# Systematic study of kinematic and dynamic moment of inertia of SD bands in A=150 mass region

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## Introduction

The significance of the proton – neutron interaction in deducing expansion of nuclear structure was stressed earlier by de – Shalit and Goldhaber [1]. Talmi [2] was the first to notice that the proton-neutron (p-n) interaction is responsible for deformed nuclei. Federman and Pittel [3] highlighted the p-n interaction between nucleons in spin-orbit partner orbits; which results in rapid phase transition near A=100. Similar mechanism has been applied to A=150 mass region [4] on the account of Z=64 subshell closure. Casten [5, 6] proposed a simple quantity, $N_pN_n$; which is an estimation for the residual proton –neutron which plays a crucial role in evolution of nuclear deformation [1, 7-8]. A simple pattern observed whenever the nuclear data relating to nuclear deformation is plotted against $N_pN_n$ [5].Various authors gave deep knowledge about nuclear structure to study collectivity in nuclei by using $N_pN_n$ product. Some fascinating features appeared when $N_pN_n$ scheme is applied to Superdeformed (SD) bands. Mittal and Sharma [9] studied about the pair of conjugate nuclei having same F-spin and $\pm F_o$ values, and superdeformed band spectra for nuclei in 72≤ N≤ 86 region using $N_pN_n$ scheme and concluded that they have identical $N_pN_n$ spectra. Sharma and Mittal [10] also measured R(I) and nuclear softness parameter with $N_pN_n$ of all the SD bands in A=190 mass region and summarized that SD bands are more rigid than Normal Deformed (ND) bands.

## Formalism

To study the systematics of dynamic and kinematic moment of inertia, one can calculate these moments of inertia by using the experimental intraband E2 transition energies from the tables of SD bands by Singh et al. [11] and continuously updated data from [12]. The kinematic $J^{(1)}$ and dynamic moment of inertia $J^{(2)}$ can be determined as,

$$J^{(1)}(I-1)\hbar^2 = \frac{2I-1}{E_\gamma(I\to I-2)} \qquad (1)$$

$$J^{(2)}(I)\hbar^2 = \frac{4}{E_\gamma(I+2\to I)-E_\gamma(I\to I-2)} \qquad (2)$$

It is noted from the equations that $J^{(1)}$ depends on the spin proposition, whereas $J^{(2)}$ does not. In this paper we have applied above stated formulas in A=150 mass region, and study the systematics of $J^{(1)}$ and $J^{(2)}$ with $N_pN_n$ scheme.

## Results and Discussion

We obtained $J^{(1)}$ and $J^{(2)}$ by using equation (1) and (2). The data has been taken from Ref. [11, 12]. The plot of dynamic moment of inertia ($J^{(2)}$) versus $N_pN_n$ present for SD bands in A=150 mass region is shown in Fig. 1. A simple pattern is observed whenever nuclear data relating to nuclear deformation is plotted against $N_pN_n$. But in our case band mixing is observed. Mixing of the bands may be expected if energy levels of two SD bands having same parity and the signature are close to each other i.e. $E_1(I) \approx E_2(I)$ for $I = I_c$ . It is also noted in Fig. 1 that $J^{(2)}$ pattern in band mixing region of perturbed band is of inverse – W type; whereas $J^{(2)}$ usually prevails unperturbed outside the band mixing region.

The variation of kinematic moment of inertia $J^{(1)}$ with $N_pN_n$ for SD bands in mass region A = 150 is shown in Fig. 2. It also indicates a band mixing between different SD bands. It is noted from eq. (1) that $J^{(1)}$ depends upon spin; so due to band mixing, the spins of the lowest levels observed in SD bands in the A=150 mass regions are generally high, which makes spin prediction in this region very difficult.

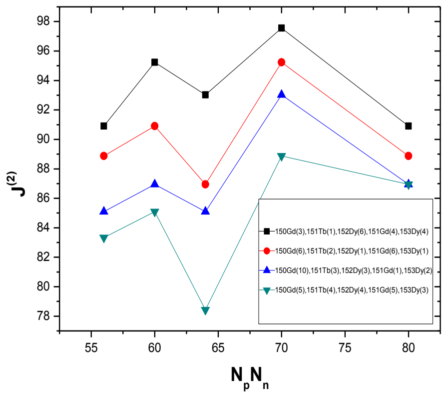


Fig.1. The variation of dynamic moment of inertia $J^{(2)}$ versus $N_pN_n$ in mass region A =150.

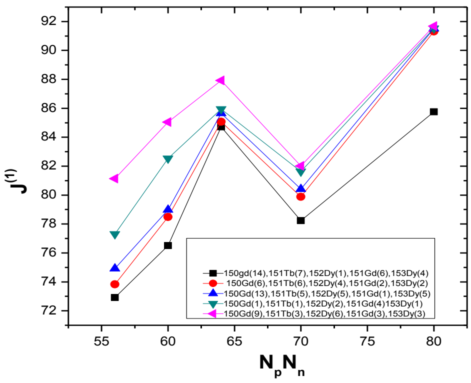


Fig.2. The variation of kinematic moment of inertia $J^{(1)}$ versus $N_pN_n$ in mass region A =150.

## Conclusion

In this present work, we calculate the $J^{(1)}$ and $J^{(2)}$ for SD bands in A=150 mass region and present their systematics in the $N_pN_n$ scheme. We show the variation of dynamic moment of inertia versus $N_pN_n$ and found a band mixing between the bands. It is also quiet interesting to note $J^{(2)}$ pattern in band mixing region is of inverse W type and this type of pattern is only observed in A=150 mass region. We also noticed that in variation of $J^{(1)}$ versus $N_pN_n$ again a band mixing is observed which makes spin determination difficult in A=150 mass region.

## Acknowledgements

Financial support from Department of Science and Technology (Govt. of India) is gratefully acknowledged.

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