Article

Life origin in the Milky Way Galaxy: I. The stellar nucleogenesis of elements necessary for the life origin

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Abstract: Chemical elements in space can be synthesized by stellar nuclear reactors. Studying the dynamics of processes occurring in the stars introduces a concept of the ensemble-averaged stellar reactor. For future interstellar missions, the terrestrial and solar abundances were compared with considerable number of stars allocated in the $\sim 200\,\mathrm{pc}$ solar neighborhood. According to the value of the effective temperature, four stellar classes are distinguished, for which the correlation coefficients and standard deviation are calculated. The statement about the possibility of transferring heavy elements synthesized by stars over long distances in space has been completely refuted. There is no immutability of the distribution of elements on neighboring stars and in the Solar System. It is shown that chemical elements are mainly synthesized inside each stellar reactor. The theory of the buoyancy of elements is generalized to stars. It has been suggested that stars overheat due to a shift in the parameters of nuclear processes occurring inside stars, which leads to the synthesis of heavy elements.

Keywords: Stellar Nucleogenesis; Solar Abundance; Ensemble-Averaged Stellar Reactor; Stellar Abundance; Interstellar Mission; Habitability; DNA-star

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1. Introduction

The problem of interstellar travels has been of interest to humanity for a long time. After Yuri Gagarin's first flight into space in 1961, the illusion of rapid discovery of interstellar space appeared. Although the period of 60 years of astronautics led to considerable achievements in space exploration by using satellites and space stations, such research practically did not go beyond the solar system. The size of modern rockets and the amount of fuel in them significantly limit the range of spacecraft flights. Important limitations of manned space research are two problems: firstly, the absence of new principles and approaches in the development of jet propulsion and, secondly, understanding of the direction of further interstellar missions.

This study focused on investigating the possibility of the life origin in the stellar systems allocated in solar neighborhoods. As it is known, all biological species on Earth have a unique DNA code (Deoxyribonucleic Acid), which determines the full diversity of biological species. The DNA includes the following elements: C, O, N, and P. In Section 6, the new concept of DNA-stars was entered, in which spectrums of C, O, N, and P elements were recorded together. The possibility of synthesizing Na, Mg, S, K, Fe, Co, Cu, Zn, Ca, Mn and Mo, regulating the growth and development of the elementary biological forms is also discussed.

However, these elements are synthesized on different stars. For example, according to the B^2FH model [1], C and N synthesize at dying low-mass stars; O, Na, and K — at exploding massive stars; Mn, Fe, Co and Cu mainly synthesize at exploding of white dwarfs. The synthesis of different elements on different stars made it impossible to raise biological forms on these stars.

At the beginning of the proceeding, in Section sec:georeactor, the criticisms of older B^2FH model and newest K^2L model, developed by [2], are carried out. In this study, it is

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shown that specified models have several defects. Except for the defect specified in [2], concerning to frequency of neutron stars merges, first, there is no invariance of element distribution in the solar system; secondary, it is the absence of invariance of elements on the neighbors' stars; thirdly, it is absence enriched stars, in particular, the stars completely consisting of Th and U and fourthly is the absence of a significant amount of elements in interstellar space.

Due to some criticism, some attention should be paid to the parity between criticism and creativity. As it is known, science develops in a spiral, and at certain moments, new knowledge comes into conflict with previously dominant concepts. At the moment of overcoming crisis usually, new hypotheses appear, and great discoveries and inventions are made. Therefore, it should not be surprising that in science, harsh criticism often accompanies the occurrence of discoveries.

After the 2011 disaster at the Fukushima Daiichi Nuclear Power Plant, the International Atomic Energy Agency (IAEA) initialized testing reactors, primarily industrial and scientific reactors. However, then this process was expanded to the natural reactors. In 2013, it was reported about problems in nuclear geophysics. As it is well–known all stars are natural nuclear reactors. This work discussed the nuclear processes in stars and the synthesis of chemical elements in stellar reactors. Unfortunately, the author is obliged to report that the nuclear astrophysics does not pass the stress–test. It is of interest to devote a few paragraphs to the issue of the spread of the crisis from the Fukushima accident to the collapse of nuclear geophysics [3] and then nuclear astrophysics.

As it is known, last 30 years several groups carried out experiments on registration geoneutrino and reconstructed inner structure of Earth. There are different schemes of such experiments; among them there is also such scheme, in which registration geoneutrino were observed in thickness of mountain ranges. In recent years there were messages, that ^{40}K and ^{235}U it is impossible to observe during such experiments, see for example in Figure 1 in [4]. It turns out an amazing situation: for about 15 years geoneutrino teams broke hard rocks, then for 10 years they established the equipment and collected statistics (10–20 events per year), then they held conference, symposiums, published numerous articles in the highly rated journals, but after all the results of such prolonged and expensive experiments of inner structure definition of the Earth are completely unsatisfactory. The author and probably many readers are not interest in image losses of these geoneutrino teams as well as journals, in which articles of geoneutrino studies were published. But the geoneutrino teams' reaction to criticism is interesting. In many journals there is an option of retracted paper by authors, or there are sections Comments or Notes, but we do not find any reaction on censorious remarks, published by the geoneutrino groups.

The implausible mistake of the geoneutrino groups caused serious loss to geophysics and set geophysics back for several decades. Note that early in [5] and [6] it was shows that the ^{40}K thermal nuclear layer, which can be called a *"hell's frying pan"* or a *"thermal nuclear bomb"*, is located at a depth of 660 km, on the borders of the upper and lower mantle. This ^{40}K fuel layer is the basis of new volcanology and seismology theory, subduction and continental drift. Highlights that the geoneutrino teams did not recognize themselves mistake, more than these losers do not nominate the author on the Nobel Prize for discovery of the role of ^{40}K.

It is possible that after reading the above paragraph, not all readers understood how to make great discoveries. The author once again demonstrates it within another studying case.

In order to make a great discovery, it is necessary to consider for a moment and formulate a critical problem. A classic example of this kind of thinking it was depicted by Auguste Rodin in the sculpture *"The Thinker"* in composition of *"The Gates of Hell"*, Musée d'Orsay, Paris. Note that it is a very relevant composition, demonstrated the *hell's frying pan*, discussed above. However, now we are starting to discuss other critical problem, namely the origin of terrestrial uranium. Note that the genius is not to criticize other researchers, but to find the right solution.

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As it is known, the solar reactor is weak, capable of synthesizing mainly light elements, such as hydrogen and helium. Therefore, according to B^2FH and K^2L models, the metallization of stars, including our Sun, occurs due to the transfer of heavy elements synthesized on powerful reactors allocated on neutron stars. So, check up the transfer presentce of uranium and decay products, such as iodine and cesium, is of our interest. However, the author with surprise finds out that the transfer equation is absent in galaxy chemical models (GCE). Note that for 80 years of the existence of GCE models, none of the astrophysicists asked a question about the transfer equation. The error is visible even in the name of the models Galactic Chemical Evolution (GCE), so these models are not Galactic Chemical Transport (GCT) models.Therefore author sends a couple of hundred publications in highly rated journals to the trash in several seconds.

Due to the fact that any words about evolution can not replace mathematical calculations, the author did not leave one chance to his opponents. Especially for angry opponents, the simplest textbook transfer task is given below. This task has no solution within the frame of up-to-date astrophysics.

Table 1. The simple task for GCE models verifications.

"The solar reactor is weak and can synthesize mainly hydrogen and helium.
According to B^2FH and K^2L models, the thorium can be synthesized in neutron stars (NS),
which have a strong reactor. The nearest NS is RX J1856.5 − 3754*, which is allocated*
at 167 pc from Sun. In the solar system was recorded 1 gram of thorium.
How much of thorium has produced the NS donor-star?"

In this work also it was shows that according to modern GCE models iodine, cesium, and uranium were produced, delivered, and distributed with the help of extraterrestrials. This phenomenon has been called the *"exclusive delivery"* paradox because iodine, cesium, and uranium were delivered from neutron stars bypassing the Sun, as well as other planets such as Venus and Mars. If we say about *"exclusive distributed"*, we can suspect an alien in each pharmacist, who sold us a bottle of iodine, about the solar abundances please see e.g. [7]. It is clear that such conclusions following from the GCE models can raise a smile. Note that the absence of the transport equation in the Galaxy Chemical Evolution (GCE) models, such as the B^2FH and K^2L models, is only the tip of the iceberg. In this work, the author officially accuses astrophysicists of cheating. All the evidence for this is available. The list is more than complete:

1. The B^2FH and K^2L models are failure due to *"mystic"* absence of a transportation equation;
2. The invariance of element distributions in the solar system, demanded at metallization Sun, is not recorded;
3. The invariance of element distributions on the neighborhood stars is also not recorded;
4. This is the absence of super mega–enriched stars, reffered to in this study as a donor–star;
5. This is the absence of a significant quantity of heavy traces in the interstellar space;
6. The absence of bands of uranium, cesium, and iodine in the solar spectrum led to the paradox of *"exclusive delivery"* of these elements to Earth by *"exoplanet aliens"*;
7. The statement about a massive explosion of a star due to *"oversaturation with iron and nickel"* looks doubtful;
8. The statement about zero-impulse *"teleportation"* of elements in dying low-mass stars contradicts the second law of mechanics. This statement looks even more incredible and fantastic than the *"exclusive delivery"* of iodine and uranium to Earth.
9. The synthesis of elements from vacuum, which can be called *"vacuum quantization"*, is questionable. It is surprising that such a vacuum feature is observed only near the outer boundary of the galaxy.

10. As it is well known, black holes are allocated mainly in the center of galaxies, so the direction of stellar metalization is opposite to the direction of mass movement towards the center of galaxies. It looks strange, see [8].

