A possible TGD based narrative for how life might have evolved

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Abstract

I have worked decades in attempting to combine various basic ideas of TGD inspired quantum biology to a single narrative about how life could have evolved at the Earth and possibly is evolving at other planets.

TGD introduces several new concepts, such as the new view of space-time and classical fields. A new quantum ontology predicts phases of ordinary particles labelled by effective Planck constant h_{eff} behaving like dark matter and residing at the field bodies. Zero energy ontology (ZEO) is part of the new quantum ontology. The basic challenge has been the fusion of these notions with the standard approach involving electromagnetic fields and biochemistry. In particular, the Pollack effect and its generalizations have turned out to be central in the development of TGD based views of living matter. Also the TGD views of cell membrane and of neuron and nerve pulse and EEG examples should be integrated with standard biochemistry- and bio-electricity based approaches.

Notions such as acids and bases and electrolysis, electronegativity, oxidation, reduction, and redox reactions belong to the basic conceptual arsenal. One should also understand how these notions relate to basic biological processes such as photosynthesis, chemical storage of metabolic energy and respiration.

Could the new physics provided by TGD provide totally new insights? The extreme efficiency of biocatalysis remains a mystery in the biochemistry based approach: where does the energy making it possible to overcome potential barriers preventing the reactions come from? How did the basic information molecules and genetic code emerge and why is the genetic code

what it is? Is there some hidden new physics behind the replication of DNA, its transcription of DNA to mRNA, and translation of mRNA to proteins? How did the genetic code evolve?

In the sequel I consider the basic notions involved. I also discuss some examples related to the evidence for life on Mars and the finding of JWST that organic molecules relevant for life existed much before the planet Earth.

1 Introduction

I have worked decades in attempting to combine various basic ideas of TGD inspired quantum biology to a single narrative about how life could have evolved at the Earth and possibly is evolving at other planets.

TGD introduces several new concepts, such as the new view of space-time and classical fields. TGD also predicts a new quantum ontology predicting phases of ordinary particles labelled by effective Planck constant h_{eff} behaving like dark matter and residing at the field bodies. Zero energy ontology (ZEO) is part of the new quantum ontology. The basic challenge has been the fusion of these notions with the standard approach involving electromagnetic fields and biochemistry. In particular, the Pollack effect and its generalizations have turned out to be central in the development of TGD based views of living matter. Also the TGD views of cell membrane and of neuron and nerve pulse and EEG examples should be integrated with standard biochemistry- and bio-electricity based approaches.

For me the challenge has been and still is the fact that biochemical thinking is very different from that of a theoretical physicist thinking in terms of action principles, field equations, and quantum theory. In order to understand the stunning complexities of biochemistry one must learn the key concepts at an intuitive level.

Of course, notions such as acids and bases and electrolysis, electronegativity, oxidation, reduction, and redox reactions belong to the basic conceptual arsenal. One should also understand how these notions relate to basic biological processes such as photosynthesis, chemical storage of metabolic energy and respiration. One begins to learn the significance of these notions as one tries to understand how to test whether some sample, taken for instance from Mars, contains organics possibly produced by the decay of living organisms.

Could the new physics provided by TGD provide totally new insights about biology and biochemistry? The mechanisms leading to emergence of the basic organic molecules serving as building bricks of basic information molecules like amino acids, DNA and RNA are poorly understood. The extreme efficiency of biocatalysis remains a mystery in the biochemistry based approach: more concretely, where does the energy making it possible to overcome potential barriers preventing the reactions come from? How did the basic information molecules and genetic code emerge and why is the genetic code what it is? Is there some hidden new physics behind the replication of DNA, its transcription of DNA to mRNA, and translation of mRNA to proteins? How did the genetic code evolve?

I am not a biochemist and this article is also an attempt to clarify these notions for myself. Google AI allows anyone to get detailed accounts of the basic notions and has been of considerable help in fact checking and learning of new facts about basic biochemistry during the writing of this article. I will also discuss some examples related to the evidence for life on Mars and the recent finding of JWST that organic molecules relevant for life existed much before the planet Earth.

2 Questions

One can start by listing some key questions.

1. Living cell involves two basic building blocks corresponding to chemistry and electromagnetism: the basic biomolecules on the chemistry side and biologically important ions forming cold plasmas accompanying the cell membrane at the electromagnetic side. Did these two components evolve separately: could one speak of chemical life and electromagnetic life as separate phenomena? If so, how did they fuse together?

2. The emergence of anabolism as energy storage and catabolism as utilization of the energy are key aspects at the chemical side.

