Origins: From the Protosun to the First Steps of Life
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Physical conditions in the early Solar system and life origin: compatible models

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Abstract. The article discusses the physical conditions in the early Solar system and on Earth, determining the origin, selection and development of the first living systems. The role of the young Sun dynamics, cosmic rays, magnetic fields and other protective shells of the Earth in the formation of the biosphere is emphasized. The selection of a single genetic code, ancient methods of long-term storage of energy and adaptive technologies of the first living systems occurred under the influence of cosmological and geophysical factors. A hypothesis was suggested that the accumulation of energy in polyphosphates without the participation of solar radiation could have ensured the survival of the primary biosphere in the conditions of the low luminosity of the young Sun.

Keywords. origin of life, physical conditions on early Earth, cosmic rays, biosphere, etc.

1. Overview

The form and structure of the heliosphere, the intensity of galactic and solar cosmic rays near the Earth and other processes in the solar system (SS) are determined by the magnetic field of the Sun and the position of the SS in the Galaxy. The magnetic field simulation of the early Sun (O.Cohen *et al.* 2012, Pipin 2017) revealed that the intensity of SCR was more, but the intensity of GCR was less than the current values. The intensity of the GCR could change by an order during the passage of the SS through the arms of the galaxy.

Young Sun (YS) had a circulation period of ∼5–8 days, a mass of ∼103% of the modern. There was no ordered periodicity. The first solar cycles (∼5 years) appeared ∼2.5 billion years ago (Pipin 2017). The intensity of sporadic radiation exceeded the current one by several orders. The intense UV radiation of YS exerted a significant influence on the biosphere formation. The luminosity of YS was less by 30%. Then the surface of the Earth must be frozen. However, according to geological data, the temperature of the Earth's surface exceeded the modern. The paradoxs solution can lie in other reflection and absorption by the early Earth. The existence of biological films on the oceans surface is reported. They significantly altered the albedo of the planet and the composition of the atmosphere. Also, the early Earth could be closer to the Sun due to the migration of Jupiter and Saturn. The geomagnetic field (GF) protects the biosphere from intense cosmic rays. The formation of the GF occurred 2 billion years ago according to dynamo theory. According to paleomagnetic data there already was a magnetic field of the Earth 4.2 billion years ago. Its values were comparable with modern. The reason for the emergence of such a field could be the process of formation of the Earth-Moon system as well as tidal interaction of proto-Earth with migrating giant planets.

The influence of space weather factors on the biosphere are observed to the present day. In the modern biosphere there are objects similar to the most ancient living

structures. Inorganic polyphosphates (the so-called "fossil molecules") accompanying biological objects at all stages of evolution. For example, they are present in human hemoglobin or yeast cells. Polyphosphates are responsible for one of the most ancient ways to store energy in cells. *Saccharomyces cerevisiae* strain Y-517 was studied by daily measurements in 2000-2012 (Gromozova *et al.* 2014, Ragulskaya 2017). The statistical distributions for space factors in random days and in the days with the relevant type of metachromasia was considered.

The main result of the analysis is that the distribution of MTC=3 considerably depends of galaxy cosmic rays intensity variations during 2006–2010; it means that galaxy cosmic rays intensity variations are the main biotropical agent of the space weather for sell structures during solar activity minimum.

2. Implications

Thus during a minimum of solar activity, a significant contribution to the dynamics of cellular structures is made by GCR. At the maximum, the influence of solar activity and variations of the geomagnetic field are expressed. Apparently the effect of GCR is not directly manifested. It can occur because changes in the oxygen, ozone and nitrogen content in the Earth's atmosphere during the solar activity cycle. Or can occur because a change in the amount of oxygen, phosphorus and iron in the blood of mammals and humans.

Probably the impact of cosmic rays on cellular structures has been evident since the origin of life and the evolutionary adaptation of the first ecosystems. The impact of galactic cosmic rays and magnetic fields on organic molecules begins else in galactic molecular clouds, during the pre-biological evolution of organic matter in the Universe. A key role in interstellar molecular chemistry is played by ion-neutral (or ion-molecular) reactions. These are the reactions between the ionized and neutral reagents, with the primary ionization provided by the particles of cosmic rays. A hypothesis was proposed that the accumulation of energy in polyphosphates without the participation of solar radiation could have ensured the survival of the primary biosphere in the conditions of the low luminosity of the young Sun in this report.

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