And the last most important question. Whether are nuclear astrophysicists losers or cheaters? If the nuclear astrophysicists introduce themselves as cheaters or gangsters, they should understand that, just as in the case of fraud in experiments with geoneutrinos, fraud in stellar (thermonuclear) synthesis will sooner or later become public knowledge and they will have to deal not with scientists, but with the DOE, NSF, Treasury Department, police (FBI), government, and Congress. However if they interpose themselves as losers, then the question of the nomination and the award of author to the Nobel Prize is relevant, please see author's studies [5], [6] about nuclear ^{40}K fuel layer. This nuclear ^{40}K fuel layer is the basis of the new volcanological and seismological theory, the revisions of the theory of subduction and continental drift, the origin of water, oils, ores and diamonds, the Moon–Earth viscous stream-droplet separation, the new elemental buoyant theory of inner structure of planets and stars, and finally, this ^{40}K fuel layer is the milestone of basic principles of creation of habitable planets around stars nearby the Sun.

After reading this publication, the reader will learn that in addition to the generally known s–and r–processes, other new synthesis process can occur in the overheated stars (h—process). The detailed analysis of the spatial distribution of overheated stars, in which an effective stellar temperature are more than 6500 K and the heavy elements are synthesized at the h–process, was carried out in [9].

For life origin sufficiently many elements of periodic table are necessary, so once again, we will underline that synthesis of various elements on different stars practically negate the possibility of the origin of life on remote planets. This study aims to find an answer to the following question: How are the chemical elements necessary for the origin of life synthesized on stars?

A new method, developed in this study for searching for habitable exoplanets, has been applied in [10] and a list of 48 DNA–stars in the solar neighborhood, on which life is possible, has been defined.

2. Materials and Methods

2.1. Terrestrial and Solar Abundances

The abundance of chemical elements on Earth is represented by an almost complete set of elements from the periodic table. From the entire periodic table up to the numbers $Z < 94$, only two elements, namely technetium (Tc, Z=52) and promethium (Pm, Z=61), are missing on Earth. However, many elements such as Se, Br, Kr, Te, I, Xe, Cs, Ta, Re, Pt, Hg, Tl, Bi, and U are not present in the solar photospheric spectrum [11], [12], and [13]. This fact presents a particular problem in the theories of the synthesis of chemical elements. In this study, the abundances of carbonaceous meteorites of Ivuna type (below called CI chondrites meteorites) also are used for comparison with terrestrial, solar, stellar abundances. The CI chondrites composition was obtained from [14] and [15].

2.2. Stellar Abundances in the Solar Neighborhood

In this work for future interstellar missions, the solar neighborhood's stellar abundance was analyzed. The data is accessible on the site of Hypatia Stellar Catalog (below HSC) by [16]. This dataset includes stellar names, spectral type, and distance from Sun, position, and the elemental abundances for stars in ~ 200 pc solar neighborhood. The database is updated continuously; currently, it contains information about 3757 stars and about 43 chemical elements. Note that the number of chemical elements registered in the spectra of stars and presented in the HSC dataset may differ for different stars. A detailed description of these data can be found in [17], [18]. For comparison, please also see the CATSUP database, which is a catalog of 951 solar neighborhood stars within 30 pc in [19]. Based on the HSC data, a spatial analysis of the distribution of elements in this part of the galaxy was carried out.

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2.3. Theories of stellar nucleogenesis

In astrophysics, stellar nucleosynthesis has been studied thoroughly for an extended period. Briefly, we recall the history of stellar nucleosynthesis. In 1946, Hoyle suggested that elements, up to iron and nickel, could be synthesized in stars [20], [21]. As it is known to explain the origin of elements heavier than iron, the theory of the generation of chemical elements was extended, and in the theory, it was added the slow and rapid processes of neutron capture (s– and r–processes) by [1]. Below this theory was called as B^2FH model or theory. Usually, the s– and r–processes occurred inside massive stars or during explosive and catastrophic events, such as merging Neutron Star (mNS) or core-collapse SuperNovae (ccSNe). More details about nucleosynthesis of the chemical elements during s– and r–process could be found in several studies [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32], [33] and many others.

Recently [2] published a new concept about an element nucleosynthesis. In the Kobayashi et al. model (below K^2L) it was performed the construct a new GCE model for all stable elements from carbon (A=12) to uranium (A=238) from first principles, i.e., by using theoretical nucleosynthesis yields and event rates of all chemical enrichment sources. The periodic tables showing the currently believed origins of each element for both these models were presented in Figure 1.

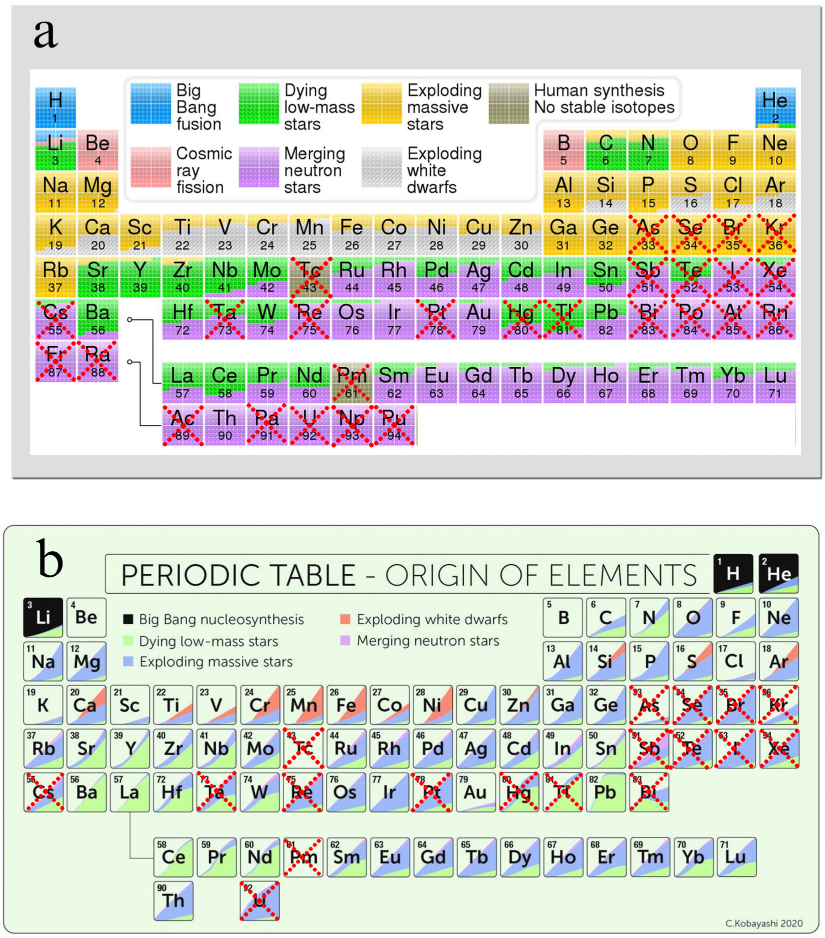

Figure 1. Two standard periodic tables, showing the origins of each chemical element. (a) —- periodic tables according to B^2FH model (adapted from Wikipedia); (b) — K^2L model (Artwork: Sahm Keily). The red crosswise marks the elements which could not be recorded in the solar photosphere spectrum.

The elements, which could not be recorded in the solar photosphere spectrum in [11], [12] [13] were marked in Figure 1 by red crosswise. In this work, we will present below a sufficiently detailed discussion to justify the failure of the previous B^2FH and K^2L models. Also, below, we will justify the need to develop a new nucleogenesis concept, which consists of the synthesis of most elements, including heavy ones, such as Th and U, in the bowels of the stars themselves.

2.4. The Ensemble-Averaged Stellar Reactore

Both models, the oldest B^2FH and newest K^2L, are hypothetical models. In this study new model was developed, but this model was based not on abstract theoretical concepts, but the spectral data available to the author. This model is called the ensemble–averaged stellar reactor model. In Section 2.4 – 2.7 description of this model can be found. Further, being based on this model, it was shown that elements are mostly synthesized in interior of the stars, and the contribution of interstellar transport is greatly exaggerated.

We do not have the possibility to scan the change of an individual stellar reactor in the range of billions of years, therefore in our study, we were forced to use the averaging over the ensemble of all HSC stars and investigate the operating characteristics of a hypothetical ensemble – averaged reactor. The novelty of this approach is in that the star ceases to be a static nuclear object. As it is well known, a nuclear reactor produces heat and chemical elements, so that the reactor's state can be evaluated by abundance and temperature. The statistical distributions of HSC stellar radius measured in the size of solar radius ($R_\odot$) and the effective stellar temperature were presented in Figure 2.

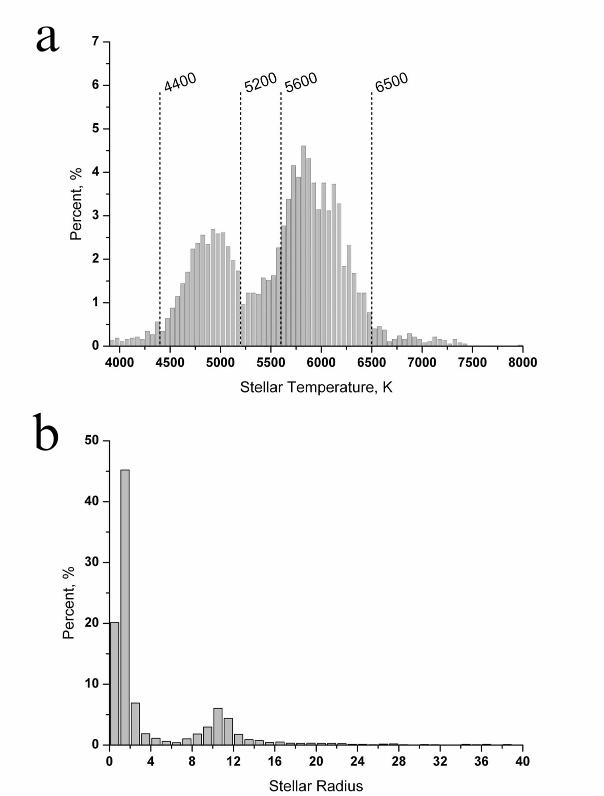

Figure 2. The statistic distributions of a stellar radius in $R_\odot$ unit, and stellar effective temperature in K for stars within 200 pc neighborhood of Solar System, according to data from Hypatia Stellar Catalog (HSC).

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Table 2. The investigation ranges in the RT charts. The T is the effective stellar temperature, Rs – HSC stellar radius and $R_\odot$ – solar radius.