Chemical energy storage involves anabolism as building up of organic molecules is essential for chemical life. Energy storage occurs mostly to covalent C-C and C-H bonds of proteins and lipids. Plants do this in photosynthesis and start from CO_2 and water plus radiation. The use of the metabolic energy involves catabolism decomposing the proteins and lipids. The inputs of photosynthesis are carbon di-oxide, water and light and the outcome consists of proteins and ATP. Amino acids store energy to the covalent bonds of their side chains. and also lipids store energy. In catabolism the bonds between covalent bonds of these molecules are split and energy is liberated so that in the ideal case CO_2 and water is obtained as an outcome.

Enzymes play a central role in metabolism, which requires metabolic energy. This raises one of the many hen-egg questions of biology [**?**] [L7]: was metabolism before biomolecules or vice versa? In TGD, the notion of dark matter as $h_{eff} > h$ phases of ordinary particles located at the magnetic/field body could solve the problem. In the Pollack effect [**?**, **?**, **?**, **?**] photon energy kicks ordinary protons to dark protons at the magnetic body so that they become temporary carriers of metabolic energy [L24]. Also alkali ions can be kicked to monopole flux tubes and this explains the original findings of Blackman and otherse [J1]. h_{eff} is a measure for number theoretical complexity and serves as a kind of universal IQ and quantum coherence scale as size scale ofa particular space-time surface increases with h_{eff}. This primary metabolism precedes the chemical storage of metabolic energy.

3. The formation of membrane bounded structures should be understood. Cell membranes are accompanied by cold plasmas. One can ask whether the proto cell involved only membrane-like structure and ions but no lipids and proteins. Here plasmoids as life forms, for which empirical evidence comes from the findings of NASA, are good candidates [L11].

   The dark ions of the cold plasma with large value of h_{eff} located at field/magnetic bodies, in particular gravitational [L6] *resp.* electric [L11] field bodies characterized by h_{gr} *resp.* h_{em}, play a central role in the TGD based view of quantum biology as also the monopole flux tubes going through the proto membrane and forming a template for the liquid crystal structure formed by lipids.

4. The understanding of the cell and DNA replication is a fundamental challenge. One of the many proposals is that the layered structures associated with clays such as kaolinite $Al_2Si_2O_5(OH)_4$) could replicate simply by splitting to pieces.

   TGD suggests a much more radical option based on the geometry and topology of space-time sheets. Dirac proposed the interpretation for a creation of a fermion pair as a turning of a fermion backwards in time forming a V-shaped structure. This turns out to be the only way to understand the creation of fermion pairs in TGD framework, where spinor fields are free and there are no primary gauge boson or graviton fields, only geometrized classical fields [L21, L20]. Also a 3-surface as a geometric particle could turn backwards in geometric time and give rise to a V-shaped 4-surface. The turning back of the DNA strand in time would be the two new DNA strands generated in the replication [L23]. This picture generalizes also to the case of transcription and translation.

5. Genetic code should be also understood and TGD suggests a universal realization of the genetic code based on icosa tetrahedral tessellations of hyperbolic 3-space [L4, L10]. Also generalizations of the representations of genetic code are suggestive. For instance, the cell membrane could realize genetic code. Also a vision about the evolution of genetic code as the addition of introns in the reverse transcription emerges [L27].

2.1 How did the basic organic molecules emerge?

How did the basic organic molecules emerge? Google language model lists several pathways leading to the emergence of the basic biomolecules: the basic organics could have emerged during the era preceding the solar system, they could have evolved to aminoacids and DNA in meteorites, they could have formed in planetary haze and also in ice via the so-called cold synthesis.

1. Ice chemistry: Before our solar system was fully formed, simple molecules such as ammonia, carbon monoxide, and formaldehyde ($O{=}CH_2$) froze onto dust grains in the interstellar

medium. It is thought that the exposure to cosmic radiation and UV light triggered reactions that created the first complex organic precursors, such as hexamethylenetetramine (HMT). The recent findings of JWST suggest that the organics emerged much earlier [L22].

2. Meteorites: The generation of amino acids and DNA and other basic biomolecules is known to take place inside meteorites.

   (a) The basic building blocks, such as ammonia NH_3, carbon monoxide CO, and formaldehyde ($O{=}CH_2$), of more complex biomolecules were generated before the full formation of the solar system. It is thought that cosmic radiation and UV light led to the formation of more complex molecules such as hexamethylenetetramine (HMT) serving as a storage of the molecules formed in this way.

   (b) Most meteorites (99.8 %) are associated with the asteroid belt between Mars and Jupiter. Basic biomolecules such as amino acids, sugars, and nucleobases were synthesized directly inside the meteorite's parent asteroids through complex chemical reactions. This could have occurred already before the formation of Earth.

   (c) Hexamethylenetetramine (HMT), also known as hexamine, is a polycyclic organic compound ($C_6H_{12}N_4$) that some scientists consider a "missing link" in the chemical evolution of life. Whereas basic biomolecules are planar, HMT has tetrahedral geometry with N-atoms at vertices and -CH_2- as at the edges connecting them. For decades, HMT was synthesized in laboratories simulating space conditions, but it wasn't officially detected in space rocks until December 2020, when an international team led by Hokkaido University found it in the Murchison, Murray, and Tagish Lake meteorites.

