Exploration

Horizontal Gene Transfer by Remote Replication?

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Abstract

This article was inspired by the discovery that a horizontal gene transfer (HGT) between eukaryotes is possible. The belief has been that HGT is possible only from prokaryotes to prokaryotes or eukaryotes. The basic obstacles are that the host DNA is within the cell nucleus and that DNA is tightly bound to chromosomes. The transfer should also occur to germ cells in order to have a lasting effect. The case considered is HGT of antifreezing gene (AFG) from herring to smelt, which could have occurred during simultaneous spawning of herring and smelt in the same area. The AFT of herring associated with a transposon could have somehow attached to the sperm cell of the smelt and carried by it to the egg of the smelt. Vector carrying AFT to the sperm cell of smelt is needed and there are only guesses about what it might be. That HGT however occurs, justifies a heretical question. Could it be only the genetic information, which is transferred and used to construct DNA in the host as a kind of remote replication analogous to quantum transportation? The findings of Gariaev and Montagnier indeed suggest remote replication and TGD provides a new physics model for it.

1 Introduction

This article was inspired by a Quantamagazine article "DNA Jumps Between Animal Species. No One Knows How Often" (`https://cutt.ly/7UKasRp`), which described the findings of Laurie Graham and Pete Davies published in the article "Horizontal Gene Transfer in Vertebrates: A Fishy Tale" in Trends in Genetics [4] (`https://cutt.ly/SUKamqP`).

1. Marine life around the Arctic and Antarctica has evolved many defense mechanisms against the lethal cold. One common adaptation is the ability to make anti-freezing proteins (AFPs) that prevent ice crystals from growing in blood, tissues and cells. This solution has emerged repeatedly and independently, not just in fish but in plants, fungi and bacteria. AFPs make possible survival at water temperature, which is by 1 degree C colder than the *unprotected* freezing point of fish blood and this offers an evolutionary advantage.

   Remark: TGD based general mechanisms possibly associated with heat and cold shock, involving zero energy ontology (ZEO) [41][25] in an essential manner, have been considered in the model for the effects of various shock proteins in [60]. The key idea is that the macroscopic counterparts of ordinary state function reduction changing the direction of time change the arrow of time at the level of the magnetic body of the system so that, from the point of view of observer with the standard arrow of time, the system seems to extract energy from the environment instead of dissipating it.

2. Herrings and smelts are two groups of fish, which have learned to make AFP. The story began when Graham discovered that smelt had a protein gene very similar to one of the AFG genes of herring. The gene's introns, stretches of non-coding DNA involved also with TEs, which in general mutate rather fast, are more than 95 % identical. That both have exactly the same gene coding for AFP proteins, is surprising since their ancestors diverged more than 250 million years ago and the AFP gene is absent from all species relating to them. Somehow the AFP gene must have found its way to the genome of smelt.

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3. Cross breeding of herring and smelt is not possible so that direct horizontal gene transfer (HGT) should have occurred. HGT is known to be possible between prokaryotes (mono-cellulars) and also between prokaryotes and eukaryotes (multi-cellulars). Herring and smelt are not rare exceptions: recent studies demonstrate that HGT occurs also in other fish, reptiles, birds and mammals.

4. However, the belief has been that HGT is not possible for eukaryotes (multicellulars) and there are several good arguments in favor of this belief. In the case of bacteria, it is enough for the gene to get through the cell membrane since there is no nucleus and HGT occurs quite generally. The DNA of eukaryotic cells is however isolated inside the nuclei and most of the time the DNA is tightly bound in chromosomes. Gene should also find its way to germ cells in order to have a lasting effect. The transferred gene of the donor should also integrate to the genome of the host.

5. In 2019, the full genome of herring was published. It turned out that the genome contains several AFP genes with associated transposable elements (TEs). The herring genome contains several copies of these TEs but they are absent from other fish with a single exception: the genome of smelt contains only a single AFP gene and this gene with similar transposable elements occurs also in the genome of herring. Therefore there is little doubt that the HGT has taken place.

Somehow HGT must be possible.

1. 94 % HGTs occur between fishes and only 3 per percent between birds and mammals. Therefore the water environment must be part of the explanation.

2. What comes first in mind is spawning. In a situation in which one has sperms and eggs in water, germ cells which are effectively monocellulars apart from the presence of cell nuclei. Most of the cells degrade and could produce fragments of DNA, say TE+AFP gene.

   If the spawning of two species occurs at the same time at the same location, HGT might have taken place from the sperm or egg cells of herring or of their degradation products to the sperm cells of smelt. These would have naturally found their way to the eggs of smelt. The amount of spawn in the sea water is so high that it changes the color of water white: this would increase the probability of HGT.

3. Maybe the AFP gene of herring has somehow attached to the DNA of the smelt sperm cells during spawning. Sperm mediated gene transfer is indeed a standard technique of genetic engineering. The challenge is to understand how the AFP genes were transported from herring cells to the smelt sperm cells. AFP gene is not able to make the travel between cells alone. In standard biology, some vector should have transported the gene between the two cells and one can make only guesses about the mechanism.

1.1 The notions of transposon and horizontal gene transfer

The notions of transposon or transposable element (TE) and horizontal gene transfer (HGT) will be needed in the sequel.

