2nd ASRC TPI
Theory Lecture Series

Date: 13:30 −17:00 Monday, November 2

Location: Conference hall, ASRC bldg.

Speaker: Dr. Toshitaka Kajino

(National Astronomical Observatory of Japan)

Title: 1. Physics of the Neutrino Oscillation in Supernova Nucleosynthesis
2. Origin of the R-process Elements in Galactic Evolution

1. Physics of the Neutrino Oscillation in Supernova Nucleosynthesis

Active neutrinos ejected from core-collapse supernovae (SNe) cause flavor oscillation due to the MSW effect which depends on still unknown neutrino mass hierarchy. We will first show that the SK or HK water-Cerenkov detections of the energy spectra of relic supernova neutrinos, which are ejected from the failed supernovae associated with black hole formation, would indicate the mass hierarchy and also distinguish the soft or stiff EoS of the proto-neutron stars. In our proposed model of shifting the critical stellar mass for the formation of neutron stars or black holes, we can solve the cosmic supernova rate problem and the red supergiant problem simultaneously.

We will secondly discuss the nucleosynthesis induced by SN neutrinos.

Several nuclei such as ^{7}Li, ^{11}B, ^{92}Nb, ^{138}La, ^{180}Ta and r-process elements are known to be strongly or never affected by the neutrino flavor oscillation caused by the MSW effect, which depends on where these elements are produced inside the exploding SNe. Light elements are affected strongly by the MSW effect. Intermediate-to-heavy mass elements are free from the MSW effect, and are used as cosmic clocks to date the astrophysical events along the Galactic evolution. R-process elements are the most sensitive probe for another effect of the collective neutrino flavor oscillation due to their self-interactions. We will propose nucleosynthetic method to determine the neutrino mass hierarchy and show successful example of the cosmic clock.

2. Origin of the R-process Elements in Galactic Evolution

The origin of astrophysical site for the r-peocess elements has not yet been uniquely identified. Both core-collapse supernovae (SNe) and binary neutron star mergers (NSMs) are viable candidates. Recent spectroscopic observations of early generations of stars in our Galaxy (i.e. extremely metal-poor (EMP) stars) have shown the universality that the relative elemental abundance pattern between these stars and the solar system is quite similar to each other although their dispersion is extremely large for [Fe/H] < -2. SN models of magneto-hydro-dynamic jets can naturally explain the universality and dispersion, but their explosion mechanism is till poorly known. On the other hand, since binary NSMs could not have arrived very early in Galactic evolution because of their cosmologically long coalescence time scale, they cannot explain the universality. We try to solve these twisted problems by carrying out numerical simulations of Galactic chemo-dynamical evolution of dwarf galaxies and the detailed studies of explosive nucleosynthesis. We then propose a best model of the origin of the r-process elements and their evolution from the early Galaxy to the solar-system.

＜Contact＞
Yutaka Utsuno (81-6901)
Advanced Science Research Center