

Linking partial dynamical symmetry to nuclear energy density functionals

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Abstract

Dynamical symmetry (DS) is a class of symmetry that appears universally in diverse quantum many-body systems. It occurs if the Hamiltonian of the system can be written in terms of Casimir operators of a chain of nested algebras. The Hamiltonian is then exactly solvable and its spectra and wave functions are completely specified by quantum numbers related to the algebras in the chain. Notable examples in nuclei are the U(5), SU(3) and SO(6) DS chains of the interacting boson model (IBM), which encode the dynamics of spherical, axially-deformed and γ -unstable shapes. In the majority of nuclei, however, an exact DS rarely occurs. More often some states obey the patterns required by the symmetry, but others do not. This necessitates a certain degree of symmetry-breaking, a prominent case of which is partial dynamical symmetry (PDS) [1]. Its basic idea is to relax the stringent conditions imposed by an exact DS so that solvability and/or good quantum numbers are retained by only a subset of states.

Detailed studies, in the IBM framework, have shown that PDSs account quite well for a wealth of spectroscopic data in various types of nuclei. In all these phenomenological studies, an Hamiltonian with a prescribed PDS is introduced, its parameters are determined from a fit to the spectra, and the PDS predictions (which are often parameter-free) are compared with the available empirical energies and transition rates. In the present contribution, we show that the PDS notion is robust and founded on microscopic grounds [2]. For that, we adapt the procedure developed in [3], to determine microscopically the IBM Hamiltonian by employing constrained mean-field methods based on universal energy density functionals (EDFs). An application to ^{168}Er (in which SU(3)-PDS was previously recognized on phenomenological grounds), shows that the IBM Hamiltonian derived from known non-relativistic and relativistic EDFs in this region, posses eigenstates whose properties resemble those of SU(3)-PDS.

References

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