Relativistic approach to nuclear spin-isospin excitations including quasiparticle-vibration coupling

Caroline Robin
Department of Physics, Western Michigan University, Kalamazoo, MI 49008-5252, USA

Charge-exchange excitations of nuclei play an important role in our understanding of nuclear structure, and are also of special interest for astrophysical simulations as they determine the rates of weak processes that govern the r-process nucleosynthesis and the late evolution of massive stars. In this talk we present a theoretical approach to spin-isospin excitations in open-shell nuclei. The developed method is based on the relativistic meson-exchange nuclear Lagrangian of Quantum Hadrodynamics, and extends in a consistent way the charge-exchange Quasiparticle Random-Phase Approximation by accounting for the coupling between single-nucleon degrees of freedom and collective vibrations of the nucleus. In the isospin-flip channel, this coupling generates a time-dependent proton-neutron effective interaction, in addition to the static pion and rho-meson exchange, and introduces complex configurations which are essential to induce fragmentation and spreading of the resonances. Such effects are needed to describe the observed quenching of the transition strength and have a great impact on the computing of beta-decay and electron-capture rates that are needed for the modeling of stellar evolution. Results of calculations for Gamow-Teller resonances in medium-mass nuclei and associated beta-decay half-lives will be presented. Further developments aim at including additional correlations in the description of the ground state. Their effects will also be discussed.