The origin of life on Earth, the panspermia hypothesis and cosmological DNA synthesis.

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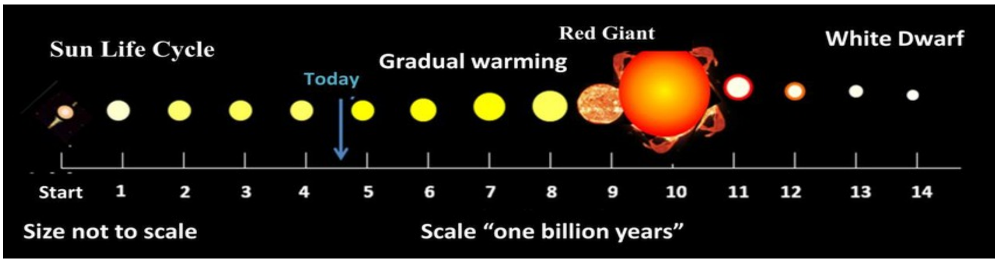
Abstract: The process of the rapid origin of life on Earth is analyzed, taking into account the evolution of our Sun (the beginning of thermonuclear reactions). Given the knowledge about DNA, viruses and the structure of bacteria, it is concluded that the origin of life on Earth was initiated from the outside. Further, using space chemistry, it is shown that spontaneous assembly of DNA/RNA molecules can occur on particles of interstellar and intergalactic dust. Therefore, when favorable conditions are created on the planet, the emergence of life begins rapidly, since the initiators of life are already available from cosmic dust (RNA and DNA molecules).

Keywords: origin of life on Earth, cosmological DNA synthesis, interstellar and intergalactic dust, the PAH World Hypothesis, panspermia hypothesis, the Sun's life cycle.

INTRODUCTION.

Life on Earth was born quickly. Very fast. It's impossible to believe... Let's make a small digression. When life occurs on Earth, as a rule, the age of the Earth is taken into account, which is logical. But, we will take into account the age of our star. That is, our Sun. And an amazing fact is revealed: when thermonuclear reactions began to take place on the Sun, that is, when it was ignited, life was born in an amazing way on planet Earth. Recall that according to modern models, life on Earth arose about 3.8 - 4.1 billion years ago [1, 2]. And now, let's see a picture (the Sun's Life Cycle) that demonstrates the process of evolution of stars [3, 4].



Given our current situation (4.57 billion years), and the fact that life was born 4.1 billion years ago, we clearly see that life was born at lightning speed when the thermonuclear reaction began on the Sun. This is an incredible fact, since it took about 400 million years to start life. Given our knowledge of DNA, viruses, and the structure of bacteria, we can confidently say that spontaneous generation of life in such a short period of time is impossible. Never! And this is fundamental.

DNA, RNA, proteins, and other biopolymers are billions of atoms. And the spontaneous origin of life implies that these molecules (specifically, DNA/RNA) must be formed randomly, from simple molecules or individual atoms. Naturally, they can accidentally form, but it will take much more time. In addition, there will also be “empty combinations” of DNA/RNA. And, their number will be truly gigantic, and nature will need time to do this sorting (empty combinations → real DNA). But, on planet Earth, we see a completely different picture: life was born instantly. Literally. One gets the impression that someone was in a hurry so that there was time for biological evolution... But, this is a false impression, everything can be explained logically using chemistry, or rather, cosmic chemistry. We also clarify that the Earth was formed from the solar nebula about 4.54 billion years ago [5].

RESULTS AND DISCUSSION.

So, it is quite obvious that the birth of life on Earth was initiated in a certain way from the outside. One gets the impression that our Earth literally "became pregnant with life". If we immediately discard the ideas of the creator, the intervention of aliens, etc., then we will only have the hypothesis of panspermia [6 - 11]. But, here, too, everything is complicated. The panspermia hypothesis postulates the possibility of the transfer of living organisms (or germs) through outer space. Such a transfer is possible by meteorites, asteroids, comets, space vehicles, etc. Therefore, life on Earth can be brought from outer space. But, unfortunately, the hypothesis of classical panspermia does not hold water.

