Charge-exchange modes and weak-interaction processes in Relativistic Nuclear Field Theory

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Nuclear excitations with isospin transfer play a crucial role in our understanding of nuclear structure, particle physics and astrophysics. A precise description of such transition modes is needed to compute the rates of weak interaction processes such as beta decay, neutrino absorption or electron capture, which are needed for the modeling of nucleosynthesis and stellar evolution.

In this talk I will present a theoretical approach to the description of charge-exchange modes in nuclei. This method describes the nucleus as a system of relativistic nucleons interacting via the exchange of effective mesons. Starting from a mean-field approximation, nuclear field theory is applied in order to account for inter-nucleon correlations emerging from the coupling between single particles and collective vibrations of the nucleus.

In the charge-exchange channel this particle-vibration coupling generates a time-dependent proton-neutron interaction, in addition to the static pion and rho-meson exchange, which induces fragmentation and spreading of the transition strength. Such dynamical effects are essential for an accurate description of giant resonances and low-energy modes, and have a great impact on the calculation of weak-interaction rates and on the quenching of the Gamow-Teller strength. I will discuss recent developments of this approach and will present applications to Gamow-Teller transitions and weak decays in nuclei of various masses.