Getting philosophical: some comments about the problems of physics, neuroscience, and biology

M. Pitkänen,

July 14, 2024
Email: matpitka6@gmail.com.
http://tgdtheory.com/public_html/.
Postal address: Rinnekatu 2-4 A 8, 03620, Karkkila, Finland. ORCID: 0000-0002-8051-4364.

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Abstract

In this chapter I summarize what I see as the basic philosophical problems of the recent conceptual framework of biology and neuroscience and discuss how TGD can resolve these problems. One cannot actually avoid the problems of fundamental physics and of consciousness theory so that also these are discussed to some degree. Also concrete mechanisms are discussed with aim to give an overall view about TGD inspired quantum biology.

1 Introduction

This contribution was inspired by an FB discussion and is an attempt to summarize basic philosophical problems of biology and neuroscience and the TGD based solution of them. One cannot actually bypass basic philosophica problems of recent day theoretical physics so that the discussion begins with these. I wrote first version of this contribution 2018 and this version year later.

1.1 Importance of philosophical thinking

The FB discussion that motivated this work once again made manifest both the extreme importance and regrettable lack of philosophical thinking - not only biology but in natural sciences in general. I do not mean with philosophical thinking academic philosophy, which I have found mostly deadly boring. Rather, for me good philosophical thinking means posing critical questions - rather than personal insults.

What we really know and what we do not know? What do we believe and what part of this is just beliefs? Are there facts challenging these beliefs? What is consciousness: is it really a property of something as "-ness" suggests? What is free will? How it manifests itself? Is it an essential aspect of consciousness so that AI hype could be forgotten? Are free will and non-determinism really in conflict with physics as physicalist has decided to believe? Concerning consciousness, what guidelines come from modern, physics, biology, and neuroscience?

In physics critical thinking would have allowed to avoid the numerous fads and fashions that have plagued us during last 4 decades: GUTs that led to the wrong track, inflation theory, various ad hoc models of dark matter postulating some exotic strong AI, supersymmetry in its GUT form, superstring models, loop gravity,...

Critical thinking would have challenged various "interpretations" of quantum theory and we could have continued immediately the work of the fathers of quantum theory rather than waiting for almost a century. Critical thinking would have also inspired the question whether the non-determinism of state function reduction has something to do with free will and how one should generalize the ontology of physics (Copenhagen ontology gives is it up altogether) to build a logically consistent framework.

Unfortunately critical thinking tends to lengthen the time spent in academic assembly line so that it is strongly discouraged. Thinkers tend also to become isolated from their social groups since everyone of us wants desperately to belong to some group and this requires sharing of its beliefs. It is easier to believe what professor and text book tell and get the research position and funding.

People are also very lazy. AI scientist decides that consciousness is running computer program or a property of the network structure or something equally ad hoc: no need to learn huge amount of physics, biology, neuroscience. Biologist decides that biology is nothing but Schrödinger equation and electromagnetism (or mere chemistry as in the older variant of the belief still prevailing). Neuroscientist desides that physicalism is correct and brain is the seat of the consciousness module. Brain as a computer paradigm makes the situation even easier. Physicist decides to believe in physicalism stating in its modern version that all physics reduces to Planck length scale: one can safely forget all other branches of sciences as a kind of taxonomy and specialize to apply one particular algorith to build CV.

1.2 Basic dogmatics

The key dogmas common to all branches of natural science are physicalism and reductionism. Physicalism states that matter is all that matters and consciousness is mere epiphenomenon and

that world is deterministic - in the quantum version of the dogma it obeys statistical determinism. Reductionist sees natural sciences are a victorious march towards shorter and shorter space and time scales. Science is an imperium that grows conquest by conquest.

We are told that super string theorists have taken the last step to Planck scale by building the only possible theory of everything. This step is really gigantic: from electroweak length scale there are 16 orders of magnitude to Planck length scale. Before this every order of magnitude has contained a lot of su4prises but now the situation would be different as already GUT theorists revealed to us.

The surprise was however that the theory in Planck length scale does not allow to predict anything in long length scales: situation is like trying to predict the behavior of initial value sensitive system. The question of philosopher would be obvious: could something have gone wrong? This question has been made by some theoreticians. The decision of elite however seems to be that physics has reached its end. Nothing can be predicted and we should be happy about this marvellous feature of the only possible theory.

This series of conquests is marked by transitions. From biology to biochemistry, from biochemistry in vivo to organic chemistry in vitro, from chemistry to molecular physics, from molecular physics to atomic physics. Then follows a transition from atomic physics to nuclear physics: the assumption is that these two physics have practically nothing to do with each other. There are numerous experimental anomalies found during the last century challenging this belief. "Cold fusion" people were labelled next to criminals for their scandalous claims. Luckily the situation has now changed. But people talking about water memory belong still to the pariah of science.

After this jump we jump from nuclear physics to hadron physics to physics at quark-gluon level and then comes the really really big Planck jump. So simple.

There is however a little problem. Every successful conqueror must build a lot of bridges, without them the maintenance fails. Reductionistic conquerors were so hasty that they did not have time to to build the bridges between these different physics. We do not understand how nuclear physics emerges from hadron physics emerges from quark physics. We do not understand how biochemistry emerges from organic chemistry emerges from molecular physics emerges from atomic physics. But we can decide that this is only a technical difficulty: if we had enough computational power we could fill these gaps.

Actually, I know a couple of finnish fellows who tried to fill a gap. The first one has read from text book that the notion of chemical bond emerges from atomic physics. He wrote a lot of computer programs and did not find a slightest indication for this. Second fellow had learned that cell membrane emerges and started to study a model in which one has just molecules and molecular dynamics simplifying the situation. Not a slightest indication.

2 TGD inspired view about the basic problems of physics, neuroscience, and biology

A reaction to not so thoughtful comments of a young otherwise friendly fellow in FB inspired me to ask why the young people who have got through the basic courses are not only ignorant but sometimes also - well - arrogant. Why they are ignorant is easy to understand but arrogance remains a mystery for me. Personally I was also extremely ignorant as also the my fellow students but quite too shy to be arrogant: could I have been as arrogant as other if I had not been so hopelessly shy? This fellow had not understood much of what I had written - something completely acceptable, understandable, and predictable since something completely new is in question and text book wisdom or what professor said is simply not enough.

So he concluded that I am writing only weird fairy tales and that it seems that I have never heard about mathematics, electrodynamics, or thermodynamics. According to him these fields allow to understand biology more or less completely: maybe he read this from a text book or professor told this to him. My FB friend also wanted to know whether I have read any book about biology during my lifetime.

I responded that I have not only heard the word "biology" but have even written about quantum consciousness and quantum biology [K1] (1000+ something pages). I forgot to mention that I have also written two published books about TGD [K16, K2] and there are 17 online books at my homepage (9 of them about quantum biology) (see `http://tinyurl.com/yddldhoe` and `http:`

//tinyurl.com/ycokk2kh) plus numerous articles both published articles- in particular in journals edited by Huping Hu - and at my homepage (see http://tgdtheory.fi/tgdarticlesall.html). I told that I have also recently published a long article in a book published by Springer about adelic physics [L12, L13] (see http://tinyurl.com/ybzkfevz): the goal of adelic physics is to describe the correlates of cognition and consciousness in terms of number theory and whose most important applications are to biology.

I informed that I have also heard the word "thermodynamics" and even developed what I call p-adic thermodynamics providing a first principle approach to particle massivation replacing Higgs mechanism [K8] (see http://tinyurl.com/y9z83aob). I forgot to mention that quantum TGD can be seen formally as a complex square root of thermodynamics replacing Boltzman weights with the complex square roots defining vacuum functionals and that the generalization of so called microcanonical leads to extremely predictive view about scattering amplitudes serving as the building bricks of zero energy states [L24] (see hhttp://tinyurl.com/yakzlllk).

This discussion was not pleasant but very useful in that it inspired me to write a summary of basic philosophical problems of biology and neuroscience and the TGD based solution of them. I hope that I have not forgotten anything from the list.

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In the following the attention is restricted mostly to the philosophical problems of biology and neuroscience. It however turns that these problems are actually also problems of physics.

2.3 Nothing but biochemistry and electromagnetism?

The basic dogmatics says that life is nothing but chemistry plus a little bit of electromagnetism needed to model cell membrane and neuronal membrane. There is also EEG but this is taken as noise due to neural circuits so that there is no need to waste time with it. Luckily, not all experimentalists know or care about dogmatics and have found correlations of EEG with behavior and physiology and they are used as a diagnostic tool. Most of them however refuse to consider seriously the possibility that EEG might possibly communicate something from brain somewhere. Where would this somewhere could reside: outside brain?

No! Philosopher must be producing totally weird fairy tale now! Says the mainstreamer inside me with such a friendly ut delicate tone that it becomes clear that he regards the poor philosopher as a screwball.

But philosopher continues asking. Didn't Libet discover that our sensory data is fraction of second old? Could it take fraction of second of this data to propagate as EEG signals from brain to this something. As a matter fact, Libet discovered also that the conscious decision to raise finger

is preceded by neural activity starting for a fraction of second earlier. One cannot understand this unless one decides that it supports the absence of free will.

Philosopher asks also whether our decision that experienced time and the time of physicist are one and the same thing is be wrong. They are indeed different in many respects as any first year physics student understands. Should we trust facts instead of textbook wisdom? And what about Libet's second finding: could we give up our firm decision that signals propagate in only single direction of geometric time?

There is also a second strange electromagnetic phenomenon in biology: bio-photons. Already discovered almost century ago, they are still taken as pseudoscience by many biologists. They appear in visible and UV range but it seems that they are not produced in molecular reactions (this would mean peaks in the distribution). What is their origin?

2.4 Why vivo-vitro difference?

Even the basic dogmatist must admit that one must speak about organic chemistry in vivo and in vitro. In vitro one can build models for reactions, deduce estimates for the excitation energies of molecules, construct thermodynamical models for reactions in terms of thermodynamics involving parameters like activation energies and chemical potentials, one can develop complex networks of reaction pathways.

The typical assumption of these models is that everything is homogenous and isotropic: one has spatially constant concentrations of various reactions obeying differential equations determined by the kinetics. One can however construct more complex structure by allowing diffusion making possible spatial gradients.

The problem is that this dynamics has very little to do with what happens in living cell. The in vitro estimates for the rates of reactions are many many orders of magnitudes too low as compared to those in living matter. We do not understand anything about bio-catalysis. We know that enzymes and ribozymes somehow make the miracle but that's all. We do not have slightest clue about how reactants manage to find each other in the molecular soup full of different molecules. We have no idea wherefrom the reactants get the energy to jump over potential wall making the reaction quite too slow.

