Presolar silicon carbide grains from supernovae: The role of carbon-14

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Introduction

Primitive Solar System materials contain small quantities of presolar grains which formed in the winds of evolved stars and in the ejecta of stellar explosions. A rare but important subgroup are silicon carbide (SiC) grains from supernova (SN) explosions, so-called X and C grains, which constitute about 1-2 % of all presolar SiC grains [1].

Here, we will compare isotope data of seven SN grains with predictions from new SN models. In particular, we will explore the role of incorporation of radioactive ^{14}C (half-life: 5700 yr) to understand $^{14}N/^{15}N$ ratios of SN grains.

Methods

By NanoSIMS ion imaging we identified ~1800 presolar SiC grains separated from the Murchison CM2 meteorite. Two X and two C grains were studied in detail for C, N, Mg-Al, Si, S, and Ca-Ti isotopic compositions [2]. These isotope data, together with those of three SN grains from the literature [3-5], are compared with predictions from 25 $M_{\odot}$ Type II SN models which consider ingestion of H into the He shell before the explosion [6].

Results and Discussion

The models by [6] predict a significant contribution of ^{14}C to the ^{14}N inventory of SN grains. Without consideration of C-N fractionation during SiC condensation, predicted $^{14}N/^{15}N$ ratios are much lower than observed in X and C grains when matching C- and Si-isotopic compositions and $^{26}Al/^{27}Al$ ratios (inferred from ^{26}Mg excesses, half-life of ^{26}Al: 716000 yr). With a C-N fractionation of a factor 50, which leads to preferential incorporation of ^{14}C over directly produced ^{14}N, it is possible to simultaneously match measured C-, N-, and Si-isotopic compositions and $^{26}Al/^{27}Al$ by small-scale mixing in SN ejecta, involving matter from a region extending over only 0.2 $M_{\odot}$ (C/Si and O/nova zones).

[1] Zinner (2014) In *Meteorites and Cosmochem. Processes* (ed A. M. Davis), pp. 181-213. [2] Hoppe et al. (2017) *GCA*, in press. [3] Besmehn & Hoppe (2003) *GCA* **67**, 4693. [4] Marhas et al. (2008) *ApJ* **689**, 622. [5] Xu et al. (2015) *ApJ* **799**, 156. [6] Pignatari et al. (2015) *ApJ* **808**, L43.