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Presolar Grain Isotopic Ratios as Constraints to Nuclear and Stellar Parameters of Asymptotic Giant Branch Star Nucleosynthesis

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Recent models for evolved low-mass stars (with M <=3 Mo), undergoing the asymptotic giant branch (AGB) phase assume that magnetic flux-tube buoyancy drives the formation of 13C reservoirs in He-rich layers. We illustrate their crucial properties, showing how the low abundance of 13C generated below the convective envelope hampers the formation of primary 14N and the ensuing synthesis of intermediate-mass nuclei, like 19F and 22Ne. In the mentioned models, their production is therefore of a purely secondary nature. Shortage of primary 22Ne has also important effects in reducing the neutron density. Another property concerns AGB winds, which are likely to preserve C-rich subcomponents, isolated by magnetic tension, even when the envelope composition is O-rich. Conditions for the formation of C-rich compounds are therefore found in stages earlier than previously envisaged. These issues, together with the uncertainties related to several nuclear physics quantities, are discussed in the light of the isotopic admixtures of s-process elements in presolar SiC grains of stellar origin, which provide important and precise constraints to the otherwise uncertain parameters. By comparing nucleosynthesis results with measured SiC data, it is argued that such a detailed series of constraints indicates the need for new measurements of weak-interaction rates in ionized plasmas, as well as of neutron-capture cross sections, especially near the N = 50 and N = 82 neutron magic numbers. Nonetheless, the peculiarity of our models allows us to achieve fits to the presolar grain data of a quality so far never obtained in previously published attempts.

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