Philosopher would say that here is an excellent opportunity for new physics to enter in biology. How can reactants find each other? Could they possibly be connected by something, which shortens as the reactants meet? Could the notion of tensor network involving quantum entanglement be essential element of biology and entire physics. Particles would not be lonely riders but could be connected by something at least temporarily. Could this something liberate energy quanta allowing to get over the potential wall making reaction so slow? Could these networks have dynamical topology and make living systems what they are.

Unfortunately, standard space-time picture does not allow this something. Also Planck constant is quite too small. Should we conclude that the philosopher is weirdly fairytaling again?

2.5 Where does the coherence come from?

A further mystery is how the biochemical reactions can occur coherently in length scales longer than atomic scale. Without this coherence I could not write this, play piano, or even raise my hand. If we were just sacks of water containing some chemicals we would be doing science and arts. We would be indeed just sacks of water containing some chemicals in chemical and thermodynamical equilibrium and microscopic sample from this water would characterize us completely.

Mysteriously the coherence of biodynamics in scales up to the size of the organism emerges somehow. The required coherence need not be quantum coherence - and probably it is not - but it could be induced by quantum coherence. Quantum coherence of what? There is also the problem due to quite too small value of Planck constant. We have learned about the effects supporting the vision about quantum biology. It is now however becoming clear that these effects would however require large value of Planck constant.

Here the philosopher remembers the findings of Blackman and other pioneers of bio-electromagnetism. They found that the irradiation of vertebrate brain by ELF radiation at EEG frequencies scale had effects on both behavior and physiology and these effects look quantal occurring at harmonics of endogenous magnetic field of .2 Gauss. $E = h \times f$ makes these effects extremely small and totally

masked by thermal noise. What if the value of Planck constant were so large that the energies were above thermal energy?

Philosopher talks shyly about effective Planck constant $h_{eff} = n \times h_0$, where h_0 is the minimal value of h_{eff} and n is integer: h_0 would be actually the real value of Planck constant and h_{eff} would be associated with space-time surfaces, which are in number theoretic approach n-sheeted covering spaces [L11, L13, L12] and replaced at QFT limit with single slightly curved piece of M^4. n can be identified the dimension of extension of rationals assignable to the space-time surface and measures algebraic complexity. There are arguments that ordinary Planck constant is given by $h = 6h_0$ [L9, L19].

Now the mainstream physicist inside us is getting really angry: is this recklessly speculating philosopher really suggesting that our cherished quantum theory might not be the final word of science?

2.5.1 The dynamics of space-time surfaces

This dynamics predicts two kinds of space-time regions [L6] (see `http://tinyurl.com/yboog5sr`.

1. The regions of first kind are locally minimal surfaces. These minimal surfaces are as 4-D analogs of geodesic lines analogs of asymptotic states of particle physics for which interactions are not on. They also satisfy non-linear geometrization of massless field equations so that both particle and wave aspects are present. What is especially important is that static minimal surfaces have vanishing mean curvature and look like saddles locally. They cannot be closed surface if stationary.

2. Second type of regions are not minimal surfaces: there is a non-trivial coupling of the minimal surface term to 4-force density analogous to the divergence of Maxwellian energy momentum tensor. This is a generalization of the dynamics of a point-like charged particle in Maxwell field. These regions are identified as interaction regions: in particle physics these two regions correspond to external free particles and the interaction region. Magnetic flux tubes play fundamental role in TGD based quantum biology are deformations of string like objects, which represent simplest 4-D minimal surfaces.

   Essential is the coupling between induced Kähler form (mathematically like Maxwell field) and the geometry of the surface: the divergence of energy momentum current assignable to the analog of cosmological term (4-volume) equals to the divergence of that assignable to Kähler action: this expresses local conservation of four-momentum. One could also speak about coupling between Kähler field and gravitational field: Penrose's intuition about the role of gravitation in biology would be correct.

   When the coupling is absent, minimal surface property implies the separate vanishing of both divergences and separate conservation of corresponding energy-momenta. All the known extremals of Kähler action are minimal surfaces: this is due to their very simple algebraic properties making easy to discover them. Physically this correspond to quantum criticality: dynamics is universal and does not depend on coupling parameters.

2.6 Questions related to bio-chemistry

2.6.1 Biocatalysis

As already mentioned, bio-catalysis remains a total mystery in bio-chemical approach. Magnetic body carrying dark matter could provide the needed mechanisms. Actually these mechanism would be also basic mechanisms behind water memory and - dare I say it aloud? - homeopathy [K5].

According to TGD view about catalysis, reactants find each other by cyclotron resonance for dark cyclotron radiation assignable to massless extremals (MEs) possibly associated with U-shaped flux tubes. The U-shaped flux tubes of the molecules reconnect to a pair of flux tubes connecting the molecules. This occurs only if 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 the energy kicking the reactants over the potential wall making the process extremely slow otherwise.

DNA replication, transcription to RNA, and translation of RNA to amino-acids are the fundamental processes in biology and TGD should provide a general model for them. Consider DNA replication as an example.

1. The standard model assumes that DNA opens and nucleotides build up the DNA codons in ordered manner. Nucleotides would be caught one-by-one from the environment by U-shaped flux tubes from DNA reconnecting with similar flux tubes from nucleotides. In the proposed model however dark codons are the fundamental units and expected to induce the process at the level of chemistry. Dark codons do not allow a decomposition to letters. Therefore ordinary codons rather than nucleotides should serve as basic units in energy resonance binding them to dark codons (triple resonance or ordinary resonance with respect to the sum of resonance energies). This looks like a problem for both replication and transcription. Translation in which RNA codons are paired with amino-acids suggests a solution of the problem.

2. Suppose that dark codons are the basic units also in the environment, and are connected by long flux tubes with rather large h_{eff} to ordinary nucleotides forming thus loose but actually strongly correlated triplets. Nucleotides would serve as basic units only apparently: the entities in question would be analogous to tRNA codons. In the replication and transcription the dark codons of opening DNA sequences would form flux tube contacts with dark codons in the environment coupled to ordinary loose codons by dark triple resonance.

   After that the Planck constant h_{eff} associated with the connecting flux tubes would be reduced, the flux tubes would shorten and the complementary dark codon would be drawn near the dark codon associated with DNA. Also the flux tubes connecting the dark codon to the nucleotides would shorten and the codon and complementary codon would form 3 base pairs. Shortening by a reduction of h_{eff} would provide the energy making the process fast enough. The loose codon property would allow to store the energy needed to make the reaction fast.

3. This model can explain also the claim of Montagnier *et al* [L1] about remote DNA replication [L1, L18]. Gariaev *et al* have reported the same process much earlier [I9] and together with Peter Gariaev we have developed a model for the process [K17].

   The situation is as follows. One has two vessels A and B: A contains genes and B only nucleotides. The vessels are connected by channels so narrow that the genes cannot leak through them. The system is irradiated at 7 Hz frequency, which is near the lowest Schumann frequency. The generation of the copies of genes in B is reported.

   The proposed model suggest that the flux tubes emanating from the dark DNA codons associated with the opening DNA extend to the other side - possibly through the channels so that there is a strong correlation between the directions of flux tubes and their endpoints are close to each other. If they have same value of h_{eff} they would have same length. They would reconnect with dark codons at the other side connected to nucleotide triplets by long flux tubes and the process would continue in the same manner as in the ordinary replication.

2.6.2 What selected the biomolecules?

Now philosopher is asking why only very few candidates for relevant biomolecules are actually selected. Who/what selected and how? This leads to very unpleasant questions circumvented by deciding that the emergence of life was nothing but a thermodynamical fluctuation. It has however become clear that complex organic molecules are present even in interstellar and intergalactic space. The miraculous thermodynamical fluctuation explaining evolution without real evolution would have been really huge.

Philosopher tends to conclude that we simply have no clue about what selection at the biomolecular level really is and continue that some new physics is involved so that it is time to think giving up the reductionistic narrative.

The selection problem appears also at the level of biochemical reaction pathways. One can imagine endless variety of "reaction vertices". If one assumes that only very few basic "reaction vertices" are allowed but the rest not, one can construct a limited number of reaction pathways.

But this is an ad hoc assumption: this selection of allowed reaction pathways certainly occurs but we do not have a slightest idea about the physics behind it.

There is also an analogy with computer science. One can construct endless variety of linguistically correct computer programs: why only very few of them would be selected. And with neuroscience: from a huge array of behavioral patterns only some are selected.

Here one can of course try a loophole: Darwinian selection. But there is no selection in the Universe of physicalist. This would require free will and intentionality. The trick does not work.

But what about this network in which biomolecules are connected by this something already mentioned?, asks philosopher. Could this something connect only biomolecules if they are in the same relationship as sender and receiver of radio signal. Could these somethings connect stably only systems possessing common resonance frequencies? Could this criterion could select both the preferred biomolecules and the "reaction vertices" and thus also reaction pathways.

One can develop this idea further.

1. The resonance between systems with the same value of h_{eff} would be both frequency - and energy resonance. The resonance between systems with different values of h_{eff} requires change of h_{eff} of either system so that h_{eff} is same for the systems. Energy is conserved, which means that the frequency of the photon would change to satisfy $E = h_{eff,1}f_1 = h_{eff,2}f_2$. One would have only energy resonance.

   The resonance of dark matter states with bio-molecules would be energy resonance and make it possible for long scales to control short scales by inducing molecular transitions. The transformed photons could have interpretation as bio-photons [K3, K4].

2. One can however argue that mere resonance is not enough to select bio-molecules. Magnetic flux tubes containing dark particles can vary their thickness and by the conservation of the monopole flux also magnetic field and cyclotron frequency so that they can get in resonance with any bio-molecule. A stronger condition is required.

   The obvious idea is that also biomolecules can be in resonance and surviving bio-molecules are able to build networks. Selection would not be selection of mere individuals but that of networks able to co-operate. There would be a choir singing resonantly in unisono rather than only resonating pairs. The biomolecules involved would have common transition energies which would poses extremely strong conditions on survivors.

It is easy to guess the reaction of the mainstreamer: fairy-taling again.

2.6.3 Genetic code

Genetic code definitely represents information. Is it really an outcome of thermodynamical fluctuation? Is there some deep mathematics associated with the genetic code?, asks the philosopher now. Be patient!

Genome contains also intronic portion: most of it consists of introns and the intronic portion is the larger the higher the evolutionary level is. The prevailing interpretation has been as "junk". Is it really junk?, wonders philosopher. Luckily, the attitude that trash bin represents the highest level of evolution has begun to slowly change to more rational one.

Could there be a beautiful mathematics behind genetic code? Could it be something similar to codes in computer science and have not only one representation - the chemical one - but numerous representations? If computer science would have developed before genetics - this question would have been completely natural and we would probably know a lot about these representations. Could this dark matter with large Planck constant at these mysterious somethings identified by our philosopher tentatively as magnetic flux tubes realize the really fundamental representation of the genetic code and also of of DNA, RNA, tRNA, and amino-acids (AAs) in information theoretic sense? And could also radiation provide realization of genetic code necessary for communications? This is what the philosopher claims [L7, L16, L15, L3, L25].

