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# Solving the Mystery of Neutrinos and the Origin of Atomic Nuclei

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We would like to propose a new astrophysical method to constrain still unknown neutrino mass hierarchy in terms of the flavor conversions at high-density in supernovae [1]. There is a growing consensus in recent multi-messenger astronomy that the explosions of single massive stars, i.e. magneto-hydrodynamic jet supernova and collapsar, dominate the heavy-element enrichment over the entire history of cosmic evolution, while kilonova, i.e. neutron-star merger, could partly contribute only to the recent epoch of cosmic history because of cosmologically long time-delay until merger due to too slow GW radiation [2,3]. We will, first, discuss when and how these astrophysical sites have contributed to the enrichment of the heavy elements in our cosmic/Galactic chemical evolution model. We have recently found that the i- and s-processes also could occur in the collapsar nucleosynthesis [4]. These explosive phenomena emit extremely large flux of energetic neutrinos that provide unique nucleosynthetic signals of the neutrino-nucleus interactions at high-density. We will, secondly, discuss the neutrino-flavor conversion including collective oscillations and MSW matter effect which could drastically affect the yields of neutrino-nuclei such as 138La, 180Ta, 92Nb, 98Tc, 11B, 7Li and abundant p-nuclei like 92,94Mo and 96,98Ru [5] whose origin have not yet been identified uniquely since B2FH1957. We also discuss the roles of de-excitation of the Hoyle state of 12C for the neutrino-proton process in hypernova [6].

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