Systematic study of rotational properties for triaxial superdeformed bands of $^{164}Lu(1,2)$

Honey Sharma* and H. M. Mittal‡
*Department of Physical Sciences,
Sant Baba Bhag Singh University,
Padhiana, Punjab, India
and
‡Department of Physics,
Dr. B. R. Ambedkar National Institute of Technology,
Jalandhar, Punjab, India

Introduction

Triaxial motion is a major issue in nuclear structure physics and plays a vital role in the various nuclear phenomenon. Total Routhian calculation proposed that stable triaxial deformation should arise in superdeformed (SD) well with energy minima appearing up to the large rotational frequency ($\hbar\omega$) in the nuclei with Z=72 and N=94. Thus, the structures situated in these minima are usually called the triaxial SD bands. Petersen and Schmitz [1, 2] experimentally recognized such case in $^{163,165}Lu$ with a large quadrupole moment values ($\varepsilon_2 \approx 0.4$, $\gamma \sim +18°$). At deformation $\varepsilon_2 \approx 0.4$ and $\gamma \sim 20°$, a gap around N=94 proves to be vital for the rise of triaxial superdeformed shapes (TSD) in the A$\sim$160 mass region. Tormanen et al. [3] studied the TSD bands and their decayed strength in ^{164}Lu. Bringel et al. [4] used Gammasphere spectrometer to identify the eight TSD bands in ^{164}Lu. In the framework of two parameter formulae, the band head spin of triaxial SD bands in Lu isotopes was calculated by Sharma and Mittal [5].

The present aim of this paper is to study the systematics of the rotational properties i.e. (band head spin I_0 and dynamic moment of inertia versus the rotational frequency) in the framework of four parameter formula for TSD bands in $^{164}Lu(1, 2)$ in A$\sim$160 mass region.

*Electronic address: honeyshrma777@gmail.com

Formalism

Four parameter formula

$$\begin{aligned} E_\gamma(I \to I-2) = A(I(I+1) - (I-2)(I-1)) \\ +B((I(I+1))^2 - ((I-2)(I-1))^2) \\ +C((I(I+1))^3 - ((I-2)(I-1))^3) \\ +D((I(I+1))^4 - ((I-2)(I-1))^4), \end{aligned} \quad (1)$$

where A, B, C and D are the model parameters which can be resolved by fitting the E_γ transitions for the SD bands.

Results and Discussion

The band head spin (I_0) for ^{164}Lu(1, 2) TSD bands

The experimental E2 transition energies of TSD bands of $^{164}Lu(1, 2)$ [6] are fitted by using the best fit method (BFM) in Eq. (1). The band head spins (I_0) obtained from the four parameter formula for TSD bands of $^{164}Lu(1, 2)$ are compared with the experimental data (see Table I). It is observed from Table I that the determined and the observed band head spin agrees well with each other.

Dynamic moment of inertia ($J^{(2)}$) versus the rotational frequency ($\hbar\omega$) for ^{164}Lu(1,2) TSD bands

At an exact and appropriate band head spin (I_0), the calculated transition energies obtained from the four parameter formula is used to determine $J^{(2)}$ by employing Eq. (2). Experimentally, the values of $J^{(2)}$ increase with

an increase in $\hbar\omega$ for TSD bands of ^{164}Lu isotope. A comparison is made between the calculated and the experimental values of $J^{(2)}$ (see Fig. 1, 2). It is observed from Fig. 1 and 2 that the same pattern is followed by TSD bands of $^{164}Lu(1,2)$ and an excellent agreement is shown between the experimental and the calculated results of $J^{(2)}$.

$$J^{(2)} = 4000/[E_\gamma(I+2) - E_\gamma(I)] \qquad (2)$$

TABLE I: The band head spin (I_0) obtained for triaxial superdeformed bands(TSD) of $^{164}Lu(1,2)$ by using four parameter formula (F.P).

TSD BANDS	$E_\gamma(I_0+2 \rightarrow I_0)$	F.P formula	Ref. [6]
$^{164}Lu(1)$	374	12	14
$^{164}Lu(2)$	354	11	13

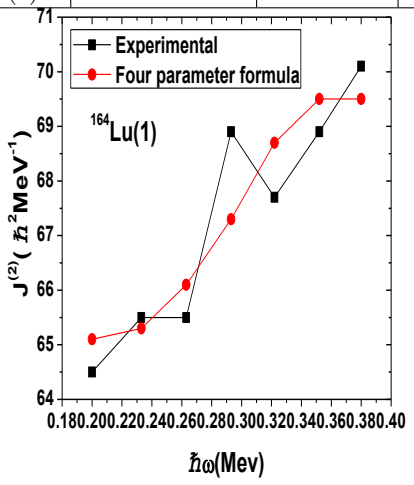

Fig.1. Variation of calculated result of $J^{(2)}$ with $\hbar\omega$ for TSD bands in $^{164}Lu(1)$ and comparison with experimental data.

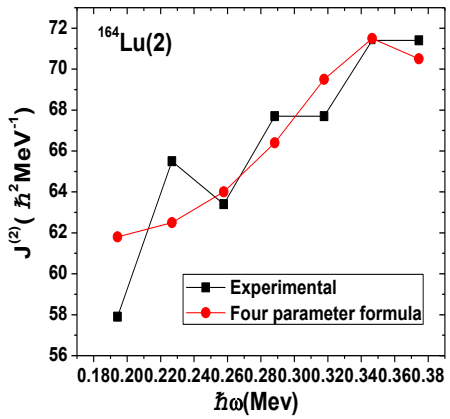

Fig 2. Variation of calculated result of $J^{(2)}$ with $\hbar\omega$ for TSD bands in $^{164}Lu(2)$ and comparison with experimental data.

Conclusion

In this present work, we have studied the rotational properties (i.e. the band head spin, dynamic moment of inertia versus the rotational frequency) for TSD bands of $^{164}Lu(1)$ and $^{164}Lu(2)$ by using the four parameter formula. It is found that the calculated and observed band head spin agrees very well with each other. The calculated and experimental dynamic moment of inertia versus the rotational frequency also matches very well with each other.

References

[1] H. Schnack-Petersen, et al., Nucl. Phys. A 594 (1995) 175-202.
[2] W. Schmitz, et al., Nucl. Phys. A 539 (1992) 112-136 ; Phys. Lett. B 303 (1993) 230-235.
[3] S. Tormanen, et al., Phys. Lett. B 454 (1999) 8-14.
[4] P. Bringel, et al., Phys. Rev. C 75 (2007) 044306.
[5] Honey Sharma and H.M. Mittal, Chin. Phys. C 42 (2018) 114102.
[6] B. Singh et al., Nucl. Data sheets 97 (2002) 241-592.