Configuration assignment to $K^{\pi}=1^{+}$& 6^{+} : $7/2[523]_{\pi}\otimes5/2[523]_{\nu}$ Gallagher Moszkowaski (GM) doublets of ^{162,164}Ho nuclides

Sushil Kumar[1], Sukhjeet Singh[1*], A.Goel[2], A.K. Jain[3] and J.K. Sharma[1]

[1]Department of Physics, Maharishi Markandeshwar University, Mullana-133207, INDIA

[2]Department of Physics, Amity University, Noida-201 303, INDIA

[3]Department of Physics, Indian Institute of Technology, Roorkee-247667, INDIA

*email: sukhjeet.dhindsa@gmail.com

Introduction

Liang *et al.* [1] and Hojman *et al.* [2] observed the $K^{\pi} = 1^{+}$ & $K^{\pi} = 6^{+}$ bands pertaining to a Gallagher Moszkowaski (GM) doublet based on $7/2[523]_{\pi}\otimes5/2[523]_{\nu}$ configuration in ^{162}Ho and ^{164}Ho nuclides, respectively. The spin, parity and configuration assignments to the $K^{\pi} = 1^{+}$ & $K^{\pi} = 6^{+}$ bands observed in ^{164}Ho are still of tentative nature. The signature effects of two-quasiparticle (2qp) rotational bands observed in odd-odd nuclei have been explored using the Two Quasiparticle Plus Rotor Model (TQPRM) [3-6], but the objectives of the present study are:

i. confirmation of spin, parity and configuration assignment to the $K^{\pi} = 1^{+}$ & $K^{\pi} = 6^{+}$ bands observed in ^{164}Ho which were tentatively assigned by Hojman *et al.* [2].
ii. fixing of 15^{+} tentative level placement observed at 2234.3 keV in the $K^{\pi} = 1^{+}$ band of ^{162}Ho [1]
iii. to explore the structure of $K^{\pi} = 6^{+}$: $7/2[523]_{\pi}\otimes5/2[523]_{\nu}$ band observed in odd-odd ^{162}Ho and ^{164}Ho nuclides.

In order to accomplish the above said objectives, we adopted TQPRM approach [3]

Theoretical Framework

Since the formulation of Two Quasiparticle Plus Rotor Model (TQPRM) is described in details elsewhere [3] so we present here its essential formulae only. The total Hamiltonian (H_{tot}) in the framework of TQPRM comprises of intrinsic Hamiltonian (H_{in}) and rotational Hamiltonian (H_{rot}) i.e. $H_{tot} = H_{in} + H_{rot}$. Further, this intrinsic part (H_{in}) of the total Hamiltonian contains the axially symmetric average field (H_{av}) plus various Hamiltonian operators corresponding to pairing (H_{pair}), vibrational (H_{vib}) and *n-p* interaction (V_{np}) terms i.e $H_{in} = H_{av} + H_{pair} + H_{vib} + V_{np}$. Similarly, the rotational Hamiltonian (H_{rot}) consists of various terms such as pure rotation (H^{o}_{rot}), Coriolis coupling (H_{cor}), particle-particle coupling (H_{ppc}), irrotational component (H_{irrot}) and hence, it can be written as $H_{rot} = H^{o}_{rot} + H_{cor} + H_{ppc} + H_{irrot}$. The explicit form of various terms comprising total Hamiltonian is:

$$H^{0}_{rot} = \frac{\hbar^2}{2\Im}\left(I^2 - I_z^2\right)$$

$$H_{cor} = -\frac{\hbar^2}{2\Im}\left(I_+ j_- - I_- j_+\right)$$

$$H_{ppc} = \frac{\hbar^2}{2\Im}\left(j_p^+ j_n^- - j_p^- j_n^+\right)$$

$$H_{irrot} = \frac{\hbar^2}{2\Im}\left[\left(j_p^2 - j_{pz}^2\right) + \left(j_n^2 - j_{nz}^2\right)\right]$$

The basis states used to solve the total Hamiltonian can be written as [3]:

$$\left|IMK\alpha\right\rangle = \sqrt{\left[\frac{2I+1}{16\pi^2\left(1+\delta_{K0}\right)}\right]} * \left[D^I_{MK}\left|K\alpha\right\rangle + \left(-1\right)^{I+K} D^I_{M-K} R_i \left|K\alpha\right\rangle\right]$$

The index $\left|K\alpha\right\rangle$ characterizes the configuration of odd proton and odd neutron. The symbols $D^I_{M\pm K}$ and R_i are the Wigner-*D* functions and rotation operator respectively.