Name	Description	Amount of stars	
		cs.	%
RT1	$4400 < T < 5200$ K, $R_s > 2\,R_\odot$	859	27.0
RT2	$5600 < T < 6500$ K	1989	62.6
RT3	$T > 6500$ K	136	4.3
RT4	$4400 < T < 5200$ K, $R_s < 2\,R_\odot$	192	6.0
	Total	3176	100

2.5. The Stellar Studying Ranges

Both distributions in Figure 2 are described with bimodal functions so that several ranges can be distinguished, namely: 0˘ – 4 $R_\odot$ and 12˘ – 14 $R_\odot$ in the stellar radius distribution and 4400–5200 and 5600–6500 K in the temperature distribution. The studying ranges RT1 — RT4 were described in Table 1. The correctness of the choice of the studied ranges is confirmed by the uniformity in the statistical distributions for individual categories of stellar groups, which were presented in SFigure 2 and 3 (in Supplementary). The range of 5200 – 5600 K, where mixed processes dominate, was not considered in this work.

2.6. The Working Cycles of Ensemble-Averaged Stellar Reactor

The ensemble–averaged stellar reactor (EASR) is a generalized thermal nuclear engine that provides the generation of heat and the variety of chemical elements in the universe. Therefore, it is convenient to represent the dynamics of the ensemble–averaged stellar reactor working in the stellar Radius and stellar effective Temperature coordinates, below RT. The dependence of the stellar radii on the effective temperature is shown in Figure 3. The directions of operation of such thermal nuclear engine are indicated in the figure by arrows.

The distribution of HSC stars in the RT diagram combines of the linear and exponential distributions, drawing by red and blue lines in Figure 3, respectively. The empirical formulas for these distributions are defined by the expressions Equation 1 and 2:

$$R_{red} = \alpha + \beta T \quad (1)$$

$$R_{blue} = \chi e^{-\gamma T} \quad (2)$$

where $\alpha = 2$, $\beta = 6 \cdot 10^{-4}$ and $\chi = 12.86 \cdot 10^5$, $\gamma = 1/400$.

In the proposed approach, the stellar mass is not the deciding parameter, so just for comparison, we note that at T= 6500 K, R$\sim$ 1.9 $R_\odot$ and stellar masses were in the range: M $\sim$ 1.33 – ˘1.38$M_\odot$. In the RT3 site, the stellar mass reached a maximum value M $\sim$ 1.76 $M_\odot$ at 7362 K.

The explosive processes of star expansion are indicated in the RT diagram by green lines. These processes occur quickly, so the number of measured values is not sufficient to determine the parameters of the generalized reactor in the area between RT3 and RT2. In the course of calculations, the site of explosive rapid star expansions was not used, and therefore, it does not have a special designation. Conventionally, the temperature corresponding to 7100 K is chosen as the starting point of this explosive site, which in the RT diagram corresponds to R $\sim$ 2.2 $R_\odot$ and M $\sim$ 1.58 $M_\odot$. Further, the stars, located between RT1 and RT2 sites (5200 — 5600 K), for which it is not possible to separate the processes, were also excluded from consideration.

Let's result in a general characteristic of work such hypothetical the thermal engine. The main process of operation of the heat nuclear engine of the EASR reactor is RT1 – RT2 –

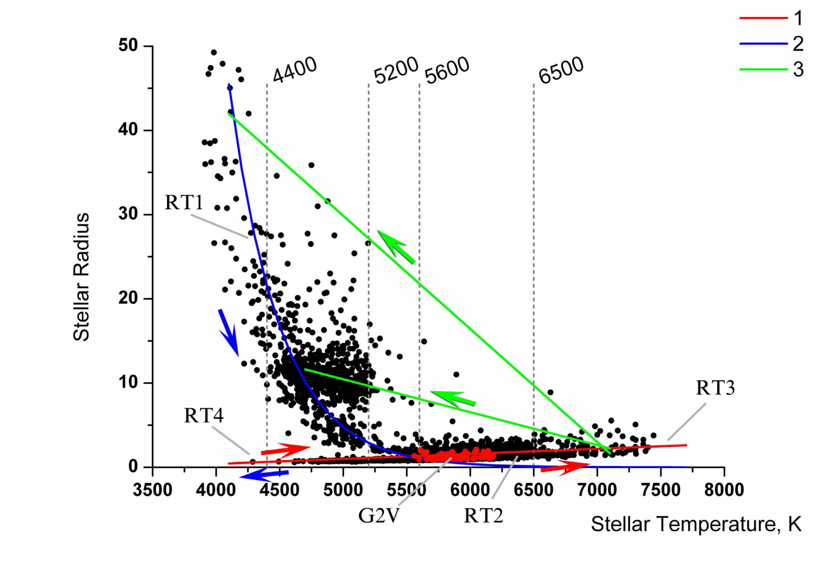

Figure 3. The scheme of working of the thermal nuclear engine, which is providing generation of heat and a variety of chemical elements in the Universe, it is designated by arrows (1—2—3). The stars from Hypatia Stellar Catalog (HSC), belonging to the G2V spectral class, are drawn as red points. The studying ranges were marked as RT1—RT4 sites.

RT3 process. This process is unidirectional, since it is a process of heating, exploding and expanding the star and its compression with the gradual restoration of the stellar reactor's working state. On the other hand, in the RT4 linear site EASR reactor can operate in both directions, both at new star birthing and at low-mass star dying. Note that synthesis of chemical elements is also possible during dying low–mass stars at the $R < 0$. Suppose at explosion a star loses a significant amount of its substance. In that case, the EASR reactor may not be able to restore its operation, and the state of the star will slowly change along the RT1—-RT2—-RT4 path or jump on RT4 path for low–mass star fragments and/or for large gaseous planets such as Jupiter.

2.7. *Rates of Element Synthesis*

In this study, element synthesis (degradation) rates were obtained as bias at the linear regression in functional dependence between element abundances and effective stellar temperature (below AT diagram). In the HSC catalog, the quantity of chemical elements is defined as the deviation from the distribution in the Sun, normalized according to data of [15] and referred to the H content. Therefore the stellar abundances are measured in relative units [element/H] looks like:

$$\log(n_{element}/n_H)(star) - \log(n_{element}/n_H)(solar)$$

and the unit of element synthesis rate is K^{-1}. The resulting tables will show the correlation coefficient (R) and standard deviation (SD) in AT diagrams. Only statistically significant values with $|R| > 0.12$ and amount stars N more than 10, ($N > 10$) will be included in the resulting tables.

2.8. *Biochemical criteria for searching for signs of life on remote stars*

Recently, much attention has been paid to exoplanets' study and the possibility of contacts with other extraterrestrial civilizations. At the moment, the criterion of the temperature comfort for biological species, based on the analysis of the exoplanet distance from a

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star, is often applied to search for extraterrestrial civilizations. This study proposes another way to search, based on the chemical abundance studied above.

As it is known, all biological species on Earth have a unique DNA code (Deoxyribonucleic Acid), which determines the full diversity of biological species. The DNA is set of four nucleotide ACGT: A — (adenine, $C_5H_5N_5$), C -— (cytosine, $C_4H_5N_3O$), G — (guanine, $C_5H_5N_5O$) and T — (thymine, $C_5H_6N_2O_2$). In RNA thymine nucleotide is replaced by U — (uracil, $C_4H_4N_2O_2$). The DNA has two helixes, which covalently linked to a phosphodiester backbone $PO4^-$ (H_3PO_4).

Thus, a star system must occur, except hydrogen, which is present in all stars, other essential elements, such as C, N, O, and P. The stars, in which spectrum it was presented together C, N, O, and P elements, below will be called DNA–stars. Note that the term DNA–star was introduced years ago to label a viral test, so please could not be confused with DNA–star, used in this study.

Biological species such as bacteria, algae, and plants can use light from the star to obtain energy, but they also need a growth medium and some microelements. The bulk growth medium, using for cyanobacteria growing, is next: $NaNO_3$ (1.5), $K_2HPO_4 \times 3\,H_2O$ (0.051), $MgSO_4 \times 7\,H_2O$ (0.075), $CaCl_2 \times 2\,H_2O$ (0.036), Na_2CO_3 (0.02), $FeCl_3 \times 6\,H_2O$ (0.003), in grams per 1 liter [34]. The several microelements involved in biological process of regulation also must be added: H_3BO_3 (2.86), $MnCl_2 \times 4\,H_2O$ (1.81), $Co(NO_3)_2 \times 6\,H_2O$ (0.0444), $CuSO_4 \times 5\,H_2O$ (0.079), $ZnSO_4 \times 7\,H_2O$ (0.222), $Na_2MoO_4 \times 2\,H_2O$ (0.39), also in milligrams per 1 liter. Thus, except C, N, O, and P, in stellar spectrum, such elements as Na, Mg, S, K, Fe, Co, Cu, Zn, Ca, Mn, and Mo are desirable.

Biochemical criteria for searching for life on remote stellar system are presence in stellar spectrum the chemical elements necessary for the origin of life.

3. Terrestrial and Solar Abundances

3.1. The terrestrial Fe–Ni core

In this section, we will pay some attention to the following question: Why is it believed that our planet's core consists of Fe and Ni? As it is known, chemical elements can be synthesized in natural or artificial reactors. Before creating the first artificial reactors, all the chemical elements were synthesized either on the Sun or other remote stars in the Milky Way Galaxy which are also natural reactors.

Because the maximum of nuclear binding energy occurs near ^{56}Fe, stars cannot get energy by nuclear fusion and stellar nucleosynthesis come to a stop on ^{56}Fe. The dependents average binding energy per nucleon versus the atomic number is presented in Figure 4a, i.e. (B/A vs. Z), where B is binding energy, A is the number of nucleons (mass number), and Z -– the atomic number.

In Figure 4a, experimental data are presented as dots. As it is well known, the experimental curve contains fusion exothermic (before ^{56}Fe) and fusion endothermic (beyond ^{56}Fe) parts. Note that these data were obtained in laboratory conditions, i.e., during experiments on accelerators, cyclotrons, or reactors.

