

Oxygen isotopic anomalies in the rocks of celestial objects: Are they the key to the planet formation mechanism?

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Abstract

We assume that the stars, during their before-explosion collapse, “spray” flows of neutron–proton (n–p) nanodrops, which transform quickly into radioactive atoms and give stable isotopes as a result of decays. As the star rotation accelerates, the nucleon number in the nanodrops increases. This assumption and available data on the half-lives and decays of radioactive atoms allow quantitative explanation for the $^{16}\text{O}/^{17}\text{O}/^{18}\text{O}$ isotopic anomalies revealed 40 years ago for different celestial objects.

1. Introduction

By the PFO–CFO hypothesis [1–5], the Solar System (SS) formed as a result of a star explosion (material 1), the cold and warm celestial objects being Physically-Formed Objects (PFO) and Chemically-Formed Objects (CFO), respectively. Another hypothesis [6] assumes a significant contribution of a material of the previous star generation (material 2) to this process. This assumption is supported by the fact that some elements, e.g., O and C, belonging to the SS celestial objects have isotopic anomalies (IAs). Thus, the ratios of the increments (relative to a standard) $(\delta^{17}\text{O})/(\delta^{18}\text{O}) = 1:2$ and $1:1$ for the Earth and Moon and for some meteoritic substances (CAIs and chondrules), respectively. The IAs as a whole have no quantitative explanation. The $1:1$ ratio is supported in [6] by the assumption that the SS minerals are obtained by mixing of 1 and 2 materials in different proportions. However, there is no independent confirmation for the material 2 contribution either to the SS origination or to the IAs formation and the door is open for new hypotheses.

2. Fore-explosion star processes as the cause of the O-anomalies

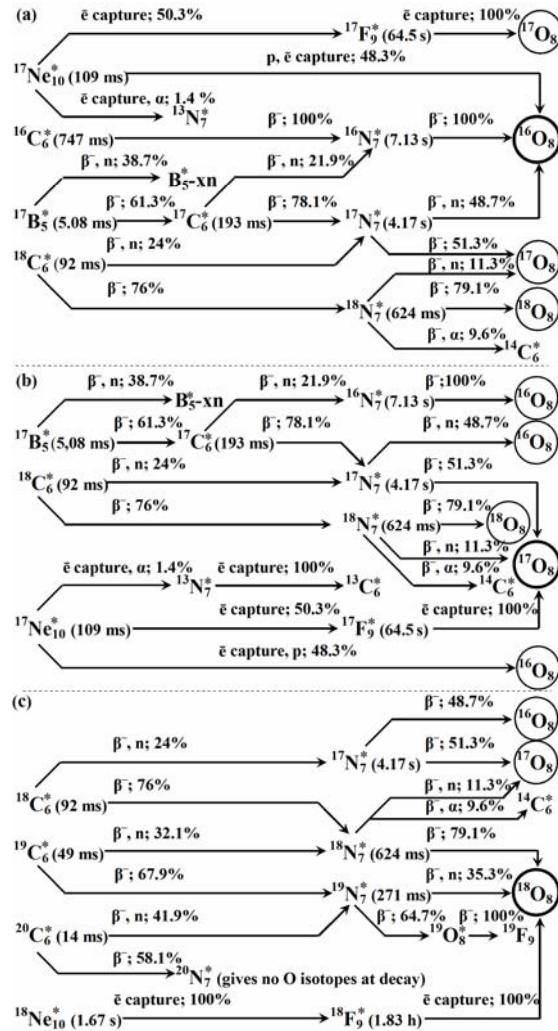


Figure 1: Sources and ways of ^{16}O , ^{17}O , and ^{18}O formation; on the left, are the initial atoms formed by restructuring of the nanodrops.