Obviously, for the spread of living organisms (or germs) it is necessary that they travel in space. That is, a meteorite that contains bacteria (for example, in its center) must have a speed sufficient to overcome the attraction to its star, or to its galaxy. This speed is called escape velocity. And this is difficult to do, since the escape velocity for stars (and especially for galaxies) is quite large. The escape velocity for the Sun is 617.7 km/s. But, taking into account the speed of the Earth, the spacecraft can already at a speed of ~ 16.6 km/s (relative to the Earth) leave the solar system (relative to the Sun, the device reached the runaway speed). Some artificial satellites have reached such speed, and will leave the limits of our system.

The escape velocity of the body within our galaxy is huge: approximately 550 km/s. It is difficult to accurately evaluate, you need to know the exact mass distribution in the galaxy. A satellite must have such speed in order to leave our galaxy (from our position, in the region of our Sun). This speed is 3.8 times less than the speed of an electron in a hydrogen atom. The speed of the Sun itself around the center of the galaxy is approximately 217 km/s. Therefore, even taking into account the speed of stars in the galaxy, the vast majority of meteorites, asteroids, and comets are prisoners of their galaxy. Since, the runaway speed will be 1.5 - 10 times less than the speed of an electron in a hydrogen atom (depending on the mass distribution in the galaxy). This means that from other galaxies, meteorites will not often fly to us. Therefore, the panspermia hypothesis is the hypothesis of the spread of life within the same galaxy. But, given the number of planetary systems like ours, as well as their location in the galaxy, it is quite obvious that this does not greatly increase the likelihood of life: there will be few such planetary systems (within the same galaxy). Panspermia would increase the likelihood of life if it could provide the "transport" of bacteria from one galaxy to another. But given the escape velocity, this is very unlikely.

Also, do not forget about the travel time of bacteria and living organisms in space (the panspermia hypothesis). Within one galaxy, it is hundreds of millions of years, since the speed of movement is not relativistic (the diameter of the Milky Way is one hundred thousand light years). And between galaxies it is billions of years. A lot of. Lots of. During such a time, living matter cannot survive. Given the ionizing radiation of space, we can confidently say that bacteria and more complex organisms have little chance of surviving. For hundreds of millions of years (especially billions), radiation quanta are guaranteed to turn a bacterium or cell into fragments of molecules. Within a single galaxy, living organisms will be very intensively subjected to various processes (x-radiation, gamma-ray bursts, etc.), and therefore, traveling within a single galaxy will be even more dangerous.

Thus, it is obvious that the panspermia hypothesis in its classical form cannot explain the rapid emergence of life on Earth. But, if we recall that life is primarily a DNA molecule, then everything can be logically explained. Traveling in space is disastrous for living organisms (or embryos), as they are complex biochemical factories. A DNA molecule is just a molecule, and it is guaranteed to be able to be destroyed only by x-radiation. Moreover, there should be a “direct hit" of a quantum in a chemical bond. If such a hit can be avoided (or if there is a recovery mechanism, synthesis), then the hypothesis of “DNA/RNA panspermia” can explain the fast appearance of life on Earth, and most importantly, the very process of the origin of life in the Universe. Consider this process.

Recall that a DNA/RNA molecule consists of carbon, hydrogen, oxygen, nitrogen and phosphorus atoms. Sulfur atoms are still found in proteins. That is, all atoms are synthesized in thermonuclear reactions of stars (with the exception of hydrogen, it is a raw material). And given the constant coronary mass ejections from the bowels of stars, all of these atoms are present in the corona of stars. For example, in the crown of our Sun.

For a demonstration, consider our Sun [12].

