Gamow-Teller States and Neutrino Reactions in QRPA and Deformed QRPA

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Neutrino-induced reactions play important roles as *the neutrino process* on the nucleosynthesis in core collapsing supernovae (SNe) explosions because emitted neutrino flux and energy from the proto-neutron star are sufficiently high enough to excite many relevant nuclei in spite of small cross sections of the weak interaction. However, we do not have enough data for the neutrino reaction to be exploited in the network calculation. Only a sparse data in the relevant energy range is known, in specific, for ^{12}C. Therefore we have to rely on theoretical estimation of the neutrino reaction, which has two different modes, charge current (CC) and neutral current (NC).

In particular, CC reactions are closely related to charge exchange reactions (CEXRs) which are feasible in the experiment, such as, (p,n) and (n,p) reactions or reactions by other light nuclei such as ^{3}He and D [1, 2]. These CEXRs are usually dominated by the Gamow-Teller (GT) transition, which also dominates the neutrino reactions, in specific lower neutrino energy region. Therefore, any theoretical approaches for the neutrino reaction should be investigated for the GT strength data from CEXR in which we have and expect more useful experimental data. After confirming our models to the GT strength deduced from the CEXR, we calculated neutrino-induced reactions in the energy range below the quasi-elastic region for nuclei of astrophysical importance.

Our calculations are carried out with the Quasi-particle Random Phase Approximation (QRPA) [3–5] and Deformed QRPA (DQRPA)[6], which successfully described the nuclear beta decays of relevant nuclei. In particular, the DQRPA turns out to describe the high-lying GT exciations of deformed nuclei. To describe neutrino-nucleus reactions, general multipole transitions by the weak interaction are considered for CC and NC reactions. Both reactions are described in a theoretical framework. Our results are shown to well reproduce the GT strength data from CEXRs and the sparse experimental data related to the neutrino-induced reaction, and further extended for neutrino reactions on various nuclear targets. Parts of the results are reported in this talk.

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