1.1.1 Transposons

Transposable elements or simply transposons (TEs) (`https://cutt.ly/HUZIItW`) were discovered by Barbara McClintock. TEs are jumping genes, which involve introns were once regarded as "junk". The basic operation is cut and paste operation.

TEs are now known to have several important functions: they make the genome dynamic and affect its identity and size, induce mutations or their reversals, and can also lead to a duplication of pieces of the genome. TEs are also involved with the control of gene expression and epigenesis (amusingly, they are still regarded as selfish genes!).

TEs are abundant in eukaryotic cells. TEs make approximately 64 % of the maize genome, 44 % of the human genome, and almost half of the mouse genome.

TEs serve as a kind of text editing tool. The TE (`https://cutt.ly/HUZIItW`) consists of inverted repeats (TEs in my terminology) at its beginning and end, and the structural genes between them.

There are at least two kinds of TEs: class I and class II. In the human genome 98 per cent of TEs class I and the rest are of type II.

1. Class I TEs or retrotransposons are first transcribed to RNA, and reverse transcriptase often encoded by the TE itself catalyzes the reverse transcription of RNA to DNA, which is then pasted to DNA sequence. The text processing analog is copy and paste.

   Retrotransposons are classified into 3 types:

   - Retrotransposons with long terminal repeats (LTRs), which encode reverse transcriptase producing DNA from the RNA transcribed from TE, which is then glued to a DNA. Retrotransposons are similar to retroviruses.
   - Retroposons, long interspersed nuclear elements (LINEs). Also they encode reverse transcriptase but lack LTRs and are transcribed by DNA polymerase II to RNA.
   - Short interspersed nuclear elements (SINEs) do not encode reverse transcriptase and are transcribed by DNA polymerase II.

   Also retroviruses can be regarded as TEs. They can transfer genes between eukaryotic target and host cell. The integrated gene in the host cell is called produces and this transfer can be seen as an eukaryotic analog of the transfer of bacterial TEs.

2. Class II TEs or DNA transposons encode for protein transposase, which they require for excision and insertion. No intermediate RNA is produced. The text processing analog is cut and paste.

   The figure `https://en.wikipedia.org/wiki/File:DNA_Transposon.png` of the Wikipedia article illustrates the situation. The structure of TE is : TSD+TIR+gene+TIR+TSD. Two inverted tandem repeats (TIR) flank the transposase gene. Two tandem site duplications (TSD) are present on both sides of the insert.

   Transposase makes a staggered cut at the target site with sticky ends and the complex TIR+gene+TIR is transferred to the new site. Gene itself is not duplicated as in the copy and paste process for retrotransposons. TSDs are left at the target site. DNA polymerase fills in the gaps at the target site leading gradually to long repeating sequences. The insertion sites can be identified by short direct repeats followed by inverted TIRs.

3. TEs can also replicate.

TEs can be also classified as autonomous and non-autonomous. Autonomous TEs can move by themselves whereas non-autonomous TEs require other TEs to move.

1.1.2 Horizontal gene transfer

Horizontal gene transfer (HGT) (`https://cutt.ly/zUKTED5`) occurs mostly in prokaryotes but also in some eukaryotes. HGT tends to occur in extreme environments.

Diatoms and algae have received genes from bacteria. For eukaryotes HGT to germ cells is required, which makes the process difficult to realize. Donor and host tend to be closely associated organisms. HGT from bacteria to chordates occurred shortly after this lineage arose.

There are several mechanisms of bacterial HGT.

1. Transformation involves three steps: introduction, uptake and expression.

2. Transduction: DNA is transferred by virus

3. Bacterial conjugation. DNA is transformed in cell-to-cell contact.

4. Gene transfer agents are viruslike elements coded by the host.

Transposable elements (TE) are often involved with HGT. One speaks of the transfer of horizontal TE (HTT). TE transfer occurs also for eukaryotes. This suggests that TEs, which distinguish between prokaryotes and eukaryotes, involve a new transfer mechanism. The mechanism of TE transportation requiring a vector carrying the TE, has not been identified and this allows us to wonder whether only information could be transferred?

1.2 General constraints on the model

Consider first general constraints on the model.

1. For eukaryotes, cell and nuclear membranes make HGT difficult if not impossible. The transfer should also occur to germ cells.

2. Water must be essential since in other species than fish the process is much rarer.

3. Sperm cells are analogous to monocellulars, and the HGT occurs for monocellulars. Note however that sperm cells and eggs have a nucleus and chromosomes, which are obstacles for HGT.

4. That HGT would occur during spawning looks a highly plausible hypothesis. This increases the probability of HGT, whatever the mechanism is. Sperm mediated transfer would allow to overcome the basic obstacles and the basic properties of TEs involved would make possible the integration to the host genome.

5. Most of the cells and their DNA degrades during the spawning and the resulting DNA fragments would also contain AFG+TE, which could be transferred to the smelt sperm cells.

How the TE involving the AFG from the sperm of herring could be transported to the sperm of smelt? This is not known.

According to Wikipedia:

Though the actual mechanism for the transportation of TEs from donor cells to host cells is unknown, it is established that naked DNA and RNA can circulate in bodily fluids. Many proposed vectors include arthropods, viruses, freshwater snails, endosymbiotic bacteria and intracellular parasitic bacteria. In some cases, even TEs facilitate the transport for other TEs.

This justifies a heretic question. Could it be only the genetic information, which is transferred and used to construct DNA in the host as a kind of remote replication analogous to quantum transportation?

