COUPLING OF SINGLE-PARTICLE MOTION TO NUCLEAR VIBRATIONS

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Models based on using perturbative polarization corrections and mean-field blocking approximation give conflicting results for masses of odd nuclei. We systematically investigated the polarization and mean-field models, implemented within self-consistent approaches that used identical interactions and model spaces, to find reasons for the conflicts between them [1]. For density-dependent interactions and with pairing correlations included, we derived and studied links between the mean-field and polarization results obtained for energies of odd nuclei. Numerical calculations were performed for the mean-field ground-state properties of deformed odd nuclei and then compared to the polarization corrections determined using the approach that conserves spherical symmetry.

We have identified and numerically evaluated self-interaction (SI) energies that are at the origin of different results obtained within the mean-field and polarization-correction approaches. Mean-field energies of odd nuclei are polluted by the SI energies, and this makes them different from those obtained using polarization-correction methods. A comparison of both approaches allows for the identification and determination of the SI terms, which then can be calculated and removed from the mean-field results, giving the self-interaction-free energies.

We also addressed the question of how to improve the agreement between theoretical nuclear single-particle energies (SPEs) and observations [2]. Empirically, in doubly magic nuclei, the SPEs can be deduced from spectroscopic properties of odd nuclei that have one more or one less neutron or proton. Theoretically, bare SPEs, before being confronted with observations, must be corrected for the effects of the particle vibration coupling (PVC). We determined the PVC corrections in a fully self-consistent way and we adjusted the SPEs, with PVC corrections included, to empirical data. In this way, the agreement with observations, on average, improved; nevertheless, large discrepancies still remained. We concluded that the main source of disagreement is still in the underlying mean fields, and not in including or neglecting the PVC corrections. We repeated the same analysis with the coupling to proton-neutron phonons taken into account and we showed that this channel significantly modifies the PVC corrections [3].

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