Contribution ID: **15** Type: **Oral**

Roles of nuclear weak processes in stars

Friday, 6 December 2013 09:40 (25 minutes)

Roles of nuclear weak processes in nucleosynthesis in stars and star evoultions are discussed based on recent studies on nuclear structure of both stable and unstable nuclei.
New neutrino-nucleus reaction cross sections are evaluated by using new shell-model Hamiltonians, which have proper tensor interactions and explain well the shell evolutions (change of magic numbers) toward drip-lines and spin properties of nuclei [1,2,3]. Results on ^{12}C, ^{13}C, ^{56}Fe, ^{56}Ni and ^{40}Ar are presented, and applications to element synthesis by neutrino-processes in core-collapse supernova explosions are discussed [4,5,6,7]. Effects of ν oscillations are also duscussed [8].
Electron capture and β-decay rates in stellar environments with high densities and high temperatures are evaluated by shell-model calculations for sd-shell and pf-shell nuclei
We show that an improved evaluation of e-capture rates in Ni isotopes has been obtained [9] by a new Hamiltonian, GXPF1J, which can reproduce recent experimental data of GT strength in ^{56}Ni [10].
The rates for URCA nuclear pairs in sd-shell are evaluated with USDB [11]. They are shown to provide clearly the URCA densities for A=23 and 25 and cooling of core temperatures of stars with mass 8-10 $M_\odot$ [12].
Finally, β-decay rates for waiting-point nuclei with N =126 are evaluated by including both the Gamow-Teller and first-forbidden transitions [9]. Possible effects on r-process nucleosymthesis at A$\sim$195 are discussed.

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Primary author: Prof. SUZUKI, Toshio (Nihon University)

Co-authors: Prof. TOKI, Hiroshi (RCNP, Osaka University); Prof. NOMOTO, Kenichi (WPI, the University of Tokyo); Prof. HONMA, Michio (University of Aizu); Prof. KAJINO, Toshitaka (National Observatory of Japan)

Presenter: Prof. SUZUKI, Toshio (Nihon University)

Session Classification: Astrophysics Session