The most plausible vision at this moment is that since magnetic body is the boss, chemical code should be incomplete secondary representation of more fundamental genetic code realized at the level of magnetic body controlling bio-matter. The realizations based on 3-proton triplets and dark light 3-chords defining icosa-tetrahedral representation of the genetic code in terms of

Hamiltonian cycles [L27] would be the deeper realizations. There would be several Hamiltonian cycles distinguishing assignable to the same chemical representation of the genetic code. The analogy with music suggests that the realization in terms of 3-chords defining bio-harmony gives rise to quantum correlates of emotions assignable to magnetic body as kind of higher level sensory perceptions. Genetic codon as 6-bit unit would correspond to the "bitty" aspects of intelligence and harmony would correspond to emotional intelligence as the holistic aspect of intelligence [L27, L3]. Emotions would be realized already at the level of magnetic body [L20, L17].

The recent findings that the RNA of a conditioned sea snail scattered over neurons of second sea snail in Petri dish generate neuronal correlates of conditioning (`https://cutt.ly/6SuLNqk`) supports the view that the magnetic body of the RNA of sea snail infects the emotion/mood related to the conditioning. The emotional state, mood, of DNA and RNA would affect gene expression. Epigenesis is a poorly understood in standard biology and could be based on emotional states lasting for several generations. This is natural in ZEO [L3, L29].

How different representations of the genetic code relate to each other?

1. The natural hypothesis is that given dark codon generates corresponding light 3-chord in communications and control. Alike likes alike rule of homeopathy suggests that triple resonance between identical codons is the basic mechanism of communications between various representations. Similar codons of DNA sequences would be in resonance if the mood defined by bio-harmony is same for them. For the same value of h_{eff} one would have both energy and frequency resonance for different values only energy resonance.

2. The condition that all possible - or at least some - moods coded by Hamiltonian cycles are realized, poses additional conditions on ordinary DNA codons since given codon should be able to respond to several 3-chords resonantly. An open question is whether ordinary codons responds via triple resonance or to the energy associated with the sum of the three frequencies in which case one can consider the possibility that the sum of frequencies does not depend of bio-harmony.

3. Since dark protons are entangled and do not allow a decomposition to letters, it is not possible to realize the correspondence with ordinary codons by assigning a frequency separately to each nucleotide: the chemical codon reacts as a holistic entity [L27]. This gives highly non-trivial conditions on transcription and DNA replication: DNA and RNA nucleotides must form loose codons connected to dark codon by long flux tubes and in transcription/replication these flux tubes shorten. This allows to understand [L1] also the remote replication of DNA reported by Montagnier *et al* [L1]. The loose codons formed by nucleotides and dark codons would be very similar to tRNA codons except that the flux tubes connecting dark codon to nucleotide would be long.

2.7 Metabolism

Metabolism is one of the key aspects of biology. We must eat and plants must busily photosynthesize in order to survive. But why metabolic energy feed is needed? Again a mystery.

2.7.1 Non-equilibrium thermodynamics

Non-equilibrium thermodynamics is one attempt to answer this question. Thermodynamical equilibrium is completely uninteresting, entropy is maximal and in the case of local dynamics the state of system is completely determined by a small sample of it. However, if one has energy feed, situation changes since equilibrium becomes flow equilibrium. The energy feed guarantees that there is macroscopic dynamics rather than mere thermal motion at microscopic level.

Also in this case one has essentially the same situation everywhere unless one introduces macroscopic parameters - also energy flow - depending on time and position to get something more interesting. Simple reaction kinematics determined by differential equations can be replaced with that determined by partial differential equations obtained by allowing diffusion. Also temperature, pressure and other thermodynamical parameters can be allowed to depend on position and time. Turing proposed a model for the coloring of Zebra as outcome of this kind of dynamics. The model for neuronal membrane and nerve pulse generation is also a rough model trying to reproduce basic

facts about nerve pulse generation using thermodynamics for neuronal membrane regarded as a capacitor. This is of course a mere parameterization of the situation. TGD leads to a quantum model for the situation [K11]. Also the interpretation about the role of nerve pulse patterns at neuronal level changes dramatically [L10, L20].

In non-equilibrium thermodynamics one speaks of self-organization. One can generalize this notion to quantum self-organization and the crucial criticality associated to the transitions between different self-organization patterns generalizes to quantum criticality [K13]. Could these transitions correspond to spatio-temporal self organization patterns, behaviors, functions, programs. This in turn leads to deep connections with conformal symmetry (even its generalization in TGD), fractality, and universality of the dynamics. It is a pity that biologists do not seem to know much about these possibilities.

Now the philosopher starts to talk about ontology. Try to be patient. In standard physics the 3-D time= constant snapshot defines the state. This belief has led to weird proposals: in quantized general relativity one ends up with a proposal that there is no time at all.

2.7.2 ZEO based view about quantum self-organization

Could it be that 4-D deterministic time evolution between initial and final states could be more fundamental than the 3-D snapshot? Could superpositions of these 4-D evolutions define quantum states. If so, the state function reductions would occur between these superpositions and their non-determinism would be consistent with the determinism of field equations. Free will would not break laws of physics. It would be like starting new deterministic computer program. Our philosopher calls this ontology Zero Energy Ontology (ZEO) and claims that it leads to a theory of consciousness as a generalization of quantum measurement theory [L14] (see `http://tinyurl.com/ycxm2tpd`). Irritating.

ZEO based quantum measurement theory predicts that in ordinary state function predicts that the arrow of time changes in ordinary state function reductions but is preserved in "small" state function reductions identifiable as analogs of so called weak measurements. The recent strange findings of Minev *et al* [L28] provide direct evidence for the change of the arrow of time in state function reductions of atomic systems [L28].

ZEO predicts also the possibility of signals propagating backwards in time. This led to the vision that episodal memories involve communications with the brain of geometric past [K12], to the idea that motor actions and sensory perception are time reversals of each other [L26]: motor action would involve sending of negative energy control signals to the geometric past, and to the notion of remote metabolism based on quantum credit card mechanism. One can say that the system sends negative energy to a system able to receive it rather than receiving positive energy.

The energy of system as a function of h_{eff} increases when other parameters are kept constant. It costs energy build intelligence. h_{eff} for a given sub-system tends also to reduce spontaneously. Hence there must be continual energy feed to keep the level of conscious intelligence. A highly interesting possibility that this condition applies to all self-organizing systems. Self-organization generates long range coherence and requires energy feed. Could it be that dark matter makes itself visible by giving rise to long range correlations and coherence induced by dark matter at the magnetic body of the system [L30]?

Just as life also self-organization involves generation of coherence in long scales and requires energy feed. In the model for living system relying on dark matter as $h_{eff} = n \times h_0$ phases at magnetic body of the system coherence is induced by quantum coherence of the dark matter, and metabolic energy feed is required to increase h_{eff} tending to reduce spontaneously. Could self-organization be quite generally modelled in the same manner so that dark matter would make itself visible in everyday physics [L30]? Could the realizations of the genetic code in terms of dark nuclei and dark photon 3-chords be involved with the self-organization of water and be involved with morphogenesis?

2.7.3 Does metabolic energy feed generate conscious information?

The basic question about the role of metabolic energy remains, says the philosopher. What is its real role? Energy feed generates structures and structural complexity means information. It seems that metabolic energy feed involves also a feed of information or generation of information.

And because living systems are in question, philosopher cannot avoid the question whether this information is actually conscious information. Is there any other kind of information than conscious information?!

To this question standard physics has no answer: it can only describe entropy mathematically and identification of information as lack of entropy is the easy answer suggested in lack of anything better. The question about a possible measure for conscious information analogous to Shannon entropy is one manner to end up with p-adic physics as a correlate of cognition and the necessary fusion of real and various p-adic physics leads to adelic physics [L12, L13]. Adelic physics in turn predicts - surprise- surprise - a hierarchy of phases of matter labelled by the value of Planck constant $h_{eff}/h_0 = n$ defining the dimension of the extension of rationals defining the adele. These phases residing at these somethings defining the networks - magnetic flux tubes - make possible macroscopic quantum coherence inducing the coherence of living matter.

Quite generally, the energies of states as function of h_{eff} increase. For instance, atomic binding energy scales decreases like h_{eff}^2 and cyclotron energies scale like h_{eff}. In order to generate phases with non-standard value of h_{eff} energy feed is needed. This energy is identifiable as metabolic energy.

In adelic physics [L13, L12] h_{eff} serves as a measure for the IQ of the living system in well-defined system. The higher its value, the better changes the system has for generating conscious information - and also for destroying it. This leads to a rather concrete view about the origin of good and evil. The ethics and moral are simple: good deed increases the conscious information of the universe. Conscious entity can choose whether to increase the conscious information of the universe or reduce it. Evil deeds indeed lead to a reduction of conscious information of the universe since the doer cannot confess others or even himself what he did. Also the members of community become secretive - complex encryption schemes develop. The self-knowledge of the universe knows is reduced. Luckily, evolution unavoidably occurs in statistical sense and resources of conscious information increase in long enough time scale.

2.7.4 Remote metabolism as a purely thermodynamical universal mechanism in ZEO

Quite recently (towards end of 2019) I found a more precice formulation for the intuitive notion of remote metabolism, which strongly suggests that energy is conserved in ZEO. There is a decomposition to system and the energy energy source: call them A and B. Intuitively, A receives energy from B by sending negative energy to B. What does this really mean?

1. A "big" (ordinary) state function reduction reversing arrow of time takes place: this would correspond to sending negative energy signal to past. The energy of A+B in the final time reversed state at new passive boundary of CD would be shared in new manner such that one can say that A has received from B the metabolic energy.

2. Energy would be conserved. I have also considered the interpretation that the total energy of the system associated with CD increases [K7] [L34]: since CD itself breaks Poincare invariance, it seems that one cannot exclude this. However, the Poincare invariance is realized at the level of moduli space for the positions of the either boundary of CD, and one can assume energy conservation. Even the wave functions at the boundary of CD can be taken to be in the representations of Lorentz group acting as its isometries. Plane waves correspond to wave functions in the moduli space for the boundary of CD keeping second boundary fixed.

3. To make this more precise one must define metabolic energy more precisely by introducing the hierarchy of Planck constants and the fact that the increase of h_{eff} of sub-system keeping other parameters constant increases it energy. Second law means that A tends to loose energy due to the decrease of h_{eff} for its sub-systems. This is true also for the time-reversed state but in opposite direction of geometric time so that with respect to standard direction of time the energy increases. This would provide extremely general purely thermodynamical mechanism of remote metabolism.

