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Microscopic and Algebraic Theory for Complex Nuclear Shapes and Dynamics

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Abstract

The nuclear shapes and the corresponding collective excitations present one of the most intriguing themes of nuclear physics. The energy density functional (EDF) framework allows for a global and reasonable description of the mean-field properties over the whole nuclide chart. Meanwhile, the algebraic theory of interacting bosons, that is, the interacting boson model (IBM), has been successful in the description of low-energy collective structure in medium-heavy and heavy nuclei.

To describe spectroscopic properties of nuclei based on a global theory, we have developed a robust framework constructed by linking microscopic EDF framework to the IBM [1, 2]. The principal idea is to establish an appropriate mapping between nucleon and boson potential energy surfaces, and thereby the Hamiltonian of the IBM, that is used for calculating excitation spectra and transition rates, can be determined for any situations of intrinsic shapes and the corresponding collective dynamics without phenomenological adjustment to data. In this way, bridge is made over the gap between the EDF and IBM, implying that the two methodologies are complementary and can develop collaboratively.

We discuss the recent advances in this method in the study of various nuclear shapes and the related spectroscopy, the examples being the quadrupole-octupole correlations in rare-earth and light actinide nuclei [3, 4] and the shape transition and coexistence in the neutron-deficient Pb region [5, 6].

References

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