On the other hand, as it is well known, that in theory the simulated curve of binding energy B(A,Z) is given by using the following formula [35]:

$$B(A,Z) = \alpha_v A + \alpha_s A^{2/3} + \alpha_c Z(Z-1)\,A^{-1/3} - \\ - \frac{\alpha_{asym}\,(A-2\,Z)^2}{A} + \delta\,\alpha_p A^{-3/4} \tag{3}$$

where Z — number of protons; N — number of neutrons; A —- is the mass number. This Equation has 5 terms corresponding to volume, surface, Coulomb, asymmetric and pairing terms. The constants of these terms are fitting parameters that are found experimentally to be equal to next: $\alpha_n = 15.5\,\text{MeV}$, $\alpha_s \sim 18\,\text{MeV}$, $\alpha_c = 0.691\,\text{MeV}$, $\alpha_{asym} = 23\,\text{MeV}$.

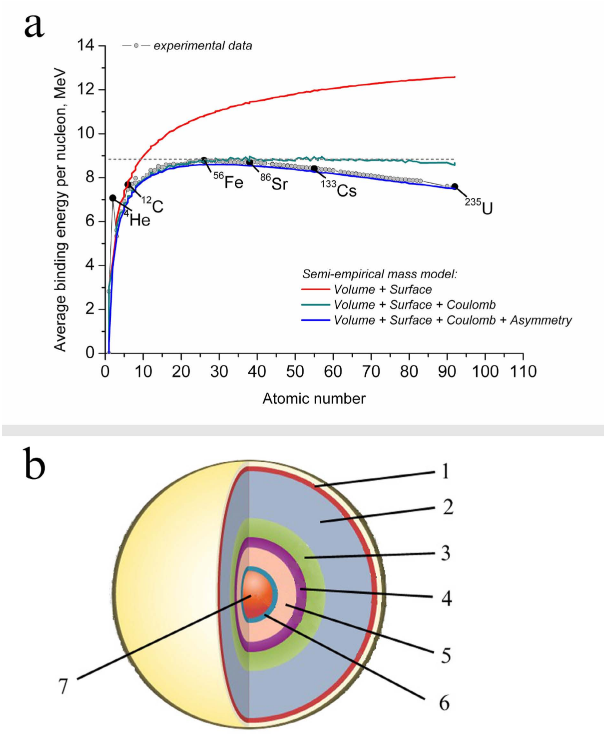

Figure 4. (a) — The nuclear binding energy per nucleon for stable nuclei in terms of mass number was presented by points (B/A vs Z). The experimental values were presented by points. The comparison between the result of the LDM model, in which it was taking into account the different model terms (color lines) and the experimental values were shown; (b) — The standard astrophysical *"onion"* model for pre-collapsed massive star (M> 10 $M_{\odot}$). Abundances for such stars are next: 1 — upper hydrogen; 2 — hydrogen and helium fusion; 3 — helium fusion; 4 — carbon, oxygen fusion; 5 — magnesium, neon, oxygen fusion; 6 — silicon, sulfur fusion; 7 — nickel and iron core.

The details about Liquid Drop Model (LDM), discussion about other binding models, and references could be found e.g., in [36], [37]. Note that the asymmetry term is thus a correction term that tries to consider the asymmetry in amount of protons and neutrons.

The curves presented in Figure 4a are related to result obtained in a vacuum on accelerators or in scientific reactors. However, if the conditions on some stars are such that the binding energy curve per nucleon is propagated along the discontinuous gray line (∼ 8.8 MeV) in Figure 4a, then all the periodic table elements were synthesized. Moreover, if the curve is above this line, there would be a constant synthesis of Th and U atoms, and the star will be extra saturated by nuclear fuels.

Thus, it is possible to assume that, under loads, the accumulation of transuranic elements can occur, leading to the heating of the stars and then, at the reached threshold values of uranium, the star can undergo explosion and destruction

Hence, exactly asymmetry term, which considers the difference in the number of neutrons and protons in the element, causes that synthesis of elements will stop at Fe. Therefore asymmetry is responsible for the fact that the core of a regular star, which has not undergone explosive transformations, is iron – nickel core. However, at present, in

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astrophysics, it is assumed that only the pre-collapsed, massive star with mass M> 10 $M_\odot$, where $M_\odot$ is the mass of Sun, has an iron – nickel core.

Heavy elements in this star will be moving down into the inner layers, separated and concentrated at several layers. An *"onion"* model for pre-collapsed massive star ($M > 10\,M_\odot$) is presented in Figure 4b. The elements much heavier than Fe, such as Th and U are not produced in the standard stellar nucleosynthesis, see e.g. review [38]. About accretion of the Earth and segregation of its core please see review [39].

Despite the fact that the Sun is not a massive star and iron synthesis is impossible on the Sun, there is a steady opinion that the core of our Earth, and the core of the planets in the solar system, consist of Fe and Ni. Thus, the contradiction was formed between astrophysics, nuclear physics, and geophysics. On the one hand, geophysicists, following astrophysicists, began to assert that the core of the planet consists of Fe and Ni. On the other hand, geophysicists state the presence of not only iron in the Earth's ores but the presence of almost the entire periodic table. However, if the core of the Earth consists of Fe–Ni, then in the depths of the planet there is no room for the rest of the elements, and actually, at present, there is no realistic theory of ore formation. It looks very curious.

It summarizes this section. First, it is essential to note that the binging model (Equation 3) and experimental values, presented in Figure 4a, apply to the individual atomic nucleus, that is, for a case when a star or planet can be represented as an ideal gas or rarefied plasma. Thus, basically the binding theory does not applicable to the nonequilibrium plasma of which mostly stars and planets are consisting. Secondary, earlier in geophysics, a hasty assumption was made that the core of our Earth and the rest of the planets in the solar system, consist of Fe and Ni. However, where elements heavier than Fe and Ni were synthesized, and how did they get to our planet, the question requires further clarification.

3.2. Terrestrial Georeactor and Geoneutrinos

This section considered the following question: Could elements heavier than Fe have been synthesized in the Earth's interior? Thus, it is a question about the existence of the terrestrial Th—U reactor. The idea about an existence of georeactor was discussed after [40]. Later the presence of Th and U heat layers in the planet center, natural nuclear georeactor, and thermal convection in the outer core were widely discussed in the serial studies by Herndon and colleagues [41], [42], [43] [44], [45], [46]. According to Herndon et al. studies, the terrestrial reactor was represented by a 12 km layer at the center of the Earth [46].

Also, the natural nuclear georeactor was investigated in several studies by different research groups [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [5], [58], [6]. According to these published studies, a natural georeactor probably exists at the different deep-earth locations, including the center of the core [59], [45], [44], [60]; on the inner core boundary [54], [55]; on the core-mantle boundary [56], [61] and on the multi-layers levels [5], [6].

It is well known the electrons' antineutrinos that would be emitted from such hypothetical georeactor have energies above the end-point of geoneutrinos from "standard" natural radioactive decays. The main reaction of geoneutrino (antineutrino, $\tilde{\nu}_e$) registration from natural sources is the inverse beta decay reaction:

$$\tilde{\nu}_e + p \rightarrow e^+ + n \qquad Q = 1.806\,\text{MeV} \tag{4}$$

Using the registration of geoneutrinos, it is possible to determine a part of the terrestrial heat flux from the radioactive elements ^{232}Th and ^{238}U. It will permit to obtain the vertical distribution of these radioactive elements inside of the Earth and, accordingly, to answer the question about presence and power of a natural nuclear reactor in the center of the Earth.

Details of two liquid-scintillator neutrino experiments, such as KamLAND in Japan and Borexino in Italy, in which the geoneutrino signals were measured, could be found in [62], [63], [64], [54], [65], [66], [67], [68], [69], [4], [70], [71], [72], [73] and in many other publications.

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A hot debate broke out between the proponents of terrestrial georeactor existence and the opponents, represented mainly by the geoneutrino research groups. However, a significant question is about the possibility of recording neutrinos emitted by ^{40}K and ^{235}U elements. It was established that ^{40}K and ^{235}U fuel layers could not be determined using the inverse beta decay reactions. The lower threshold of inverse beta decay reaction is equal to 1.806 MeV, while the upper boundaries of ^{40}K and ^{235}U geoneutrino spectra are below this value. Thus, the ^{40}K yield is equal to 1.311 MeV, see Equation 5:

$$^{40}K \rightarrow ^{40} Ca + e^- + \tilde{\nu}_e \qquad Q = 1.311\,\text{MeV} \tag{5}$$

The possibility of registration only fuel elements ^{232}Th and ^{238}U casts doubt on the advisability of carrying out long and expensive experiments such as the KamLAND and Borexino Experiments. To summarize the above, it is necessary to state that the attempt to restore Earth's structure by using geoneutrino experiments ended unsuccessfully before the beginning of these experiments.

3.3. Problems of Terrestrial and Solar Nucleosynthesis

If elements such as Fe, Th, and U elements could not have been synthesized on the Earth and Sun, then the next question arises: Could heavy elements have been transferred from neighboring stars? To answer these questions, we should refer to the history of stellar nucleosynthesis research.

As it is known, to explain the origin of elements heavier than iron, the nucleosynthesis theory was expanded and supplemented by the processes of slow neutron capture (s–process) and rapid neutron capture (r–process). Examples of s process and element transformations ^{56}Fe $\rightarrow$ ^{63}Ni are presented in Equation 6:

$$\begin{aligned} ^{56}Fe &+ n \rightarrow ^{57} Fe + n \rightarrow ^{58} Fe + n \rightarrow ^{59} Fe \rightarrow ^{\beta} \\ ^{59}Co &+ n \rightarrow ^{60} Co \rightarrow ^{\beta} \\ ^{60}Ni &+ n \rightarrow ^{61} Ni + n \rightarrow ^{62} Ni + n \rightarrow ^{63} Ni \rightarrow ^{\beta} \ldots \end{aligned} \tag{6}$$

The alternative reactions with involving of the ^{60}Fe, ^{61}Co, ^{64}Ni and corresponded s–process neutron capture equations are not represented in Equation 6.

