R-PROCESS IN NEUTRON-STAR MERGERS AND SUPERNOVAE: Difference in Nuclear Physics and Implication in Galactic Chemical Evolution

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Both core-collapse supernova (CCSNe) and neutron-star mergers (NSMs) are viable candidates for the r-process nucleosynthesis. Although successful explosive numerical simulations are limited for still smaller computer power, magneto-hydrodynamical jet (MHD jet) is one of the successful CCSN models. However, the underproduction of isotopic abundances just below and above the pronounced three peaks have not yet been resolved in the MHD jet models. We have recently focused on the NSM models as well as MHD jets to account for this underproduction problem at least in the solar-system (s.s.) r-process abundances [1], although NSMs have a difficulty of not explaining the enhanced weak r-process elements as observed in extremely metal-poor halo stars. The ejected matter from the NSMs is extremely neutron-rich (Ye ~ 0.01) and the r-process path proceeds along the neutron drip line and enters the region of fissile nuclei. In this situation, theoretical models of nuclear masses and fission modes and also (n,g) cross sections on the neutron drip are quite important. In this study [1] we carry out r-process simulations in the NSMs based on Korobkin's outflow models [2]. We construct a network code by setting KTUY mass model [3] that describes very well the recently measured beta-decay half-lives [4] of neutron-rich unstable nuclei and also the fission fragment distributions [5]. Our r-process simulation then shows that the final r-process elemental abundances exhibit very flat pattern due to several fission cycling in extremely neutron-rich conditions. Combining these results with MHD jet models for CCSNe that predict successful r-process abundance peaks [6], we find that the NSMs can resolve the underproduction problems of such CCSN model prediction for the elements just below and above the abundance peaks. We discuss relative contributions to the s.s. r-process yields from CCSNe and NSMs in Galactic chemical evolution.

[1] S> Shibagaki, T. Kajino, S. Chiba & G.J. Mathews, in preparation (2014).
[2] O. Korobkin, et al., Month. Not. Roy. Astro. Soc. 426, 1940 (2012).
[3] H. Koura, et al., Prog. Theor. Phys. 113, 305 (2005).
[4] S. Nishimura, et al., Phys. Rev. Lett., 106, 052502 (2011)
[5] M. Ohta, et al., in Proc. of Int. Conf. on Nucl. Data for Science and Technology, Nice, France, (2007).
[6] N. Nishimura, T. Kajino, G.J. Mathews, S. Nishimura, & T. Suzuki, Phys. Rev. C85 (2012), 048801