   It is remarkable that both chiralities of the biomolecules are present in meteorites. Also non-protein amino acids are present. If meteorites provided the amino acids, chiral selection should have occurred later.

   The TGD based view of the formation of solar system [L14, L15, L18] suggests that planets and also spherical layers of matter were formed in the explosions of the Sun so that meteorite belt would have emerged before the Earth and Mars. The belt is indeed slightly older than the Earth.

3. Hydrothermal synthesis (working like "pressure cooker"): As asteroids were formed, the decay of radioactive elements (like Aluminum-26) could have provided enough heat to melt ice into liquid water. This "wet chemistry" phase acted like a natural chemical reactor leading to

   (a) Strecker synthesis: Ammonia NH_3 and cyanide CN^- reacted with highly reactive aldehydes (O=CHR, (R corresponds to hydrogen for formaldehyde) in the presence of water to form amino acids.

   (b) formose-like reactions: formaldehyde ($O{=}CH_2$) molecules combined to build complex sugars, including ribose (the sugar in RNA).

   The conditions prevailing in hydrothermal vents support the idea that metabolism-like reactions could have emerged as predecessors for the appearance of the genetic material. Simple inorganic ions could have acted as catalysts instead of proteins. The presence of the mineral surface could protect and stabilize the organic molecules. The hydrothermal vents could have also served as shields against cosmic radiation. It has been conjectured that also a formation of protocell encapsulating the RNA molecules could be possible in this environment.

4. Haze-derived organics: Haze-derived organics are high-molecular-weight organic compounds formed in planetary atmospheres through photochemical reactions. They are a critical component of hazy environments, such as Titan (a moon of Saturn) and early Earth, and are formed when solar ultraviolet (UV) radiation or energetic electrons interact with gases like methane (CH_4).

   (a) Organic hazes are produced in the atmosphere, often in a haze layer that acts as a shield or a reservoir of organic material. These aerosols grow from microscopic, gaseous precursors to form complex, fractal agglomerates.

(b) Studies of haze analogs suggest they consist of diverse, complex species, including aromatic and aliphatic structures. These often include nitrogen-containing compounds (NOCs) like amines, imines, and nitriles. Haze-derived organics are strong absorbers, particularly in the UV-blue range, and have different optical properties compared to graphite, often showing strong vibrational absorption bands at 3.0, 4.5, and 6.0 μ m.

It has been proposed that on the Hadean Earth (about 4.5–4.3 billion years ago), such haze could have produced vital building blocks for life, including amino acids and nucleobases.

(c) The absorption bands for haze derived organics are in the same range as the IR absorption bands of so called PAHs obtained by fusing together organic molecules involving aromatic rings are produced in burning and are often poisonous. The list of the basic properties of PAHs [?, ?] (see `http://tinyurl.com/atx4t9a`) can be found for instance in [?].

The properties of PAHs have led to the PAH world hypothesis stating that PAHs are predecessors of the recent basic organic molecules. For instance, the distances of aromatic molecules appearing as basic building bricks are the same as distances of DNA base pairs.

So called Unidentified Infrared Bands (UIBs) of radiation around IR energies $E \in \{.11, .20, .375\}$ eV arriving from the interstellar space are proposed to be produced by PAHs. The UIBs can be mimicked in the laboratory in reactions associated with photosynthesis producing PAHs [?, ?].

PAHs are detected in interstellar space. James Webb telescope found that PAHs exist in the very early cosmology 1 billion years before they should be possible in the standard cosmology! Intriguingly, PAHs exist also in regions, where there are no stars and no star formation [E5]. PAHs could give rise to a curious phenomenon known as space smell [L11].

5. Cold Synthesis: This mechanism was discovered quite recently: Bennu (see this) is a 4.6-billion-year-old near-Earth asteroid and therefore older than Earth. Quite recent 2026 research from the Bennu asteroid mission suggests that life's ingredients might have formed in the extremely cold, radioactive environments of the outer solar system, without the presence of liquid water. Besides amino acids also phosphates and salty liquid water were found (see this).

TGD forces us to ask whether at least some of these pathways for leading to the basic biomolecules could rely on what I call the generalized Pollack effect [L11].

1. In the TGD based model for the ordinary Pollack effect, solar photons are assumed to kick protons of water molecules to the magnetic body associated with the system and create a negatively charged exclusion zone (EZ) as a phase of water consisting of water molecules with effective stoichiometry $H_{1.5}O$. The photons energies are in the IR range around physiological temperature. Ordinary Pollack effect is possible for molecules containing hydroxides -OH, which would split into O^- + a dark proton.