2.7.5 A model of protocell based on Pollack effect

I learned about extremely interesting Quanta Magazine article (`http://tinyurl.com/y34o784j`) telling about findings related to water droplets as protocells able to perform chemical metabolism

as a transfer of molecules to exterior and back. See

The work is carried out by David Zwicker and collaborators at the Max Planck Institute for the Physics of Complex Systems and the Max Planck Institute of Molecular Cell Biology and Genetics, both in Dresden. The report about the work is published in Nature Physics.

In a simplified model for the droplets (P-granules in C-elegans cell is the real life example) the proteins in droplet can be in two states: in state A the stay in droplet and do not get out but can enter to the droplet from outside. In state B they can get out from droplet. To get into state B energy such as sunlight would be required.

TGD suggests a concrete counterpart for the droplet as exclusion zones (EZs) induced by energy feed such as radiation in water in Pollack effect. EZs are able remove inpurities 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 zero energy ontology (ZEO): self-organization would be dissipation with reversed arrow of time at 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.

TGD suggests for the model of protocell as droplet a realization as exclusion zone (EZ) generated in Pollack effect.

1. The exclusion zones (EZs) discovered by Pollack [I15, I11, I1, I6, L4] (`http://tinyurl.com/oyhstc2`) behave just like this. TGD allows to build a model of the Pollack effect [L4] (`http://tinyurl.com/gwasd8o`). The formation of EZs requires water bounded by a gel phase and they are negatively charged. Their really strange feature is that they throw out impurities just like state B in the model: this seems to defy second law telling that gradients tend to disappear. This makes possible primitive chemical metabolism involving exchange of chemicals between droplet and exterior. Light signal initiating the transfer by providing the metabolic energy needed. Transfer would stop as light signal stops.

   In TGD inspired quantum biology EZs are in crucial role. For instance, cell is negatively charged as also DNA double strand. Interpretation as EZs is natural.

2. The explanation for the negative charge of EZ is that part of protons and possibly other ions go to magnetic flux tubes forming the magnetic body (MB) of the system [L21, L32] (`http://tinyurl.com/yyyk6fu8` and `http://tinyurl.com/yjhx9xp7`). Dark ions form phases with nonstandard value $h_{eff} = n \times h_0 > h$ of effective Planck constant as cyclotron Bose-Einstein condensates. This system has long length scale quantum coherence and serves as a master controlling bio-chemistry, which is in the role of slave. This forces the mysterious coherence of the ordinary bio-matter impossible in life-as-mere-chemistry approach.

3. MB could control chemical metabolism of the droplet by sending dark photons to the droplet transforming to bio-photons and generating EZ state in the droplet and initiating transfer of molecules to the outside. The transition reducing the value of h_{eff} at MB would bring protons back to EZ droplet and it would become normal again. Secpnd law would force the molecules from outside to diffuse back to the droplet.

4. There is still one hard problem to be solved. What causes the mysterious removal of impurities from EZ challenging second law? Here zero energy ontology (ZEO) comes in rescue [L33] (`http://tinyurl.com/wd7sszo`). In ZEO macroscopic quantum jump corresponding to ordinary state function reduction changes the arrow of time . This would occur to MB as EZ is formed. Second law holds still true but in reverse time direction. MB is the boss and forces time reversal also at the level of ordinary bio-matter. The usual diffusion of molecules to cell occurs but with reverse arrow of time and explains the mysterious removal of impurities observed by Pollack for EZs.

All biological self-assembly processes would use this mechanism. In fact, self-organization quite generally would be dissipation in reverse direction of time: this would explain self-assembly aspect of self-organization. The big quantum jumps would inducing change of the arrow of time would tend to increase of h_{eff} in statistical sense (h_{eff} is identifiable number theoretically essentially as the dimension of extension of rationals and bound to increase in statistical sense). This would correspond to the evolutionary aspect of self-organization [L13, L21]. The increase of h_{eff} requires

energy since the energy of state increases with h_{eff} with other parameters kept constant. Energy feed is therefore needed. Dark matter n TGD sense would make itself visible in everyday life.

2.8 The mystery of replication

Replication is one of the deepest mysteries of biology. It is really something totally counterintuitive if cell is seen as a sack of water plus some chemicals. We have a lot facts about what happens in the replication at DNA level but how this miracle happens is a mystery. At cell level the situation gets even more complex.

Philospher thinks that behind the chemistry there might lurk a much simpler quantum dynamics and that chemistry only makes its best to mimic this deeper dynamics. Is biochemistry controlled by something? Does this something provide a template for the dynamics at chemical level? The idea about the presence of this something popped up already in the mystery of EEG. What could this something perhaps receiving sensory information from vertebrate brain and maybe providing feedback as control signals affecting also chemistry?

Now our brave philosopher attacks the length scale reductionism again. Isn't it quite too much to require that all these replications in different length scales would result as accidental "emergence" due to thermodynamical fluctuations? Could the dynamics be fractal with essentially same patterns - for instance replication - occurring in different scales. Could this dynamics be induced by what happens on this something.

Philosopher also suggests a concrete model for the controlling level: dark matter with large value of Planck constant $h_{eff}/h_0 = n$ at magnetic flux tubes and asks whether the conjectured dark realization of DNA in various scales performs the fundamental replication inducing in turn the biological replication in various scales as a mimicry? This would simplify the situation enormously but in totally different manner than length scale reductionism. Morphogenesis controlled by the hierarchy of dark realizations of genetic code would be the basic vision (see `http://tinyurl.com/yalny39x`). This would simplify the situation enormously but in totally different manner than length scale reductionism.

TGD suggests also a purely topological element involved with replication. Magnetic body (MB) could replicate [K9]. Replication would be like 3-vertex of Feynman diagram representing the decay of a particle to two particles. MB or part of it regarded as particle like entity splits into two. The incoming 4-surface and two outgoing 4-surfaces meet along 3-D surface common to all three. After that various molecules would self-organize around the resulting templates. This could happen also for the MB of dark DNA in replication and induce the bio-chemical part of replication.

2.9 Morphogenesis

The problem of structure formation in biology - morphogenesis - was put under the rug by most biologists after the emergence of genetics. Sheldrake [L2, I13] is one of those who have taken it seriously and has been labelled as a crackpot by mainstreamers (I have discussed Sheldrake's views from TGD point of view in [L2, L8]). One just assumes that the structures are there and performs chemistry around these structures. This approach is very practical and has given an enormous amount of data but very little understanding.

In standard physics the description of spatial structures would be in terms of enhanced densities of biomolecules or of their gradients in some space-time region. This is the only possibility because the space-time of standard physics is topologically and geometrically utterly trivial. Empty Minkowski space is an excellent approximation for it.

What philosopher has to say about this? If space-time topology were topologically non-trivial, situation would change dramatically. Already Wheeler saw this possibility and in the biology inspired by TGD (for which Wheeler suggested its name) all structures correspond to structures of topologically non-trivial space-time identified as surface in certain 8-D space-time: space-time sheets, magnetic flux tubes, etc... The entire TGD inspired quantum biology relies on this vision. The structures that we see around us would represent the non-trivial topology of space-time surface.

All structures - including bio-molecules, membrane like structures, organelles, organs, ... - would be 4-D space-time surfaces. Again philosopher gets excited since this would reduce the notion of shape in biology to a precisely defined and testable geometrodynamics coupling to em fields.

2.9.1 General view about morphogenesis

The new view about space-time lead to a rather general view about morphogenesis.

1. The presence of the Kähler field (em field is sum of Kähler field and second term) makes possible flow equilibria such as cell membrane, which are not minimal surfaces. These surfaces can be closed and stationary making possible isolation from environment crucial for living organisms.

   Spherical soap bubble is a good analogy: it is not minimal surface as the soap films spanned by frames are. They look locally like saddle surfaces with opposite external curvatures in two orthogonal directions, this implies that they cannot be closed surfaces. Bubble is not possible without a pressure difference Δp between the interior and exterior of the bubble: the blowing of the soap bubble generates Δp, and means external energy feed analogous to metabolic energy feed.

   Δp is analogous to a non-vanishing voltage V over cell membrane. The electric field of cell membrane and the energy feed providing the energy of electric field as metabolic energy are essential for the stability. More generally, V would generalize to non-vanishing of energy momentum tensor of Kähler field with non-vanishing divergence serving as a correlate for the energy transfer between Kähler and volume (gravitational) degrees of freedom.

   This generalises to all morphologies, which correspond to closed surfaces. They necessarily involve both Kähler electric and magnetic fields coupling to the geometry to stabilize the morphology. This statement would give some content for the exaggerated claim that biology is nothing but electricity + Schrödinger equation that I heard during my first student year.

2. For instance, the presence of Kähler electric field can correspond to electric fields of cell membrane or along a part of body. If it is too weak, things go wrong in development. As was found decades ago, consciousness is lost if the electric field between frontal lobes and hindbrain gets too weak or has wrong direction [J1]. Cell dies if the membrane potential becomes zero and EEG disappears in death. Also microtubules have electric field along their axes essential for their existence.

   Michael Levin and his collaborators [I7, I8, I14] have discovered further fascinating connections between electric fields and morphogenesis. One of the discoveries is that the electric fields of the embryo are controlled by neurons of the still developing brain (see `http://tinyurl.com/y77fcc7r`). This conforms with the view that neurons and their MBs correspond to a higher level in the hierarchy than ordinary cells and there take care of control in longer scales. The MB of the developing brain would be the controller.

3. A non-trivial coupling (four-momentum transfer) between the volume and Kähler degrees of freedom requires that the energy momentum currents have opposite and non-vanishing divergences. For the energy momentum tensor of ordinary Maxwell field the divergence is proportional to the contraction of Maxwell current and Maxwell field so that the current must be non-non-vanishing.

   In TGD the energy momentum tensor is replaced with energy momentum current allowing to have well-defined notion of energy momentum and corresponding conservation laws. Now the divergence contains two terms. The first one is the contraction $Tr(T_K H^k)$ of energy momentum tensor T_K of Kähler action with the second fundamental form H^k: this term proportional to T_K is new. Second term is proportional to the contraction $j_K J \nabla h^k$ of the induced Kähler form J with Kähler current j_K and gradients ∇h^k of embedding space coordinates analogous the divergence of energy-momentum tensor $j^\beta F^\alpha_{\ \beta}$ in the case of ordinary Maxwell action. One expects both terms to be non-vanishing.

   For the mere Kähler action, which I believed for decades to determine the preferred extremals, j_K is either vanishing or light-like. In presence of coupling it can be both non-vanishing and time-like. The realization that cosmological term is present was forced by the twistor lift of TGD whose existence is possible only for $H = M^4 \times CP_2$ [K15, K14].