Due to the s–process, it is possible to explain formation of all elements up to Z = 83. Nuclei with Z, greater than 84, do not have stable isotopes and are radioactive. Therefore, the isotope ^{232}Th is formed from the ^{232}Pb nucleus as a result of eight consecutive β decays. The initial ^{232}Pb nucleus formed in the r–process and it has 24 neutrons more than the stable ^{208}Pb isotope. Note that while the s–process is way of making elements heavier than iron, but a several of lighter isotopes, such as ^{40}K, is also made by the s–process in the massive stars.

In [74], it was suggested that our solar system was formed by the explosions of one or more supernovae. The Sun converted from a young regular star to a heavy element–rich star. According to B^{2}FH model, these elements could be synthesis only during neutron stars merging (mNS). However, the nearest single neutron stars are RX $J1856.5 - 3754$ and Geminga, allocated 167 and 250 pc from Sun [75]. The Th–U transfer is schematically represented in Figure 5.

However, the possibility of interstellar of a considerable quantity of heavy elements over long distances, and as well as the frequency of Neutron Stars merging (mNS) or core-collapse SuperNovae (ccSNe), raise some doubts in transferring interpretation. Also note that, in this scenario. the relative saturation of mNS products, in particular the Th/U ratio, should be the same in the entire solar system. Moreover, at long–range transferring, in addition to the spatial homogeneity of isotopes and elements within the solar system, same isotopic invariance must be observed for a group of nearby stars, see Figure 5b.

Thus, after we run away from the problem of the synthesis of heavy elements in the solar system, we are faced with other problems, namely the problem of transferring

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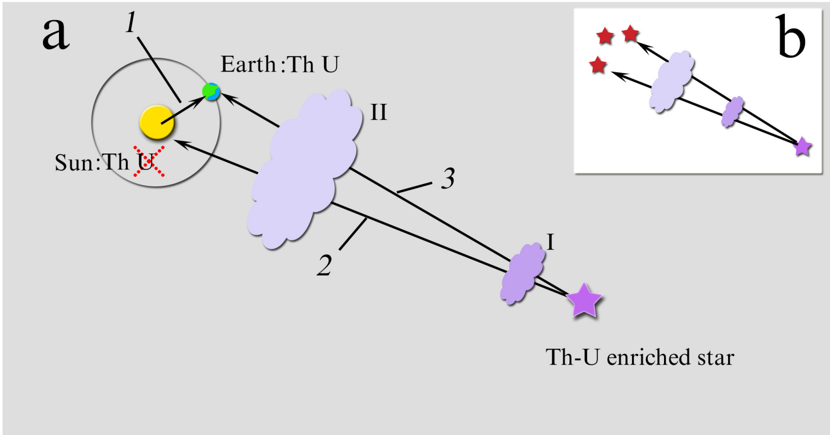

Figure 5. (a) — The scheme illustrates a problem of the Th–U nucleosynthesis from the Th–U enriched star, nearest to the Earth. The nearest single neutron star is allocated at the distance of 167 pc from our solar system. Clouds I and II demonstrated reducing concentrations at the propagation in space; (b) — property of invariance of isotopes for a group of neighborhood stars is shown on a plate.

of heavy elements in the galaxy at large distances and the problem of a lack of spatial homogeneity of the element distribution of in the solar system and on the stars in the solar neighborhood.

3.4. Solar Reactor and Solar Abundances

In this section, we will focus on the following question: How to solve the problem of the transfer of elements between stars? The absence of clusters of stars with comparable chemical compositions reduces to a minimum probability of transfer from the ccSNe stars or mNS. Therefore, it is necessary to develop a new concept of heavy element synthesis. This concept should be based on the generation of heavy chemical elements in the interior of the star. Therefore, refusing the paradigm of the element transfer, we should argue that the solar reactor provides the synthesis of all elements represented in the Sun.

The dependences between atomic numbers and logarithmic abundances in the solar photosphere were presented in Figure 6a for odd and even nuclei. The solar abundances, demonstrated in this Figure, were obtained from [11], [12], [13]. The solar abundances were normalized to $\log N_H = 12$. Note that, several elements such as Se, Br, Kr, Te, I, Xe, Cs, Ta, Re, Pt, Hg, Tl, Bi, and U are absent from the photospheric solar spectrum.

In the helioseismology were recorded two parameters: the base of the convection zone (rb) and the helium abundance in the solar convection zone (Ys), see e.g. [77]. The values of these helioseismological parameters may differ with different study methods; please see Table 3 in [77]. The red arrows in Figure 6 demonstrated convection processes, which were determined by helioseismological methods. Based on references data from [77] it was found that the median values of rb and Ys which are equal to 0.717 and 0.241, correspondingly.

The reduction of heavy elements' abundances at the increasing atomic number is represented in both the terrestrial and solar distributions. Also, in Sun, just as in Earth, the heavy elements sink downward, and their presence in the photospheric spectrum is masked by thermoclines. However, unlike the structure of the Earth's layers, the presents of ^{40}K fuel and Cs decay layers was not clearly recorded in the solar structure. At the same time the thermocline, corresponding to Cs layer, is noticeable in the solar structure, presented in Figure 6a.

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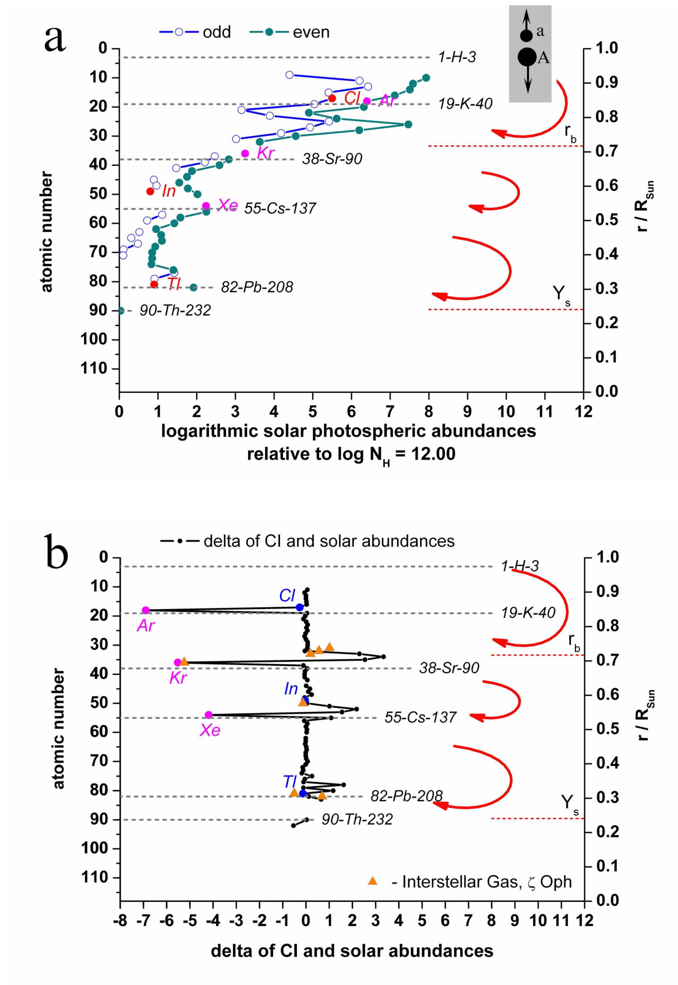

Figure 6. (a) —- The logarithmic solar abundances of elements in the solar photosphere are shown. In grey plate the theory of buoyancy schematically is shown: the light elements flow up and heavy elements sink down. (b) —- The delta of CI carbonaceous chondrites logarithmic abundance [15] and solar photosphere abundance [11], [12], [13] was presented. The indirect photospheric estimates have been used for the noble gases: Ar, Kr, Xe (magenta color). Abundances chlorine Cl, indium In, thallium Tl, obtained from sunspot spectrums, were presented as blue points. All values were calibrated to $\log N_H = 12$. The red arrows demonstrated convection processes determined by helioseismological methods (r_b, Y_s). The delta between interstellar gas abundances ($\zeta - Oph$) and CI meteorites was presented by orange triangles [76].

It is well known that another essential source of information of solar abundance is chondrites, which are meteorites that have never been heated to melting temperatures. In this study, we used carbonaceous meteorites of Ivuna type, below called as CI chondrites meteorites. The CI chondrites composition data was obtained from [14] or [15]. For Kr and Xe, the solar abundances can be estimated by interpolating the theoretical s–process production rates [14], [13].

Usually, in the studies, the coincidence of solar and CI abundances were analyzed, but we are interested in the Melted–Non–Melted filter, which is characterized by the difference between these values. The difference of logarithmic CI carbonaceous chondrites abundance by [15] and solar photosphere abundance by [11], [12], [13] was presented in Figure 6b. The indirect photospheric estimates have been used for the noble gases: Ar, Kr, Xe (magenta color in Figure 6b). The keys fuel products, such as ^{40}K, ^{90}Sr, ^{137}Cs, and ^{232}Th were marked

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by blue color. Note that abundances of chlorine (Cl, z=17), indium (In, z=49), thallium (Tl, z=81) were obtained from sunspot spectrums [14], [11], [12], [13]. As we can see in Figure 6b, the typical nuclear fuel and Th–U decay-product layers are presented in the solar spectrum

Thus, it is possible to assert with some certainty that the decay products and the nuclear fuel elements form the system of discontinuities due to a change in the state of upper and lower layers. These K–Sr–Cs–Pb–Th–U discontinuities are recorded in seismograms. Also, it is remarked that in the solar spectrum, the Sr discontinuity is noticeable, but chemical elements such as I, Cs and U are absent, which indirectly indicates that, at present the Th burning with the U isotopes formation does not occur, so our star is in equilibrium, steady condition.

If stars explode, it is undoubtedly interesting to find out what heavy elements are present in interstellar space. The delta between interstellar gas abundances, forward to $\zeta - \breve{}Oph$ and CI meteorites, was presented in Figure 6b by orange triangles [76]. Thus, the abundances of interstellar gas confirm that elements allocated near Sr, Cs, and Pb convective thermoclines, which are products of Th–U chain processes, are involved in emission into interstellar space. For convenience, the interstellar gas abundances data is written in STable 1 in Supplementary.