   EZ corresponds to a phase (ordered water) with a large value of h_{em} proportional to the total em charge of EZ [L11, ?] whereas the protons at the magnetic body have large gravitational Planck constant h_{gr}. EZ consists of layers with the geometry of a hexagonal lattice just like ice.

2. I have proposed [L11] a mechanism for the formation of organic molecules based on a generalization of the Pollack effect in which the formation of a bound state of atoms giving rise to an organic molecule liberates the binding energy of the molecule by kicking protons or positively charged alkali ions to the magnetic body. As a matter of fact, the original experiments of Blackman [J1] involving Ca^{2+} ions led to the h_{eff} hypothesis. The energies of the photons generated in the formation of the bound state would be in the visible and UV range and could kick protons and also heavier alkali atoms to the gravitational magnetic body.

   The signature of the process is the formation of negatively charged EZs. DNA, RNA and various regions bounded by biological membranes are negatively charged. Large values of

h_{em} and h_{gr} means high complexity and "IQ". They form a natural evolutionary hierarchy since the charge increases with the area of the membrane [L26]. This would be a concrete realization of the predicted unavoidable increase of number theoretic complexity [**?**] [L13].

2.2 Basic ingredients of life found in conditions prevailing in the early universe

Using the James Webb Space Telescope, astronomers have detected complex organic molecules frozen in ice around a baby star called ST6, located in the Large Magellanic Cloud, a neighboring galaxy about 160,000 light-years away (see). There is an article [E3] about the finding by Sewilo M. et al, with title "Protostars at Subsolar Metallicity: First Detection of Large Solid-State Complex Organic Molecules in the Large Magellanic Cloud", published in Astrophysical Journal Letters (see this).

Molecules like methanol, ethanol, acetaldehyde, methyl formate, and even acetic acid the key ingredient of vinegar were locked inside cosmic ice. These chemicals belong to the molecules that help kick-start chemistry needed for life. Until now, finding them in solid ice was incredibly rare, even inside our own galaxy.

The Large Magellanic Cloud is a harsh place. It has fewer heavy elements and stronger radiation conditions similar to the early universe, long before planets like Earth existed. Despite this complex organic chemistry is possible there. Does this mean that the ingredients for life don t need perfect conditions or that there is new physics involved? Even more, is this new physics universal.

It is very difficult to imagine how a complex biochemistry (biochemistry as we understand it) could have prevailed much before planets like Earth did exist. New physics seems to be required and TGD predicts it. The notion of a field body (field-/magnetic body) carrying large h_{eff} phases of ordinary matter [L8, L25, L6, L11, **?**] could explain how the organic molecules crucial for life could have formed in these circumstances.

1. Water is a key element of life in TGD inspired quantum biology. Therefore the fact that the molecules were inside ice is a valuable hint. Pollack effect [**?**] occurs when water is irradiated with, say, infrared photons arriving from the Sun or some other source now the protostar. Pollack effect generates negatively charged regions, Exclusion Zones (EZs) with rather strange properties such as the ability to kick out impurities, which seems to be in conflict with the second law of thermodynamics.

   Protons must go somewhere from the EZ and the TGD inspired proposal is that they go to the magnetic body of the system and form a large h_{eff} phase, in many cases behaving like dark matter. These phases are not however identifiable as galactic dark matter. h_{eff} serves as a measure for the algebraic complexity of the space-time surface and also for the level of conscious intelligence, a kind of universal IQ. The magnetic body naturally controls the physics of ordinary matter.

   What matters is the energy needed to kick ordinary protons to the magnetic body: the needed energy corresponds to the energy difference between $-OH$ and O^- + dark protons in the magnetic body. These two states of proton are proposed to define what might be regarded as a universal topological qubit [L6, L11, L17]). Also the formation of organic molecules as bound states liberates binding energy and can induce the generalized Pollack effect.

2. The formation of dark protons at the magnetic body of water could represent one of the first steps in the evolution of life and already at this stage the dark analogs of the basic information molecules, genetic code and metabolism could have emerged. The chemical realization of the genetic code would have emerged later.

Could the Pollack effect and the notion of magnetic body allow us to understand the formation of the basic molecules of life found to exist in the Magellanic Cloud. -OH group, appearing also in water molecules, is essential for the standard form of Pollack effect so that it could be important also now.

1. Complex alcohols can contain more than one -OH group bound to a saturated Carbon atom. Simple alcohols (see this) obey the formula $H-(CH_2)_n-OH$. Both methanol $(CH_3)-OH$

and ethanol $(CH_3)-(CH_2)-OH$ contain the -OH group so that Pollack effect is possible for them and could explain the special effects of alcohol on consciousness. Note that methane CH_4 emerges from the decompositions of organic materials.