4. The predicted stabilizing Kähler (and em) currents would naturally correspond to the DC currents flowing along the body in various scales discovered already by Becker [J3, J1] and

found to be essential for the survival of the organism. In particular, Becker's DC currents are essential for the healing of wounds and in the regeneration of organs. In the first first aid stage of the healing DC currents are generated locally and after than central nervous system (CNS) takes care of the generation of the current (for TGD based discussion of Becker currents see [K9] (see `http://tinyurl.com/ydg6okkk`) or [K10]). Also this is easy to understand from the proposed stability criterion.

This picture is discussed quantitatively in the framework of the twistor lift TGD in [K6] [L23].

2.9.2 Is genetic code involved with morphogenesis?

The chemical realization of the genetic code tells virtually nothing about morphogenesis. Could morphogenesis emerge via a general self-organization process having no dependence on genetic code? For instance, cell membrane consists of two lipid layers and soap films emerge spontaneously, and do not involve chemical genetic code.

TGD strongly suggests that quantum theory of self-organization replaces non-equilibrium thermodynamics so that the increase of h_{eff} generating dark matter is crucial for all self-organization processes involving dark matter in TGD sense: there would be no sharp distinction between living and inanimate matter. Furthermore, Pollack effect suggests that the dark phases of water could realize dark proton representation of the genetic code. Also the realization in terms of dark photon triplets is possible. Could morphogenesis rely on non-chemical realization of genetic code in long length scales?

Remark: In TGD also ordinary nuclei correspond to nuclear strings. Could genetic code be realized even at this level?

2.10 Hen-or-egg questions of biology

Standard biology suffers from several hen-or-egg problems. Which came first: genes or metabolism? The problem is that genes require metabolism and metabolism requires genes! Genes-first leads to the vision about RNA world and metabolism-first to lipids world idea.

The emergence of basic biomolecules is the second problem. What selected these relatively few basic molecules from huge multitude of molecules? Again hen-or-egg problems emerge. Which came first: proteins or the translation machinery producing them from RNA? Did RNA arrive before proteins or did proteins and RNAs necessary for their transcription and translation machinery emerge first. One can argue that ribozymes served as catalysts for RNA replication but how RNAs managed to emerge without replication machinery involving ribozymes? What about DNA: did it emerge before RNA or could it have emerged from RNA? It seems that something extremely important is missing from the picture.

TGD predicts the existence of dark variants of basic biomolecules DNA, RNA, tRNA, and amino-acids (AAs). One can ask whether something very simple could be imagined by utilizing the potential provided by dark variants of bio-molecules present already from beginning and providing both genes and metabolism simultaneously.

One can start from a couple of observations which forced myself to clarify myself some aspects of TGD view and also to develop an alternative vision about prebiotic period.

1. Viruses are probable precedessors of cellular life. So called positive sense single stranded RNA (ssRNA) associated with viruses can form temporarily double strands and in this state replicate just like DNA (see `http://tinyurl.com/yc5f8b3t`). The resulting single stranded RNA can in turn be translated to proteins by using ribosomal machinery. RNA replication takes place in so called viral replication complexes associated with internal cell membranes, and is catalyzed by proteins produced by both virus and host cell.

   Could ribozyme molecules have catalyzed RNA replication during RNA era? For this option AA translation would have emerged later and the storage of genetic information to DNA only after that. There is however the question about the emergence of AAs and of course, DNA and RNA. Which selected just them from enormous variety of options.

2. Lipid membranes are formed by self-organization process from lipids and emerge spontaneously without the help of genetic machinery. It would be surprising if prebiotic life would

not have utilized this possibility. This idea leads to the notion of lipid life as a precedessor of RNA life. In this scenario metabolism would have preceded genes (see `http://tinyurl.com/y7ehv8cq` and `http://tinyurl.com/y8nltb9e`). The basic objection against both genes-first and metabolism-first options is that they need each other!

Consider now the situation in TGD.

1. In TGD framework the dark variants of DNA, RNA, AA, and tRNA would provide the analogs of genes and all basic biomolecules. They would also provide a mechanism of metabolism in which energy feed by (say) solar radiation creates so called exclusion zones (EZs) of Pollack [L4] in water bounded by a hydrophilic substance. EZs are negatively charged regions of water giving rise to a potential gradient (analog of battery) storing chemically the energy provided by sunlight and the formation of these regions gives rise to dark nuclei at magnetic flux tubes with scaled down binding energy.

   When the p-adic length scale of these dark nuclei is liberated binding energy is liberated as metabolic energy so that metabolic energy feed giving basically rise to states with non-standard value $h_{eff}/h = n$ of Planck constant is possible. For instance, processes like protein folding and muscle contraction could correspond to this kind of reduction of h_{eff} liberating energy and also a transformation of dark protons to ordinary protons and disappearance of EZs.

   The cell interiors are negatively charged and this is presumably true for the interiors of lipid membranes in general and they would therefore correspond to EZs with part of protons at magnetic flux tubes as dark nuclei representing dark variants of basic biomolecules. Already this could have made possible metabolism, the chemical storage of metabolic energy to a potential gradient over the lipid membrane, and also the storing of the genetic information to dark variants of biomolecules at the magnetic flux tubes formed in Pollack effect.

2. In TGD framework biochemistry would have gradually learned to mimic dark variants of basic processes as a kind of shadow dynamics. Lipid membranes could have formed spontaneously in water already during prebiotic phase when only dark variants of DNA, RNA, AAs and tRNA, water, and lipids and some simple bio-molecules could have been present. The dark variants of replication, transcription and translation would have been present from the beginning and would still provide the templates for these processes at the level of biochemistry.

   Dark-dark pairing would rely on resonant frequency pairing by dark photons and dark-ordinary pairing to resonant energy pairing involving transformation of dark photon to ordinary photon. The direct pairing of basic biomolecules with their dark variants by resonance mechanism could have led to their selection explaining the puzzle of why so few biomolecules survived.

   This is in contrast with the usual view in which the emergence of proteins would have required the emergence of translation machinery in turn requiring enzymes as catalyzers so that one ends up with hen-or-egg question: which came first, the translation machinery or proteins. In RNA life option similar problem emerges since RNA replication must be catalyzed by ribozymes.

3. Gradually DNA, RNA, tRNA, and AA would have emerged by pairing with their dark variants by resonance mechanism. The presence of lipid membranes could have been crucial in catalyzing this pairing. Later ribozymes could have catalyzed RNA replication by the above mentioned mechanism during RNA era: note however that the process could be only a shadow of much simpler replication for dark DNA. One can even imagine membrane RNAs as analogs of membrane proteins serving as receptors giving rise to ionic channels. Note however that in TGD framework membrane proteins could have emerged very early via their pairing with dark AA associated with the membrane. These membrane proteins and their RNA counterparts could have evolved into transcription and translation machineries.

   DNA molecules would have emerged through pairing with dark DNA molecules. The difference between deoxi-ribose and ribose would correspond to the difference between dark RNA

and dark DNA manifesting as different cyclotron frequencies and energies making possible the resonant pairing for frequencies and energies. Proteins would have emerged as those proteins able to pair resonantly with dark variants of amino-acid sequences without any pre-existing translational machinery. It is difficult to say in which order the basic biomolecules would have emerged. They could have emerged even simultaneously by resonant pairing with their dark variants.

The FB post of Robert Stonjek (that I read much later than the previous text was written) told about a popular article in Phys Org (see this) about the modelling of unexpected findings related to muscle contraction [**?**]. The article is very interesting from the point of view of TGD inspired quantum biology (see for instance [L21, L35].

1. Muscle contraction requires energy. From the article one learns that the contraction is not actually well-understood. The interesting finding is that the rate of muscle contraction correlates with the rate of water flow through the muscle. As if the water flow would provide the energy needed by the contraction. How? This is not actually well-understood. This is only one example of the many failures of naive reductionism in recent biology.

2. In the muscle contraction, the flow of water involving these contracting flux tubes would liberate the energy needed by contraction and the process would be very fast. The water flowing through the muscle is a fuel carrying energy at its monopole flux tubs with $h_{eff} > h.The energy is used and water becomes ordinary. The rate of the flow correlates with the rate of contraction and w$

3. The interesting question is whether ATP-ADP mechanism loads the monopole flux tubes associated with water, say those carrying dark protons and associated with information molecules and providing a realization of genetic code, with energy. Second question is whether the ATP-ADP mechanism is a special case of this mechanism. I have indeed proposed that the very long monopole flux tubes associated with gravitational field of Earth with gravitational Planck constant $\hbar_{gr}$ or with the electric field of, say, Earth with electric Planck constant $\hbar_{em}$ could serve as temporary energy storages and contract in the process and liberate energy [L37].

2.11 How life began?

The central question of biology is "How life began?" and dark variants of biomolecules suggest not only a solution to various paradoxes but also a concrete answer to this question.

The transcription machinery for rRNA including ribozymes and mRNA coding for the proteins associated with ribosomes is central for the translation. The DNA coding for rRNA is associated with nucleolus (see `http://tinyurl.com/yavahwzt`) in the center of the nucleus.

1. After the emergence of the first ribosome the ribosomes of the already existing nucleus can take care of the translation of the ribosomal proteins. But how could the first ribosome emerge? This question leads to a paradox bringing in mind self-reference - the basic theme of Gödel-Escher-Bach of Douglas Hofstadter, perhaps the most fascinating and inspiring book I have ever read. The ribosomal proteins associated with the first ribosomes should have been translated using ribosome, which did not yet exist!

2. Could the translation of the first ribosomal proteins directly from the dark variants of these proteins solve the paradox? The idea of shadow dynamics induced by the pairing of basic biomolecules with their dark variants even allows to ask whether the replication, transcription, and translation could occur at dark level so that dark genes for ribosomes would be transcribed to dark ribosomal RNA and dark mRNA translated to dark AA associated with the ribosomes. These in turn would pair with ordinary ribosomal RNA and AA.

3. But what about dark variants of ribosomes? One can encounter the same paradox with them if they are needed for the translation. Could it be that dark variants of the ribosomes are not needed at all for the translation but would only give rise to ordinary ribosomes by the pairings basic biomolecules and their dark variants. Dark DNA would pair with dark mRNA, which pairs spontaneously with dark tRNA. Once the ordinary ribosomes are generated from the dark ribosomes by pairing, they could make the translation much faster.

4. There is however a problem. Both dark RNA and AA correspond to dark nuclear strings. Dark tRNA realized as nuclear string in the proposed manner does not have a decomposition to dark AA and dark RNA as ordinary tRNA has. The pairing of dark tRNA and dark mRNA should rise to dark AA and dark nuclear string - call it X - serving as the analog for the pairing of mRNA sequence with "RNAs" of tRNAs in the ordinary translation.