Below, we briefly recall why the gaps appear near Sr and Cs in the distribution of chemical elements during reactor operation. The heavy isotopes involved in the fractional chain neutron fission yields and the synthesis of elements are as follows: ^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, and some other.

As an example, the mass yield curves for the thermal, fast and high neutron fission of ^{232}Th and ^{235}U were presented in SFigure 3 (in Supplementary). These plots are obtained from JEFF-3.1 data (Joint Evaluated Fission and Fusion File), which are available on server [78] and in [79].

Note that distribution of chain fission products has two maxima in $\sim$ 90 and 140. Like this the first maximum gives more than 5.5% in the yield of ^{235}Uthermal path for the next isotopes: $^{90}_{38}$Sr (5.73%), $^{95}_{40}$Zr (6.50%), $^{95}_{41}$Nb (6.50%), $^{99}_{42}$Mo (6.13%) and $^{99}_{43}$Tc (6.13%). Further the second maximum in yield gets isotopes: $^{133}_{53}$I (6.59%), $^{135}_{53}$I (6.39%), $^{133}_{54}$Xe (6.60%), $^{135}_{54}$Xe (6.61%), $^{137}_{55}$Cs (6.22%), $^{140}_{56}$Ba (6.31%), $^{140}_{57}$La (6.32%) and $^{141}_{58}$Ce (5.86%). Also note that similar peaks of I, Xe and Cs fractional chain fission yields are obtained of ^{233}U, ^{239}Pu and ^{241}Pu decays.

Also remind that, the thermal emissions of ^{232}Th, ^{235}U, ^{238}U are equal to 9.46×10^{-5}, $5.69 \times\ 10^{-4}$, $2.64 \times\ 10^{-5}$ W/kg, respectively. The half-lives of ^{232}Th, ^{235}U, ^{238}U are equal to $14.01, 0.704, 4.468$ Ga, respectively. The thermal emissions of the fuel element ^{40}K are equal to 2.92×10^{-5} W/kg and this fuel element has a half-life period of 1.25 Ga years.

Summarize all the above.

The synthesis of different elements on different stars made it impossible to create biological forms on remote stars. Therefore, first of all, it was necessary to show that the B^{2}FH and K^{2}L models of the synthesis of chemical elements incorrectly describe the processes occurring on stars. Thus there are four major lacks in the B^{2}FH and K^{2}L theories:

- The invariance of element distributions in the solar system is not recorded;
- The invariance of element distributions on the neighborhood stars also is not recorded;
- It is the absence of super mega-enriched stars, called in this study as a donor–stars;
- It is absent significant quantity of heavy traces in the interstellar space.

The difference in representation of the enriched process between this study and B^{2}FH and K^{2}L models was presented below in Table 5. Further, having finished with the point-by-point comparison of terrestrial, solar, and stellar reactors, we proceed to investigate the ensemble-averaged stellar reactors and stellar abundances.

Table 3. Different approaches to investigation of stellar nucleogenesys.

Stellar Enriched Process is :	
Nuclear Fusion (self–enriched process)	this study
Nuclear Fusion (in donor star) + Interstellar Transfer[a] from donor star to acceptor star	B^2FH and K^2L

[a] However the transfer equation in the GCE models is *mistical* lacking

4. Periodic Tables for RT1—RT4 Stellar Groups

By examining the stellar reactors of stars in different stages of development, we can observe the dynamics of stellar reactors' operation. As a result, a reactor's work is characterized by temperature changes, and a synthesis of elements. It is of interest to determine the correlation coefficients between element abundances and effective stellar temperature.

The total amount of recorded processes, both synthesis and degradation, are presented in Table 3 for RT1—RT4 stellar groups. Only statistically significant values with $|R| > 0.12$ and amount stars more than 10 ($N > 10$) are included in the table. The amount of studying cases, in which it was recorded in the stellar spectrums the element in the ionization state, is marked in additional in the brackets. As it can be seen from Table 3, the number of statistically significant synthesis cases ($R > 0.12$) increases in RT1—-RT2—-RT3 cycle, and it reaches 28 pcs for RT3 stellar group.

Due to limited place in the paper, all linear regressions are collected in Tables in Supplementary (STable 2—STable 5). By analogy with Figure 1, our results of linear regressions also were presented in the form of a periodic table in Figure 7. The margin color in Figure 7 indicates element which has $R > 0.12$ in specified RT group in the linear regression between the abundance of effective stellar temperature. Blue color indicates an element, which has the statistical significant negative slope $R < -0.12$. Green color corresponds to an element, which has statistically none significant value or which is not present in selected RT stellar group. White color marks a chemical element which is not present in the Hypatia Stellar Catalog (HSC) and the label $\text{Element}_{\text{II}}$ indicates the ionized state in the stellar spectrum.

Due to stars being far away, so the absorption in the spectral lines are comparable to the noise, which prevents accurate recorded element abundances in the stellar spectrums. Therefore, only for several elements, which are colored in the margin or blue in Figure 7, it is possible to determine the statistically significant rate, but it is not mean that nucleosynthesis of other elements does not occur on these RT1—RT4 stars.

5. Nucleogenesis of Biospheric Elements

This section is devoted to an analysis of the abundances of DNA elements in stellar spectrums. The dynamics of the star's development depend neither on the statistical significance of the calculations nor on the accuracy of the spectral measurements carried out by researchers on Earth. Therefore, at the research of dynamics of element syntheses in RT stellar groups, we may present all the results regardless of their statistical significance. Remind that statistically significant results have been shown above in STable 2 -– STable 5 and Figure 7.

First, the proton-proton (pp) chain and the carbon–nitrogen–oxygen (CNO) cycle will be considered. The last update to the standard solar model and a discussion on CNO cycle can be found in [80]. There is a question: Will we see this cycle in our linear regresses? The linear regressions for C, N, and O are presented in Figure 8c, 8d, and 8a. Some reactions

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Table 4. The amount of synthesis and degradation processes of chemical elements which were recorded in this study. R is the correlation factor on RT diagram between abundance and effective stellar temperature. The table includes only statistically significant values with $|R| > 0.12$ and amount stars, $N > 10$. The amount of studying cases, in which it was recorded in the stellar spectrums the element in the ionization state, is marked in brackets.

Name	Amount of elements		Total amount
	Synthesis $R > 0$	Degradation $R < 0$	
RT1	9 (3)	28 (9)	37
RT2	14 (1)	7 (2)	21
RT3	28 (6)	6 (3)	34
RT4[a]	3 (0)	13 (6)	16

[a] ORT4 site the generalized star nuclear reactor can work in both directions, both at the origin of new stars and at dying low-mass stars. Therefore element synthesis is also possible at dying low-mass stars, i.e. at the $R < 0$.

involved in the CNO cycle, more precisely in the CNO–sub–cycle II, are described by Equation 7:

$$\begin{array}{rcl} {}^{14}_{7}N + {}^{1}_{1}H & \rightarrow & {}^{15}_{8}O + \gamma + 7.35MeV \\ {}^{15}_{8}O & \rightarrow & {}^{15}_{7}N + e^{+} + \nu_e + 2.75MeV \\ {}^{15}_{7}N + {}^{1}_{1}H & \rightarrow & {}^{16}_{8}O + \gamma + 12.13MeV \\ {}^{16}_{8}O + {}^{1}_{1}H & \rightarrow & {}^{17}_{9}F + \gamma + 0.60MeV \\ {}^{17}_{9}F & \rightarrow & {}^{17}_{8}O + e^{+} + \nu_e + 2.76MeV(fast) \\ {}^{17}_{8}O + {}^{1}_{1}H & \rightarrow & {}^{14}_{7}N + + {}^{4}_{2}He + 1.19MeV \end{array} \quad (7)$$

Note that the CNO cycle involves fluorine (F, Z=9), which is not represented in Figure 8 due to lack of space. Like phosphorus, the fluorine spectral line was registered only in the RT2 stellar group. However, only 35 points for fluorine were recorded, i.e., fluorine yield in CNO cycle was equal to 1.76%. The small number of points for F can be explained by the high decay rates of fluorine isotopes. At β^{+} decay lifetime for ${}^{17}_{9}$F isotope is 64.49 sec and for ${}^{17}_{8}$F isotope – 109.77 sec.

According to B^2FH and K^2L models, several elements, including C and N, are synthesized at dying low-mass stars. These elements are colored in Figures 1a and 1b in green. Unlike ccSNe or mNS exploding, at a dying low-mass star, the initial impulse is small or zero, and without impulse, the dispersion cloud can not be a star to travel from one star to another. The statement that stellar spectrums are enriched with elements synthesized at dying low-mass stars looks even more incredible and fantasy than the exclusive delivery of uranium to Earth, presented in Figure 5.

According to GCE models, such as B^2FH and K^2L, the star enrichment happened due to matter transfer from donor – star to acceptor – star. However, considerable impulse is required to transfer the matter to interstellar distances. Since there is burning out of nuclear fuels with the gradual cooling of the stellar nuclear reactor at dying low-mass stars, the transfer of impulse from dying low-mass star to the impurity cloud seems doubtful.