2. Acetaldehyde $(CH_3)-(H-C=O)$ can be formed by a partial oxidation of ethanol in an exothermic reaction at temperatures 500-650 C. The reaction equation for the condensation of acetaldehyde and O_2 is 2 $(CH_3)-(CH_2)-OH+O_2 \rightarrow 2(CH_3)-(H-C=O)+2H_2O$.

   One can imagine the following sketch for what might happen. At the first step the protons of $-OH$ groups of ethanols are kicked to dark protons at the magnetic body. This would induce the transformation of $C-O$ bonds to $C=O$ bonds, forcing C to give up the second H atom of CH_2. The dark protons would drop back to ordinary protons and together with electrons and the two H atoms and oxygens of O_2 would form 2 water molecules.

3. Methyl formate $(CH_3)-(O=C-OH)$ can be produced in the condensation reaction $(CH_3)-OH+H-(O=C-OH) \rightarrow CH_3)-(O=C-OH)+H_2O$ of methanol $(CH_3)-OH$ and formic acid $H-(O=C-OH)$. Dehydration is involved.

   OH group must be replaced with $O=C-OH$ in the reaction. One can imagine that the proton of $-OH$ is temporarily transformed to a dark proton at the magnetic body and facilitates the replacement. After that the dark proton, O^- and $H-$ of $H-(O=C-OH)$ combine to form the water molecule.

4. Acetic acid $(CH_3)-(O=C-OH)$ is formed by the transformation $H_2 \rightarrow = O$ occurring in the condensation reaction of ethanol and oxygen as $(CH_3)-(CH_2)-OH+O_2 \rightarrow (CH_3)-(O=C-OH)+H_2O$ involving dehydration. Also now the proton of $-OH$ could transform to a dark proton. This should induce replacement $CH_2 \rightarrow C=O$, the splitting of O_2 and the formation of H_2O. The dark proton would drop back and $-OH$ would be regenerated.

Could the detected molecules allow us to conclude anything about the presence of more complex biomolecules such as sugars and riboses crucial for life?

1. Sugars or carbohydrates (see this), involve monosaccharides with formula $C_nH_{2n}O_n$, with n in the range 5 to 7, have a key role in metabolism. They contain a relatively large number of -OH groups associated with an aromatic ring. For $C_6H_{12}O_6$ (fructose, galactose, glucose) have 4 -OH groups. Yeasts break down fructose, galactose and glucose to ethanol in alcoholic fermentation. More generally, alcohols such as mannitol emerge in the reduction of saccharides.

2. TGD suggests that the metabolic energy liberated as sugars burn to alcohols involves the transfer of dark protons to the magnetic bodies of the acceptor molecules followed by their transformation to ordinary protons liberating the metabolic energy. This would occur in the $ADP \rightarrow ATP$ process.

3. Ribose $C_5H_{10}O_5$ (see this), appearing in RNA, contains 4 -OH groups and deoxyribose $C_5H_{10}O_4$ appearing in DNA contains 3 -OH groups. Phosphorylated ribose appears in ADP, ATP, coenzyme A and NADH.

   Biological and chemical reduction and fermentation can produce ribitol $C_5H_{12}O_5$, which is a sugar alcohol. When ribitol is subjected to hydroxyl radicals, $C-C$ bonds are cleavaged and formic acid $((H-C=O)-(OH))$ appears as a decay product. Methanol was detected: could formic acid transform to methanol $((CH_3)-(OH))$ in the presence of water by the reaction $(H-C=O)-(OH)+H_2O \rightarrow (CH_3)-(OH)+O_2$?

To conclude, the temporary transformation of proton to dark proton at the magnetic body by Pollack effect could be involved with all these reactions.

2.3 How did the cell membrane emerge?

Also ions are as important for life. In TGD, ordinary ions, in particular alkali ions such as H^+, Li^+, Na^+, K^+, Ca^{2+}, and Mg_{2+} are important since they can transform to large h_{gr} ions at

the gravitational magnetic body. Dark protons are in a special role. The h_{eff} hypothesis was motivated by the findings [J1]. The transfer of protons and positive ions to the magnetic body induces a negatively charged exclusion zone (EZ) to which a large electric Planck constant h_{em} can be assigned.

The findings of NASA, suggesting the existence of plasma-like life forms in the ionosphere, gives support for the hypothesis of plasmoid life without organic molecules [L11]. Pollack effect generated negatively charged EZ as the interior of the proto cell bounded by 2-surface. It could have had a network of parallel magnetic flux tubes going through it and analogous to the lipid layer. Lipids and proteins would not have been present yet.

2.4 How did plasma life and haze (and/or meteorite-) life fuse?

Plasmoids and various organic pre-biotic life forms had to fuse to form a proto cell. Thunder storms and lightning strikes could have brought plasmoids to regions containing organic molecules. The simulations by Oparin demonstrated long ago that this could have led to the emergence of complex biomolecules such as amino acids. Pollack effect as an explanation of the findings leads to a model of proto cell [L3].

