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Justification of a Unified Algebraic Shell-Model Approach Based on Existing Symmetries of the Nuclear Shells

K.P. Drumev

Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, 1784 Sofia, Bulgaria

Abstract

It is a well-known fact that the symmetry of the three dimensional isotropic harmonic oscillator, used as a good first-order approximation to any attractive potential, is SU(3). This symmetry lies at the base of the Elliott approach for the quite successful description of a number of characteristics in many of the sd-shell atomic nuclei. A possible existence of higher-rank symmetries of the nuclear shells as well as common symmetries of the effective nuclear interaction have been looked for during the years. This search is related to the realization of an effective and unified description of several competing modes in nuclei.

Some of the new outcome on these topics will be pointed out as I will discuss the quality of various dynamical symmetries in nuclei from the upper pf-shell revealed in results with the use of effective interactions. The advantages that these findings imply will be demonstrated by addressing the highly-dimensional many-body nuclear problem in the traditional shell-model unrestricted full-space calculations. The possibility to achieve a unified approach to describe variety of effects using a selected mixed-mode basis from a restricted model space will be debated.

In this talk, I will also present our recent progress within the framework of the Algebraic Microscopic Pairing-plus-Quadrupole Shell Model. Specifically, the description of the shapes, superdeformation, as well as the existence of phases in atomic nuclei and the possible treatment of the shape-phase transition phenomenon will be discussed.