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QRPA with the Gogny force: description of vibrational states up to octupole

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The QRPA approach, well known to be adapted for giant resonance description, is also a good formalism to describe low energy vibrational states for all multipolarities and parities with the same accuracy. We will present selected recent successful results obtained within the QRPA approach using the Gogny interaction.
First, we will compare the first 2+ collective state obtained in QRPA and in 5DCH (a GCM-like method, including rotation) in tin (Z=50), N=16 isotones, and in the Nickel isotopic chain, from drip line to drip line [1]. Concerning octupolar modes, predictions for first 3- states (energies and transition probabilities) in the tin isotopic chain will be discussed, before presenting the low energy spectra obtained in super heavy nuclei such as Cm, Cf and Fm.
Secondly low energy dipole resonances in light nuclei and giant resonances in doubly magic exotic nuclei [3] will be addressed, enlightening the role of the intrinsic deformation [4]. The first fully coherent microscopic description of the multipolar spectrum of the heavy deformed nucleus 238U [5] will be used to summarize our know-how. On the basis of all these satisfactorily results, large-scale calculations of dipole responses, both electric and magnetic, for all nuclei for which data exist have been undertaken. Preliminary results [6] will be displayed. A strategy for an application to odd-A and odd-odd nuclei will be discussed with few examples.
Finally, we present the generalization of QRPA to the charge-exchange nuclear excitation (pnQRPA) [7] namely the Isobaric Analog and Gamow-Teller resonances which play a crucial role in several fields of physics (nuclear physics, astrophysics and particle physics). A comparison of the results with existing experimental data on Fermi and Gamow-Teller strength distributions is presented and the role of nuclear deformation analyzed. A special attention is paid to the reproduction of β-decay half-lives as well as for the specific N = 82 isotonic chain relevant for the r-process nucleosynthesis [8]. For these charge-exchange modes possible extension to odd systems will be presented too.

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