How did lipid membrane emerge? In the TGD based model of cell membrane lipids and proteins are attached to monopole flux tubes through the cell membrane. Did the attachment of lipids to the flux tubes of the proto membrane lead to the formation of the predecessor of the cell? Ball lightnings might be an outcome of this process [L9] and represent a fusion of plasmoid and organic prebiotic life form. I have also considered a connection with icosa tetrahedral tessellation and possible 2-D realization of the genetic code [**?**, L23].

2.5 Was there a period of underground life?

Cosmic rays and UV radiation were not favorable for the evolution of more complex life forms. Life had to go underground. When did it occur? Did the haze organics emerge shortly after the formation of Moon (or first moon in the case of Mars) when the temperature was low enough.

1. The TGD view the formation of Moon and moons of Mars [L16, L2] suggests that Moon and moons of Mars were formed in gigantic nuclear explosion [L25] as dark nuclei predicted by TGD and consisting of dark protons transformed to ordinary ones and liberated practically all nuclear binding energy. This mechanism would explain also "cold fusion" [L19]. There is direct empirical evidence for a huge nuclear explosion in the case of Mars [E4]!

2. Multicellular life would have evolved in the womb of Mother Gaia [L1, L5, L12] providing shielding against the meteorites and cosmic rays in underground oceans. The core of the Earth would have provided metabolic energy as radiation, possibly in the form of dark photons. This would have lead to the evolution of photosynthesis and multicellulars.

3. In Cambrian Explosion the radius of the Earth would have increased by a factor 2 in Cambrian Explosion [L1, L5, L12]. This would have been caused by a gigantic nuclear expansion in the interior of the Earth [L25]. This bursted the underground oceans and multicellular life to the surface of the Earth and oceans were formed.

4. The really dramatic proposal is that "big" state function reductions (BSFRs) in a giga year scale was involved. The arrow of time would have changed in the first BSFR as the Moon was formed and changed again in Cambrian Explosion. Similar model applies in the case of Mars [L25].

3 Some applications

3.1 Life in Mars after all?

I encounted highly interesting articles related to the possibility of life in Mars. This hypothesis was already thought to be dead but has experienced re-incarnation.

The first piece of evidence for microbial metabolism comes from he samples found by Mars rover Perseverance. Perseverance found rocks with blue-green and brown speckles in an area it mapped last July believed to be an ancient lakebed. According to a recent study, the speckles on the rocks are minerals that are commonly found on Earth in sediments, peat bogs, near decaying organic material, or produced by microbes. The presence of minerals could indicate life, because on Earth, these minerals are often present in soil as a result of microbial metabolism.

The peer-reviewed study was published in the journal Nature. The following is the abstract of the article [E2] (see this) "Redox-driven mineral and organic associations in Jezero Crater, Mars" by Hurowitz JA et al.

The Perseverance rover has explored and sampled igneous and sedimentary rocks within Jezero Crater to characterize early Martian geological processes and habitability and search for potential biosignatures. Upon entering Neretva Vallis, on Jezero Crater's western edge, Perseverance investigated distinctive mudstone and conglomerate outcrops of the Bright Angel formation.

Here we report a detailed geological, petrographic and geochemical survey of these rocks and show that organic-carbon-bearing mudstones in the Bright Angel formation contain submillimetre-scale nodules and millimetre-scale reaction fronts enriched in ferrous iron phosphate and sulfide minerals, likely vivianite and greigite, respectively. This organic carbon appears to have participated in post-depositional redox reactions that produced the observed iron-phosphate and iron-sulfide minerals.

Geological context and petrography indicate that these reactions occurred at low temperatures. Within this context, we review the various pathways by which redox reactions that involve organic matter can produce the observed suite of iron-, sulfur- and phosphorus-bearing minerals in laboratory and natural environments on Earth. Ultimately, we conclude that analysis of the core sample collected from this unit using high-sensitivity instrumentation on Earth will enable the measurements required to determine the origin of the minerals, organics and textures it contains.

I learned also about second interesting finding supporting life in Mars [E1] see this). The article "Viking Mars, Now 50 Years Old, Still Needs a Scientific Analysis" [**?**]see this)

The article describes the findings of scientists led by Steve Benner, a professor of chemistry at the Foundation for Applied Molecular Evolution in Florida. The samples were studied for possible presence of life already 50 years ago in Viking mission. It was concluded that there are no signs for life. It however seems that the conclusion was not correct.

The GC-MS worked by heating samples of Martian dirt (mud stone) — first to 120 degrees Celsius to remove any excess carbon dioxide from Mars' atmosphere, and then to 630 degrees C in order to vaporize any organics present in the dirt so that they could be analyzed by the mass spectrometer.

Puzzlingly, all that the mass spectrometer detected was an unexpected second burst of carbon dioxide and a small quantity of methyl chloride and methylene chloride, when instead there should have been some organic molecules present, if only from meteoritic debris that had built up over billions of years.

