COSMOGENIC PRODUCTION RATES IN PRESOLAR SiC GRAINS.

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Introduction: Presolar grains formed from the outflow of dying stars and were incorporated into meteorite parent bodies at the formation of the Solar System. These grains recorded snapshots of stellar nucleosynthesis. However, the time gap between their and solar system formation is still a conundrum. Two recent studies [1,2] analysed He, Ne, and Li isotopes in such grains and derived cosmic ray exposure (CRE) ages. Due to the small grain size, cosmogenic nuclides can be lost due to recoil. Here we present a physical model to calculate cosmogenic production rates and recoil loss in presolar SiC grains.

Model: Cosmogenic production rates were calculated for SiC assuming a galactic cosmic ray (GCR) spectrum with no solar modulation, an integral flux of 17.4 cm^{-2} s^{-1} [3], and assuming 92% protons and 8% α particles [3]. The cross section database used is the same as in [4], however, several excitation function were calculated using TALYS-1.2 [5] and INCL/ABLA-4.5 [6] and adjusted to experimental data (if available). Recoil losses for energies up to 240 MeV were constrained using the same model as [4] using recoil spectra from the TALYS-1.2 code. For higher energies we calculated recoil spectra using INCL/ABLA-4.5, converted them into the same format as the TALYS-1.2 calculations, and plugged these spectra into our model [4].

Results: Our newly calculated cosmogenic production rates [in 10^{-10} cm^3 STP g^{-1} Ma^{-1}] are 322 ± 167 for ^{3}He, 72.8 ± 13.6 for ^{6}Li, 128 ± 24.0 for ^{7}Li, 41.0 ± 15.6 for ^{21}Ne, and 50.8 ± 18.1 for ^{22}Ne. The quoted uncertainties are purely from the cross sections and do not include uncertainties in the GCR spectrum. Retention rates for these isotopes in, e.g., a presolar grain with 5 µm radius are 6%, 17%, 26%, 62%, and 65%, respectively.

Disucssion: The calculated production rates are similar to but more state-of-the-art than previous estimates [7]. Retention of cosmogenic nuclides are rather small for ^{3}He and increase with mass of the produced nuclide. The low retention of, e.g., ^{3}He yields a rather large uncertainty in CRE ages calculated via ^{3}He. Reevaluating the data of [1] and [2] using the new model results in older CRE ages. The ages increases by an average factor of 2.7 for ^{3}He and 1.1 for ^{21}Ne. Due to the large uncertainties in the ^{3}He production and retention rates, the ^{21}Ne measurements are preferred. CRE ages for Li are about a factor of 5 higher than given in [2], mostly due to the fact that retention rates are much lower than previously estimated. Uncertainties in CRE ages determined via Li isotopes are again rather large but they are still underestimated because the uncertainties of the Li/Si ratio, which are needed for proper modeling, are not given in [2]. All reevaluated grains show ages between 20 Ma and 3.5 Ga prior to Solar System formation.

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