Article

Some Mysteries of the Biological Evolution from the TGD Point of View

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Abstract

In this article 3 mysteries related to the origin of life on Earth are discussed. The recent candidate for life's universal common ancestor (LUCA) has a surprisingly large number of genes, much larger than the earlier candidate and it would be a rather complex life form. The sudden emergence of complex multicellular life forms in the Cambrian Explosion is the second mystery. The TGD proposal for the solution of the LUCA mystery relies on the solution of the mystery of the Cambrian explosion. Bacteria and archaea would have evolved at the surface of the Earth and eukaryotes having a cell nucleus and reproducing sexually in the underground oceans. Bacteria and archaea would have evolved from a counterpart of LUCA having a much smaller genome and eukaryotes would have evolved from an archaea with maximum size, which became the nucleus of the first eukaryote, LUCA. The third mystery relates to the asteroid Ryugu, which was found to contain basic amino acids and also RNA and microorganisms bacteria and microfossils resembling those living at Earth were found. Does this support the Panspermia hypothesis? There are however strong objections against this hypothesis and it has been proposed that the microorganisms living on Earth might have somehow colonized the Ryugu sample. There is no known mechanism for how this could happen. The TGD based solution of the mystery relies on the prediction that life and its evolution are long length scale phenomena involving gravitational and electric field bodies, which can have an astrophysical size.

1 Introduction

Biological evolution involves several deep mysteries. In this article 3 such mysteries are discussed.

1.1 The mystery of life's origin deepens

Sabine Hossenfelder told about new study, which deepens the mystery of life's origin (see this). The key notion is LUCA, life's universal common ancestor, whose genome should be common to all life forms, which in the most general case involves both archaea, prokaryotes (bacteria), and eucaryotes (plants, fungi and animals).

The newest study gives a considerably larger number than the previous estimates.

1. LUCA would have 2,657 genes. Luca would have had 2.7 million bps to be compared with about 3 billion bps of humans. LUCA would have lived about 4.2 billion years ago.

2. The proteins coded by the genes of LUCA suggest that hydrogen was important in the metabolism of LUCA. Presumably LUCA lived near volcanoes. LUCA also had a rather complex metabolic circuitry and the genome suggests that it was a part of an ecosystem. The size of LUCA is 10 μm in size, which is also the size of cell nucleus, and it has a genome but no nucleus.

3. An interesting side observation is that 2,657 is prime and forms a twin prime together with 2659. Maybe number theory is deeply involved with the genome.

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4. The earlier estimate for the gene number of LUCA by Bill Martin's team (see this) left only 355 genes from the original 11,000 candidates, and they argue that these 355 definitely belonged to LUCA and can tell us something about how LUCA lived.

The problem is that there are two widely different candidates for the LUCA and the new candidate seems to be too complex if one assumes a single evolutionary tree.

1.2 The mystery of Cambrian Explosion

Cambrian Explosion represents a long standing mystery [6] of evolutionary biology. The basic mystery is that highly evolved multicellular life forms emerged suddenly in the Cambrian explosion about .5 billion years ago. There are much older fossils of monocellular life forms archaea and prokaryotes and they would have lived at the surface of Earth as separate evolutionary lineages.

The TGD based solution of the mystery mystery of Cambrian Explosion does not involve ETs bringing multicellular life to the Earth [7] [9, 8, 13].

1. In the TGD Universe, quantum gravitation is possible in arbitrarily long scales and cosmic expansion is replaced by a sequence of quantum phase transitions occurring in astrophysical scales as very rapid local expansions between which there is no expansion.

2. The life on Earth could have evolved in two ways and as three separate evolutionary trees. Multicellular life forms possible for sexually reproducing eukaryotes would have evolved in the underground oceans, where they were shielded from meteor bombardments and cosmic rays. There are indications that underground oceans and underground life are present on Mars and possibly also some other places in the solar system.

3. In the Cambrian Explosion, identified as a short lasting rapid local cosmic expansion, the radius of Earth would have increased by a factor of two. This hypothesis was originally inspired by the observation of Adams [2] that the continents seem to fit nicely together if the radius of Earth is taken to be 1/2 of its recent radius. This hypothesis would generalize the continental drift theory of Wegener. Rather highly developed photosynthesizing multicellular life forms would have bursted to the surface of Earth from underground oceans and oceans were formed [7] [9, 8, 13].

The TGD proposal for the solution of the LUCA mystery relies on the solution of the mystery of the Cambrian explosion. Bacteria and archaea would have evolved at the surface of the Earth and eukaryotes having a cell nucleus and reproducing sexually in the underground oceans. Bacteria and archaea would have evolved from a counterpart of LUCA having a much smaller genome and eukaryotes would have evolved from an archaea with maximum size, which became the nucleus of the first eukaryote, LUCA.