During coronal mass ejections, huge masses of matter are erupted from the bowels of the Sun, which are accelerated to gigantic speeds. The outlier contains a plasma consisting of electrons, protons, and other elements (helium, oxygen, carbon, nitrogen, phosphorus, etc.). The mass of such an emission is up to 10 billion tons of matter. The flight speed is approximately 400 km/s. Fast emissions have speeds of up to 2000 km/s. Pay special attention that fast ejections easily overcome escape velocity for stars and even galaxies. That is, the atoms of matter from the fast coronal emissions of stars will travel throughout the Universe. And this is the source material for DNA synthesis (emissions contain all the necessary elements), which is scattered throughout the Universe.

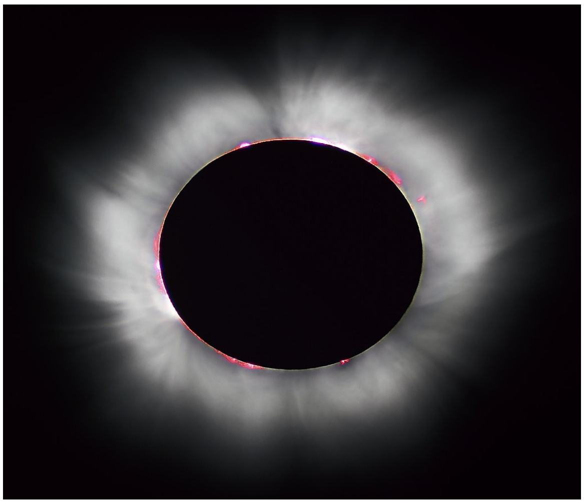
Thus, our entire Universe turns into a reactor for the synthesis of DNA/RNA. And given that the Universe is infinitely large, random synthesis of DNA/RNA molecules becomes a very likely process. Our flask, our reactor are infinitely large, therefore, the synthesis should end with a successful combination, that is, a real DNA molecule that will give rise to life! Nature is not without irony: everyone was looking for a place for primary DNA synthesis in the ocean, lake, under water, etc., but it turns out that the place of DNA/RNA synthesis is our whole infinite Universe. This is the scope, although..., everything is logical.

Add some information about coronal mass ejections from the bowels of stars. If such an ejection from the Sun is directed toward the Earth, it reaches the planet within one to three days. When an ejection reaches the Earth, it can have a strong influence on its magnetosphere (auroras, magnetic storms, disturbances in the operation of electrical equipment, etc.). It is also necessary to add that the entire solar system is located inside the solar corona, the upper boundary of which is not defined.

“The solar corona is the outer layers of the atmosphere of the Sun, starting above the thin transition layer above the chromosphere, in which the temperature rises 100 times...

The upper boundary of the corona of the sun has not yet been established. Earth, like other planets, is inside the corona. The optical radiation of the corona can be traced to 10 - 20 radii of the Sun... and merges with the phenomenon of zodiacal light.

The temperature of the crown is about a million kelvin. Moreover, from the chromosphere it rises to two million at a distance of about 70 000 kilometers from the visible surface of the Sun, and then begins to decrease, reaching one hundred thousand Kelvin at the Earth... During a total solar eclipse, the Sun's corona and prominences are visible to the naked eye" [13].



From the foregoing, it is obvious that the region of the solar corona, or in the general case of the stellar corona, guarantees in space the presence of atoms necessary for the assembly of DNA/RNA molecules. Moreover, these atoms will be present both in the stellar system and in outer space between galaxies. Next, we need to explain how exactly the primary DNA/RNA molecule was formed. That is, the chemical assembly mechanism itself. Using space chemistry to do this is quite simple. For this we use knowledge of cosmic dust. Yes, yes, it is dust. "And God created man from the dust of the earth..." (Bible. Genesis). As we will see later, this is exactly what happened... with some clarifications. Nature, God, the laws of the Universe, chaos, etc., must be considered as synonymous words.

"Cosmic dust is dust that is in space or enters the Earth from space. Its particle size ranges from a few molecules to 0.2 microns. According to various estimates, 60 to 100 tons of cosmic dust are deposited on the Earth's surface daily, which is 25 - 40 thousand tons per year.

