguishes humans from animals. The special ability of the humans to imagine would have emerged at the same time as the complex language. This could be due to the mutations of certain language genes like FOXP2 acting as genes for which the 3N-photon resonance is realized and one must understand how this could be the case.

The proposed notion of universality is not in conflict with the fact there exist large number of languages. The development of different languages is actually easy to understand as reflecting the fact that there is underlying universal language which is minimal in the sense that the content of the message is the address of the receiver. Language acquisition is a conditioning process associating sensory inputs and motor outputs to language expressions at a more fundamental level and the words are just labels for them. This is like general coordinate invariance in general relativity. Points of space-time can have infinite manner of different labelings in terms of numbers (now words).

4.5 Geometrization and topologization of the grammar and syntax in terms of many-sheeted space-time

These aspects of speech make understanding of speech acquisition possible but what about intentional learning of speech involving learning of grammar and syntax, which have nothing to do with contents of speech? In computer languages and mathematics as language this aspect would dominate.

4.5.1 Fractal flux tubes networks and structures of language

The TGD proposal is that magnetic flux tube networks - possibly trees in case of speech and associated with nerve pulse patterns are in an essential role. Flux tubes are effectively 1-D and have orientation which corresponds to temporal direction of speech and spatial direction of written language. There are flux tubes inside flux tubes flux tubes giving rise to hierarchical structures corresponding to the parsing of language expressions. MB would as many-sheeted structure would geometrize/topologize grammar and syntax.

There are also 2-D and even 3-D flux tube networks but not accompanied by neural networks. These would be essential for the geometric and holistic aspects of cognition: visual cognition in particular. The meridian system of Eastern medicine could be associated with the MB. These flux tube networks would have been present before the emergence of the neural system and would be possessed even by plants. TGD could reduce the structures of language to purely geometric structures. Sentences would correspond to many-sheeted space-time surfaces with their topology representing the parsing structure. Basic space-time sheets would represent words, and the gluing of them to larger space-time sheets by topological sum operation would build sentences. Topological sum of surfaces A and A_0 essentially means that A is inside A_0 . Also the ordering of the words matters: AB and BA are not the same thing. When A and B are inside an effectively 1-D magnetic flux tube A_0 , the ordering of the positions inside the flux tube makes it possible to tell whether A is before B or vice versa.

Non-associativity forcing use of brackets in mathematical expressions would be also important $((A + B)C \neq A + BC)$. For instance, $(AB)C$ would correspond to the structure formed from a pair A_0C of flux tubes by putting AB inside flux tube A_0 . $A(BC)$ would be obtained from the AA_0 by putting BC inside A_0 . Putting inside brackets means gluing at a larger space-time sheet. The reader is encouraged to imagine what these examples look like when represented in terms of flux tubes within flux tubes.

The hierarchy of extensions of rationals realized in terms of functional composition of polynomials defining space-time surfaces in M^8 as n -sheeted structures provides a number theoretical view about linguistic structures [L22]. The functional decomposition $P_1 \rightarrow P_1 \circ P_2(x)$ replaces each space-time sheet of the n_1 -sheeted structure with an n_2 -sheeted structure associated with P_2 . This is like fractal zoom each sheet to n_2 sheets.

This is due to the fundamental theorem of algebra stating that a polynomial P_n of complex argument with degree n obtains all its values n times. The argument $y = P_{n_2}(x)$ of $z = P_{n_1}(y)$ has the same value for n_2 points x_k . This gives n_2 sheets at y . The value z is turned obtained for n_1 points. Therefore n_1 sheets decompose to n_2 sheets.

4.5.2 How the structural elements of language can be understood?

One must understand what is behind the notions of subject, object, verb. How tense, case, singular and plural, pronouns, adverbs, etc. are expressed: at the level of genetic code or of conscious experience as contents of imagined sensory experience and motor activity associated with the experience? Are they coded already by the oscillation pattern of the basal ganglia membrane giving rise to imagined experience beside genuine sensory experience? This would be the most elegant option.