2 Some key ideas of TGD inspired quantum biology

In this section basic notions of TGD inspired quantum biology relevant to the recent article are discussed. The ideas discussed the notion of magnetic body (MB) as a controller of ordinary matter; the hierarchy of effective Planck constants assigned to the hierarchy of extensions of rationals defining a hierarchy of phases of ordinary matter behaving like dark matter; Galois confinement as a universal mechanism for the formation of bound states; dark realizations of genetic code; communications and control in TGD inspired quantum biology. Zero energy ontology (ZEO) [41] [25] plays a central role in TGD inspired quantum biology but is not discussed in the sequel.

2.1 MB carrying dark matter as controller of ordinary biomatter

MB contains dark matter identified, as phases of ordinary matter characterized by EQ with a dimension $n = h_{eff}/h_0$ serving as a measure of the algebraic complexity of a given space-time region [48, 49], and interpreted as a universal IQ. The scales of quantum coherence increase with h_{eff}. The layers of MB characterized by the value of n naturally form a master-slave hierarchy in which ordinary matter with the smallest Planck constant is at the bottom, and controlled by higher levels. The energies of systems increase with h_{eff} and since h_{eff} tends to be spontaneously reduced, an energy feed is needed to preserve the distribution of h_{eff}: the interpretation is as an analog of a metabolic energy feed.

MB acts as a "boss" controlling ordinary matter and induces self-organization [40].

2.1.1 Anatomy of MB

MB has, as its body parts, magnetic flux quanta: flux tubes and flux sheets. There are two kinds of flux quanta. Flux can be vanishing, which corresponds to a Maxwellian regime. Flux can also be non-vanishing and quantized corresponding to a monopole flux. In the monopole case, the magnetic field requires no current for its creation. This option is not possible in the Maxwellian world. By fractality of the TGD Universe, these flux tubes play a key role at all scales [39].

Also the Earth's magnetic field with nominal value of $B_E = .5$ Gauss has two parts.

1. The monopole flux part corresponds to the "endogenous" magnetic field $B_{end} = .2$ Gauss and explains the strange effects of ELF EM radiation on the physiology and behavior of vertebrates [15].

   The presence of this part explains the stability of the Earth's magnetic field. This field should have decayed long ago in a Maxwellian world since it is generated by currents which disappear.The contribution of the molten iron in the Earth's core to B_E decays but the changes of the orientation of B_{end} regenerate it [33]. Also, magnetic fields that penetrate super-conductors as quantized fluxes and even those of permanent magnets (as opposed to electromagnets) may have a monopole part consisting of flux quanta.

2. The interaction of MB with the gravitational field of Earth is discussed in [58]. Intriguingly, the metabolic energy currency with the nominal value of .5 eV is rather close to the energy for the escape velocity of a proton. Could the transfer of ions from the surface of the Earth to MB be a standard process?

2.1.2 Communications to and control by MB

Communication from the biological body (BB) to MB and its control by MB would rely on dark photons, which can transform to ordinary photons with a large h_{eff} and vice versa. Molecular transitions would represent one form of control.

1. Cell membranes could act as generalized Josephson junctions generating dark Josephson radiation with energies given by the sum $E_J + \Delta E_c$ of ordinary Josephson energy E_J and the difference ΔE_c of cyclotron energies for flux tubes at the two sides of the membrane. The variation of the membrane potential modulates the Josephson frequency and codes the sensory information at the cell membrane to a dark photon signal sent to MB.

2. The large effects of radiation at ELF frequencies observed by Blackman and others [15] could be understood in terms of the cyclotron transitions in $B_{end} = .2$ Gauss if "h in $E = hf$ is replaced with h_{eff}. h_{eff} should be rather large and possibly assignable to the gravitational flux tubes with $\hbar_{eff} = \hbar_{gr} = GMm/v_0$. For the simplest model, M represents the Earth's mass coupling to the small mass m, and v_0 is a parameter with dimensions of velocity expected to have discrete spectrum.

The energies $E = h_{eff}f$ of dark photons should be in the biophoton energy range (visible and UV) characterizing molecular transitions [22, 23].

3. For the value $v_0/c \simeq 2^{-11}$, suggested by the Nottale's model for planetary orbits [1], the predicted cyclotron energy scale is 3 orders of magnitude higher than the energy scale of visible photons. Several solutions of this problem were considered [57]. The most plausible solution [57, 50] is $\beta_0 = v_0/c = 1/2$ for living matter so that gravitational Compton length $\Lambda_{gr} = GM/\beta_0$ equals to Schwartschild radius at the surface of Earth. and brings nothing new to the original Nottale hypothesis.

By its higher level of "IQ", MB would naturally be the master controlling BB by cyclotron radiation - possibly via a genome accompanied by dark genome at flux tubes parallel to the DNA strands.

1. Cyclotron Bose-Einstein condensates (BECs) of bosonic ions, Cooper pairs of fermionic ions, and Cooper pairs of protons and electrons would appear as dark matter in living systems and the $h_{eff} = h_{gr}$ hypothesis predicts a universal cyclotron energy spectrum in the range of bio-photon energies.

2. Dark photons may transform to bio-photons [29, 28] with energies covering the visible and UV energies associated with the transitions of bio-molecules. This control of biomolecules implies that remote mental interactions are routine in living matter. EEG signals would represent a particular instance of these communications: without the presence of MB it is difficult to understand why the brain would use such large amounts of energy to send signals to outer space.

