Study of band spectra of odd-even ^{163}Ho

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Introduction

With the advancement in detector technology precise measurements of lifetimes of nuclear states and high spin spectroscopy of nuclei in mass region A≈160, having large neutron excess, became possible. Incomplete fusion reactions and heavy ion multi-nucleon transfer reactions were used to obtain information on excitation energy spectra, electromagnetic quantities, lifetimes and nuclear g-factors of nuclei in this mass region. Holmium isotopes happen to be one such isotopic mass chain for which the nuclear spectroscopic data has become available inspite of the fact that these nuclei possess high single particle level density at low excitation energy which results in multitude of near-yrast bands and configurations. High-spin spectroscopic studies in the A ~ 160 region of the nuclear chart have resulted in the discovery of many new nuclear phenomena. These include the observation of backbending [1], triaxiality [2], prolate to oblate shape changes via the mechanism of band termination [3], and the more recent discovery of the re-emergence of collectivity beyond band termination at ultrahigh spin (~60ħ) in $^{157-160}$Er.

The aim of the present work is to study the band spectra of odd-even ^{163}Ho in the Projected Shell Model (PSM) [4] framework.

Model

The projected shell model is a shell model truncated (Nilsson-type) in a single particle basis, in which the pairing correlations are incorporated into the basis by a BCS calculation for the Nilsson states. Angular momentum projection method is then used to restore the rotational symmetry violated in the deformed basis. Finally, the Nilsson Hamiltonian is diagonalized in the projected basis. The bogolyubov transformation is performed in order to take into account the static monopole force. The PSM calculation proceeds in two steps. In the first step, an optimum set of deformed basis is constructed from the standard Nilsson potential. The Nilsson parameters are taken from the ref. [5] and calculations are performed by considering the three major harmonic-oscillator shells (N=3,4,5) each for neutrons and protons. This defines the Nilsson + BCS quasiparticle basis. The intrinsic states within an energy window of 3.5 MeV around the Fermi surface are considered. This gives rise to the size of the basis states of the order of 36. In the second step, these basis states are projected to good angular-momentum states and the projected basis is then used to diagonalize the shell model Hamiltonian.

Results and Discussion

The values of quadrupole (ε_2) and hexadecapole (ε_4) deformation parameters which are employed in carrying out the present calculation are 0.285and 0.009, respectively. The results have been obtained for all the positive and negative parity bands of ^{163}Ho within the model space for given angular momenta. In figure 1, the calculated energy spectra are compared with the experimental data. From the figure, it is clearly seen that the calculated energy states of Band 1 are reasonably well reproduced. It may be noted that the energy difference between observed and calculated energy states for spin $35/2^-$, which is the highest observed spin in Band 1 is 0.047 MeV. In Band 2, the observed energy values above $13/2^+$ state are tentative so, it is not possible to make a comment regarding their agreement with the theoretical results. Similarly, for Band 3 the spectra is known up to $7/2^+$ only where as the value of energies of other states is tentative. Present results are in reasonable agreement with the observed values. In figure 2 (a), the calculated transition energies E(I)-E(I-1) of the ground state band of ^{163}Ho are presented. It is seen from the figure that the transition energies are in close agreement with the experimental data and follow the same trend up to the higher spins as shown by the experimental ones. In figure 2(b), the calculated transition energies E(I)-E(I-2) of the band 2 and band 3 are plotted. They follow the same trend as shown by