At zero impulse, respectively, the transfer to zero distance will occur. Thus, according to B^2FH and K^2L theories, at dying the low-mass stars enriched themselves. In the frame of these theories, with an exception for binary stars, it looks paradoxical. I would like to emphasize that this contradiction exists only within the framework of B^2FH and K^2L

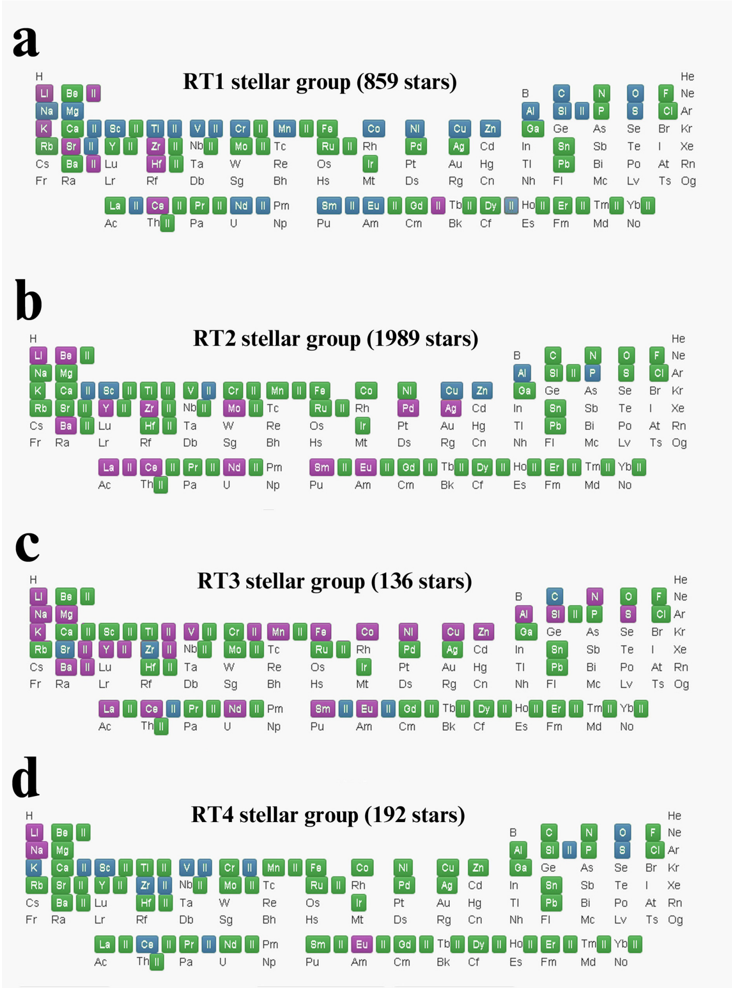

Figure 7. The periodic tables of stellar abundances for RT1—-RT4 stellar group are presented. Margin color indicates an element that is synthesized in the specified RT group, i.e. indicate element that has the statistically significant positive slope in the linear regression abundance of effective stellar temperature. Blue color indicates an element which has a statistical significant negative slope. Green color corresponds to an element with a statistical none significant value or has not been present in the selected RT group. White color marks a chemical element which does not present in the Hypatia Stellar Catalog (HSC). In Figures, the label "II" after element name is presented the abundance of ionized state of an element.

theories. According to this conception, one star enriches another star; sometimes the last one allocates at hundreds pc away from ones. Note that this study suggested another concept, according to which the star itself synthesizes all the elements (self–enriched process), passing through different stages of its development.

According to the results of this study, nitrogen is synthesized in a *"hot"* stellar group in the RT3 stage in Figure 8a. However, carbon and oxygen are synthesized in the same way, probable in the nebula near the star; see RT4 paths in Figure 8c and Figure 8d. Oxygen, nitrogen, and carbon are light elements, and when superheated stars explode, oxygen and carbon are easily dispersed to form large CO_2 clusters, comets, or even planets; at the same time, nitrogen forms rivers and oceans of liquid nitrogen on the surface of planets.

Next, we will consider the elements necessary for the growth of the simplest phototrophs, such as cyanobacteria. The linear regression for Na, Mg, S, K and Fe, Co, Cu, Zn abundances were presented in Figures 9 and 10, correspondently. The following behaviors characterized these elements: for the RT1 stellar group the correlation coefficient is negative;

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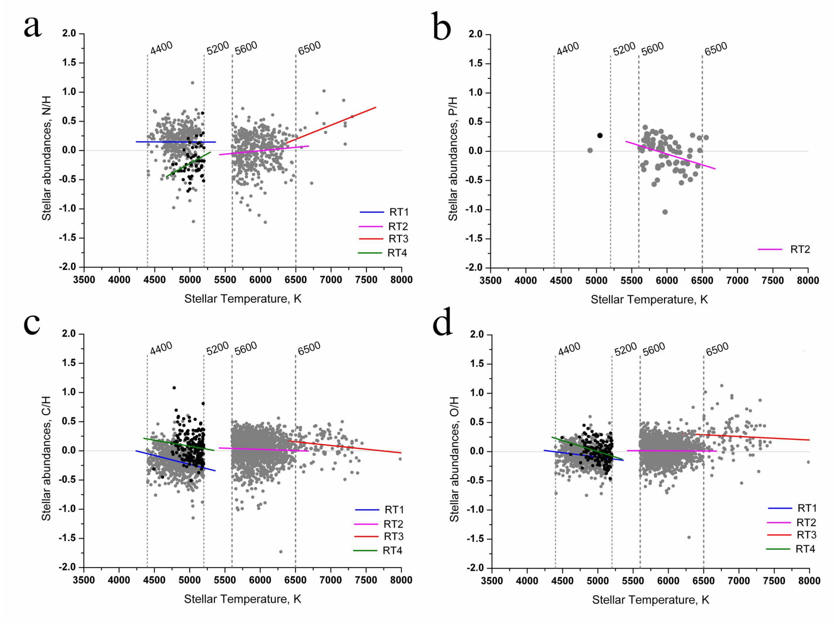

Figure 8. The linear regressions for C, N, O, and P abundances for RT1-–RT4 stellar groups were presented in Figure (c), (a), (d), and (b), correspondingly.

for RT2 stars, it is a neutral or slightly negative, and for RT3 stars, it was recorded a positive correlation which may be associated with the synthesis of chemical elements in overheated stars.

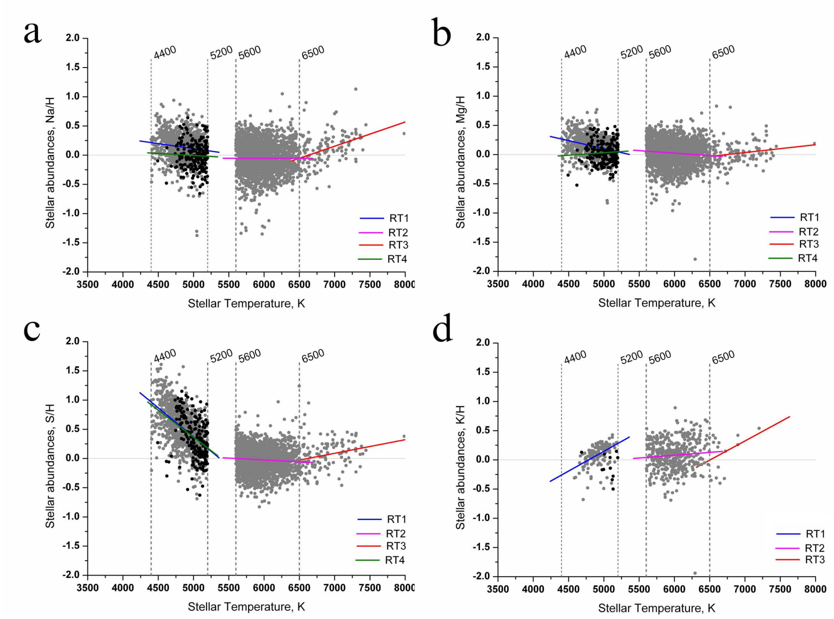

Figure 9. The linear regressions for Na, Mg, S, and K abundances for RT1—RT4 stellar groups were presented in Figures (a), (b), (c), and (d).

Note the following: nearby elements have similar patterns of stellar reactor operation; for example, this is true for Na–Mg or other Fe—Co pairs; please compare Figure 9a with 9b and Figure 10a with 10b. However, sometimes for nearby elements, the ensemble–average

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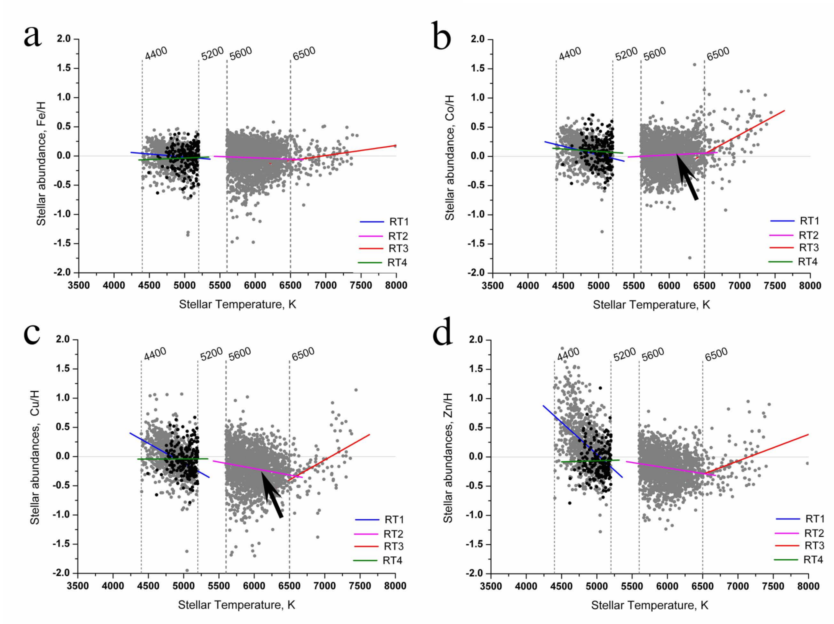

Figure 10. The linear regressions for Fe, Co, Cu, and Zn abundances for RT1–RT4 stellar groups were presented in Figures (a), (b), (c), and (d).

stellar behaviors are different, i.e., for the Co–Cu pair, the stellar reactor workings are markedly noticeably at the RT2 stage; see the arrows in Figure 10b and 10c.

Unlike mentioned above Na, Mg, S, Fe, Co, Cu, and Zn elements, potassium behavior is different. In the spectrums of the RT4 stellar group, the presence of potassium was practically not revealed. In addition, for big, cold stars from the RT1stellar group, an increase in the K abundance is observed, and it is not surprising since it is known that potassium has a fuel isotope of ^{40}K.

We especially note that the theoretical Fe–Ni threshold of exothermic – endothermic fusion reactions (Equation 3 and Figure 4a) is not detected in the stellar abundances. As follows from Figure 9 and Figure 10, it can be argued that the operating cycle of the ensemble–average stellar reactor is well–established for reference elements.