Results and Discussion

In order to explore the band structures of the K^{π} = 1^{+} & K^{π} = 6^{+}:7/2[523]$_{\pi}$⊗5/2[523]$_{\nu}$ GM doublets observed in ^{162}Ho and ^{164}Ho nuclides, we performed the TQPRM calculations. The basis set involved in the present calculations consist of total 40 bands appearing from the coupling of $h_{11/2}$ (K=1/2, 3/2, 5/2, 7/2, 9/2) and $f_{7/2}$ (K=1/2, 3/2, 5/2, 7/2) Nilsson orbitals. The single proton and neutron wave functions used in the present calculations are obtained using Nilsson Model [7] with deformation parameters as ε_2 = 0.250 and ε_4 = -0.007 for ^{162}Ho and ε_2 = 0.258 and ε_4 = 0.007 for ^{164}Ho [8]. The potential strength parameters as k = 0.0620 and μ = 0.614 for protons and k = 0.0636 & μ = 0.393 for neutrons are adopted from Jain *et al.* [9].

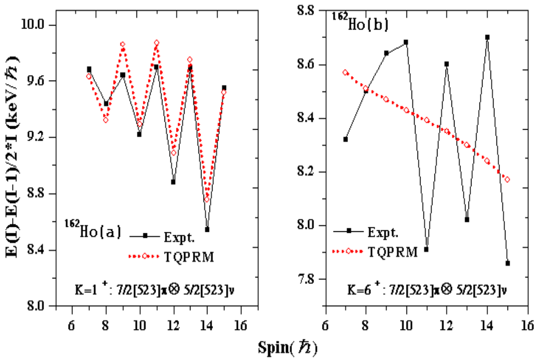

Fig. 1(a-b): Comparison among experimental and theoretical staggering pattern in the K^{π}=1^{+} and K^{π}=6^{+} GM doublet of ^{162}Ho nuclide [1].

From figures 1(a) & 2(a) it is clear that for the K^{π} =1^{+} bands, there is an excellent agreement among experimentally observed staggering pattern and the present TQPRM results and hence on the basis of these calculations, we confirm the tentative placement of 15^{+} level at 2234.3 keV observed in ^{162}Ho [1]. The figure 1(b) shows that there is a disagreement among experimental and calculated results, as the K^{π} = 6^{+} band exhibits pronounced signature splitting at higher spins. But, the present TQPRM calculations show that this band does not shows any signature splitting throughout the observed spin range.

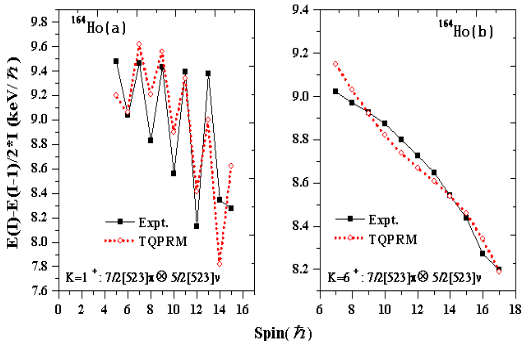

Fig. 2(a-b): Comparison among experimental and theoretical signature splitting in K^{π}=1^{+} and K^{π}=6^{+} GM doublet of ^{164}Ho nuclide [1].

If we compare the staggering pattern of this band (Fig. 1(b)) observed in ^{162}Ho [1] with the K^{π}=1^{+} band having same configuration (Fig. 2(b)) observed in ^{164}Ho [2]**,** one expects the same staggering behavior as appeared from our TQPRM calculations, which further strengthen our TQPRM results for this band. Thus, on the basis of present calculations, we suggest that an additional experimental studies are required to confirm tentative the structure of this K^{π} = 6^{+}: 7/2[523]$_{\pi}$⊗5/2[523]$_{\nu}$ band observed in ^{162}Ho.

Acknowledgement

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