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Exploring nuclear deformations and low level spectroscopy of Hg isotopes with pairing adjustment within relativistic EDFs.

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Abstract

Relativistic energy density functionals have been extensively used to describe shape transitions and coexistence in numerous studies. With a few parameters adjusted using a limited set of experimental data, they provide a consistent framework for studying both static and dynamic properties of nuclei across the nuclear chart [1, 2]. In this present study, specific types of relativistic functionals are employed to explore changes in shapes and the systematics of low-lying collective levels within the series of neutron-deficient 174-200Hg isotopes. This area has been extensively researched experimentally, with well-established shape coexistence observed in several isotopes [3–7], making it a suitable testing ground for theoretical approaches.

The first step involves calculations at the mean-field level, wherein the relativistic Hartree-Bogoliubov equations are solved under constraints on the beta and gamma shape parameters. This enables the construction of potential energy surfaces for the nuclei, revealing the position of the absolute minimum of the ground state and the existence, or absence, of secondary or more minima at different deformations. The second step extends beyond the static mean-field level and encompasses the dynamics of rotations and vibrations as collective excitations of the system. The initial constrained calculations are utilized to derive mass and inertial parameters, as well as to establish the potential of a five-dimensional collective Hamiltonian (5DCH) [8]. Solving the corresponding eigenvalue problem allows for the calculation of excitation energies of low-lying levels and B(E2) transition probabilities that can be directly compared with observations. In both steps, we demonstrate how adjusting the strength of the pairing interaction enhances the theoretical description both quantitatively and qualitatively.

References

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