Sometimes in the stellar spectra, along with the ground state, ionized excited lines are observed. The behavior of the ground and the excited state can be explained by the Non–LTE effects of Ca I or Ca II lines [81]. An example of the difference is presented in Figure 11a and Figure 11b for calcium (Ca, z=20). In this case, the average value of Ca abundance is weakly dependent on effective temperature, but the behavior of Ca II abundance is similar to the ones of Na, Mg, Al, Fe, Co, Cu, and Zn, presented above.

The manganese (Mn, z=25) and molybdenum (Mo, z=42) are the last elements that we have classified as elements necessary for the simplest phototrophic organisms' growth. The linear regression of Mn and Mo were shown in Figure 11c and Figure 11d.

Note the general trend: moving ahead along the periodic table, the number of stars in the spectrum of which these elements were registered decreases rather quickly, even in comparison to the elements located in the same row of the periodic table. Molybdenum is not synthesized in the entire RT3 range, but only in the temperature range of 5500 -— 6000 K, that is, closer to the G2V spectral group. Moreover, Mo abundance was not detected in the RT3 stellar group, and in the RT4 group, it was detected only in three stars Figure 11d. Unlike phosphorus, molybdenum belongs to the regulatory elements, so at the moment, it remains unclear how critical is the absence of this element in the stellar spectrum, but note that in terrestrial conditions, molybdenum is necessary for the growth of bacteria.

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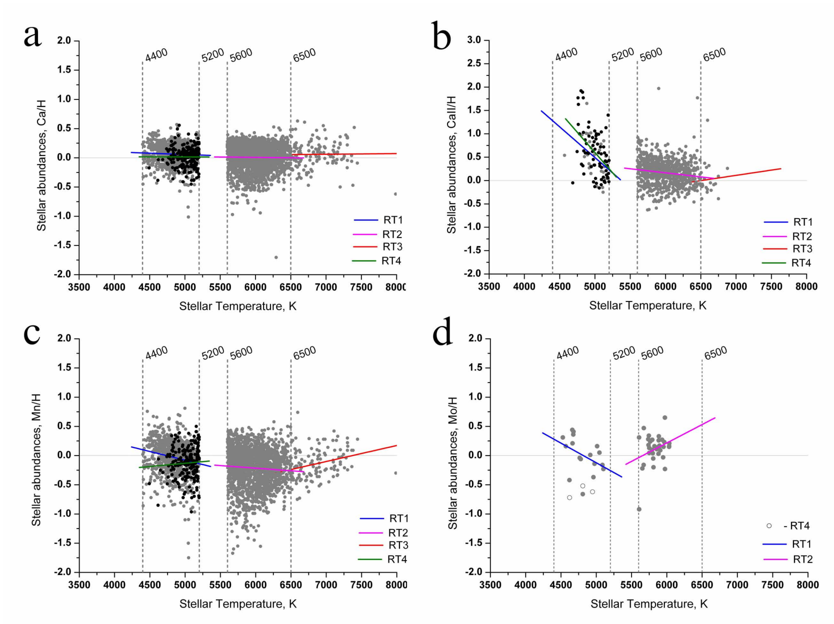

Figure 11. The linear regressions for neutral (ground) and ionized states for Ca (a, b), and for Mn (c), and Mo (d) for RT1—-RT4 stellar groups are presented.

It is summarized the results of Section5. In this section, we analyzed the work of the ensemble–averaged stellar reactor. We showed that this reactor works similarly for all the stars presented in the catalog and provides the synthesis of stellar abundances. Due to stratification and sink of heavy elements, the spectra of heavier elements are less pronounced in stellar spectrums. The effective temperature of the stars is a kind of indicator of the power of the reactor operation. Therefore, the main synthesis of elements occurs in the RT2 and RT3 stellar groups, on which the temperature of the stars is higher.

The statistical values of C, N, O, and P, are summarized in Table5. It turned out that phosphorus was found only in the 86 cases of the 3757 HSC stars. That is only 2.3% of stars contain phosphorus. Also, phosphorus has only been detected in stars of the RT2 stellar group (Figure 8b). Therefore phosphorus is the main limiting element. In HSC catalog, there is no distinction between ND (Not Detected) and NS (Not Studying). Of course, it is impossible to draw an unambiguous conclusion from a negative signal; in other words, phosphorus can be determined on some stars during further experiments.

Table 5. The amount of HCS stars, in which spectrum was specified by the chemical elements that are demanded for DNA creation.

Elements	Amount of stars pcs.	%
C	3217	85.6
O	3107	82.7
N	1044	27.8
P	86	2.3
C, N, O and P (DNA–stars)	48	1.3
C, N, O and P (class G2V)	3	0.08
similar to Earth abundances	9	0.24
Total amount of stars	3757	100

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6. Discussion and some remarks

1. From the comparison of the B^2FH and K^2L models with terrestrial element abundance, it follows that the existence of a set of elements, which was found on Earth, can not be provided by a single source. To provide a full abundance of chemical elements in the solar spectrum, different types of stars located around our Sun had to blow up together, which is a very low–probability event.

2. In the B^2FH model, the frequency of neutron star collisions raised doubts, so new K^2L model was included in our consideration. According to the K^2L model, the neutron star collisions do not create the quantity of chemical elements that than were previously assumed. In addition to the common lack of these models, related to the element transfer in space, each model has individual defects. This K^2L model can not explain the amount of such elements as Cl, K, Sc, As and Au and creating new astronomical mystery. In summary, we can conclude: the new K^2L mode did not solve the previous B^2FH model's problems.

3. During propagation in interstellar space, the concentration of element abundances will rapidly decrease with the donor star's distance. At uniform spherical 3D expansion, the decrease will occur as $\sim 1/r^2$, and at cylindrical 2D expansion the concentration will decrease as $\sim 1/r$. Thus, for receiving one gram of Th and U on Earth, it is required that the donor star has a colossal value of transuranic elements, i.e., this case the donor–star must entirely consist of thorium or uranium. But such stars have not been found in our galaxy.

4. On nearby stars, the invariance of abundances of individual elements, or invariance of the ratio of the abundances of related elements are not recorded. Therefore, it can be argued that in stellar spectrums there are no traces of plumes from ccSNe or mNS. In addition, only several nuclear decay elements were recorded in the interstellar space, but plumes themselves are not recorded. Thus, the spatial distribution of elements does not confirm the correctness of the B^2FH and K^2L models. In these two models, it was stated that all elements, heavier than iron, synthesized on stars during the s and r processes, have been transferred to other star systems.

5. At the dying low–mass stars, the initial impulse is small or absent, so there is a problem to explain the interstellar transfer of elements from a donor–star to neighboring ones.

6. Looking at the *"onion"* structure of a massive star, the author wants to cry bitter tears. Astrophysicists, without a shadow of a doubt, very seriously claim that iron isotopes, including ^{56}Fe, can explode. Probably astrophysicists do not realize that it is impossible to make a nuclear bomb from iron.

Therefore, the statement that massive stars will explode due to the over–saturation of Fe and Ni, causes reasonable anxiety to the author of the study. Recall that according to B^2FH and K^2L synthesis models, ^{40}K can be obtained only in the s–process, so in stars with the *"onion"* structure, this nuclear layer is absent. Thus, we have led readers to the idea that massive stars with *"onion"* structure can not explode since there are no fuel nuclear K-–Th-–U layers in their internal structures. The clue to solve the problem of explosive massive stars could be found in an abundance of interstellar gas in [76], see also Figure 6. The elements of Ga, Ge, As, Kr, Sn, Tl, and Pb may be specified as a trace of uranium explosive. Therefore it is possible to come out with the assumption that before explosions, massive stars suddenly start to get oversaturated Th-–U elements.

7. Next, we will pay attention to one more feature. According to the B^2FH and K^2L models, it turns out that there is *"exclusive delivery"* of uranium from neutron or massive stars to the Earth. This paradox of an *"exclusive delivery"* of U and I, Cs, Pt, Hg, Bi, Po, and Rn to Earth for sure can bring interest to our readers and probably raise a hot discussion.

7. Conclusions

In this study, the possibility of the life origin in other star systems, located at a distance of ~ 200 *pc* from the solar system, was investigated. For the origin of life the synthesis of chemical elements, such as C, N, O and P, which are necessary for the forming of DNA and biological organisms, are essential. The stars, in spectrums of which these elements are presented, are called as DNA stars. However, the synthesis of chemical elements is impossible without the work of nuclear reactors. For that, the concept of the ensemble––averaged stellar reactor (EASR) was introduced. The comparisons between the working of terrestrial, solar, and EAST nuclear reactors were carrying out.

The main results of this study:

In life science
Based on the chemical compounds, a new method for searching for habitable star systems has been developed and 48 DNA–stars in the solar neighborhood, on which life is possible, has been determined. These stars make up only 1.3 % of the total 3176 amount of studied stars (see Table 5).

In stellar nucleogenesis
From the comparison of terrestrial, solar, and stellar abundances, it was established that terrestrial, solar, and ensemble—averaged stellar reactors have a common K—Sr—-Cs—-Pb—-Th—U multilayer structure. The theory of the buoyancy of elements and isotopes, developed earlier to describe the processes occurring in the interior of the planet in [5], is generalized to stars.

It is suggested that stars warming up due to the displacement of the nuclear processes occurring inside the stars, which leads to the synthesis of heavy elements. The majority of the elements, which have been found out in the solar system, have been synthesised in our solar system. Further accumulation of transuranic elements inside star leads to reach a critical nuclear mass, and at the end to the star explosion.

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Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/1010000/s1. The set of **Tables** are included: STable 1: The Abundance of Heavy Elements in Interstellar Gas, according Cardelli [76]; STable 2: The linear regression for RT1 stellar group; STable 3: The linear regression for RT2 stellar group; STable 4: The linear regression for RT3 stellar group; STable 5: The linear regression for RT4 stellar group.

The set of **Figures** are next: SFigure 1: The mass distributions of fission products produced in the thermal, fast, and high neutron fission yields of ^{232}Th (a) and ^{235}U (b); SFigure 2: The statistic distributions of the stellar radius for RT1–RT4 stellar groups; SFigure 3: The statistic distributions of stellar effective temperature for RT1–RT4 stellar groups.

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