Neutrino-nucleus reactions based on relativistic nuclear energy density functional

N. Paar*
Physics Department, Faculty of Science, University of Zagreb, Croatia

Abstract

The relativistic nuclear energy density functional (RNEDF) has been employed in modeling charged and neutral-current neutrino-nucleus cross sections [1-5]. The weak lepton-hadron interaction is expressed in the standard current-current form, the nuclear ground state is described in the relativistic Hartree-Bogoliubov model, and the relevant transitions to excited nuclear states are calculated in the relativistic quasiparticle random phase approximation (RQRPA). The RQRPA is formulated in the canonical single-nucleon basis of the relativistic Hartree-Bogoliubov (RHB) model, for an effective Lagrangian characterized by density-dependent meson-nucleon couplings.

The RNEDF framework has been employed in calculations of charged-current [1,3,4,5] and neutral-current [2] neutrino-nucleus cross sections, including also unstable nuclei of relevance in astrophysical processes. Using the neutrino fluxes from muon decay at rest (DAR), as well as supernova neutrino distributions, the large-scale calculations of averaged cross sections have been conducted for the pool of even-even nuclei from oxygen toward lead [4]. By employing several theoretical approaches, the current theoretical uncertainties in modeling neutrino-nucleus cross sections are assessed in relation to the predicted Gamow-Teller transition strength and available data, as well as with respect to the multipole decomposition of the cross sections [5]. Employing different microscopic approaches and models, the DAR neutrino-^{56}Fe cross section and its theoretical uncertainty are estimated: $< \sigma >_{th}$=(258±57) $\times 10^{-42}$cm^2, in very good agreement with the experimental value: $< \sigma >_{exp}$=(256±108±43) $\times$ 10^{-42}cm^2.

[1] N. Paar, D. Vretenar, T. Marketin, and P. Ring, Phys. Rev. C 77, 024608 (2008).
[2] H. Dapo, N. Paar, nucl-th/arXiv:1203.5224, submitted to Phys. Rev. C (2012).
[3] A. R. Samana, F. Krmpotic, N. Paar, C. A. Bertulani, Phys. Rev. C 83, 045807 (2011).
[4] N. Paar, H. Tutman, T. Marketin, in preparation (2012).
[5] N. Paar, T. Suzuki, M. Honma, T. Marketin, and D. Vretenar, Phys. Rev. C 84, 047305 (2011).

*npaar@phy.hr