The same FoxP2 gene or its analogs could be involved. Consider tense as an example. How the tense would be coded to the oscillations of the ganglia membrane or to the position of these membranes in the brain - to what subself they represent. Who is talking and about what and when!

- "I see" would correspond to a real sensory perception.
- "I saw" corresponds to immediate personal memory: could this be a virtual almost percept produced by a memory and realized at different places as virtual sensory percept. Basal ganglia associated with a level higher than sensory organs responsible for imaginations and inner speech..
- "I will see" would correspond to sensory percept, precognitions in reversed arrow of time.
- "I have done" seems to refer to a remote past: different time scale and perhaps different value of h_{eff} .
- "I had done" is talk of another self above or parallel me in self hierarchy about me as sub-self as an outsider. Now the basal ganglia would be at some part of the brain containing mental images representing some outsiders, say community as sub-self.

One should also understand what makes the sentence a question or command. In written language formal tools to express whether the sentence represents a question, command or something else have emerged. The many-sheeted structure of space-time should express these aspects of language using fixed words as vocabulary at the basic level. For instance, the building bricks for "Did you do this?" and "Do this!" should have the same "genotype" but different "phenotypes" if the reduction to dark genetic code makes sense. The context represented by a mental image containing the standard mental images representing the words of the sentence would determine "phenotype" allowing to differentiate between the two cases. The geometric representation would be based on flux tubes. Context - the larger flux tube - would be associated with the mental image "I do not know" for "Did you do this?" and "I am the boss" for "Do this!": this context would determine the phenotype just like the environment affects the phenotype in ordinary genetics.

5 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.

5.1 ZEO based quantum measurement theory extends to a theory of consciousness

ZEO based quantum measurement theory [L28] leads to a quantum theory of consciousness (see **Fig. 4**) 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. 5**).

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 preserved 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.

