Si Isotopic Ratios Evaluated from Supernova Nucleosynthesis Models

Takashi Yoshida[1]; Hideyuki Umeda[2]; Ken'ichi Nomoto[3]

[1] NAOJ; [2] Dept. of Astronomy, Univ. of Tokyo; [3] Astronomy, U Tokyo

Presolar grains have large isotopic anomalies indicating the traces of nucleosynthesis in their birth before the solar-system formation. The origin of the presolar grains is classified on the basis of the comparison between their isotopic signatures and those of nucleosynthesis processes. Silicon carbide type X, low density graphite, and some of silicon nitride have been measured the excesses of 28Si, thus, they are thought to be a supernova origin. Si has three kinds of the isotopes, 28Si, 29Si, and 30Si. The 29Si/28Si and 30Si/28Si ratios have been measured for most of presolar grains. In most cases, the delta-value notation is used for Si isotopic ratios. Most of the presolar grains from supernovae have shown that d(29Si/28Si) is larger than d(30Si/28Si). On the other hand, recent studies of quantitative comparison with the results of supernova nucleosynthesis models have indicated that d(29Si/28Si) is smaller than d(30Si/28Si) in the region where the 28Si excesses are shown. However, the comparison has been carried out using only stellar models with about 15 solar mass. The stars heavier than 12 solar mass end in supernova explosions and some of the supernovae explode with higher explosion energy. In the present study, we investigate the possible ranges of the 29Si/28Si and 30Si/28Si of supernova ejecta considering the varieties of the stellar masses and the explosion energies.

We pursue the stellar evolution and the supernova explosion using the evolution and explosion models of 3.3, 4, and 8 solar mass He stars. These He stars correspond to 13, 15, and 25 solar mass zero-age main sequence stars. Then, we calculate detailed nucleosynthesis using the time variations of the temperature, density, and so on, by postprocessing. The adopted nuclear reaction network consists of 515 species of nuclei. We investigate the possible ranges of d(29Si/28Si) and d(30Si/28Si) using the obtained results of the mass fraction distributions of the supernova ejecta.

We divide the supernova ejecta into seven layers based on the characteristics of chemical compositions: the Ni, Si/S, O/Si, O/Ne, O/C, He/C, and He/N layers. The excesses of 28Si are seen in the Si/S layer. We obtained that for given d(30Si/28Si) ratios in the Si/S layer the corresponding d(29Si/28Si) ratios of 8 solar mass He star model are smaller than those of 4 solar mass He star model. In the poster presentation, we will show the result of 3.3 solar mass He star model. Furthermore, we will investigate the Si isotopic ratios of supernova explosions with higher explosion energy.