5. How to identify X? Could the translation be analogous to a reaction vertex in which dark mRNA and dark tRNA meet and give rise to dark AA and X? X cannot be completely trivial. Could X correspond to the dark DNA?! If so, the process would transcribe from dark DNA dark RNA and translate from dark RNA and dark tRNA AA and dark DNA. This would lead to an exponential growth of dark DNA and other dark variants of bio-molecules. This exponential growth would induce exponential growth of the basic bio-molecules by pairing. Life would have emerged! No RNA era or lipid era might be needed. All basic biomolecules or their precursors could emerge even simultaneously - presumably in presence of lipids - but this is not the only possibility.

One can take a more precise look at the situation and try to understand the emergence of bio-molecules and their basic reactions as shadows of the dark variants of bio-molecules appearing in dark particle reactions. The basic idea is that same dark reaction can give rise to several reactions of biomolecules if varying number of the external dark particles are paired with corresponding bio-molecules. Under what conditions this pairing could occur, is left an open question. Consider now the dark $2 \to 2$ reactions and possible reactions obtained by pairing of some particles.

1. The reaction

   DmRNA+DtRNA$\to$ DAA + DDNA

   gives rise to translation mRNA+tRNA $\to$ AA if DDNA-DNA pairing does not occur in the final state but other dark particles are paired with the their ordinary variants. If only DmRNA-mRNA and DDNA-DNA pairings occur, the reaction gives the reversal mRNA $\to$ DNA of transription.

   It should be easy to check whether this is allowed by the tensor product decomposition for the group representations associated with dark proton triplets [L7]. Same applies to other reactions considered below.

   If the reaction is possible then also the reversal

   DAA + DDNA $\to$ DmRNA+DtRNA.

   can occur. If only DDNA-DNA and DmRNA-mRNA pairings occur this gives rise to transcription of DNA$\to$ mRNA. Also reverse translation AA $\to$ mRNA is possible.

2. One can consider also the reaction

   DmRNA+DtRNA $\to$ DAA + DmRNA

   is possible. If all pairings except DAA-AA pairing are present, the outcome is instead of translation the replication of mRNA such that the amino-acid in tRNA serves the role of catalyzer. I have considered the possibility that this process preceded the ordinary translation: in a phase transition increasing h_{eff} the roles of AA and RNA in tRNA would have changed [L25].

   If this reaction is possible then also its reversal

   DAA + DmRNA $\to$ DmRNA+DtRNA

   is allowed. If all pairing except DmRNA-mRNA occur, this gives rise to AA +RNA $\to$ tRNA allowing to generate tRNA from AA and RNA (not quite RNA).

3. The replication of DNA strand would correspond at dark level to a formation of bound states by the reaction

   DDNA+DDNA$\to$ DDNA $+_{bound}$ DDNA

   in which all particles are paired. The opening of DNA double strand would correspond to the reverse of this bound state formation.

These dark particle reactions behind the shadow dynamics of life should be describable by S-matrices, which one might call the S-matrix of life.

1. For instance for

   DmRNA+DtRNA$\rightarrow X$,

   where X can be DmRNA+DtRNA (nothing happens - forward scattering) or DAA + DDNA and perhaps even DAA+DmRNA, one would have unitary S-matrix satisfying $SS^{dagger} = Id$ giving probability conservation as $\sum_n p_{m,n} = |S_{mn}|^2 = 1$ as a special case. Writing $S = 1+iT$ unitarity gives $i(T - T^\dagger) + TT^{dagger} = 0$ giving additional constraints besides probability conservation.

   For

   DmRNA+DtRNA$\rightarrow$ DAA + DDNA

   the non-vanishing elements of T are only between pairs [(DmRNA,DtRNA), (DAA,DDNA)] for which mRNA pairs with tRNA and DNA codes for AA. Unitary matrix would be coded by amplitudes $t(AA, DNA_i(A))$ satisfying $\sum_i p_i(DAA) = p(DDNA + DAA)$, $p_i(AA) = |t(DAA, DDNA_i(A)|^2$. $p(DDNA+DAA)$ equals to $p(DDNA+DAA) = (1-p)Br(DDNA+DAA)$, where p is the probability that nothing happens (forward scattering) and $Br(DDNA+DAA)$ is the branching ratio to DDNA+DAA channel smaller than 1 if $Br(DDNA + DmRNA)$ is non-vanishing. The natural interpretation for $p_i(AA)$ would be as probability that DNA_i codes for it.

2. For the reverse reaction

   DAA + DDNA *rightarrow* DmRNA+DtRNA

   it is natural to assume that DtRNA corresponds to any tRNA, which pairs with RNA. The AA associated with this tRNA is always the same but the counterpart of RNA can vary (wobbling). One can speak of the decomposition of dark genetic code to $DmRNA \rightarrow DtRNA \rightarrow DAA$ to a pair of codes mapping DmRNA to DtNRA and DtRNA to DAA [L22]. There is a set tRNA_i(mRNA) of tRNAs coding for given mRNA, and the probabilities $p_i(DmRNA)$ sum up to $p = \sum_i p_i(DmRNA) = (1 - p)Br(DmRNA + DtRNA)$, where p is the probability for forward scattering and $Br(DmRNA + DtRNA)$ is the branching fraction. The natural identification of $p_i(DmRNA)$ is as the probability that mRNA pairs with tRNA_i.

A possible weak point of the proposal is pairing: what are the conditions under which it occurs and are different pairing patterns possible. Possible second weak point is purely group theoretic: one should check whether which reactions are allowed by the tensor product decompositions for the states of dark proton triplets.

2.12 Homeostasis

Homeostasis means that system is able to preserve its flow equilibrium under changing conditions. This involves many-layered hierarchies of pairs of control signals with opposite effects so that the system stays in equilibrium. For instance, we could not stand without this control system as one can easily check by using non-living test body! For instance, in bio-chemical homeostasis the ratios of concentrations remain constant. It is not at all clear whether ordinary chemistry can explain homeostasis.

In zero energy ontology (ZEO) one can imagine very fundamental mechanism of homeostasis.

1. Zero energy states are pairs of ordinary 3-D states with members located at opposite boundaries of causal diamond (CD). Their total quantum numbers are opposite, which is only a way to say that conservation laws hold true. The space-time surfaces connecting the 3-surfaces are preferred extremals of the action principle.

   In quantum field theory this picture can be seen only as a book keeping trick and one assumes that space-time continues beyond causal diamond. There is however no need for this in TGD framework although it is natural to assume that there is some largest CD beyond which

space-time surfaces do not continue. CDs form a hierarchy and sub-CDs of this CD can be connected by minimal surfaces, which are analogs of external particles. One obtains networks analogs to twistor Grassmannian diagrams.

2. Conscious entities (selves) correspond in ZEO to a sequences of state function reductions having interpretation as weak measurements, "small" state function reductions [L14]. In given weak measurement the members of the zero energy state at the passive boundary of CD are not affected: this is essentially Zeno effect associated with repeated measurements in ordinary quantum theory. The members of the state pairs at the active boundary of CD change and also the temporal distance between the tips of CD increases: this assigns a clock time to the experienced flow of time as sequence of state function reductions.

   Eventually it becomes impossible to find observables, whose measurement would leave the passive parts of the zero energy state invariant. First "big" state function reduction changing the roles of active and passive boundaries of CD takes place and time begins to run in opposite direction since the formerly passive boundary recedes away from the formerly active boundary which is now stationary. Self dies and re-incarnates with an opposite arrow of time. In TGD biology these two time-reversed selves are proposed to correspond to motor actions and sensory perceptions.

   Already Fantappie [J2] realized that two arrows of time seem to be present in living matter (consider only spontaneous assembly of bio-molecules as decay in opposite direction) and introduced the notion of syntropy as time-reversed entropy. For an observer with given arrow of time, a system with opposite arrow of time seems to break the second law. Temperature and concentrations gradients develop, system self-organizes.

3. These two quantal time evolutions with opposite arrows of time look very much like competing control signals in homeostasis. The 4-D conscious entities corresponding to control signals would have finite lifetime so that in their ensemble the effects of the signals with opposite arrows of time tend to compensate. This would give rise to homeostasis.

2.13 Evolution

I forgot perhaps the most important piece from the original text. Philosopher cannot avoid the question "What is evolution?"

In standard biology evolution is mystery. If one believes on standard thermodynamics, evolution is impossible by second law and the eventual heat death is unavoidable. Evolution means generation of structures and second law indeed states that all gradients die so that the finals state is totally uninteresting homogenous stuff.

I already mentioned the weird proposal that biology is just an enormous thermodynamical fluctuation. Boltzmann brain was indeed a kind of fad of pop physicists for some years ago. The idea - if you want to call it such - was that Boltzmann brains - and also ours - popped up from the multiverse by a complete accident. One could even argue that this occurred only at planet Earth to make the claim more plausible. This is however not science anymore, this is just pure plain idiocy.

Philosopher asks questions and now the most obvious questions are following. Is evolution something much more general than biological evolution? Is evolution a basic aspect of physics as already cosmological evolution suggests? Is evolution "must", something completely unavoidable? What could force it?

The Universe governed by second law certainly does not allow evolution: just the contrary. Could the increase of entropy and increase of conscious information and development of cognition relate somehow? It has been argued by Jeremy England [I10] (see `http://tinyurl.com/o64rd7o`) that biological evolution involves increase of the rate of entropy production as any-one can see by just looking around. These two things are not the same but are they somehow related [L5] (see `http://tinyurl.com/zjp3bp6`).

Philosopher gets now childishly excited. We must just tolerate. Our philosopher already mentioned that p-adic physics as physics of cognition not only leads to a measure for conscious information - something very non-trivial - but to adelic physics fusing physics in various number fields [L12, L13]. Adeles form a hierarchy labelled by the dimension of the extension of rationals

inducing the extension of p-adic number fields labelled by primes. This dimension corresponds to the effective value of Planck constant and the larger it is, the larger the scale of quantum coherence is.

This has been already said but now comes the basic point and philosopher gets really excited. Since the number of extensions of rationals with dimension larger than given integer n is finite and the number of those with dimension larger than n is infinite, this dimension is bound to increase in statistical sense in the sequence of state function reductions recreating the quantum Universe again and again. Evolution is unavoidable! This is like random work from origin upwards. The height from the origin unavoidably increases.

Even more, the total negentropy coming from various p-adic sectors turns out to be larger than the entropy coming from the real sector. The bad news - not actually a news - is that increase of this negentropy is accompanied by the increase of entropy: civilizations indeed have the bad habit of polluting their environments. The good news is that negentropy increases faster than entropy: for a trivial extension of rationals from which everything would have started, negentropy equals to entropy. But for more complex extensions it is larger.

2.14 Darwinian or neutral theory of evolution or something else?

I learned recetly that the so called neutral theory of evolution has been challenged by evidence for DNA selection (see `http://tinyurl.com/ybhyh6rc`). I must admit that I had no idea what neutral theory of evolution means. I had thought that Darwinian view based on random mutations and selection of the most adaptive ones is the dominating view. The debate has been about whether Darwinian or neutral theory of evolution is correct or is some new vision needed. This inspired a more precise formulation of how evolution at genetic level could take place in TGD Universe.