3. In ZEO, the field body (FB) and MB correspond to 4-D rather than 3-D field patterns and quantum states correspond to quantum counterparts of behaviors and biological functions. Conscious holograms could be generated as a result of interference of a dark photon reference beam from MB and a dark photon beam carrying the sensory information. This hologram would be read by MB using the conjugate of the reference beam.

   In ZEO time reversals of these processes also take place. This makes it possible to understand memory as a result of communications with memory mental images.

2.2 Galois confinement

Galois confinement is a universal number theoretical mechanism for the formation of all bound states [55, 54]. Galois confinement emerged originally in TGD inspired quantum biology but has become a central theme of also the TGD view about condensed matter. Galois confinement provides a purely number-theoretic mechanism for the formation of hierarchies of bound states.

1. Galois confinement involves $M^8 - H$ duality and requires $h_{eff} > nh_0 > h$. M^8 has an interpretation as an analog of momentum space and the points of $X^4 \subset M^8$ assignable to polynomial P with rational coefficients have interpretation as 4-momentum. Monic polynomials P are physically especially interesting [56]. P defines an algebraic extension of rationals with dimension $n = h_{eff}/h_0$. The physical interpretation is as a hierarchy of phases of ordinary matter with an increasing value of effective Planck constant behaving like dark matter.

2. The roots r_n of P correspond to 3-D mass shells $m^2 = r_n$ in fixed $M^4 \subset M^8$ and X^4 itself contains these mass shells and is determined as a deformation of M^4 which corresponds to an element of local group $SU(3) \subset G_2$, where G_2 is automorphism group of M_c^8 having interpretation as complexified octonions. The condition that $U(2) \subset SU(3)$ leaves the point $g(x)$ invariant implies that one has local CP_2 element defining the $M^8 - H$ duality.$SU(3)$ corresponds to color group physically.

3. Quark states as solutions of algebraic octonionic Dirac equation (all equations are algebraic at M^8 side of $M^8 - H$ duality while everything is differential geometric at H side) correspond to points of M^8 assume to correspond to algebraic integers in the extensions of rationals defined by P so that the points carrying quark define what I have called cognitive representation playing a key role in adelic physics [35, 36]. For instance, p-adic variants of the cognitive representations make sense.

4. Periodic boundary conditions allow only many-quark states assignable to mass shells for which the total M^4 momentum is an ordinary integer (in suitable units defined by the size scale of CD considered) are possible [55, 54]. This is the simplest realization of Galois singlet property/confinement. The integer valued total momenta emerge also in the twistorial construction of scattering amplitudes [56]. This is the simplest realization of Galois singlet property/confinement.

5. This gives rise to an infinite hierarchy of bound states. One can also consider composite polynomials and if they vanish at origin, the roots of composite polynomials contain also the roots of the functional factors of the composite. This is analogous to conservation of genes. All kinds of states: nucleons, nuclei, photons, etc... , can form Galois bound states. It is enough that one deforms the states so that they are not Galois singlets with the original Galois group or to increase the extension so that they are not Galois singlets in the larger extension. From these kinds of states one can form Galois singlets.

2.3 Dark realizations of genetic code

The model of bio-harmony [24, 38, 45, 51, 52] is essential for the TGD based understanding of what might be called emotional intelligence (whose reality is accepted) and its relations with ordinary intelligence. The surprising outcomes are the connection with genetic code and the key role of bioharmony in quantum information processing in living matter.

1. The notion of bioharmony relies on icosahedral and tetrahedral geometries. The representation of the 12-note scale as a sequence of quints, reduced by an octave equivalence (notes differing by octave are experienced as equivalent) to the basic octave, defines the harmony for a given Hamiltonian cycle: the 20 allowed 3-chords of the icosahedral harmony correspond to the 20 triangular faces. The symmetries of the harmony are defined by some subgroup (Z_6,Z_4, or Z_2) of the icosahedral group.

2. Genetic codons correspond to dark photon triplets (3-chords of light) defined by the triangular faces of an icosahedron and tetrahedron. The counterparts of amino-acids are identified as orbits of 3-chords under the symmetries of a given harmony.

   Any combination of 3 icosahedral harmonies with 20 chords with symmetries Z_6, Z_4 and Z_2 and of the tetrahedral harmony with 4 chords gives a particular bioharmony with 20+20+20+4=64 chords assignable to DNA codons. DNA codons coding for a given amino acid correspond to the chords at the orbit of the symmetry group. Rather remarkably, the numbers of DNA codons coding for a given amino acid come out correctly.

3. Music expresses and creates emotions. Musical harmony codes for moods and emotions as holistic aspects of music. Bio-harmony with 64 3-chords, would assign the binary, local, aspects of information to the 6 bits of the codon and its holistic, emotional aspects to the bio-harmony. A chemical representation of the genetic code can thus correspond to several moods represented by bioharmony. In contrast with physicalism, emotions would appear already at the molecular level, and would have physical effects that are not reducible to bio-chemistry. This understanding is not possible without using the notion of MB.

   The model of bio-harmony requires that the values of B_{end} correspond to those associated with the Pythagorean scale definable by the quint cycle. These frequencies correspond to energies that a

molecule must have in order to serve as a basic biomolecule. This criterion could select DNA, RNA, tRNA, and amino-acids.

