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The Abundance of 60Fe in the Early Solar System

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The abundance of the extinct radionuclide 60Fe (2.62 Myr half-life) in the early Solar System is highly disputed in the literature. On one hand, bulk measurements of early Solar System materials indicate an initial abundance consistent with galactic background [1, 2]. On the other hand, in situ studies by secondary ion mass spectrometry (SIMS) report a variety of ratios, e.g., [3], including some as high as 60Fe/56Fe = 1 × 10−6, e.g., [4]. Such high ratios are incompatible with galactic background and would require the injection of fresh nucleosynthetic material prior to the birth of the Solar System.
Here we present new resonance ionization mass spectrometry (RIMS) measurements of a Semarkona chondrule (DAP1), which has been previously analyzed in situ by SIMS [3]. Despite improved precision compared to SIMS, our new RIMS measurements show no enhancement in 60Ni that could be attributed to the in situ decay of 60Fe. Our new value for the Solar System initial 60Fe/56Fe ratio of (6.4 ± 11.9) × 10−8 (2σ) is consistent with the low value as measured by bulk techniques and as found in some SIMS analy- ses, and agrees well with the 60Fe expected in galactic background. Our new result also agrees with a reevaluation of the previous SIMS DAP1 measurements. Supernova injec- tion of freshly synthesized 60Fe into the solar nebula just prior to the condensation of the first solids is thus not required to explain our measurement. It is however in agreement with a recent model by [5], which shows that Wolf-Rayet stars could have con- tributed the other short-lived radionuclides to the solar nebula, especially 26Al, without significantly enhancing 60Fe.

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