1.3 Perplexing findings about asteroid Ryugu

Anton Petrov told in in Youtube video (see this) "Shocking Discovery of Earth Bacteria Inside Ryugu Asteroid Samples + Other Updates" of highly interesting recent discoveries, which might provide very strong direct evidence for the TGD view of quantum biology. Ryugu was found to contain basic amino acids and also RNA and microorganisms bacteria and microfossils resembling those living at Earth were found.

The motivation for studying asteroids is that they could have been very important in the planetary formation. The Panspermia hypothesis suggests that asteroids and similar objects could have also brought life to the Earth and the findings about Ryugu could at first be seen as a support for this hypothesis.

One question raised by the study is whether the microorganisms living at the Earth managed somehow to colonize the Ryugu asteroid sample. In standard biology this should not be possible. The alternative possibility is that the evolution in Earth and Ryugu has been very similar: Ryugu indeed orbits the Sun at an on orbit for which the distance from the Sun is smaller than the orbital radius of Mars.

This would however require that the biological evolution is dictated by physics in a much longer length scale than the Earth size scale. This is just what TGD predicts. These findings provide a test for the TGD view of life which suggests a very general basic mechanism for the emergence of life [10, 12, 14].

2 LUCA from the TGD perspective

In the following the explanation for the perplexing findings about LUCA are discussed from the TGD point of view.

2.1 Some basic facts about evolution

Let us relate the proposed identification of LUCA with 2657 genes to basic facts about biology.

1. It is known that parasitic bacteria have 500–1200 genes, free-living bacteria have 1500–7500 genes, and archaea have 1500–2700 genes. Prokaryotes and archaea are monocellular organism and do not have cell nucleus. Eukaryotes differ from Archaea and prokaryotes in that they can sexually reproduce: this means huge evolutionary step.
2. Archaea (see this) are often thought to be more primitive than prokaryotes (see this) and eukaryotes (see this but it seems that they resemble eukaryotes more than prokaryotes. It should be noticed that mitochondria (see this) responsible for the metabolism have their own genome having only 37 genes to that one could (just for fun) argue that mitochondria are a natural identification of LUCA!
3. The lower bound for the gene number of free living bacteria and archaea is 1500 and smaller than 2657. It is however known that ancient bacteria had more genes than their recent forms. This might be due to the fusion of the genes to longer genes. They could be also predecessors of LUCA in some sense.

2.2 The number of genes for LUCA is upper bound for the genes of archaea: what does this mean?

Intriguingly, 2657 is near the upper limit 2700 for the gene number of archaea. This raises questions.

1. Could the branches of the evolutionary tree have genuine dead ends, and are archaea and bacteria such dead ends? Could prokaryotes and archaea correspond to separate lineages of the evolutionary tree and did eukaryotes evolve from archaea as the cell nucleus emerged?
2. Was the gene number 2657 a critical gene number distinguishing between archaea and higher life forms? Could this be the critical gene number above which the cell nucleus possessed by eukaryotes becomes possible and makes possible sexual reproduction and explosive evolution of new life forms. Did the maximally complex archaea with 2657 genes become the first eukaryote nucleus, LUCA?

   If this was the case, did prokaryotes really share the genes of LUCA? Also prokaryotes and archaea with shorter genomes exist. Are these predecessors of the nucleus of LUCA? Did prokaryotes with gene number larger than 2657 evolve from prokaryotes separately?
3. Do prokaryotes and archaea have a common predecessor analogous to LUCA having much lower number of genes and is it the previous candidate for the LUCA having 355 genes.

2.3 Two mysteries with a common solution: Cambrian Explosion and the complexity of LUCA

The complexity of the genome of LUCA looks like a mystery as also the existence of two widely different candidates for LUCA. One possible solution of the mystery relies on the Panspermia hypothesis. Most life forms would have arrived to the Earth from elsewhere and only sufficiently complex organisms, whose genomes contained the LUCA genome, survived in the new environment. The TGD based solution of the mystery does not involve ETs but relies on the TGD inspired solution of the mystery of Cambrian Explosion [7] [9, 8, 13].

In this framework, one can imagine three separate evolutionary lineages.

1. Archaea and prokaryotes such as cyanobacteria, about which there are fossils much before the Cambrian Explosion, would have evolved at the surface of Earth. Note that cyanobacteria have about 559 core-genes (see this).

2. More complex multicellular eukaryotes, having a cell nucleus and reproducing sexually, would have evolved in the underground ocean oceans. The basic evolutionary step would have been the emergence of the cell nucleus, perhaps as a fusion of two monocellulars. This step could have led from LUCA as a maximally complex archaea to eukaryotes. For some reason, eukaryotes would have survived only in underground oceans. Cosmic rays causing damage to the genes inside it might have made sexual reproduction too risky.