In the second model of genetic code [37, 34, 38], codons are represented as dark proton triplets assignable to flux tubes parallel to DNA strands.

1. The numbers of dark proton triplets turn out to correspond to numbers of DNA, RNA, tRNA codons, and amino acids. The numbers of DNA and RNA codons assignable to a given amino-acid in the vertebrate genetic code are correctly predicted. Genes would correspond to sequences of dark proton triplets [42].

2. Dark proton triplet - dark codon - would be analogous to baryon and Galois confinement [47] behaving like a single quantum unit. The N dark codons of a dark gene would, in turn, bind to Galois confined states of the Galois group of an EQ associated with the sequence of codons. An entire hierarchy of confinements is possible.

3. Galois confinement can be realized also for dark photon triplets and the sequences of N dark-photon triplets representing genes as dark $3N$-photon states. Genes could serve as addresses for communications based on dark $3N$-photon resonances.

   For communications between levels with the same value of h_{eff} there would be both energy and frequency resonance and for levels with different values of h_{eff} only the energy resonance. It is an open question whether dark $3N$-photons transform to a single ordinary photon or $3N$ ordinary photons (biophotons) in dark-ordinary communications.

4. The basic hypothesis is that both DNA, RNA, tRNA, and amino acids are paired with their dark analogs, and that energy resonance mediates the interaction between the members of pairs.

How could the icosahedra and tetrahedra be realized? Why must one glue them together? This looks aesthetically unappealing. However, surprisingly, both icosahedrons and tetrahedrons appear in, perhaps the simplest honeycomb of the hyperbolic 3-space H^3 (cosmic time = constant hyperboloid). H^3 is also central to special relativity and cosmology [52]. Dark genetic code can be realized in terms of both dark protons and photons using this particular tessellation and would be universal. This master tessellation would induce sub-tessellations at the space-time surface, in particular representations of genetic code at magnetic flux tubes. Also 2-D and even 3-D representations of genetic code can be considered (i.e. cell membrane and microtubules) [53].

2.4 Communication and control in living matter

The TGD inspired model for bioharmony suggests a universal communication and control mechanism based on frequency modulation of dark photon radiation and its resonant receival producing a sequence of pulses. The signal sent by the DNA sequence would be resonantly received by a similar DNA sequence as a temporal sequence of resonance peaks determined by the modulation.

An interesting hypothesis is that nerve pulse patterns are basically produced by this mechanism transforming membrane potential oscillations producing Josephson radiation sent to MB and producing pulse sequences initiating nerve pulse pattern at the level of cell membrane.

U-shaped flux tubes serve as the basic tools of communication. Their reconnection replaces U-shaped flux tubes with pairs of flux tubes between two objects and occurs when a resonant dark photon communication between objects is possible. This requires the same cyclotron energy implying identical cyclotron frequencies if the values of h_{eff} are the same: this implies the value of magnetic field and by flux quantization the same thickness of flux tubes.

Galois confinement allows a generalization replacing U-shaped flux tubes with N-flux tubes along which dark N-photons can propagate and to replace dark photon resonance with M-resonance. This

communication and control mechanism would be realized at the level of DNA and other biomolecules. The generalization of the notion of genetic code allowing higher dimensional realization of DNA generalizes this communication mechanism further.

2.4.1 Some applications

The proposed general model of communications and control has an impressive number of applications to living matter.

1. The model of water memory involves dark DNA [19] [27, 30] assignable to the ordinary DNA and also the dark variants of other biomolecules can be involved. The MBs of water clusters can vary the thickness of their U-shaped flux tubes and therefore their cyclotron frequencies. This makes possible recognition of bio-active molecules with MB involving flux tubes with cyclotron frequencies shared by living matter. When the U-shaped flux tube meets a similar flux tube of a bio-active molecule, reconnection takes place and if it leads to dark photon resonance, a long-lived flux tube pair is formed. The bioactive molecule is "caught".

2. The MB of water clusters can mimic the MBs of invader molecules and this could give justification for the claimed homeopathic effects. Resonant reconnection could be behind water memory, immune system, the claim about homeopathic healing [19], and the bio-catalysis involving the mysterious looking ability of reactants to find each other in dense molecular soup.

3. The most general option is that every polar molecule in living matter is accompanied by a dark nucleon sequence or several of them (as in the case of amino-acids) serving as its "name"". This would also associate a unique dark nucleon sequence with the MB of DNA so that DNA-dark DNA association would be automatic. The same applies to mRNA and tRNA and amino-acids.

The model for the communications also leads to a model for the emergence of language [61, 62]. Amazingly, only a few point mutations for relatively few genes seem to have led to human languages and transformed biological evolution to cultural evolution? What happened to these genes? In the biochemistry framework it is difficult to imagine an answer to this question. Here TGD could come to the rescue.

One can assign a value of h_{eff} characterizing the evolutionary level also to genes. The genes with larger h_{eff} would serve as control genes and the increase of h_{eff} would mean an evolutionary step. Perhaps a dramatic increase of h_{eff} occurred to FOXP2 and some other genes as human language emerged.

The fundamental language would be defined by genetic code realized in terms of dark $3N$-photons and h_{eff} as a measure of algebraic complexity and a universal "IQ" would characterize the realizations of this language.

