

The Galactic chemical evolution of Mg-isotopic compositions inferred from presolar silicate grains

Thursday 13 June 2024 12:30 (20 minutes)

Primitive Solar System materials contain small concentrations 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. Based on O-isotopic compositions, O-rich presolar dust is divided into four distinct groups [2]. Most abundant are Group 1 grains (ca. 80% of all presolar silicates) which are characterized by enrichments in ^{17}O and close-to-solar $^{18}\text{O}/^{16}\text{O}$ ratios. About 60% of Group 1 silicates, called “normal” Group 1 grains, formed in the winds of low-mass asymptotic giant branch (AGB) stars, while the remaining 40% are likely from supernovae, supergiants and/or intermediate-mass (4-5 M_{sun}) AGB stars with super-solar metallicities [3-5].

The surface Mg-isotopic compositions of low-mass AGB stars are predicted to change only little during stellar evolution [e.g., 6], i.e. initial Mg-isotopic compositions at stellar birth are largely preserved. In a Mg three-isotope-representation the normal Group 1 silicates [4,7] plot along a line with slope 0.84 ± 0.05 , called the Mg mainstream line, which is interpreted to represent GCE [4]. The slope of the Mg mainstream line is close to the slope of about 1 predicted by GCE models at around solar metallicity [8,9]. In a Si three-isotope representation normal Group 1 silicates [4,7] plot along a line with slope 1.34 ± 0.09 , called the “silicate Si mainstream line” [4], which is compatible with the slope inferred for presolar SiC mainstream grains (1.342 ± 0.004 [10]). Magnesium-isotopic compositions of normal Group 1 silicates are correlated with Si-isotopic compositions and to some extent also with $^{18}\text{O}/^{16}\text{O}$ ratios, which supports the GCE interpretation of the Mg mainstream line.

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Session Classification: Seeds and grains: AGB stars as dust factories in galaxies