3. Eukaryotes would have had the proposed LUCA as a common ancestor as the maximally complex archaea whereas the earlier candidate for LUCA would be the common ancestor of archaea and prokaryotes.

4. Either all the organisms of the underground oceans contained the maximally complex archaea genome or only the organisms of the underground oceans having a genome not sorter than the LUCA genome were sufficiently complex to survive besides the prokaryotes present from the beginning at the surface of Earth.

   LUCA as the first eukaryote, having the maximally evolved archaea as cell nucleus, would have had just the minimum number of genes needed to survive at the surface of the Earth. The archaea and bacteria having a genome shorter than LUCA genome would have emerged in the evolution at the surface of the Earth before the Cambrian Explosion.

5. A fusion of two unicellulars took place in the formation of LUCA and outer cell membrane emerged. An archaea with the genes of LUCA became the nucleus of the first eukaryote cell. The minimal choice for the second unicellular is mitochondria with 37 genes: this would give 2694 genes, almost the upper bound of 2700 for archaea. If cell membranes are an outcome of self-organization rather than being coded, this system might have been able to code itself.

3 The perplexing findings about the asteroid Ryugu from the TGD perspective

The TGD perspective about Ryugu is based on the notion of long range quantum coherence predicting the notions of gravitational and electric magnetic body carrying phases of ordinary matter with a very large value of Planck constant [11, 10, 12, 14]. These field bodies with sizes in astrophysical scales are predicted to be fundamental for life and its evolution and imply that the evolution of the chemical life is predicted to be induced by the evolution at the level of the field bodies. In this framework one can understand why Ryugu can contain life forms resembling those on Earth.

3.1 Some facts about Ryugu

Some basic facts about Ryugu are in order. Consider first the origin of Ryugu.

1. The surface of Ryugu is very young and has an age of 8.9 ± 2.5 million years. The composition of Ryugu shows that its material has been at a rather high temperature about 1000 C and presumably near the Sun. Eventually Rygu would have left the inner solar system and its composition suggests that it has been very near to the Kuiper belt with distance 30-55 AU.

2. The asteroid that arrived near the Earth from outer space must have been for a long period in complete darkness. The object giving rise to Ryugu could have originated far from Jupiter, possibly near the Kuiper belt. Some compounds in Ryugu can only form near the Kuiper belt. A larger object of radius about 100 km could have suffered a collision near Earth and produced Ryugu with a size of 10 km near Earth.

3. Recently Ryugu orbits the Sun at a distance of 0.96-1.41 AU once every 16 months (474 days (16 months); semi-major axis of 1.19 AU). Note that the distance of Mars from the Sun is about 1.5 AU. Its orbit has an eccentricity of 0.19 and an inclination of 6 degrees with respect to the ecliptic.

The circumstances at Ryugu are favorable for life.

1. The highest temperature on the Ryugu asteroid reaches 100 degrees C, while the coldest regions sit at about room temperature. Temperatures also change depending on the solar distance of the asteroid, lowering as Ryugu moves further away from the Sun. This would mean that the circumstances at Ryugu become favourable for life as it passes Earth. The lowering of the temperature at a large distance would not be fatal.

   Hydration is essential for life. The required range of dehydration reaction temperature decreases with increasing substitution of the hydroxy-containing carbon: Primary alcohols: 170–180 degrees C; secondary alcohols: 100–140 degrees C; tertiary alcohols: 25 degrees-–80 degrees C. Primary/secondary/tertiary refers to the position of -OH substitution in Carbon atom.

2. Ryugu contains liquid water and also carbonated water. Coral-like inorganic crystals are present. The sample contained carbon rich molecules, amino acids and components of RNA and hydrated compounds! Ammonium.

3. It has also been found that Ryugu contains phosphorus rich samples. Phosphorus plays a central role in metabolism and in the ”dark” realization of the genetic code in TGD. The abstract of the article [4] summarizes the findings.

   Parent bodies of C-type asteroids may have brought key volatile and organic-rich compounds to the terrestrial planets in the early stages of the Solar System. At the end of 2020, the JAXA Hayabusa2 mission successfully returned samples from Ryugu, providing access to a primitive matter that has not suffered terrestrial alteration. Here we report the discovery of a peculiar class of grains, up to a few hundreds of micrometres in size, that have a hydrated ammonium–magnesium–phosphorus (HAMP)-rich composition. Their specific chemical and physical properties point towards an origin in the outer Solar System, beyond most snow lines, and their preservation along Ryugu history. These phosphorus-rich grains, embedded within an organic-rich phyllosilicate matrix, may have played a major role when immersed in primitive terrestrial water reservoirs. In particular, in contrast to poorly soluble calcium-rich phosphates, HAMP grains favour the release of phosphorus-rich and nitrogen-rich ionic species, to enter chemical reactions. HAMP grains may have thus critically contributed to the reaction pathways of organic matter towards a biochemical evolution.