2.14.1 Darwinian and neutral theories of evolution

Darwinian and neutral theories of evolution and their variants represent two different views about evolution.

1. Adaptive evolution is the Darwinian view. Random mutations are generated and organisms with the most adaptive genome survive. One can of course argue that also recombination occurring during mitosis creating germ cells creates new genetic combinations and must be important for the evolution. Selection can be either negative (purifying) and eliminate the non-adaptive ones or positive favoring the reproduction of the adaptive ones.

   One can argue that notions like "fight for survival" and selection do not fit with the idea about organisms as basically inanimate matter having no goals. Also second law poses problems: no evolution should take place, just the opposite. Metabolic energy feed induces self-organization but by second law all gradients about which metabolic energy feed is an example, disappear.

2. Neutral evolution theory was proposed by Morita 50 years ago and gained a lot of support because of its simplicity. Point mutations for the codons of DNA would create alleles. Already in Darwinian evolution one knows that large fraction of mutations are neutral having not positive or negative effect of survival. Morita claims that all mutations are of this kind. There would be no "fight for survival" or selection.

   The so called genetic drift, which is completely random process is possible in small populations and can lead to counterpart of selection: it can happen that only single allele remains and is counterpart for the winner in selection. This is purely random and combinatorial effect and in physics one would not call it drift.

   The first objection is that if one has several isolated small populations, the outcomes are completely random so that in this sense there is no genetic drift. Furthermore, there is no reason why further mutations would not bring the disappeared alleles back. Second objection is that there would not be no genuine evolution - how one can speak about theory of evolution?

   Now the feed of experimental and empirical data is huge as compared to what it was 5 decades ago and it is now known that the neutral theory fails: for instance, varying patterns

of evolution among species with different population sizes cannot be understood. It is also clear that selection and adaptions really occur so that Darwin was right.

3. The shortcomings of the neutral theory led Ohta to propose nearly neutral theory of evolution. Mutations can be slightly deleterious. For large populations this leads to a purging of slightly deleterious mutations. For small populations deleterious mutations are effectively neutral and lead to the genetic drift.

   There is however a further problem: why the rate of evolution varies as observed between different lineages of organisms.

4. One reason for fashionability was that the model was very simple and allowed to compute and predict. Only the size of the population and rate for the mutations is enough to predict the future in small populations. The predictions have been poor but this has not bothered the proponents of the neutral evolution theory.

   As an outsider I see this as a typical example of a fashionable idea: these have plagued theoretical particle physics for four decades now and led to a practically complete stagnation of the field via hegemony formation. Simple arguments show that the idea cannot be correct but have no effect.

Article explains several related notions.

1. It has been possible to determine the mutation rates at the level of individual sites of genome since 2005. Only subset of mutations of say cancer cells are functionally important to cancer and they can be identified. This leads to a selection intensity as basic notion. This notion is expected to be very valuable for the attempts to find targeted cure of cancer.

2. Neutral theory of evolution assumes that only point mutations matter. Theory was therefore completely local at the level of genome - and certainly simple! Innocent outsider knowing a little bit about biology wonders why the recombination of maternal and paternal chromosomes in meiosis creating the chromosomes associated with germ cells are not regarded as important. This mechanism is non-local at the level of genome and would naturally lead to a selection at the level of individuals of the species. It has been indeed learned that the genetic variation and the rate of recombination in meiosis correlate in given region of genome. This sounds almost obvious to the innocent novice but had to be discovered experimentally.

   One can however still try to keep the neutral theory of evolution by assuming that recombination is completely random process and there is no selection and adaption - contrary to the experimental facts and the basic idea behind the notion of evolution. Recombination would bring only an additional complication.

   Besides the direct purifying selection and neutral drift there would be recombination creating differences in the levels of variation across the genomic landscape. This leads to the notion of genetic hitchiking. When beneficial alleles are closely linked to neighboring neutral mutations, selection acts as a unit on them. One speaks about linked selection. Frequencies of neutral alleles are determined by more than genetic drift but one can speak of neutrality still. Linkage of hitchiker to allele - beneficial or not - is however random. Does genuine evolution takes place at all?

3. Most of the DNA is not expressed as proteins. It would not be surprising if this part of DNA could have important indirect role in gene expression or perhaps be expressed in some other manner - say electromagnetically. How important role this part of DNA has in evolution? There are also transposons inducing non-point like mutations of this part of DNA: what is their role. There also proposals that viruses, usually though to be a mere nuisance, could play decisive role in evolution by modifying the DNA of host cells.

4. It is now known that up to 80-85 per cent of human genome is probably affected by background selection. Moreover, height, skin color blood pressure are polygenic properties in the sense that hundreds or thousands of genes are acting in concert to determine these properties. This strongly suggests that point-like mutations cannot be responsible for evolution and not even recombinations are enough if random. A control of evolution in longer scales seems to

be required. This of course relates to the basic problem of molecular biology: what gives rise to the coherence of living matter. Mere bio-chemistry cannot explain this. Something else perhaps controlling the bio-chemistry is needed.

2.14.2 TGD based view about evolution

One can start by criticizing the standard view.

1. Is the standard view (to the existent that such exists) about evolution consistent with second law? One can even ask whether standard view about thermodynamics assuming a fixed arrow of time is correct.

2. If mutations and more general changes of genome occur by pure change, can they really lead to a genuine evolution. The notions of selection and survival of fittest are notion, which do not conform with the view about evolution as mere standard physics. A probable motivation for neutral evolution theory has been the attempt to get rid of these notions: physicalism taken to extreme.

3. The reduction of life to bio-chemistry does not allow to understand the coherence of organisms.

4. One can also criticize the reduction of life to mere genetics.

   (a) Genetic dogma does not tell much about morphogenesis.

   (b) Is genetic determinism a realistic assumption? Clones of bacterium are know know to have personalities behaving differently under given conditions (see `http://tinyurl.com/us7fxlh`).

   (c) Most of the genome of the higher organisms consists of DNA not transcribed to RNA still interpreted as junk by some biologists. What about introns? Could there exists other forms of gene expression - say electromagnetic.

TGD based view about evolution can be seen as a response to these criticisms but actually developed from a proposal for a unification for fundamental interactions and from the generalization of quantum measurement theory leading to a theory of consciousness and generalization of quantum theory itself.

1. TGD leads to a new view about space-time and classical fields. In particular, many-sheeted space-time and magnetic body bring in new element changing dramatically the views about biology.

   The notion of Maxwellian fields is modified. Unlike in Maxwellian theory any system has field identity, field body, in particular magnetic body (MB) carrying dark matter n TGD sense and in well-define sense at higher evolutionary level as compared to ordinary bio-matter. This expands the standard pairing organism-environment to a triple MB-organism-environment.

   MB can be seen as the controlling intentional agent and its evolution would induce also the evolution of the ordinary bio-matter. MB carries dark matter as $h_{eff}/h_0 = n$ phases giving rise to macroscopic quantum coherence at level of MB. MB forces the ordinary bio-matter to behave coherently (not quantum coherently).

   TGD leads also to a realization of genetic code at the level of dark analog of DNA represented as dark proton sequences [L27] - dark nuclei, which are now essential element of TGD based view about nuclear physics [L31]. Dark photons are essential for the communications between MB and ordinary bio-matter. Also dark photons would realize genetic code with codon represented as 3-chord consisting of 3 dark photons.

   Genetic modification would take place at the level of magnetic flux tubes containing dark analog of DNA and induce changes of the ordinary genome, which would do its best to mimic dark genome. In particular, the recombination occurring during the meiosis would be induced by the reconnection of the flux tubes of dark genome.

2. Number theoretical vision about evolution deriving from the proposal that p-adic physics for various primes combining to what I call adelic physics is second needed element [L13]. Any system can be characterized by a extension of rationals defining its algebraic complexity. The dimension of extension identifiable in terms of the effective Planck constant $h_{eff}/h_0 = n$ defines evolutionary level as a kind of IQ. What is remarkable that n increases in statistical sense since the number extensions with n larger than that for given extension is infinitely larger than that of lower-dimensional extensions. Intelligent ones have larger scale of quantum coherence and thus coherence of bio-matter and survive. Evolution is directed process forced by number theory alone.

   Quantum jumps in the sense of ZEO tending to increase n occurring naturally in mitosis generating germ cells lead also to a more intelligent genomes. Point mutations could be seen something occurring at the level of ordinary matter rather than being induced by dark matter.

3. Zero energy ontology (ZEO) is behind the generalization of quantum measurement theory solving the basic problem of standard quantum measurement theory. There are two kinds of state function reductions. "Small" state function reductions (SSFRs) as analogs of weak measurements give rise to the life cycle of conscious entity self having so called causal diamond (CD) as a correlate. Under SSFRs the passive boundary of CD is unaffected as also members of state pairs at it: this gives rise to the "soul" as unchanging part of self.

   "Big" state function reductions (BSFRs) correspond to ordinary state function reductions. They change the arrow of time and one can say that self dies and re-incarnates with a reversed arrow of time. This applies in all scales since consciousness and cognition predicted to be universal. In BSFRs the value of h_{eff} increases in statistical sense and this gives rise to evolution also at the level of genome. The reversal of the arrow of time allows to see self-organization and metabolism as dissipation in non-standard time direction so that generalization of thermodynamics to allow both arrows of time allows to understand both self-organization and evolution.

2.14.3 What could happen in meiosis and fertilization?

A possible application would be TGD based model for meiosis and fertilization.

1. In meiosis BSFR for the dark proton sequences defining dark DNA could induce reconnections of parallel maternal and paternal dark proton flux tubes inducing recombination at the level of the ordinary genome.

2. The resulting germ chromosomes - or rather their dark variants realized in terms of dark proton sequences would have arrow of time opposite that of chromosomes. They would be in a dormant state analogous to sleep.

3. Fertilization involves the pairing of paternal and maternal germ chromosomes and looks almost like time reversal of meiosis. In the proposed picture it would indeed change the arrow of time for the germ chromosomes - wake up them. The sequence meiosis replication-meiosisI-division - meiosisII would correspond to 4 BSFRs leading to germ cells having dark genome as as time reversal of ordinary genome.

   Remark: One can ask whether also the passive strand of ordinary DNA has arrow of time opposite to that of the active strand.

2.14.4 Mutations do not add: global epithasis and the notion of dark DNA

The Quanta Magazine article "How Genetic Surprises Complicate the Old Doctrine of DNA" (`rebrand.ly/xhr95c4`) provides a lot of food for thought. Epistasis is the concept discussed. One has a reasonable empirical understanding of point mutations. Point mutations are however not independent as simple linear thinking would suggest. This gives rise to epistasis.

