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Fingerprints of the triaxial deformation from energies and $B(E2)$ transition probabilities of γ-bands in transitional and deformed nuclei

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Abstract The energies and $B(E2)$ transitions involving the states of the ground- and γ-bands in thirty transitional and deformed nuclei are calculated using the triaxial projected shell model (TPSM) approach. Systematic good agreement with the existing data substantiates the reliability of the model predictions. The Gamma-rotor version of the collective Bohr Hamiltonian is discussed in order to quantify the classification with respect to the triaxial shape degree of freedom. The pertaining criteria are applied to the TPSM results and the staggering of the energies of the γ-bands is analyzed in detail. An analog staggering of the intra-γ $B(E2, I \rightarrow I-2)$ is introduced for the first time. The emergence of the staggering phenomena in the transitions is explained in the terms of interactions between the bands.

1 Introduction

A recurring theme in nuclear structure research is how to classify the collective excitation modes and how to discern the nature of the collective motion from the measured properties [1]. The appearance and the consequences of triaxial quadrupole deformation are currently of considerable interest. The topic is mostly addressed in terms of some version of the Bohr Hamiltonian [1], which describes the collective motion in terms of the deformation parameters of the nuclear shape. These approaches may be purely phenomenological or based on fitted parameters to a microscopic theory. A recent review of these approaches can be found in Ref. [2]. From the phenomenological perspective emerge the concepts of static and dynamic triaxiality that are used to interpret the experimental results for energies and transition probabilities between the near-yrast states.

The spherical shell model (SSM) is an alternative approach that has been demonstrated of being capable of accounting for the data on the collective excitations in lighter nuclei [3–5]. Recent progress in the shell model techniques has made it possible to carry out calculations for heavy deformed nuclei [6,7]. Besides reproducing the energies and transition probabilities, the authors devote substantial effort to connect the SSM results with the established concepts of a triaxial shape and its fluctuations.

In the present work, we have employed the triaxial projected shell model (TPSM) [8] which incorporates a major part of the SSM correlations by generating the shell model basis space from quasiparticle configurations in a deformed potential. The details of the TPSM approach can be found in our previous publications [8–16]. The pairing plus quadrupole Hamiltonian is diagonalized in a basis consisting of angular-momentum projected [17] quasiparticle configurations that are generated with a fixed triaxial deformation value. The basis space in the TPSM approach consists of zero-, two- and four- quasiparticle configurations that allows one to describe the interplay between the collective and the quasiparticle excitations. The computational effort in TPSM approach is negligible compared to the SSM approach, and it has been shown that TPSM provides an accurate description of the experimental data of the states in the near-yrast region. Nevertheless, like for the SSM approach, one would like to relate the results of the TPSM diagonalization to the concepts developed in the framework of the collective models, which is one of the major aims of the present study.

The present work is a continuation of our previous investigation of the collective γ-degree of freedom for a large set

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