2.4.2 What is the role of introns and TEs?

Interesting questions relate to the role of introns and transposons (TEs), which involve introns besides genes.

1. Introns do not express themselves as proteins and their fraction is highest in humans so that the interpretation as junk DNA does not look realistic. TGD inspired quantum biology motivates the proposal that the dark genes could express themselves electromagnetically and that remote replication (and the remote variants of transcription and even translation) could rely on this. This leads to a general model for communications and control.

2. The simplest assumption is that all DNA related structures and also RNA proteins and tRNA, can "talk" by applying these communication mechanisms.

The difference between TEs and genes not belonging to TEs brings to mind the difference between animals and plants. TEs can move and actively control their environment. TEs are also involved with epigenesis, that is control of gene expression, and modifications of genes.

Animals and plants differ also in that animals have a nervous system. Could also TEs and ordinary genes have an analogous difference? Animals are thought to represent a level of evolution higher than plants. Could this be true also for TEs? A higher value of h_{eff} for the MBs of TEs would concretize this idea. Nervous system in TGD inspired quantum biology means communications to MB by Josephson radiation. Could one think something like this also now?

The relation of TEs to genes looks like the relation of a programmer to the program modules of a software. This suggests that the MBs of TEs represent a higher level in the h_{eff} hierarchy than the MBs of genes. The higher value of h_{eff} means also a longer scale of quantum coherence so that TEs might be involved also between communications of even different organisms of the same species.

3 Is remote replication of DNA involved with HGT?

In remote replication only the information about TE would be transferred and one would have a biological analog of teleportation.

3.1 Is replication of the magnetic body behind biological replication?

The vision [32] about exclusion zone (EZ) like regions discovered by Gerald Pollack [10, 3, 14, 13] as primordial life forms and facts about water memory and homeopathy [19] lead to a vision about how a primitive immune system might have developed and how the recent genetic code might have emerged.

Magnetic bodies and dark analogs of bio-polymers should still play a key role in living matter. The basic idea is that the time evolution of the MB is the template for the time evolution of the biological body. In [20] [31] various pieces of evidence for the role of the MB as "morphogenetic field" is discussed. For instance, the replication of DNA and cell would reduce basically to that for corresponding magnetic bodies.

Replication of the MB is analogous to what happens in the 3-vertex of a Feynman diagram. This occurs on several scales. This would make possible dark DNA (dDNA) replication and copying of dDNA to dDNA+dRNA as well as copying of dRNA to dRNA+dark protein.

Replication process should start from the higher levels of dark matter hierarchy and proceed to shorter scales. The basic constraint from ZEO is that the time evolutions of magnetic bodies at various levels of the hierarchy are highly unique as preferred extremals connecting initial and final 3-surfaces. For the maxima of vacuum functional only preferred pairs of 3-surfaces are possible. This gives rise to what might be called "standard behaviors". Also the replication would be this kind of behavioral pattern. In the context of the positive energy ontology it is extremely difficult to understand the predictability of cell replication or the development of the organism from a single cell by repeated cell divisions.

Remote gene replication [26] might be one application: the model described was actually developed before the idea that the replication of the MB could be the fundamental mechanism. Its reversal could be a basic mechanism of bio-catalysis and induce the attachment of the bio-molecules together. Also ordinary DNA replication could be induced by the same electromagnetic signal as remote replication.

3.1.1 TGD based model for ordinary DNA replication

Consider first a TGD based model for the ordinary replication of DNA.

1. Assume that the portion of DNA promoting DNA replication is activated by dark radiation at some frequency and that the promoter region emits radiation with the same frequency. This activates further promoter regions -also in other cell nuclei. The replication process is amplified exponentially.

The negative feedback is necessary in the general case and is provided by attachment of the produced proteins (basically dark proteins) to the genes making them inactive.

2. This might occur during cell division which might involve irradiation by dark analog of white noise exciting all promoter regions. Certainly the coherence of this process is essential and here the higher levels of the dark matter hierarchy would be essential.

3.1.2 Remote replication in weak sense

Gariaev has reported a phenomenon suggesting remote replication in the sense that the DNA strands exist in B and the irradiation of the DNA at A induces the remote replication in B. In the sequel I will speak about the weak form of remote replication (WRR). We have written together with Peter Gariaev an article discussing a possible TGD based model for the findings [59].

The work of Gariaev [6, 5][7, 11] provides the experimental guidelines.

1. The phantom DNA [6] identified as dark nucleon sequences in TGD framework and the evidence for remote activation of DNA transcription [5] - both discovered by Gariaev's group - are assumed as the first two key elements of the model.

2. The notion of wave DNA introduced suggests that genes express themselves by em radiation and that genetic code is involved. Wave DNA should provide a mechanism of information transfer. Somehow DNA should be encoded to spatial or temporal patterns in turn decoded somehow to DNA. Gariaev has suggested that the modulation of polarization direction for the radiation propagating along the DNA strand could encode for the DNA to a temporal pattern.

The TGD based model for WRR using existing DNA in both A and B is discussed in the article [59] written together with Peter Gariaev. This discussion and also later developments can be found in [26, 20].

WRR would use existing DNA strands in B accompanied by dark DNA strands realizing the genetic codons as dark proton triplets. The replication would be remotely induced by the dark radiation from DNA at A possibly arriving to B via the MB having contacts with both A and B. This would be a general mechanism of remote mental interactions in the TGD Universe.

