QUEST FOR THE ORIGIN OF R-PROCESS IN NUCLEAR PHYSICS AND GALACTIC EVOLUTION

Taka Kajino[1,2], Shota Shibagaki[1,2], Yutaka Hirai[1,2], Hirokazu Sasaki[1,2], Kanji Mori[1,2], Wako Aoki[1], Takuma Suda[2], and Grant J. Mathews[3]
[1]National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo, Japan;
[2]The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
[3]University of Notre Dame, Notre Dame, Indiana 46556, USA

Both core-collapse supernovae (SNe) and binary neutron-star mergers (NSMs) are viable candidate as the r-process astrophysical sites. We will first discuss the importance of nuclear structure data especially of the beta-decay half-lives of extremely neutron-rich unstable nuclei measured at RIKEN-RIBF and the fission modes of heavy actinides with masses $250 < A < 300$, in order to explain the "universality" in the observed r-process abundance pattern between the solar-system and the extremely metal-poor stars (EMPs) in the Milky Way halo or recently discovered ultra-faint dwarf galaxy. Although SN models such as neutrino-driven winds and magneto-hydrodynamic jets naturally explain the "universality", their explosion mechanism is still poorly known. NSMs in contrast have a serious difficulty such that their arrival is delayed due to very slow GW radiation before they merge in at least 100 My ("time-scale problem"), which therefore could not produce the r-process elements in the early galaxies. We will propose a new theoretical model of galactic chemo-dynamical evolution that the r-process elements were first produced by SN explosions in the early galaxy, followed by the later gradual contribution from the binary NSMs at $100\ \mathrm{Myr} < t$ in cosmic time. In our proposed model we solve the "time-scale problem" imposed on the binary NSM r-process scenario and can reproduce the "universality". We also found that the asymmetric fission fragment mass-distribution plays an important role in the NSM r-process to explain the isotopic abundances of the solar-system.