Configuration assignment to ground state rotational band of ^{184}Au

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Introduction

Recently, the rotational level scheme of ^{184}Au has been investigated by means of in-beam γ -ray spectroscopy techniques [1]. On the basis of a comparison of the measured and calculated *B(M1)/B(E2)* ratios, Li *et al.* [1] suggested a highly mixed character for the ground state two-quasiparticle (2qp) rotational band of ^{184}Au. In this paper, the configuration assignment to ground state band of ^{184}Au is revisited in terms of Two Quasi-Particle Rotor Model (TQPRM) calculations. Our results further strengthen the earlier proposed configuration assignments to this band [1, 2].

Formulation

The theoretical formulation of TQPRM is well known and a detailed description has already been published in the literature [3]. In the TQPRM approach, the total Hamiltonian can be written as:

$$H_{tot} = H_{\text{int}} + H_{rot}$$

where

$$H_{\text{int}} = H_{av} + H_{pair} + H_{vib} + V_{np}$$

$$H_{rot} = H_{rot}^{o} + H_{Cor} + H_{PPC} + H_{irrot}$$

The intrinsic part (H_{int}) of total Hamiltonian (H_{tot}) is constructed by the axially symmetric average field (H_{av}) plus various parts corresponding to pairing (H_{pair}), vibrational (H_{vib}) and *n-p* (V_{np}) interactions. Similarly, the rotational part of total Hamiltonian (H_{rot}) consists of pure rotation (H_{rot}^{o}), Coriolis coupling (H_{Cor}), particle-particle coupling (H_{PPC}) and irrotational component (H_{irrot}).The basis states for diagonaliztion of the total Hamiltonian (H_{tot}) are:

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

Here, $\left|K\alpha\right\rangle$ represents the 2qp configuration of odd neutron and odd proton. The symbols such as D_{MK}^{I} and R_i represent Wigner functions and rotational operator respectively. All other terms appearing in the above expression have their usual meaning [3].

Result & Discussion

Ibrahim *et al.* [4] tentatively assigned $\pi h_{9/2}\otimes\nu 7/2^-[514]$ configuration to the ground band of ^{184}Au. However an experimental study based on resonance ionization spectroscopy performed by Blanc *et al.* [5] suggested a pure *K* value ($K=5^+$) for this band, which results from $\pi 3/2^-[532]\otimes\nu 7/2^-[514]$ configuration. The semi-microscopic calculation by Sauvage *et al.* [2] suggested a strongly mixed character of this band with $K=5^+:\pi 3/2^-[532]\otimes\nu 7/2^-[514]$ configuration for the low spin region ($I\leq 7$) and $\pi 1/2^-[541]\otimes\nu 7/2^-[514]$ for the high spin region ($I>7$). On the basis of a comparison of the measured and calculated *B(M1)/B(E2)* ratios, Li *et al.* [1] further supported the configuration assignment by Sauvage *et al.* [2]. Although, both (Li *et al.* [1] and Sauvage *et al.* [2]) proposed $\pi 1/2^-[541]\otimes\nu 7/2^-[514]$ configuration for the high spin ($I>7$) region but, which one of the Gallagher-Moszkowski (GM) [6] partner out of $K=4^+$ and $K=3^+$

corresponding to *π1/2⁻[541]⊗ν7/2⁻[514]* configuration at high spin region (*I*>7) of ground state band, is not clear. So, the main objectives of the present study are:

(i) confirmation of configuration assignment at low and high spin regions of this band

(ii) explanation of signature splitting observed in high spin region of this ground state band.

In order to achieve above said objectives, we did TQPRM calculations for this band. Although this band is observed up to spin $I=24^+$, but in present calculations, we considered this band up to spin $I=17^+$ because of band crossing at higher spins [1]. The experimental staggering (ΔE_γ *vs. I*) along with the results of TQPRM calculations are presented in Fig. 1(a-c). From Fig.1 (a), it is clear that this band exhibits signature splitting at higher spin values and pronounced staggering at the top of this band is due to band crossing [1]. For minute inspection of this band, we considered this band into three spin regions: low ($I\leq8$), intermediate ($8\leq I\leq10$) and high ($13\leq I\leq17$) spin regions. From Fig. 1(b), it is clear that for low spin region ($I\leq8$), experimental results are consistent with the configuration $K^\pi=5^+$:*π3/2⁻[532]⊗ν7/2⁻[514],* and Fig. 1(c) clearly shows that for high spin region ($13\leq I\leq17$), experimental staggering is well reproduced for $K=3^+$ *π1/2⁻[541]⊗ν7/2⁻[514]* configuration. Sauvage *et al.* [4] and Lie *et al.*[1] also proposed that the dominant component of the ground band changes from *π3/2⁻[532]⊗ν7/2⁻[514]* to *π1/2⁻[541]⊗ ν7/2⁻[514]* with increasing spin. Our calculations further strengthen these results and we also suggest that with increase of spin (for *I>13*) this band is well reproduced by $K=3^+$:*π1/2⁻[541]⊗ν7/2⁻[514]* and in the intermediate spin region, there is appreciable mixing of $K=3^+$ and $K=4^+$ bands based on *π1/2⁻[541]⊗ν7/2⁻[514]* configuration with main component of $K=4^+$ at initial spins of this intermediate spin range. Our assignments, as $K=4^+$ and $K=3^+$ corresponding to the configuration *π1/2⁻[541]⊗ν7/2⁻[514]* in the intermediate and high spin regions, is further corroborated by the *B(M1)/B(E2)* ratios measurement by Li *et al.* [1]. In addition to this configuration assignment, we also successfully reproduce the phase as well as magnitude of experimentally observed signature splitting.

Conclusions

To conclude, the configuration assignment of strongly mixed ground state rotational band of ^{184}Au is revisited in terms of TQPRM calculations. The earlier observation *i.e.* dominant component of this band changes from *π3/2⁻[532]⊗ν7/2⁻[514]* to *π1/2⁻[541]⊗ ν7/2⁻[514]* with increasing spin, is confirmed and phase as well as magnitude of signature splitting is successfully reproduced.

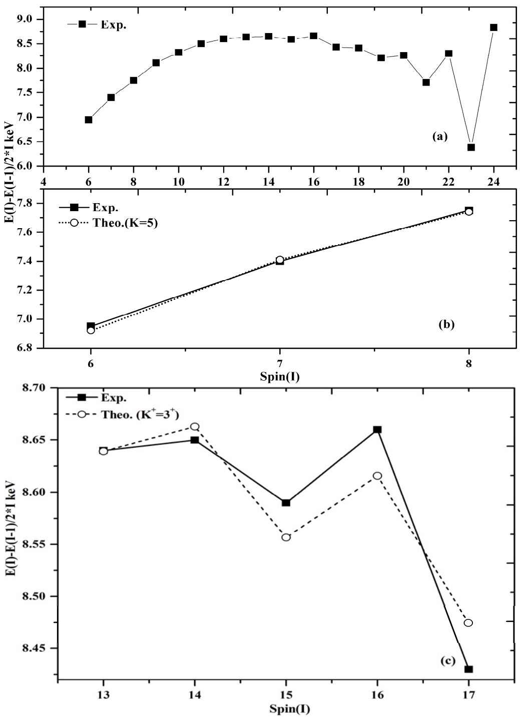

Fig.1 (a-c): Comparison of experimental and calculated energy staggering ($\Delta E_\gamma=E(I)-E(I-1)/2I$ *vs. I*)

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