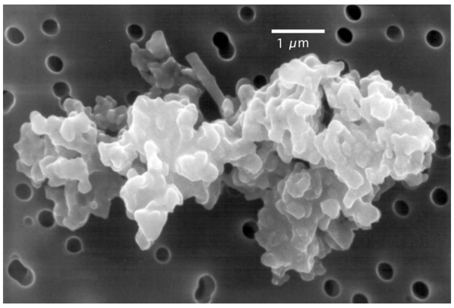
Solar system dust includes cometary dust, asteroid dust, Kuiper belt dust, and interstellar dust passing through the solar system. The density of the dust cloud through which the Earth passes is approximately 10^(-6) dust particles per m^3. In the solar system, interplanetary dust creates an effect known as the zodiacal light" [14].

Look at the photo: Cosmic dust of the Andromeda Galaxy as revealed in infrared light by the

Spitzer Space Telescope [15].

The definition of dust is given in a research paper [16]: Cosmic dust is particles smaller than 10 microns in size that move in interplanetary space. If such particles subsequently coalesce with large bodies of natural or artificial origin, they continue to be called "cosmic dust".

For us, interstellar dust and intergalactic dust will be of most interest. Since, when the solar system moves in space, it will pass through these types of dust. And therefore, if there was a “fertilization” of the Earth by a DNA/RNA molecule, then it was interstellar or intergalactic dust that did it [14].



Interstellar dust is solid particles (from 0.01 to 0.2 microns) that fill the space between stars. They have a refractory core surrounded by organic matter or an ice shell. The chemical composition is determined by the origin of the dust. That is, in the atmosphere of which stars they condensed. In the case of carbon stars [17], the dust particles will be composed of graphite and silicon carbide. To understand the physicochemical processes of the formation of dust microparticles, we quote [18]:

“The formation of refractory particles apparently occurs in a fairly dense medium at temperatures of 500 - 2000 ºK. These conditions can be satisfied by the outer parts of the atmospheres of giant stars and supergiants of late spectral classes, the envelopes of new and supernova stars, planetary nebulae and gas-dust condensations, from which protostars arise.

For fall out of elements or compounds from the gas phase to solid, it is necessary to exceed the gas pressure over the saturated vapor pressure of condensing substances. When nuclei of dust particles are formed in the atmospheres of cold stars, very refractory nuclei first appear. With moving gas, they move to higher and colder layers, where already more fusible compounds fall out into the solid phase. If in these layers the particles spend little time due to the acceleration of motion, then only part of the elements with low condensation temperatures fall out into the solid phase...

The chemical composition of the resulting dust particles is determined by the chemical composition of the gas from which they condensed... In the atmospheres of carbon stars, particles of graphite and silicon carbide appear, and in the atmospheres of oxygen stars, silicate particles appear. This is due to the fact that O atoms in the first case, and C atoms in the second, are connected into a CO molecule, and CO molecules are unable to condense into dust particles...

In interstellar clouds, condensation nuclei quite quickly become enveloped in shells of volatile elements, by the deposition of atoms of the most common elements H, C, N and O on them. In this case, physical adsorption on the surface is possible, in which an atom colliding with a dust particle... becomes connected.

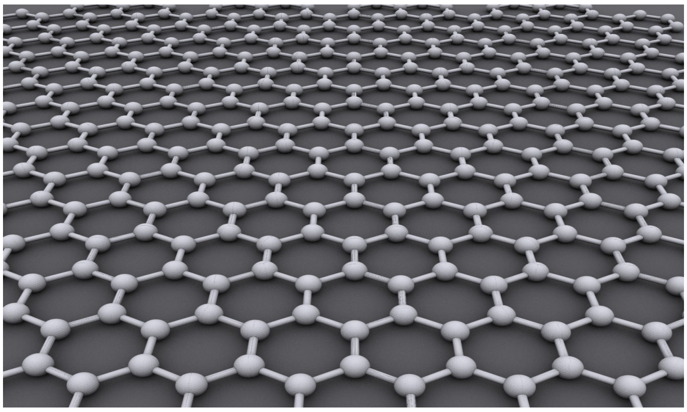
On particles with sizes less than 0.01 μm, the formation of shells most likely does not occur. This is due to the fact that from very small dust particles, atoms can evaporate (sublimate) with increasing dust temperature due to absorption of one photon, or the formation of one molecule on the surface.