We consider the star-life period when the H-fuel comes to the end, collapse accelerates, star angular velocity rises, neutronization of the star develops, and star photosphere expands. We believe that the

stars “spray” flows of n-p “nanodrops” (NDs), the nucleon number and n-to-p ratio in the NDs steadily increasing. The NDs of any definite composition leave a star when the centrifugal force comes up with the force of bond between these NDs and the star body. Each of the NDs transforms to one or two radioactive atoms just after isolation from the n-p-He mass. The radioactive atoms steadily decay and transform to stable atoms. Fig. 1 (a, b, c) gives the available data [7, 8] on all chains of radioactive decays that can lead to ^{16}O , ^{17}O , ^{18}O formation and on the side O-isotopes that form together with each of them; it also gives data on the types of decays, degrees of the decays in different directions, and half-lives for the intermediate radioactive atoms. The atoms form clouds that go out under the action of the angular impulses. In each cloud, O-isotopes are of a specific origin and of a specific isotopic ratio, both depending on the ND size and nuclide composition in the period of ND formation. Later, the O-containing clouds mix with other clouds and with each other and form minerals with different $^{16}\text{O}/^{17}\text{O}/^{18}\text{O}$ ratios. An analysis of the data of Fig. 1 allows quantitative explanation of the oxygen IAs. Let us assume the following mechanism. In three rather short star-life periods characterized by different sets of intra-core conditions, three O-containing flows of different isotopic compositions were emitted by the star. Each outflow contained, along with O, other chemical elements. We don't analyze their contents because they don't influence the relative contents of O-isotopes in the outflows. One of three outflows (I) is considered by us as the basic one. Later on, the O-compositions of celestial objects were influenced by outflow I and by additional outflows II and III incorporated in different proportions. In the outflows, each of the O-isotopes was formed from specific precursors as a result of several radioactive decays. In the process of SS formation, outflow I could be incorporated into the celestial objects individually or in the form of mixtures with outflows II and III added in different proportions. Thus, the oxygen IAs could be understood if the ^{17}O and ^{18}O concentrations would be in the ratio 1:1 in one of the additional outflows and in the ratio 1:2 in the other. An analysis of the chains starting from ^{17}Ne (Fig. 1b) and ^{18}Ne (Fig. 1c) leads to two conclusions: (1) If each of these chains would be the only source of ^{17}O and ^{18}O , the $^{18}\text{C} \rightarrow ^{17}\text{N} \rightarrow ^{17}\text{O}$ chain would be absent, and the intensities of ^{17}Ne and ^{18}Ne outflows would be equal, the ^{17}O and ^{18}O concentrations in the total O-outflow from the star would be in the ratio close to 1:2; (2) If ^{17}Ne and ^{18}Ne would be absent and the intensities of

^{17}F and ^{18}F outflows would be equal, the ^{17}O and ^{18}O contents in the total O-outflow from the star would be in the ratio 1:1. These conclusions represent the clue to the IAs. To clarify them fully, it is necessary to understand whether the conditions causing the 1:1 and 1:2 isotopic ratios could be realized in reality.

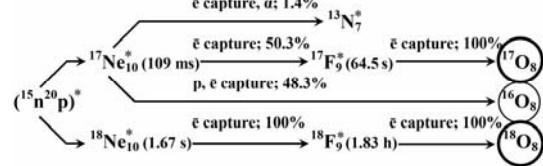


Figure 2: Formation of flow II with $^{17}\text{O}:^{18}\text{O}=1:2$.

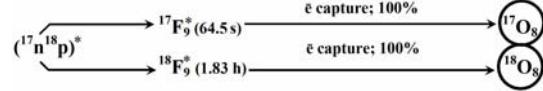


Figure 3: Formation of flow III with $^{17}\text{O}:^{18}\text{O}=1:1$.

Flow II with the ratio $^{17}\text{O}:^{18}\text{O}=1:2$ could originate if a portion of the emitted $(^{15}\text{n}^{20}\text{p})$ NDs would transform according to Fig. 2. Flow III with equal ^{17}O and ^{18}O concentrations could originate if a portion of the emitted $(^{17}\text{n}^{18}\text{p})$ NDs would transform according to Fig. 3. Namely, each $(^{17}\text{n}^{18}\text{p})$ ND dissociates quickly ((before its reorganization to $^{35}\text{Ar}_{18}$) into ^{17}F and ^{18}F atoms; each ^{17}F atom produces one ^{17}O atom, and each ^{18}F atom produces one ^{18}O atom. The outflow of $(^{17}\text{n}^{18}\text{p})$ NDs (flow III) forms afterwards a cloud (cloud III) in which $^{17}\text{O}:^{18}\text{O}=1:1$ ratio is fulfilled.

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