Microscopic mean field approximation and beyond with the Gogny force

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Many theoretical models have been developed to describe nuclear structure. Among them, a crucial role is played by the mean field based models using effective forces which allow to solve at the same time many body and nuclear interaction problems. Here we present a review of several works including D1S Gogny interaction in mean field approaches and beyond, leading to a better understanding of nuclear structure phenomena and pointing out the limitations of the models themselves. This allows a rigorous analysis of strong and weak points of the assumptions made in theoretical approaches.

Starting from the pure HFB description and extenting it to the five dimension collective Hamiltonian (5DCH) we will discuss the evolution of shell closures : vanishing for N=20,28 [1], appearance for N=16 [2] and the existence of N=40 [3]. We will point out that some data cannot be reproduced within the 5DCH model, which implies the need of a formalism able to simultaneously describe high and low energy spectroscopy as well as collective and individual excitations. Then we will present the RPA formalism and the study of giant resonances in doubly magic, spherical, exotic nuclei [4]. After exposing the QRPA approach in axially symmetric deformed nuclei and the role of the intrinsic deformation in giant resonances [5], we will discuss the appearance of low energy dipole resonances for light nuclei [6]. The isoscalar or isovector as well as the collective or individual nature of pygmy states will be debated. As a feasibility example, we present the first microscopic fully coherent description of the multipole spectrum of heavy deformed nucleus ^{238}U [7].

In this context, the comparison of the low energy spectroscopy obtained with these two extensions of static mean field is done for several nuclei especially for 2^+ and 0^+ states. This comparison leads to perspectives for evolution of our models to bridge the gap between QRPA and 5DCH approaches.

References

[1] S. Péru, M. Girod, JF. Berger , Eur. Phys. J. A 9,35-47, (2000).

[2] A. Obertelli *et al*, Phys. Rev. C 71, 024304, (2005).

[3] L. Gaudefroy *et al*, Phys.Rev. C 80, 064313, (2009).

[4] S. Péru, JF. Berger, PF. Bortignon, Eur. Phys. J. A 26, 25-32, (2005)

[5] S. Péru, H. Goutte, Phys. Rev. C 77, 044313, (2008).

[6] M. Martini, S. Péru and M. Dupuis, Phys. Rev. C **83**, 034309 (2011).

[7] S. Péru *et al*, Phys. rev. C **83**, 014314 (2011).