...The bombardment of the surface of dust by atoms, ions or molecules having high speeds leads to the destruction of particles. The same effect should be manifested if a strong shock wave passes through the gas-dust region, for example, from a supernova burst. Dust particles in interstellar clouds are crushed as a result of collisions with each other at speeds greater than 20 km/s, however, in collisions with speeds less than 1 km/s, the process of coagulation (clumping) is going on".

Approximately the same physical chemistry of intergalactic dust particles [19, 20].

Intergalactic dust is cosmic dust in intergalactic space. This dust can be part of clouds of intergalactic dust. By 1980, four intergalactic dust clouds were detected within a few megaparsec (Mpc) from the Milky Way galaxy, as an example, the Okroy cloud.

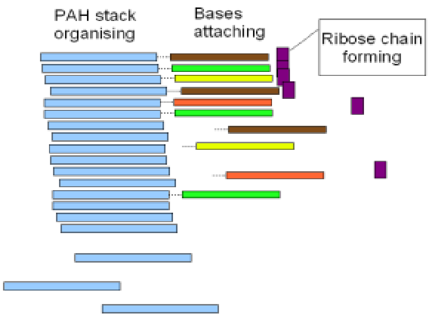
We will examine in detail the dust that contains graphite, since this is a direct path to the synthesis of a DNA/RNA molecule. Obviously, and it's chemically true, that graphite is a polycyclic aromatic hydrocarbon in which the number of benzene nuclei is equal to infinity (in one plane). That is, when we have two benzene nuclei, we get a naphthalene molecule. If we have an infinite number of benzene nuclei condensed in one plane, then we get graphene. That is, one plane of layered graphite [21].



It is clear that the dust that contains graphite will be destroyed under the influence of various factors (particle collisions, the action of radiation quanta, shock waves, etc.). Now let's ask ourselves: what will we get when graphite (more precisely graphene) is destroyed?

The answer for chemists is obvious: we will get various polycyclic aromatic hydrocarbons. Simply put, the number of benzene nuclei in one plane will no longer be infinitely large, but will be a small natural number. And this means that we got the transition from graphite to polyaromatic hydrocarbons. And this process is constantly taking place in cosmic dust, since the collisions of particles, their coagulation, etc., occur constantly. And as you know, there is a hypothesis of the world of polyaromatic hydrocarbons, which claims that it is these substances that led to the synthesis of RNA molecules, which ultimately led to the world of RNA, and then to the appearance of life.

"The hypothesis indicates that planar ring molecules of polycyclic aromatic hydrocarbons have the effect of spontaneously assembling into "stacks" with a step of 0.34 nm and attaching nucleotides to their side from the nitrogen base with hydrogen bonds. Then, due to the rotation of the "stack" rings, the nucleotides are attached by the ends with the formation of already covalent bonds, and so the RNA chain is joined with its typical step of 0.34 nm. The hypothesis also explains the higher likelihood of spontaneous assembly and the nucleotides themselves, since, first, their nitrogenous bases can join, and then the oligomeric backbone" [22].