The answet to the mystery came in 2008, when NASA's Phoenix lander discovered perchlorate on the Martian surface. Perchlorate is also an oxidant, strong enough to destroy organics from meteorites over the course of millennia. In 2010, Rafael Navarro-González showed that organics plus perchlorate produces methyl chloride and carbon dioxide. Perchlorate would have destoyed the organics as evidence for life!

There is also a third article "Does the Measured Abundance Suggest a Biological Origin for the Ancient Alkanes Preserved in a Martian Mudstone?" by Pavlov et al [**?**] (see

this). Here is the abstract of the article .

The measured abundance (30–50 ppb) of long-chain (C10–C12) alkanes and their possible carboxylic acid precursors found in the ancient Cumberland mudstone in Gale Crater would have been substantially higher before the onset of exposure to ionizing radiation approximately 80 million years ago. Based on recent radiolysis experiments, we estimate conservatively that the Cumberland mudstone would have contained 120–7700 ppm of long-chain alkanes and/or fatty acids before ionizing radiation exposure.

Such a high concentration of large organic molecules in martian sedimentary rocks cannot be readily explained by the accretion of organics from carbon-rich interplanetary dust particles and meteorites, nor by the deposition of hypothetical haze-derived organics from an ancient martian atmosphere.

We discuss the feasibility of two additional mechanisms––one abiotic and one biological––that could have been capable of depositing this level of long-straight-chain organic molecules in the ancient martian mudstones: allochthonous transport of hydrothermally synthesized organics and autochthonous accumulation of organics from a hypothetical ancient Mars biosphere. To advance and test these and any additional working hypotheses put forth to explain such high concentrations of primary organics on Mars requires an understanding of the radiolytic degradation products expected for organics preserved in mineralogically comparable mudstones.

Allochthonous transport refers transport from elsewhere. The article excludes the hydrothermal vents and meteoritic orgin. Also haze organics option are excluded. If the claim is true, the organics could come from life forms, say bacteria, at the surface in the interior of the Mars, which would generalize the the TGD based model for the evolution of life in the underground oceans.

3.2 Basic ingredients of life found in conditions prevailing in the early universe

Using the James Webb Space Telescope, astronomers have detected complex organic molecules frozen in ice around a baby star called ST6, located in the Large Magellanic Cloud, a neighboring galaxy about 160,000 light-years away (see). There is an article [E3] about the finding by Sewilo M. et al, with title "Protostars at Subsolar Metallicity: First Detection of Large Solid-State Complex Organic Molecules in the Large Magellanic Cloud", published in Astrophysical Journal Letters (see this).

Molecules like methanol, ethanol, acetaldehyde, methyl formate, and even acetic acid the key ingredient of vinegar were locked inside cosmic ice. These chemicals belong to the molecules that help kick-start chemistry needed for life. Until now, finding them in solid ice was incredibly rare, even inside our own galaxy.

The Large Magellanic Cloud is a harsh place. It has fewer heavy elements and stronger radiation conditions similar to the early universe, long before planets like Earth existed. Despite this complex organic chemistry is possible there. Does this mean that the ingredients for life don t need perfect conditions or that there is new physics involved? Even more, is this new physics universal.

It is very difficult to imagine how a complex biochemistry (biochemistry as we understand it) could have prevailed much before planets like Earth did exist. New physics seems to be required and TGD predicts it. The notion of a field body (field-/magnetic body) carrying large h_{eff} phases of ordinary matter [L8, L25, L6, L11, **?**] could explain how the organic molecules crucial for life could have formed in these circumstances.

1. Water is a key element of life in TGD inspired quantum biology. Therefore the fact that the molecules were inside ice is a valuable hint. Pollack effect [**?**] occurs when water is irradiated with, say, infrared photons arriving from the Sun or some other source now the protostar. Pollack effect generates negatively charged regions, Exclusion Zones (EZs) with rather strange properties such as the ability to kick out impurities, which seems to be in conflict with the second law of thermodynamics.

   Protons must go somewhere from the EZ and the TGD inspired proposal is that they go to the magnetic body of the system and form a large h_{eff} phase, in many cases behaving like dark matter. These phases are not however identifiable as galactic dark matter. h_{eff} serves as a measure for the algebraic complexity of the space-time surface and also for the level of conscious intelligence, a kind of universal IQ. The magnetic body naturally controls the physics of ordinary matter.

   What matters is the energy needed to kick ordinary protons to the magnetic body: the needed energy corresponds to the energy difference between $-OH$ and O^- + dark protons in the magnetic body. These two states of proton are proposed to define what might be regarded as a universal topological qubit [L6, L11, L17]). Also the formation of organic molecules as bound states liberates binding energy and can induce the generalized Pollack effect.