Two mutations with qualitatively similar effects can produce a mutation with an opposite effect. Poorly understood interactions between mutations exist and give rise to the epistasis. One might call these interactions non-linear in a lack of a better word. The proposal that has been developed

is global epistasis [I3] (rebrand.ly/9jkuylm) suggesting that genes and even large units would tend to have like coherent units.

My own intuitive view of DNA is based on quantum coherence in DNA length scales predicted by the TGD based view of chemical DNA as a chemical "shadow" of what I call dark DNA.

Dark DNA is realized as sequences of dark protons at the monopole flux tubes of the magnetic body associated with the ordinary DNA. It relies on a universal realization of the genetic code based on a completely unique icosa-tetrahedral tessellation of hyperbolic 3-space (light-cone proper time constant 3-surface in Minkowski space M^4). Genetic code might be universal at the level of the magnetic body and biological realization(s!?) would be only of the many. This would make the Universe intelligent, conscious and evolving in all scales using the fundamental binary coded with a codon as a 6-qubit unit [L36].

Not only codons but also genes would be quantum coherent units interacting like particles. For instance, dark genes consisting of N dark codons (each with 3 dark protons) would emit 3N-photon as a single unit in communications based on 3N-resonance, which implies that identical dark genes can communicate with each and that the modulation of frequency scale as a message is coded to a sequence of resonance peaks analogous to a sequence nerve pulses. This is a quantum generalization of what occurs in radio communications. Even larger quantum coherent units can be considered.

This implies that mutations are not anymore independent as in the picture based on chemistry alone. Mutations could have profound effects on the communications by 3N-resonance and 3N frequency resonance is not anymore complete if one codon changes. Therefore the effects of two or more mutations on dark gene communications do not simply add up. This raises the hope that their interactions might be understood some day.

2.14.5 Phenotype is much more stable against point mutations of genotype as one might expect: Why?

Paul Kirsch sent an interesting link (rebrand.ly/r7pdwdj) to a genetics related article [I5] discussing the question how stably genotype determines the phenotype. The article proposed a number theoretic formula for the probability that a point mutation does not affect the phenotype. This probability is called robustness of the phenotype. The number theory involved is very different from that in the TGD framework and I do not understand the technical details.

One considers the correspondence between genotype and phenotype and point mutations in which code letter changes. The point mutations that do not affect the phenotype, are called neutral.

1. It is empirically found that robustness defined as the probability that a point mutation does not change a phenotype is orders of magnitudes higher than expected by assuming that this property is given by the probability that a random letter sequence gives rise to the phenotype. This is very natural since it makes possible steady evolution: quite few point mutations change the phenotype.This requires that there are strong correlations between genes which can give rise to a given phenotype. The pool of allowed letter sequences is much smaller than the pool of all possible letter sequences.

2. It is argued that a certain number theoretical function gives a good estimate for this probability. I have no idea how they end up with this proposal. What this also suggests to me is that quite generally, the allowed genes are not random sequences of letters. There are correlations between them.

Could one understand these correlations by using the number theoretic view of biology proposed in the TGD framework? Consider first how general quantum states are constructed in number theoretical vision.

1. In the TGD framework, all quantum states are regarded as Galois singlets formed from dark particles. This universal mechanism for the formation of bound states is a number theoretic generalization of the notion of color confinement.

2. One obtains a hierarchy of Galois confined states. If one has Galois singlets at a given level one can deform them to non-singlets. One can also consider a larger extension in which the

Galois group is larger and singlets cease to be singlets. One can however form Galois singlets of them at the next level. This is the general picture and applies to any physical state in number theoretical vision. In biology dark codons, dark genes, parts of the genome, perhaps even the genome, can belong to this hierarchy.

3. What does Galois singletness mean? The momentum components assignable to the Galois singlet as a bound state are Galois singlets and therefore ordinary integers when the momentum unit defined by causal diamond is used. The momenta of the particles forming the Galois singlet state are not Galois singlets: they have momentum components which are algebraic integers which can be complex. They are analogous to virtual particles. Galois singletness gives a large number of constraints: their number is 4 times (d-1), where d is the dimension of the extension.

This mechanism for the formation of bound states is universal and should apply also to codons and genes.

1. Free dark codons would be Galois singlets formed from 3 dark protons, which are not Galois singles. In gene, dark codons need not be Galois singlets anymore but the gene itself must be a Galois singlet and therefore defines a quantum coherent state analogous to hadron and behaving like a single unit in its interactions.

2. Galois singletness poses a constraint on the gene as a quantum state. Not any combination of dark codons is possible as a dark gene. In the momentum representation, the total momentum of genes as a many-codon state must have components, which are ordinary integers in the unit defined by the causal diamond. The momentum components assignable to codons are algebraic integers: they are analogous to virtual particles.

2.15 Maximally symmetric Universe, self-organized quantum criticality, and symmetry between order and disorder

The following comments were inspired by the Big Think article "A surprise new theory of everything involves the symmetry between order and disorder" (`https://rb.gy/vyh8g`). The article relates to the book "The language of symmetry" edited by Rattigan, Noble and Hatta (`https://rb.gy/h0d7n`).

Two ideas considered in the article, maximal symmetries and self-organized criticality, define two key principles of TGD. Also the third, rather paradoxical idea that symmetry breaking leads to a generation of symmetry, has a precise meaning in the TGD Universe.

Consider first the maximization of symmetries as a fundamental principle.

1. In the TGD framework, the fundamental principle determining physics as geometry is that the infinite-dimensional geometry of the "world of classical worlds" (WCW) exists mathematically. Physics is unique because of its mathematical existence and has maximal symmetries.

   Freed demonstrated that for the loop spaces this geometry is unique and indeed has an infinite-D group of isometries (Kac-Moody symmetries).

2. 4-D general coordinate invariance is essential in TGD and implies holography in reducing to a generalization of 2-D holomorphy to 4-D case, which in turn corresponds to 4-D quantum criticality.

   (a) The first guess would be that WCW consists of 3-D surfaces in $H = M_2^4$: $H = M_2^4$ is indeed unique by several mathematical arguments and also by standard model symmetries. 3-surface generalizes the notion of a point-like particle.

   (b) 4-D general coordinate invariance requires that a given 3-surface corresponds to a *nearly* unique 4-surface in H. This means holography, or equivalently, Bohr orbitology. WCW also has interpretation as a space of 4-D analogs of Bohr orbits. Quantum TGD becomes the analogue of wave mechanics in WCW.

   Note that in atomic physics this would mean the replacement of electrons configuration space E^3 with the space of its Bohr orbits: this would be fiber space over E^3 with fiber at given point consisting of Bohr orbits through it.

Consider next self-organized criticality as a basic principle. In TGD quantum criticality is behind the analogous principle.

1. For 2-D systems conformal invariance implying holomorphy of string orbits extends to 4-D analog of holomorphy, which realizes quantum criticality in 4-D case. Holomorphy implies holography!

   Field equations reduce to a purely algebraic form, having no dependence on the coupling parameters of the action as long as it is general coordinate invariant and constructible using the induced geometry.

2. This happens outside 3-D and lower-D singularities. Space-time surface is a minimal surface, analog of a soap film spanned by frames. Minimal surface property is analog of massless field equations at field level and analog of massless geodesic property at particle level. The classical and quantum dynamics distinguishes between different actions only at the frames, which can however depend on action.

To understand the self-organized quantum criticality (SOC), quantum TGD is required.

1. In Quantum TGD, wave functions of the ordinary wave mechanics are replaced with analogs of wave functions in WCW (WCW spinor fields as many-fermion states as WCW spinors) consisting of analogs of Bohr orbits. This forces a new ontology: I call it zero energy ontology (ZEO) forcing a new view of quantum measurement.

2. In state function reduction (SFR) this kind of superposition inside quantization volume (causal diamond (CD) is replaced with a new one, and also the size and other parameters characterizing the CD can change. The standard paradox of quantum measurement theory disappears.

3. There are two kinds of SFRs.

   (a) In small SFRs (SSFRs), the boundary of CD is stationary and states at it are not affected but the active boundary is shifted and CD tends to increase. The sequences of SSFRs correspond to Zeno effect, having no effect in standard QM, and give rise to a conscious entity, self, for which subjective time as sequence of SSFRs correlates with the increase of the distance between tips of CD.

   (b) In big SFRs (BSFRs), the arrow of time changes so that the active boundary of the CD [L39] becomes passive and vice versa. BSFRS correspond to ordinary SFRs. BSFR means "death" of self and reincarnation with an opposite arrow of time. Even small perturbations can induce BSFR by affecting the set of the observables measured in SSFR: if the new set does not commute with those defining the passive states, BSFR unavoidably occurs.

   (c) BSFRs give rise to SOC. Self lives at criticality against death! This is the analogy for the critical sandpile. As a consequence, the flow of consciousness of self has gaps with a distribution of gap durations. This is known for human consciousness [L40].

4. Paradoxically, this continual short term dying in BSFRs makes it possible for the system able to survive and correct behaviors. Self can also learn of avoidable behaviors by trial and error. Self can learn moral and ethical rules: do not do anything destroying quantum coherence! [L38]. Perhaps most of the learning is by this method.

   Homeostasis is a basic implication [L41]. The system is at quantum criticality at the top of a hill and unstable. When it starts to fall down, it makes BSFR in some scale and changes the arrow of time and returns back near criticality. Self-organization, say spontaneous generation of molecules from their building bricks, can be understood as a time reversed dissipation.

The third topic discussed in the article relates to the paradoxical creation of symmetries by symmetry breaking. The emerging vision indeed is that symmetry breaking paradoxically leads to the emergence of a deeper symmetry. This is what the TGD view of the concrete realization of the isometries of WCW as symmetries of the physical system indeed predicts.

1. The half Virasoro algebra V with non-negative conformal weights serves as a simplified example. V contains an infinite set of sub-algebras V_k for which conformal weights are divisible by integer $k = 1, 2, ...$ One also obtains inclusion hierarchies $...V_{k(n)}V_{k(n+1)}...$ such that $k(n)$ divides $k(n+1)$, whose generalizations are very relevant to quantum TGD.

2. The ordinary realization of conformal symmetries is as a gauge symmetry for which the generators L_n, $n > 0$, annihilate the physical states. One can however generalize this and only assume that V_k and $[V_k, V]$ for some k annihilate the physical states. In this case, the generators L_n , $n < k$ do not annihilate the states and act as genuine symmetries. Gauge symmetries are broken but have transformed to genuine physical symmetries! This removes the paradox from the idea of emergence of symmetries by symmetry breaking!

These kinds of mathematical structures are the cornerstone of quantum TGD. Virasoro algebra is replaced with the isometry algebra of WCW and associated algebra but completely analogous conditions hold true. This mechanism would not hold true for the isometry algebra of WCW only.

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