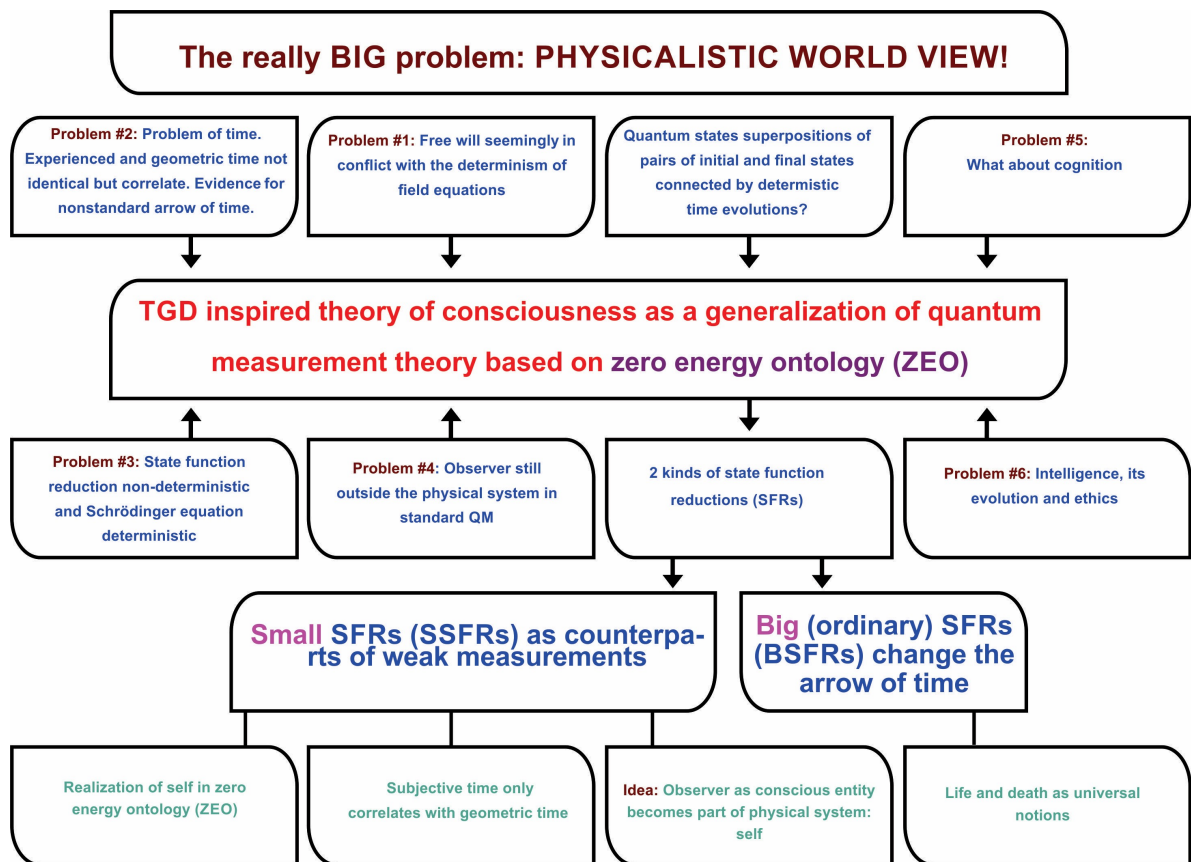


Figure 4: Consciousness theory from quantum measurement theory

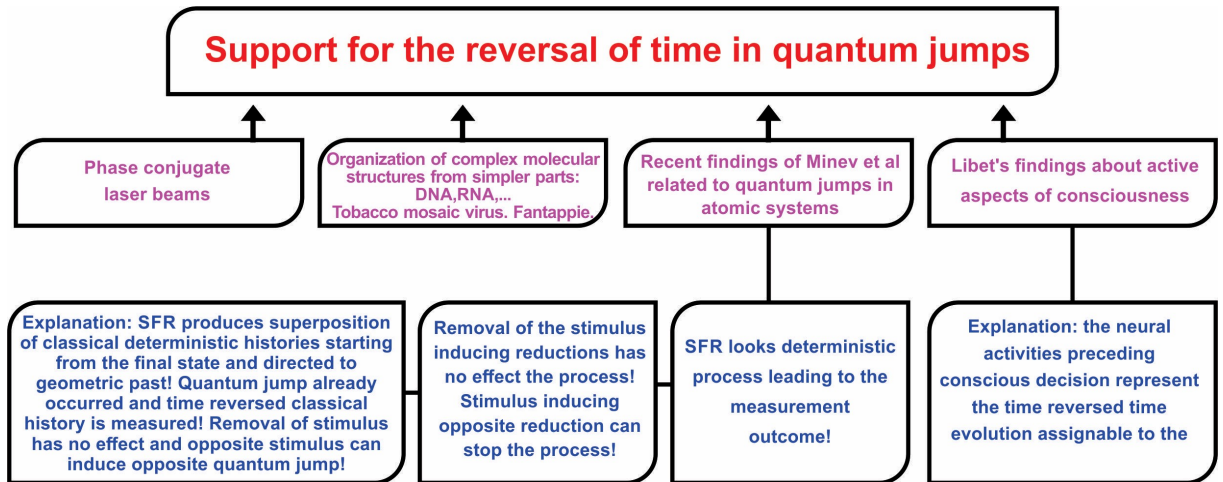


Figure 5: Time reversal occurs in BSFR

5.2 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.

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) [K5] [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 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 $0 < t_1 < t_2 < \dots < t_N = T$.
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 [L19] it is proposed that one could super-symmetrize TGD and quark spinors as embedding space spinors by replacing embedding 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 [L23].
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.

5.3 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 [L21]. 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 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 [L2, L1] 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 $\hbar_{eff} = \hbar_{gr} = GMm/v_0$.

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

5.4 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 [L9]. 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 [I7]. TGD suggests an explanation [L10] in terms of flux tubes assignable to hydrogen bonds [L10, 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 [L26]. In this framework water would represent a primitive life form.

In Pollack effect [I5] 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, L20]. 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) [L28]: 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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