2. The formation of dark protons at the magnetic body of water could represent one of the first steps in the evolution of life and already at this stage the dark analogs of the basic information molecules, genetic code and metabolism could have emerged. The chemical realization of the genetic code would have emerged later.

Could the Pollack effect and the notion of magnetic body allow us to understand the formation of the basic molecules of life found to exist in the Magellanic Cloud. -OH group, appearing also in water molecules, is essential for the standard form of Pollack effect so that it could be important also now. Pollack effect has also a generalization [L11, L9] in which the formation of bound state of atoms would involve the emission of the binding energy as visible or UV photons, which could kick protons or even alkali ions to the magnetic body and generate negatively charged EZs. The wildest dream is that the generalized Pollack effect gives rise to basic organic molecules of life.

1. Complex alcohols can contain more than one -OH group bound to a saturated Carbon atom. Simple alcohols (see this) obey the formula $H-(CH_2)_n-OH$. Both methanol $(CH_3)-OH$ and ethanol $(CH_3)-(CH_2)-OH$ contain the -OH group so that Pollack effect is possible for them and could explain the special effects of alcohol on consciousness. Note that methane CH_4 emerges from the decompositions of organic materials.

2. Acetaldehyde $(CH_3)-(H-C=O)$ can be formed by a partial oxidation of ethanol in an exothermic reaction at temperatures 500-650 C. The reaction equation for the condensation of acetaldehyde and O_2 is $2\ (CH_3)-(CH_2)-OH+O_2 \rightarrow 2(CH_3)-(H-C=O)+2H_2O$.

   One can imagine the following sketch for what might happen. At the first step the protons of $-OH$ groups of ethanols are kicked to dark protons at the magnetic body. This would induce the transformation of $C-O$ bonds to $C=O$ bonds, forcing C to give up the second H atom of CH_2. The dark protons would drop back to ordinary protons and together with electrons and the two H atoms and oxygens of O_2 would form 2 water molecules.

3. Methyl formate $(CH_3)-(O=C-OH)$ can be produced in the condensation reaction $(CH_3)-OH+H-(O=C-OH) \rightarrow CH_3)-(O=C-OH)+H_2O$ of methanol $(CH_3)-OH$ and formic acid $H-(O=C-OH)$. Dehydration is involved.

   OH group must be replaced with $O=C-OH$ in the reaction. One can imagine that the proton of $-OH$ is temporarily transformed to a dark proton at the magnetic body and facilitates the replacement. After that the dark proton, O^- and $H-$ of $H-(O=C-OH)$ combine to form the water molecule.

4. Acetic acid $(CH_3)-(O=C-OH)$ is formed by the transformation $H_2 \rightarrow = O$ occurring in the condensation reaction of ethanol and oxygen as $(CH_3)-(CH_2)-OH+O_2 \rightarrow (CH_3)-(O=C-OH)+H_2O$ involving dehydration. Also now the proton of $-OH$ could transform to a dark proton. This should induce replacement $CH_2 \rightarrow C=O$, the splitting of O_2 and the formation of H_2O. The dark proton would drop back and $-OH$ would be regenerated.

Could the detected molecules allow us to conclude anything about the presence of more complex biomolecules such as sugars and riboses crucial for life?

1. Sugars or carbohydrates (see this), involve monosaccharides with formula $C_nH_{2n}O_n$, with n in the range 5 to 7, have a key role in metabolism. They contain a relatively large number of -OH groups associated with an aromatic ring. For $C_6H_{12}O_6$ (fructose, galactose, glucose) have 4 -OH groups. Yeasts break down fructose, galactose and glucose to ethanol in alcoholic fermentation. More generally, alcohols such as mannitol emerge in the reduction of saccharides.

2. TGD suggests that the metabolic energy liberated as sugars burn to alcohols involves the transfer of dark protons to the magnetic bodies of the acceptor molecules followed by their transformation to ordinary protons liberating the metabolic energy. This would occur in the $ADP \rightarrow ATP$ process.

3. Ribose $C_5H_{10}O_5$ (see this), appearing in RNA, contains 4 -OH groups and deoxyribose $C_5H_{10}O_4$ appearing in DNA contains 3 -OH groups. Phosphorylated ribose appears in ADP, ATP, coenzyme A and NADH.

   Biological and chemical reduction and fermentation can produce ribitol $C_5H_{12}O_5$, which is a sugar alcohol. When ribitol is subjected to hydroxyl radicals, $C-C$ bonds are cleavaged and formic acid $((H-C=O)-(OH))$ appears as a decay product. Methanol was detected: could formic acid transform to methanol $((CH_3)-(OH))$ in the presence of water by the reaction $(H-C=O)-(OH)+H_2O \rightarrow (CH_3)-(OH)+O_2$?

To conclude, the temporary transformation of proton to dark proton at the magnetic body by Pollack effect could be involved with all these reactions.

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