3.2 Objections against the Panspermia hypothesis as explanation of the findings about Ryugu

The panspermia hypothesis states that Ryugu and similar objects could have served as a source of life on Earth.

1. Overpopulation problem is the theoretical objection against the Panspermia hypothesis. No new forms of life are possible since no niches are left untouched.

2. There is also a second objection against the panspermia hypothesis as an explanation of these findings about Ryugu. It has been claimed that the Ryugu sample was contaminated by terrestrial microorganisms [3] (see this). Nitrogen dioxide NO_2 is used in sterilization meant to remove, kill, or deactivate all forms of life present in fluid or on a specific surface. Life forms of Earth should not be able to colonize samples under extremely sterile conditions. If contamination occurred, its mechanism is unknown.

   The Ryugu samples contained terrestrial microbes and they evolved with time. Their DNA has not yet been identified. They resemble bacilles, which are everywhere on the Earth.

3. Microfossils have been found in meteorites [5]. They have been found also in Ryugu but only at the surface of Ryugu and were reported to be new fossils. The reason could be that microbes have survived only at the surface of Ryugu where they receive solar light necessary for photosynthesis. The proposal of [3] is that terrestrial organisms might by some unknown mechanism have contaminated the surface of Ryugu and produced the microfossils.

3.3 The TGD view of Ryugu

Neither panspermia hypothesis nor contamination look plausible in the TGD framework. Life would have evolved by the same basic mechanism both at the Earth and the asteroids and other similar objects.

1. Ryugu stays relatively near the Earth at its orbit. This could have also made possible the generation of organic matter inside the sample during the period that Ryugu has spent at its orbit around the Sun. This requires a model for how this happens and standard physics does not provide such a model.

2. The notion of the field body is central in the TGD inspired quantum biology and would act as controller of the biological body [10, 12]. Ordinary genetic code is proposed to be accompanied by its dark variant realized at the field body for ordinary particles at it having a very large value of effective Planck constant and behaving like dark matter. Could the field body of the Earth and Sun have induced the generation of organic molecules and even bacterial life forms in the same way as they did this at the Earth?

3. The notion of the gravitational magnetic body, characterized by gravitational Planck constant introduced by Nottale [1], containing protons behaving like dark matter, represents new quantum physics relevant to the TGD inspired quantum biology. OH-O^- + dark proton qubits and their generalizations based on biologically important ions formed by salts would be the key element of life [14] suggesting besides chemical life also other forms of life.

   Any cold plasma (plasmoids as life forms) and even quartz crystals could give rise to these qubits at temperatures near the room temperature around which the flips of these qubits are possible. The difference of OH bonding energy and O^- binding energy determines the relevant energy. Its nominal value is .33 eV and is near the metabolic energy quantum of about .5 eV and near to the thermal energy .15 eV at physiological temperatures.

4. These qubits would make the matter living and life in this sense is universal. Dark genetic code is predicted and corresponds to the ordinary chemical genetic code. Basic biomolecules would give rise to analogs of topological quantum computers.

   The flipping of these qubits would make quantum computation like information processing possible? Pollack effect by photon absorption can induce OH→ O− +dark proton transition and the reversal of this process and the reversal of this process can take place spontaneously. If O^-+dark proton has a lower energy than OH, it can be also induced by a presence of electric field or absorption of photons by O^- so that OH becomes the minimum energy state.

Could one understand the findings about Ryugu in this framework?

1. The presence of gravitational magnetic bodies of Earth and Sun could have induced the formation of OH-O^- qubits and more general qubits, not only at the Earth but also at Ryugu. The presence of OH bonds requires hydration and hydration is indeed possible at Ryugu.

   Therefore the same mechanism could have led to the emergence of the basic organic molecules at the Earth, at Mars and inside the Ryugu asteroid and meteorites. Since the minimal distance of the Earth and Ryugu from the Sun is nearly the same, the temperature of Ryugu is near its maximal value when it is near the Earth so that the temperature would never get too hot.

2. Ryugu is under the influence of the gravitational bodies of both the Earth and the Sun. Ryugu passesnear the Earth repeatedly with a period of 4 years. The organic molecules and various hydrated compounds could have gradually formed during about 10 million years as it passed near the Earth. Also bacterial life could have emerged in this way. Therefore contamination need not be in question.

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