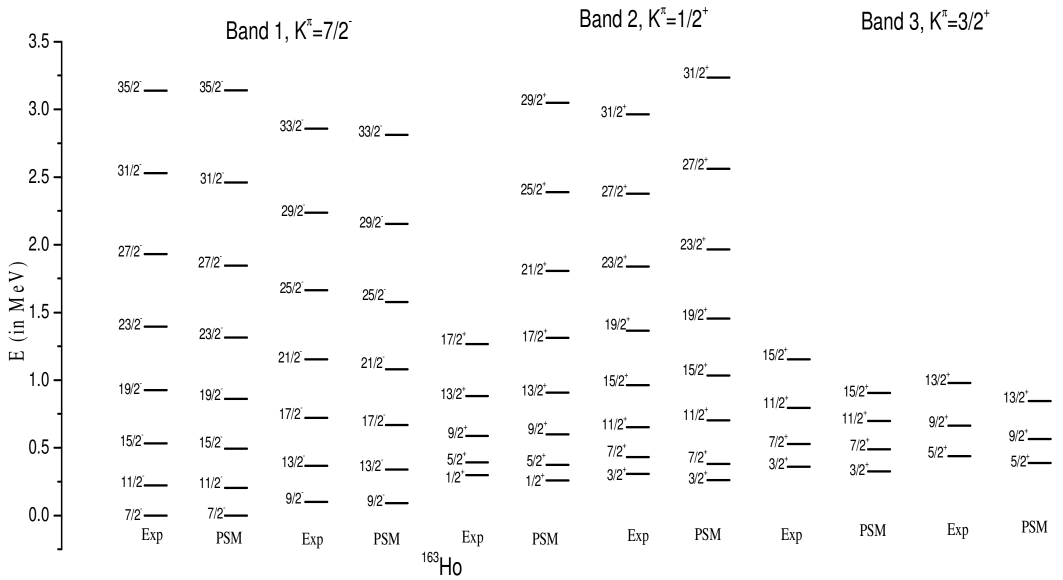

Fig.1 Comparison of calculated (PSM) energy levels with the available experimental (Exp.) [6] data for the negative and positive parity bands for ^{163}Ho.

experimental data. In case of Band 3, the calculated values of transition energies are found to be smaller than the observed values for all the observed spins.

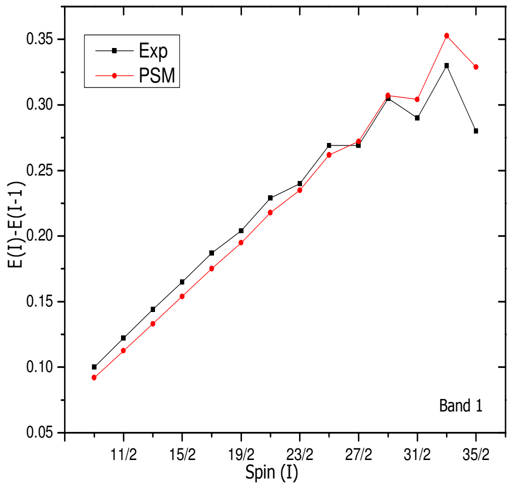

Fig.2(a) Comparison of experimental (Exp.) and theoretical (PSM) transition energy E(I)-E(I-1) versus angular momentum I for ^{163}Ho.

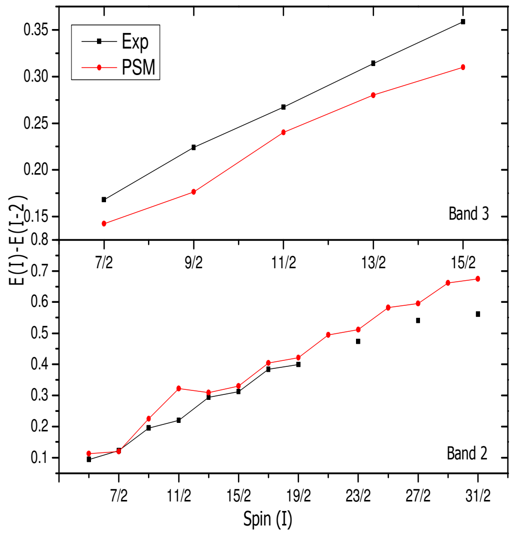

Fig.2(b) Comparison of experimental (Exp.) and theoretical (PSM) transition energy E(I)-E(I-2) versus angular momentum I for ^{163}Ho.

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