R-process Nucleosynthesis during the MHD Explosions of a Massive Star

M. Saruwatari[1], M. Hashimoto[1], K. Kotake[2], S. Yamada[3]
[1] Department of Physics, Kyusyu University, Fukuoka, 812-8581, Japan.
[2] National Astronomical Observatory of Japan, Tokyo, 181-8588, Japan.
[3] Waseda University Faculty of Science and Engineering, Tokyo, 169-8555, Japan

The study of collapse-driven supernovae is crucial for the understanding of astrophysical relevance, such as nucleosynthesis of heavyelements and chemical evolutions in the universe, radiations of neutrinos and gravitational waves, and possibly gamma-ray bursts and hypernovae (Arnett 1996, Raffelt 2002, Andersson 2003, MacFadyen & Woosley 1999). However, the explosion mechanism has not been clarified yet(Liebendorfer 1998). On the other hand, it has been considered that the origin of heavy neutron-rich elements like uranium is mainly due to the r-process nucleosynthesis that occurs during the supernova explosions(Nishimura et al.2006). The main issue concerning the r-process research is to reproduce the three peaks in the abundance pattern for the r-elements in the solar system.

We investigate the possibility of the r-process during the magnetohydrohynamical explosion of supernova in a massive star of 13 solar mass with the effects of neutrinos induced. We adopt five kinds of initial models which include properties of rotation and the toroidal component of the magnetic field. The simulations which succeed the explosions are limitted to a concentrated magnetic field and strong differential rotation. Low Ye ejecta produce heavy elements and the third peak can be reproduced. However, the second peak is low because Ye distribution as a function of radius is steep and ejecta corresponding to middle Ye is very few.

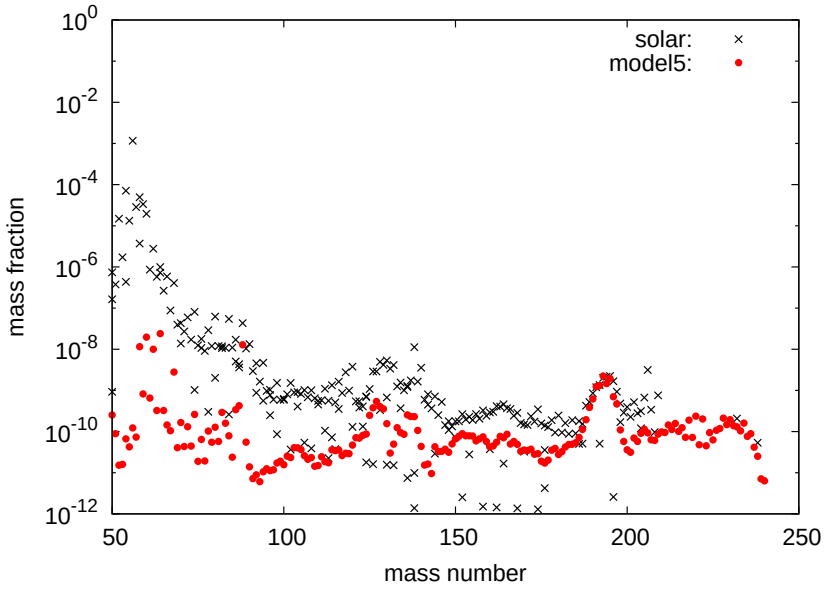

Figure 1: *Mass fractions as a function of the mass number.*