1. WRR becomes possible if the dark radiation exciting promoter region can leak to other cells or even other organisms. Large h_{eff} might make this possible.

2. Also remote transcription is possible by the same mechanism. Actually remote variants of very many basic processes seem to be possible.

3. The observations of Peter Gariaev's group about effects of laser light on genes [7, 11] could be interpreted as remote replication in this sense.

The analog of this mechanism could make remote transcription and even remote translation at the dark level possible. These processes would induce these processes at the level of biochemistry in accordance with the proposal that biochemistry is quite generally shadow dynamics induced from the level of the MB.

3.1.3 TGD based model for the remote replication in strong sense

For the strong form of remote replication (SRR) only DNA codons are available at B, and under some conditions the presence of DNA at A induces the remote replication at B.

The findings of the group of HIV Nobelist Montagnier [8, 9] could be interpreted in terms of SRR. In this case the information about DNA at A must be transferred from A to B. Peter Gariaev has reported replication in this sense for years after Montagnier' findings [12].

1. Montangier's experiment involves two chambers A and B. A contains water plus genes and B contains water plus DNA nucleotides. There were channels between the chambers but so thin that DNA could not get through. Also an em field with 7 Hz frequency was present. Same genes as in A appeared also in B. As if remote replication of genes in A had happened in B. In the TGD framework the presence of 7 Hz frequency suggests that MB was present: the identification either as Schumann frequency or the cyclotron frequency of K ion in the endogenous magnetic field of .2 Tesla is suggestive.

2. Polymerase chain reaction (PCR) [2] (see `http://tinyurl.com/ybv6mn5l`) is the technique used in the experiments of Montagnier's group and in somewhat modified experiment by Gariaev's group involving irradiation of the second test tube by laser light.

The findings of Montagnier et al [8, 9] can be described in terms of SRR. The model for SRR has developed gradually and the latest version was discussed in 2020 [46]: this discussion is included also in[26, 20]. The following describes the definition and development of the model for SRR.

1. Consider two positions A and B. A could be a chamber containing DNA strands and B a chamber containing DNA codons. Assume that DNA to be remote-replicated is in A and the codons producing the replica are in B. The dark flux tubes parallel to ordinary DNA in A and carrying dark codons would be accompanied by dark planar flux tube bundles transverse to them and leading to B. Each flux tube would be analogous to a wave guide for dark photons. In Gariaev's model photons polarized orthogonally to DNA would propagate along these.

2. The planar flux tube bundles extending from A to B would have $h_{eff} > h$. The associated space-time surface which could be seen as a many-valued map from CP_2 or its lower-D surface to M^4 giving rise to a planar bundle of parallel U-shaped flux tubes in M^4 as a quantum coherent structure. DNA codons floating in water in B would reconnect to the ends of these U-shaped flux tubes by resonance mechanism and the resulting DNA strand in B would be the same as in A.

3. The dark photon signal representing DNA sequence could catalyze the formation of conjugate DNA in chamber B from existing DNA sequences in chamber A serving as a template. Since the catalytic interaction of DNA polymerase takes place with already existing DNA sequence, the simplest possibility is that first some conjugate DNA sequences are generated by WRR after which DNA polymerase utilizes these sequences as templates to amplify them to original DNA sequences. Whether the product consists of original DNA or its conjugate can be tested. I have also commented on Montagnier's findings from the TGD point of view [27, 30].

4. The crucial assumption, which is in conflict with the standard picture, is that the dark DNA nucleotides (dark protons) serving as building bricks of DNA strands do not float freely in water but are already loosely bound to form dark codons.

   The motivation for this assumption is that one cannot assign the frequencies of the 3-chord with different nucleotides of the codon but only to the entire codon. The difference between ordinary codon and dark codon is like that between spoken and written language: in spoken language word is basically a single entity but in written language it decomposes to letters. Interestingly, in written Chinese the words decompose to syllables but not to letters.

   The assumption of effective independence of codons makes sense if the magnetic flux tubes connecting the codons have either value of string tension or larger value of h_{eff} than in the dark codon accompanying the ordinary codon.

Galois confinement allows to generalize the model and gives a justification for the formation of units with increasing complexity and size and behaving quantum coherently.

1. Triplets of dark codons can bind to a single dynamical unit by Galois confinement [55, 54]. Dark codons can in turn bind to dark genes and even to DNA strands with a larger Galois group. Strands can in turn bind to double strands and double strands to chromosomes. Even larger structures are possible since Galois confinement is hierarchical and new levels correspond to the increase of algebraic complexity associated with the polynomials P defing 4-surfaces in M^8 and by $M^8 - H$ duality in H [43, 44, 55].

   Biological evolution could be seen as a number theoretical evolution of Galois singlets with increasing size as the algebraic extension and the Galois group associated with space-time regions defined by polynomials would increase and become more complex.

2. Dark codons represented by 3 dark photons would be Galois singlets. From these dark photon genes and even larger dark photon structures can be formed as analogs of dark Bose-Einstein condensates. Photons as particles would be replaced by dark $3N$ photons. Also the planar flux tube bundles would be particle-like entities: $3N$-flux tubes forming quantum coherent structures. The entire gene would use this $3N$-tentacle to build resonant connections to other similar genes or to build similar genes from dark codons to which ordinary codons would be attached.

