S-process nucleosynthesis preserved in presolar grains

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Grains of silicon carbide (SiC) are the most abundant of the different presolar minerals that survived the high-temperature formation in the early solar system. SiC grains most commonly condensed around low-mass (1.5-3 $M_{\odot}$) carbon-rich asymptotic giant branch stars as indicated by C, N, and Si isotope compositions. These stars are also undergoing *s*-process nucleosynthesis with this signature evident in the isotopic compositions of heavy elements. Presolar SiC grains give us unprecedented detail concerning the nucleosynthetic pathway of the *s*-process.

We have analysed through secondary ion mass spectrometry many elements around the lanthanide and actinide region including Ba, Eu, Gd, Dy Hf, W, and Pb [1-4]. In general, these elements show enrichments in the nuclides according to their neutron capture cross sections. However, branching points in the *s*-process pathway provide sensitive indications of neutron fluences as neutron capture reactions compete against β-decays. For example, the Eu isotopic composition (^{151}Eu/^{153}Eu) is affected by branching points at ^{151}Sm, ^{153}Sm, ^{152}Eu, and ^{153}Gd; our measurements are in good agreement with ^{151}Eu/^{153}Eu derived from astronomical observation of carbon-enhanced metal-poor (CEMP) stars. Isotopic abundances in the Hf-Ta-W-Re-Os region of the nuclides have significant importance for several radionuclides used in cosmochronometry (including ^{182}Hf and ^{187}Re). Measurements of SiC show ^{182}W/^{184}W, ^{183}W/^{184}W, and ^{179}Hf/^{180}Hf isotopic compositions in good agreement with theoretical predictions for AGB nucleosynthesis. However, the ^{186}W/^{184}W appears low and cannot be explained even by increasing the ^{185}W neutron-capture cross section by a factor of two. SiC grains also show enrichment in the nonradiogenic *s*-only ^{204}Pb, however, Pb isotopic ratios (^{208}Pb/^{204}Pb, ^{207}Pb/^{204}Pb, and ^{206}Pb/^{204}Pb) show a much larger spread than that predicted by theoretical models, which do not include the radiogenic component of ^{208}Pb, ^{207}Pb, and ^{206}Pb.

[1] J. N. Ávila et al. (2012) Astrophys. J. 744:49.
[2] J. N. Ávila et al. (2013) Astrophys. J. Letts. 768:L18.
[3] J. N. Ávila et al. (2013) Geochimica Cosmochimica Acta 120:628.
[4] J. N. Ávila et al. (2012) 43th Lunar and Planetary Sci. Conf. #2709.