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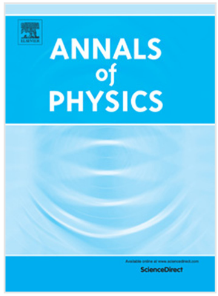

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Extended study on a quasi-exact solution of the Bohr Hamiltonian

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Abstract

A unified presentation of the quasi-exact solutions of the Bohr Hamiltonian with a sextic oscillator potential is offered by evidencing the similarities and the differences between them. An extended study of the Bohr Hamiltonian with sextic potential for γ-rigid triaxial nuclei is conducted, focusing on the evolution of the energy spectra and $B(E2)$ transition probabilities when the order of the quasi-exactly solvable system is increased. The effect is analyzed throughout the shape phase transition from a γ-rigid triaxial vibrator to an anharmonic one and especially in its critical point. The new results are tested by several applications for experimental data, improving the previous calculations and providing new possible triaxial nuclei.

1. Introduction

In the frame of the Bohr-Mottelson model [1, 2], the collective low energy states of the nucleus are described in terms of rotations and vibrations of its ground state shape, which is parameterized by β and γ variables defining the deviation from sphericity and axiallity, respectively. The potential energy of the associated Hamiltonian depends in a mixed way on both β and γ deformation variables, following however the symmetry restrictions imposed by the geometry of the shape phase space [3]. On the other hand, to solve the eigenvalue problem for such a potential represents a difficult task, even numerically [4, 5, 6, 7, 8, 9, 10]. Therefore, simplified forms of the potential were preferred. The most simple example is that of a γ-independent potential, situation met for the spherical vibrator [1], γ-unstable [11, 12] and γ-rigid [13, 14, 15, 16] systems. A step forward was done when γ-stable solutions were introduced [17, 18, 19, 20]. In this case, the potential depends on both β and γ variables but due to a very sharp minimum with respect to the γ shape variable acquires a separated form which enables independent treatment of the β and γ-angular degrees of freedom [7, 11, 20, 21]. Solutions of the Bohr Hamiltonian up to present were collected in Refs. [22, 23], while other reviews related to this topic are found in Refs.[24, 25, 26, 27, 28, 29]. The potentials for the γ variable are more often of harmonic oscillator type [11, 17, 20] or of a periodic form [30, 31, 32, 33].

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