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Tests of Partial Dynamical Symmetries and their Implications

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Abstract

Symmetries often provide an elegant and simple framework for the elucidation of nuclear structure. Symmetry–based descriptions are usually parameter–efficient and give insights into the structure of the nucleus as a many–body system with its own quantum numbers, selection rules, analytic relations for observables, and so on. Unfortunately, very few nuclei manifest any symmetry exactly and, normally, one diagonalizes phenomenological, parameterized Hamiltonians that break the symmetries. One of the most common approaches is that of the Interacting Boson Model with its three benchmark symmetries U(5), SU(3) and O(6) and a simple Hamiltonian written in terms of s and d bosons and their interactions.

Some years ago the idea of Partial Dynamical Symmetries (PDS) was developed by Leviatan. In a PDS some of the properties of a symmetry are maintained while others are (often severely) broken. The most appealing PDS was based on SU(3) and described a situation seemingly at complete variance with known data, namely one in which the ground and gamma bands are pure SU(3) while all other bands are mixed. Nevertheless, Leviatan showed that E2 transitions from the gamma to the ground band in ^{168}Er could be well described by this PDS in a parameter–free manner. Recently, we have carried out the first extensive test (for more than 60 nuclei) of this PDS throughout the rare earth, actinide, and A$\sim$100 regions. The results show significant areas of agreement but also characteristic disagreements. They reveal the importance of finite nucleon number effects, and they affect the standard decades–long interpretation of band mixing in deformed nuclei. They also lead to unexpected realizations concerning which observables are best suited to distinguishing different models of deformed and transitional nuclei. These and related topics will be discussed.

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