It should be clarified that the step 3.4 Å (or 0.34 nm) is the distance between the layers in graphite. Strictly speaking, this is the intermolecular distance when the classical covalent bonds can no longer form (due to the large distance). Chemical bonds are formed at distances between nuclei (atoms) in the range from 0.7 Å to 3 Å. Further, intermolecular interactions begin. For this reason, the distance between the layers of graphite (and polyaromatic hydrocarbons) is 3.4 Å. From a chemical point of view, this is justified, since, with a greater distance between the layers, the interaction energy will be much less (which means that such structures will be less stable). And already between the layers of graphite the interaction energy is small, so the pencil writes (the layers are easily exfoliated). Compare this to diamond, where all bonds are classic covalent C - C bonds. You won't be able to write with diamond (the energy C - C of the bond is large), but you can scratch everything. The reason for this diversity is the energy of the chemical bond (dependence on length).

Thus, in cosmic dust, we have many microparticles that contain graphite. These particles during various processes generate polyaromatic hydrocarbons, which are the matrix for the synthesis of RNA molecules. Therefore, the synthesis of RNA and DNA molecules in cosmic dust is a very likely process. Given the presence of the necessary atoms, as well as the presence of polyaromatic hydrocarbons, it can be argued that the synthesis of RNA/DNA in space is almost guaranteed. Since the assembly of RNA and DNA molecules is actually a probabilistic process. The difficulty is that such a molecule consists of 1 billion atoms. But, the reactor is an infinite Universe.

CONCLUSION.

Therefore, sooner or later, a DNA/RNA molecule will be synthesized in space. Moreover, polyaromatic hydrocarbons (PAHs) are widespread in the visible Universe.

"The PAH World Hypothesis has led astronomers to analyze the prevalence of PAHs in the Universe. In 2014, NASA published a research database from which it follows that about 20 % of the carbon in the nebulae of the universe is represented as PAHs. PAHs could be brought from space to Earth during a meteorite bombardment at the beginning of the formation of its surface. An argument in favor of this hypothesis is the discovery of traces of PAHs on the ALH 84001 meteorite. According to NASA, PAH molecules are also a frequent comet material. In 2018, researchers discovered the process of synthesizing PAHs in the atmosphere of Titan" [22].

After the synthesis of the RNA/DNA molecule in outer space, it will travel on dust microparticles (interstellar, intergalactic) through space. Naturally, dust microparticles can travel in meteorites, comets.

Also, DNA and RNA molecules can travel in space themselves, under the influence of light pressure. A radiation quantum, the energy of which is insufficient to break chemical bonds, when it enters a molecule, will transmit its momentum to it. And therefore, the RNA molecule (or DNA) will be slightly accelerated. Given the unimaginable number of photons, molecules can even be accelerated to relativistic speeds. Provided that the molecule will be packed compactly, on a very small particle of dust. In fact, we came to the conclusion reached by Svante Arrhenius back in 1903. In his work, Svante Arrhenius substantiated (by calculation) the fundamental possibility of transferring bacterial spores from planet to planet under the influence of light [23]. We carry a DNA or RNA molecule, which is much simpler.

Moreover, in 1974, Fred Hoyle and Chandra Wikramasinghe proposed the panspermia hypothesis that cosmic dust the interstellar space is mainly composed of organic substances, which was later confirmed by observations [24 - 26]. We corrected this hypothesis, and specified exactly what substances (DNA, RNA) should be contained in interstellar and intergalactic dust, and what is the mechanism of their formation.

We also clarify that planetary systems, along with their stars, travel all the time in the galaxy. And the galaxy moves through the Universe. Therefore, interstellar and intergalactic dust will always be in contact with new planetary systems (the speed of movement of dust microparticles will no longer be decisive). And if we accept that interstellar and intergalactic dust contains RNA/DNA molecules, then the origin of life on planets is understandable. For this, it is necessary that the conditions necessary for the evolution of life be created on the planet. When such conditions are created, then life begins rapidly, since the initiators of life (RNA and DNA molecules) are already available. DNA/RNA molecules are essentially nanorobots. And if they get into a favorable environment, then the process of copying and the formation of viruses begins (for example, in the ocean). Further, from a huge number of viruses, the first simple bacterium is formed in the process of evolution. After this, classical biological evolution begins. That was approximately the way it was in our native Earth.

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