NUCLEAR STRUCTURE AND BETA DECAYS IN EXTENDED DENSITY FUNCTIONAL THEORY

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No-core configuration interaction (NCCI) models rooted in multi-reference density functional theories (MR-DFT) offer an interesting alternative to the conventional nuclear shell model. Firstly, they are capable of treating rigorously both the fundamental (spherical, particle number) as well as approximate nuclear (isospin) symmetries. Secondly, by invoking the generator coordinate method and/or mixing of discrete (quasi)-particle-(quasi)hole configurations, they allow to incorporate important correlations into the nuclear wave function. Thirdly, by construction, they are able to capture core-polarization effects resulting from a subtle interplay between the long-range and short-range nucleon-nucleon forces what makes them perfect tools to study the isospin symmetry breaking phenomena.

The aim of this talk is to present the NCCI formalism developed by our group [1] which involves the angular momentum and isospin projections and subsequent mixing of states having good angular-momentum and properly treated isospin. The states that are mixed are projected from low-lying (multi)particle-(multi)hole deformed Slater determinants calculated self-consistently using Hartree-Fock method. After brief introduction to the model I will show the selected numerical results focusing on the nuclear beta-decay matrix elements in N~Z nuclei. Among the others, I will present the first ever application of the MR-DFT rooted NCCI approach to study Gamow-Teller (GT) transitions [2]. This fundamental process, more specifically the physical mechanism behind quenching (or renormalization), q, of the axial coupling constant $g^{(eff)}_A = q\, g_A$ with respect to its free neutron decay value $g_A = -1.2701(25)$, constitutes, in our opinion, one of the biggest puzzles of the contemporary nuclear structure theory.

REFERENCES

[1] W. Satuła, P. Bączyk, J. Dobaczewski, and M. Konieczka, arXiv:1601.03593 [nucl-th].
[2] M. Konieczka, P. Bączyk, and W. Satuła, Phys. Rev. C **93**, 042501(R) (2016).