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The stellar sources of presolar silicates revisited - New insights from magnesium isotopic compositions

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Primitive Solar System materials contain small amounts of presolar grains that formed in the winds of evolved stars and in the ejecta of stellar explosions [1]. These grains exhibit large isotopic abundance anomalies, the fingerprints of nucleosynthetic and mixing processes in their parent stars, and of Galactic chemical evolution (GCE). Silicates are the most abundant type of presolar grains with stellar origins. Based on O-isotopic compositions, O-rich presolar dust was divided into four distinct groups [2]. Most abundant are Group 1 grains (about 80% of all presolar silicates) which are characterized by enrichments in 17O and close-to-solar 18O/16O ratios. For a long time it was believed that the vast majority of Group 1 silicates formed in the winds of low-mass asymptotic giant branch (AGB) stars. However, recently conducted high-resolution in-situ Mg isotope measurements on presolar silicates, facilitated by technical advancements on the NanoSIMS ion probe, have changed this view considerably [3-5].

The surface Mg-isotopic compositions of low-mass AGB stars are predicted to change only marginally during stellar evolution [e.g., 6], i.e, initial Mg-isotopic compositions at stellar birth are largely preserved. In a Mg three-isotope-representation about 60% of Group 1 silicates plot along a line with slope 1, interpreted to represent GCE [5]. The O-, Mg-, and Si-isotopic compositions of these grains are compatible with origins in low-mass AGB stars. About 25% of Group 1 silicates show strong enrichments in 25Mg of up to a factor of 2 or more, along with typically 4-5 times smaller 26Mg/24Mg anomalies. Type II supernovae (SNe) and intermediate-mass (4-5 Msun) AGB stars with super-solar metallicities have been proposed as most likely stellar sources of 25Mg-rich Group 1 silicates [3, 5]. The remaining 15% of Group 1 silicates are 26Mg-rich and might have formed in the winds of supergiants or in the ejecta of SN explosions [5]. Similarly, Group 2 silicates (a few percent of all presolar silicates) might have formed in intermediate-mass AGB stars, super-AGB (8-10 Msun) stars, supergiants, and SNe [4, 5].

[1] Zinner, E. 2014, in Meteorites and Cosmochemical Processes, ed. A. M. Davis, Elsevier, 181. [2] Nittler, L. R. et al. 2008, ApJ, 682, 1450. [3] Leitner, J., & Hoppe, P. 2019, Nature Astronomy, 3, 725. [4] Verdier-Paoletti, M. J. et al. 2019, 82nd Ann. Meeting of The Meteoritical Society, #6433. [5] Hoppe, P. et al. 2021, ApJ, 913, 10. [6] Karakas, A. I., & Lugaro, M. 2016, ApJ, 825, 26.

Session

Dust and presolar grains

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