

Study of dynamic moment of inertia versus rotational frequency for superdeformed bands in ^{83}Y

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Introduction

The study of spin determination is an essential step towards characterizing the overall nature of superdeformed (SD) bands in various mass regions. The kinematic moment of inertia ($J^{(1)}$) and dynamic moment of inertia ($J^{(2)}$) are the critical parameters to investigate the spectroscopy of SD bands in further detail. $J^{(1)}$ completely depend upon spins, in contrast to $J^{(2)}$. Because the spin assignments of the SD bands in various mass regions are still up for debate, $J^{(2)}$ is primarily considered. In the context of the $N_p N_n$ scheme, Sharma et al. [1] examined the systematics of $J^{(1)}$ and $J^{(2)}$ in A~190, 150, and 130 mass regions. There is a continuous increase of $J^{(2)}$ with rotational frequency ($\hbar\omega$) for the mass region A~190 and a continuous decrease of $J^{(2)}$ with rise of $\hbar\omega$ for A~150,130. SD bands were seen in the A~80 mass region up to $\hbar\omega$ of approximately 1.3 MeV/h [2], in contrast to A~190, 150, and 130 mass regions. In nuclei with atomic numbers Z=38–40 and N=42–45, the estimate for extremely elongated forms with an axis ratio of 2:1 was discovered in the A~80 mass region [3–8]. Baktash et al. [9] observed similar estimates experimentally in $^{83}\text{Sr}(1)$. In this present work, the calculated transition energies of $^{83}\text{Y}(1,2,3,4)\text{SD}$ bands obtained from various rotational energy formulae i.e nuclear softness formula [10], VMI model [11], VMINS3 model [12], four parameter formula [13] are used to calculate $J^{(2)}$ and

its variation with $\hbar\omega$ is investigated.

Formalism

A) Nuclear softness formula [10]

$$E_\gamma(I) = \frac{\hbar^2}{2\mathfrak{I}_0} \times \left[\frac{I(I+1)}{(I+\sigma I)} - \frac{(I-2)(I-1)}{1+\sigma(I-2)} \right] \quad (1)$$

B)VMI model [11]

$$E_\gamma(I \rightarrow I-2) = \frac{[I(I+1) - (I-2)(I-1)]}{2\mathfrak{I}_0} + \frac{[I(I+1)]^2 - [(I-2)(I-1)]^2}{8C(\mathfrak{I}_0)^4} \quad (2)$$

C)VMINS3 model [12]

$$E_I = \frac{\hbar^2}{2\mathfrak{I}_0} \frac{I(I+1)}{(1+\sigma_1 I)} + \frac{1}{2} C \mathfrak{I}_0^2 I^2 \sigma_1 \quad (3)$$

D)Four parameter formula [13]

$$E_\gamma(I \rightarrow I-2) = A(I(I+1) - (I-2)(I-1)) + B((I(I+1))^2 - ((I-2)(I-1))^2) + C((I(I+1))^3 - ((I-2)(I-1))^3) + D((I(I+1))^4 - ((I-2)(I-1))^4) \quad (4)$$

E)Dynamic Moment of Inertia ($J^{(2)}$)

$$\mathfrak{I}^{(2)}(I) = 4000/[E_\gamma(I+2) - E_\gamma(I)] \quad (5)$$

F) Rotational Frequency ($\hbar\omega$)

$$\hbar\omega = \frac{E_\gamma(I) + E_\gamma(I+2)}{4} \quad (6)$$

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Results and Discussion

The $J^{(2)}$ scatters at around $25\hbar^2/MeV$ in $A\sim 80$ mass region. Upbends are visible in the SD bands at high rotational frequencies in the ^{83}Y nucleus [2] due to a rotational alignment of a pair of nucleons. Hence, it is observed from Fig. 1 that this type of trend is well reproduced by four parameter formula for all the $^{83}Y(1,2,3,4)$ SD bands.

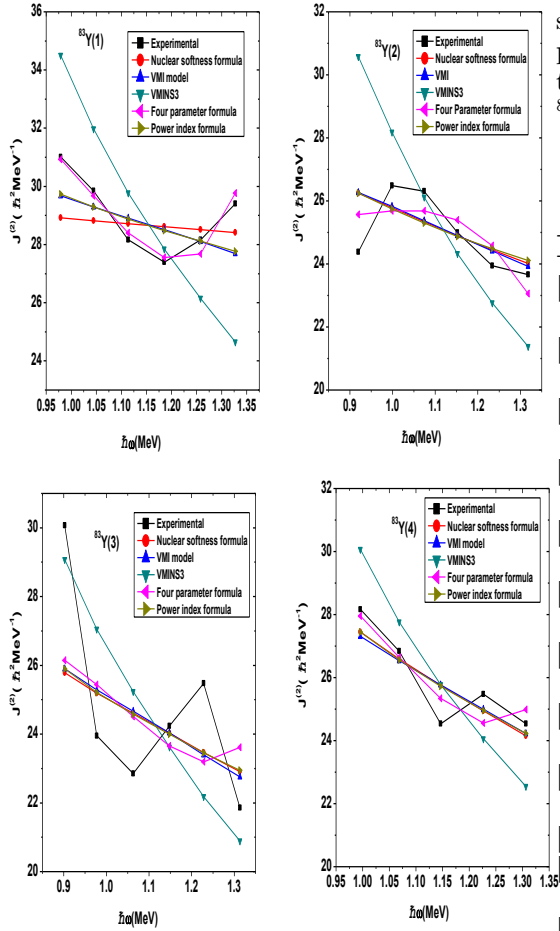


FIG. 1: Variation of calculated result of dynamic moment of inertia $J^{(2)}$ with rotational frequency for $^{83}Y(1,2,3,4)$ SD bands in $A \sim 80$ mass region and comparison with experimental data.

Conclusion

To study the behaviour of SD bands the dynamic moment of inertia $J^{(2)}$ is a vital quantity. The change of $J^{(2)}$ with $\hbar\omega$ for $^{83}Y(1,2,3,4)$ SD bands is investigated in present study. As reported in Ref.[2] $J^{(2)}$ with $\hbar\omega$ for ^{83}Y SD nuclei show upbends at high rotational frequency due to a rotational alignment of a pair of nucleons. In the present study also it is well noticed that the same experimental trend is followed by four parameter formula for all four SD rotational bands in ^{83}Y .

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