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The PFO–CFO hypothesis of Solar System formation: the birth of chemical elements

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Abstract

The Solar System formation PFO–CFO hypothesis is developed. An original mechanism of the birth of chemical elements is proposed and grounded.

1. Introduction

We consider the Solar System (SS) formation as a phenomenon initiated by the presolar star with no significant contribution from any other source and divide this phenomenon into two phases, namely, formation of the **P**hysically **F**ormed **O**bjects (PFO) and **C**hemically **F**ormed **O**bjects (CFO). The PFO–CFO hypothesis [1-8] considers the presolar-star and Sun transformations over the period between the presolar-star "mature age" and the future Sun explosion. For the last years, the hypothesis was in progress, the discovery [9] of a difference between the rotation rates of the solar core and radiation zone being the Ariadne thread for its development. We propose original stellar transformation mechanisms that led to planetary-system formation. In our opinion, searches for new mechanisms are useful because the available approaches are insufficient for explaining, from a unified point of view, a number of paradoxes and principal questions that arise on the way of the Nature movement cognition. Some paradoxes and questions are discussed in [6, 8]. We believe that the mature-age presolar star was likened to a great extent to the present Sun and relate this consideration to each of these two stars.

2. The birth of chemical elements

According to the PFO–CFO hypothesis, the young presolar star represented an energy-matter electrically-neutral unstructured amorphous object, where no particles were individualized. Its energy-matter specific internal energy density increased from the star periphery to the center; it was higher than that in any atomic matter available under the Earth conditions but much lower than the energy density of atomic nuclei. The energy-matter (ω) was capable of ionizing. This process started in the central zone of the star when the ω density reached a critical value as a result of gravitation and extended symmetrically over the sphere as the outward layers compressed. The resulted giant amorphous pseudo-liquid positively-charged pressed matter was neutralized by electrons that were produced by the process $\omega = \omega^{+} + \bar{e}$. The distance of the electron layer from the center was determined by the balance between its attraction to the positively-charged core, buoyancy force, superstratum inward pressure, gravitation, and other forces that, possibly, work in such systems. Just the process of the energy-matter ionization in the star central field led to formation of the electron-enriched layer (ElEL) and to segregation of the newly-formed radiation zone from the core. With time, the star-core positive charge, ElEL negative charge, gravitational compressing, and radiation-zone density increased. Progressively, these processes led to such an increase in the negative-charge density at the core–ElEL boundary when the process of the core neutronization started. Neutronization proceeded significantly slower than ionization. We assume that just the electron capture at the core–ElEL boundary led to nucleation of the presolar-star core, i.e., to formation of a p–n (proton–neutron) layer "diluted" with electrons. The p/n ratio in this layer decreased progressively. Meanwhile, the radiation-zone–ElEL boundary layer became stronger with time under gravitation, core ionization progressed, and electron diffusion into the ElEL continued. Therefore, the ē-pressure within the ElEL increased with time and occasionally reached a value at which radiation-zone local disruptions occurred and p–n–ē-matter picodrops was ejected with prominences from the ElEL to the space. The inter-prominence intervals were constant for centuries because the solar processes develop slowly on a scale of the human epoch. From epoch to epoch, the critical pressure became higher and the prominences became more powerful. Progressively, the p/n value at the star-core−ElEL boundary decreased and the p/n value in the picodrops decreased as well. According to the PFO–CFO hypothesis, just the radioactive picodrops after their decays gave stable atoms for SS origination.

To analyze the sequence of formation of different atoms from the picodrops ejected by prominences as n_0/p_0 increased, we used a procedure described in [6, 7] and developed here. For 105 stable isotopes of 39 arbitrarily chosen elements from H to U (see columns in the figure), each characterized by a numbers of protons (p_{stable}) in its atom, we determined the n_0/p_0 ratios in the parent picodrops by using the information [10, 11] on the origin of stable isotopes and transformations of radioactive isotopes. For each stable isotope with p_{stable}, we found the sequence of radioactive transformations and determined the n_0/p_0 ratio in the parental picodrop that was born near the star-core-ElEL boundary. The figure gives the p_{stable} values *vs*. the n_0/p_0 values.

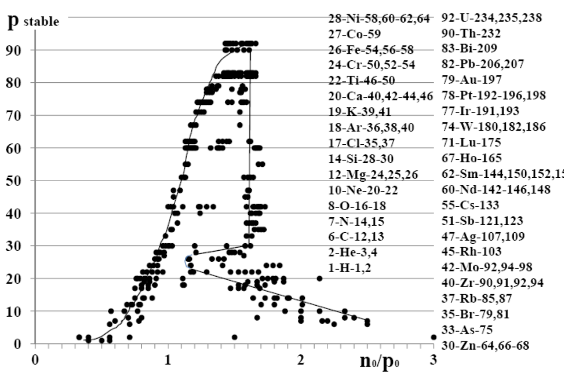

Figure: the number of protons in the newly formed atoms *vs*. the p_0/n_0 ratio in the outward layer of the star core in the moments of separation of the parental picodrops from it.

Briefly, our understanding of this figure is as follows. First, it is clear that the differences in the isotopic ratios observable for chemical elements at SS celestial bodies and at their different points are caused by repeated ejections of these elements from the presolar star when the n_0/p_0 ratios at the star-core−ElEL boundary were different. However, this conclusion is by no means the only one. The left upward branch of the curve up to n_0/p_0=1.4 gives a progressive increase in the number of protons in the stable atoms that originate from the stellar picodrops in the prominences. The older is the star, the greater is the n_0/p_0 value and the higher is the power of the prominences. The curve slope grows with the n_0/p_0 ratio and with time up to Fe (p=26). Apparently, the ejection period for the elements from H to Ne ($1 \le p \le 10$) into the space is longer than that for the elements from Na to Ca ($11 \le p \le 20$), and the elements from Zr to Nd with $40 \le p \le 60$ are ejected even more quickly with n_0/p_0. At $(n_0/p_0)>1.5$, the curve descends abruptly, i.e., the elements with $30 \le p \le 80$ are ejected at n_0/p_0=1.6; then, the curve acquits itself darkly: it turns left and then falls diffusively to the right. We explain such a behavior of the curve by the explosive destruction of the radiation envelope under the force of the electron gas pressure at n_0/p_0=1.6, emission of the electron gas into the space, displacement of equilibrium at the star-core–ElEL boundary toward a decrease in the degree of neutronization, and ejection of a portion of the star mass into the space with a subsequent returning of the major portion of this mass back to the presolar star and progressive arrangement of a new life of the star. The mass that was irreversibly ejected into the space and the earlier ejected masses became the sources for the SS formation [1, 6–8].

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