Mixing compositions of supernova ejecta reproducing isotopic ratios of presolar grains from supernovae

Takashi Yoshida[1]

[1] Tohoku Univ.

Presolar grains have large isotopic anomalies. It is considered that these isotopic anomalies are traces of nucleosynthesis, the galactic chemical evolution, and grain formation in their birth before the solar system formation. Comparing the isotopic ratios of presolar grains to those of nucleosynthesis processes in AGB stars, supernovae, novae, and so on, we identify the origin of individual presolar grains.

Presolar grains from supernovae have been identified in SiC and graphite grains on the basis of the excesses of 28Si (after Amari et al. 1992). Some of the grains have an evidence for original presence of short lived nuclei 44Ti, which strongly supports their supernova origin (Nittler et al. 1995, Hoppe et al. 2000). Quantitative comparison between isotopic ratios of presolar grains from supernovae and those of supernova nucleosynthesis models considering heterogeneous mixing has been carried out by Travaglio et al. (1999) and Hoppe et al. (2000). They divided supernova ejecta of a 15 M star model into seven zones, i.e., Ni, Si/S, O/Si, O/Ne, O/C, He/C, and He/N , and mixed several layers with various mixing ratios in order to investigate isotopic ratios of the supernova mixtures on the planes of isotope plots. Yoshida and Hashimoto (2004) calculated the nucleosynthesis of a supernova of 4 M He star corresponding to 15 M zero-age main sequence stars and investigated mixing ratios to reproduce isotopic ratios of C, N, 26Al/27Al, 29Si/28Si, 30Si/28Si, and 44Ti/48Ti of fifteen individual presolar grains from supernovae. They also divided the supernova ejecta into seven layers and considered four-layer mixing. However, they did not considered the mixing of all seven layers. In the present study, we investigate the mixing of all seven layers to reproduce isotopic ratios of individual presolar grains from supernovae.

We calculate the nucleosynthesis during stellar evolution and supernova explosion of 3.3, 4, and 8 M He stars corresponding to 13, 15, and 25 M zero-age main sequence stars. Then, we divide the supernova ejecta into seven layers as carried out in Yoshida and Hashimoto (2004). We investigate the mixing ratios of seven layers to minimize chi-square of isotopic ratios of individual presolar grains from supernovae. The minimization is carried out using genetic algorithm. We adopt C, N, Al, 29Si/28Si, 30Si/28Si, and 44Ti/48Ti ratios for five SiC grains and five graphite grains. We also adopt 29Si/28Si, 30Si/28Si, and 44Ti/48Ti ratios for five SiC grains. The isotopic ratios of the grains have been compared in Yoshida and Hashimoto (2004).

For ten supernova originating grains with the six measured isotopic ratios, we reproduce five isotopic ratios of six grains, i.e., three SiC and three graphite grains using seven layer mixing models. The mixtures reproducing the isotopic ratios have C/O ratios larger than unity for four grains and smaller than unity for two grains. All mixtures reproducing five isotopic ratios of each grain mainly consist of the He/N and He/C components and small amounts of the inner-layer components. For five grains with three measured isotopic ratios, we also reproduce the isotopic ratios of all grains. Details will be presented in the meeting.