   The communications between dark proton genes with N codons would be by using dark photon genes involving $3N$-fold cyclotron resonance selecting the receiver. In communications, the simultaneous frequency modulation would yield the message transformed to a sequence of resonance pulses with temporal durations between pulses determined by the modulation.

3.2 Could HGT rely on remote replication in strong sense?

Transposons are abundant in eukaryotic cells unlike in prokaryotic cells. This suggests that TEs could make possible SRR and thus allow to circumvent the problems posed by the presence of nuclear membrane and chromosome structure. The reason for this could be simply that the value of h_{eff} is so large for the TEs (or rather, for their MBs) that it makes coherent activities possible in longer length scales and therefore also the control by MB. MB would have a larger size scale and higher "IQ".

Perhaps TE is one particular structure behaving like a unit expressing itself in terms of codons realized as dark photon triplets. TE would be moving gene as an analog of animal. This structure could be essential for SRR. If TE has MB with large h_{eff}, it (or its MB) would be able to behave autonomously: this is what jumping genes are. Genes not associated with TEs would be like plants coding for structure and TEs would be like animals making the structure dynamical.

Therefore the question in the concrete example considered is the following: Could SRR take place and yield a copy of a TE involving the AFG of herring inside the sperm cell or egg of smelt? The TE complex could belong to the sperm cell or egg of herring or their degradation products.

3.3 Some reckless speculations

It is interesting to try to see this proposal in a more general context.

1. Introns were for a long time regarded as "junk DNA". Junk interpretation does not resonate with the fact that human genome has the highest portion of introns and humans have also developed culture and language [61, 62], which in TGD framework would correspond to an evolution of collective consciousness. The reasons for the junk interpretation might have been the repetitive nature of introns and the belief that genes can be expressed only as proteins or RNA.

   TEs as jumping genes are now known to have many important functions: they make the genome dynamic and affect its identity and size and can lead to a duplication of pieces of the genome. They are involved with the control of gene expression and epigenesis (amusingly they are still regarded as selfish genes!).

DNA is interpreted as information theoretically and one can wonder whether TEs might play an essential role in the communications at molecular level. Magnetic body (MB) and the hierarchy $h_{eff} = nh_0$ of effective Planck constants are a central element in TGD inspired quantum biology. The larger the value of h_{eff}, the longer the quantum coherence length and time scales are and genes could be classified using the value of h_{eff} for their MB as a criterion, a kind of universal IQ.

2. TEs dominate also in the genomes of crops (see `https://cutt.ly/5UZGvbY` and `https://cutt.ly/QUZG8qa`) and trees. It has become clear that trees are not isolated entities but know each other and take this into account in their behavior. Forest is not a collection of isolated trees, but a highly refined self-organizing social structure. For instance, conifers have a high amount of TEs, which suggests that forest is a conscious entity, which has MB controlling the forest at the level of the ordinary biomatter.

   Concerning crops, at least 35 % of the rice genome % of the sorghum genome [3], and nearly 85 % of the maize genome is made up of transposable elements (TEs). It is difficult to avoid seeing an analogy between human community and crop field or forest. Could TEs make possible communications in the scale of the crop field and forest and make it, or rather, its MB, a conscious intelligent creature?

3. I know that I should overcome the temptation of mentioning crop circles although most mainstream biologists certainly regard crop circles as human made. I cannot. It is also better to immediately confess that I have even written two articles about crop circles about a quarter century ago [17, 18]. I of course know that there is no statute of limitations for this kind of science crimes so that this is not intended to be a defense for what I have done.

   Are the crop circles really human made? Some biologists have risked their career by studying them and have found that the folded straws of crops of the crop circle have the appearance of being affected by microwave radiation (think of a tomato, which has exploded in a microwave oven). Also light balls have been reported around crop circles as well as glass balls resulting from molten quartz.

   Microwave photons are known to induce "burning" of water, an effect which is poorly understood. If microwave photons are dark with energy $E == h_{eff}f$, say in biophoton range, this might be understood. One can also create in a microwave oven small light balls consisting of plasma.

   This raises questions: Could TEs make possible communications between individual plants of the crop field? Could TEs make it possible for the MB of the crop field to control the field? Could MB of the crop field of some other conscious entity use dark microwave photons to induce the formation of crop circles. Could the crop circles be interpreted as an expression of an intelligent conscious entity (not necessarily the MB of crop field) and analogs of patterns of neural activity as I proposed years ago [17, 18]?

4. Cannabis is one of humanity's oldest crops and has a high proportion of TEs `https://cutt.ly/8UZW5v1`. Could this relate to its dramatic effects on human consciousness?

   Usually these effects are interpreted as being due to the biochemistry of cannabis (`https://cutt.ly/8UZET6t`). In the TGD framework, the idea that the binding of various psychoactive molecules on synaptic contacts activates flux tubes to MBs, even those in outer space, is attractive. The book "Inner paths to Outer Space" [16] by Rick Strassman, Slawek Wojtowicz, Luis Eduardo Luna and Ede Frecska inspired an model [21] for the possible mechanism of the action of psychedelics.

   Could also the TEs in the DNA of cannabis play some role? Could they have MBs with especially high h_{eff}? Could it make sense to speak of co-evolution of the human consciousness and cannabis-consciousness (or crop-consciousness in general) based on interactions not directly conscious to us?

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