# Band head moment of inertia of superdeformed bands in La-Nd in A∼130 mass region

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## Introduction

In nuclear structure physics, the phenomenon of superdeformation (SD) was used many years ago to describes fission isomers noticed in actinides [1]. The interest for superdeformation raised immensely when SD bands in $^{152}Dy$ nucleus was observed [2]. Numerous astonishing properties of SD nuclei was recognized experimentally, such as consistent energy spacing between the transitions, missing transition linking the yrast SD band to normal deformed states resulting in 1-2$\hbar$ unreliability in the spin assignment of the SD bands. The presence of first SD rotational bands in the A∼130 mass region was observed in $^{132}Ce$ by Kirwan et al. [3]. The concept of high-N shells was used to explain the role of the moment of inertia in the SD bands in the N =73 isotones (La, Ce and Nd) [4]. The relative deformation in $^{131,132}Ce$ and quadrupole moment of SD bands in $^{131,132}Ce$ was calculated in the framework of the Doppler-shift attenuation method [5]. Hauschild et al. [6, 7] studied the lifetime measurement of $^{132,133}Ce$ nuclei, the phenomenon of triaxiality in the $^{133}Ce$ nucleus in the framework of the Cranked Strutinsky. Consequently, Bazzacco and Deleplanque [8, 9] recognized the decay process in the odd $^{133,135,137}Nd$ nuclei for the first time. Afterwards, Petrache et al. [10] detected the similar transitions in $^{132,134}Nd$. In the second minimum the lifetime measurement of $^{133,137}Nd$ nuclei was reported by Mullin et al. [11]. Systematic study of rotational energy formulae for superdeformed bands in La and Ce isotopes was studied by Sharma and Mittal [12].

In this present paper, we have calculated the band head moment of inertia ($\Im_0$)of superdeformed bands in La-Nd in A∼130 mass region by using the nuclear softness formula.

## Formalism

**Nuclear softness formula**

Nuclear softness formula was establised by Gupta [13]. The transition energies for the SD bands can be expressed as

$$E_\gamma = \frac{\hbar^2}{2\Im_0} \times \left[ \frac{I(I+1)}{1+\sigma I} - \frac{(I-2)(I-1)}{1+\sigma(I-2)} \right]. \quad (1)$$

where $\Im_0$ and $\sigma$ are the model parameter, which can be found by the fitting procedures.

## Results and Discussion

Signature partner SD bands are the one which have identical values of band head moment of inertia ($\Im_0$). We have applied the nuclear softness formula to calculate the band head moment of inertia ($\Im_0$) for SD bands in La-Nd of A∼130 mass region. The data has been taken from Ref. [14]. It is noticed from Table I that the obtained band head moment of inertia ($\Im_0$) of $^{132}Ce$(1)SD band is identical to the band head moment of inertia ($\Im_0$) of $^{132}Ce$(2) SD bands and also the band head moment of inertia ($\Im_0$) of $^{132}Pr$ (1) SD bands is identical to the band head moment of inertia

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TABLE I: Parameters obtained from least square fitting for SD bands in La-Nd of A∼ 130 mass region by using Nuclear softness formula.

| SD BANDS | $E_\gamma(I \to I-2)$ | $\Im_0$ |
|---|---|---|
| $^{130}La$ | 762.4 | 44.3 |
| $^{130}Ce$ | 865 | 49.7 |
| $^{131}Ce$ | 591.5 | 57.6 |
| $^{132}Ce(1)$ | 770.8 | 66.7 |
| $^{132}Ce(2)$ | 724.4 | 66.2 |
| $^{133}Ce(1)$ | 748.30 | 67.8 |
| $^{133}Ce(2)$ | 720.32 | 59.4 |
| $^{133}Ce(3)$ | 956.9 | 47.9 |
| $^{132}Pr(1)$ | 695.5 | 39.5 |
| $^{132}Pr(2)$ | 565.3 | 46.0 |
| $^{132}Pr(3)$ | 709 | 39.7 |
| $^{132}Pr(4)$ | 736 | 48.4 |
| $^{133}Pr(2)$ | 800 | 74.6 |
| $^{133}Pr(1)$ | 840 | 73.6 |
| $^{133}Pr(3)$ | 784 | 81.2 |
| $^{133}Pr(4)$ | 821 | 82.1 |
| $^{133}Nd$ | 345.3 | 53.2 |
| $^{134}Nd(1)$ | 667.9 | 56.6 |
| $^{134}Nd(2)$ | 726.4 | 51.5 |
| $^{136}Nd(1)$ | 656.6 | 58.9 |
| $^{137}Nd$ | 634.7 | 52.8 |

($\Im_0$) of $^{132}Pr(3)$ SD bands. Hence, $^{132}Ce(1)$ and $^{132}Ce(2)$SD bands, $^{132}Pr(1)$and $^{132}Pr(3)$ SD band are the signature partner bands.

## Conclusion

In this present work, it is very well noticed that the band head moment of inertia ($\Im_0$) of $^{132}Ce(1)$ and $^{132}Ce(2)$SD bands, $^{132}Pr$ (1) and $^{132}Pr$ (3) SD bands obtained by the nuclear softness formula are identical. Hence, $^{132}Ce(1)$ and $^{132}Ce(2)$ SD bands and $^{132}Pr$ (1) and $^{132}Pr$ (3)SD bands are the signature partner bands.

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