Study of high-spin states in doubly odd ^{158}Ho

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Introduction

The study of neutron-rich nuclei in the mass region A≈160 poses a challenge for the experimentalists, as they cannot be populated via fusion evaporation reactions which have been proven to be the benchmark for high-spin spectroscopy. Due to lack of experimental techniques, nuclear structure information was limited to the low spins only for the odd-odd nuclei. The high spin states in doubly odd ^{158}Ho nucleus has been studied by using ^{152}Sm(^{11}B, 5n) ^{158}Ho reaction by the authors of ref. [1] and obtained the three rotational bands in addition to the previously known [2] yrast band. They have also reassigned the configuration of the yrast band as $\pi_{7/2}^{-}[523]\otimes\nu_{3/2}^{+}[651]$, $K^{\pi} = 5^{-}$ rather than $\pi_{7/2}^{-}[523]\otimes\nu_{5/2}^{+}[642]$, $K^{\pi} = 6^{-}$. It was found that the spin values of member states of yrast band in ref. [1] are larger by three units with respect to earlier tentative spin assignments.

The aim of the present work is to interpret the observed rotational bands in doubly odd deformed nucleus ^{158}Ho in the Projected Shell Model (PSM) [3] framework.

Brief Description of Theoretical Framework

The Projected Shell Model (PSM) is a spherical shell model built over a deformed mean field plus BCS vacuum which incorporates the strong particle-hole and particle-particle correlations to quasiparticle (qp) states. For odd-odd nuclei, the ground-band is a two quasi-particle configuration and in order to describe the structure of well-deformed odd-odd nuclei, it is necessary to consider at least two qp configurations in the basis. In PSM, the shell model configuration is formed by carrying out the angular-momentum projection on the multi-quasiparticle states $\hat{P}^{I}_{MK}\,|\phi\rangle$, with $\hat{P}^{I}_{MK}$ being the angular momentum projection operator and $|\phi\rangle$ multi-quasiparticle states. The quasiparticle states are constructed from the solution of the deformed Nilsson Model followed by a BCS calculation. The Hamiltonian that has been used in the present calculation contains the single particle energies, monopole pairing between like particles, quadrupole-quadrupole and quadrupole pairing interactions. The monopole pairing strengths G_M takes the form

$$G_M = \left[G_1 \mp G_2 \frac{N-Z}{A} \right] A^{-1}$$

where minus (plus) sign is for neutrons (protons) and G_1 and G_2 are adjusted to reproduce the pairing gaps in the mass 160 region. G_1 and G_2 are taken as 20.12 and 13.13. The quadrupole pairing strength G_Q is assumed to be proportional to G_M with proportionality constant 0.16 for ^{158}Ho.

Results and Discussion

In this nucleus, four bands have been experimentally known. Out of which three are of positive parity and one is of negative parity. The experimentally energies of these bands are known upto 17^{+}, 20^{+}, 23^{-} and 18^{+} respectively. The quadrupole (ε_2) and hexadecupole (ε_4) parameters used for carrying out the present calculations are 0.215 and -0.014 respectively. In Fig.1, the calculated transition energies E(I)-E(I-1) of different bands of ^{158}Ho nucleus is compared with experimental data. From Fig. 1, it is seen that the transition energies of low-lying energy states of the band 1 and band 3 in ^{158}Ho are reproduced well. However, at higher spins the calculated results shows large staggering as compared to observed ones. For band 4, the calculated and observed energies show a disagreement at higher spins. This disagreement is found to be maximum of 0.132 MeV for spin 18^{+}.

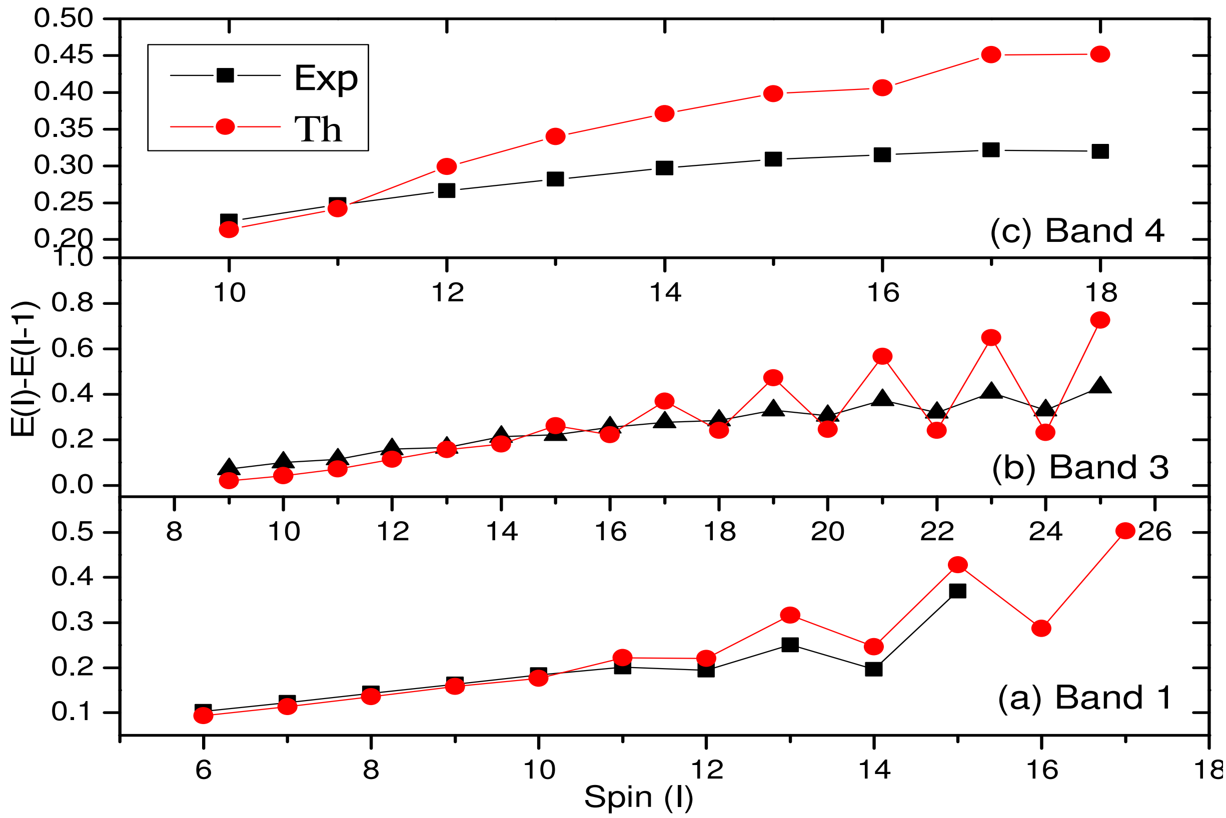

Fig. 1 Comparison of experimental and theoretical transition energy E(I)-E(I-1) versus angular momentum I for (a) Band 1 (b) Band 3 and (c) Band 4 in ^{158}Ho.

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