Influence of triaxiality on yrast and excited Superdeformed bands

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Introduction

V.M. Strutinsky [1] first predicted the superdeformed (SD) shapes, which have been observed experimentally by Twin et al., [2]. A large number of SD bands have been observed in the mass region A=60, 80, 130, 150, 190 [3, 4]. It may be pointed out that a lack of knowledge of the spins assignments has led to an emphasis on the study of dynamical moment of inertia of SD bands and the systematics of the kinetic moment of inertia have not been examined in a detailed manner. Sharma and Mittal [5] have studied that all the excited SD bands in even-even nuclei are signature partner SD bands because the J_0 value of each signature partner SD band is almost identical. The J_0 values obtained from fitting of SD bands in A=190 mass region exhibit spread in many cases which point towards the presence of structural effects in these SD bands [6].

In this paper, we extract the band moment of inertia J_0 of all the known yrast and excited SD bands spread all over the nuclear chart and present their systematics.

Results and Discussion

First of all, we classify the bands into yrast and excited SD bands spread all over the nuclear chart by using the feeding intensities from the experiments and reported in ref. [3, 4]. We have calculated the band moment of inertia J_0 by fitting the E2 gamma ray energies of all the yrast and excited SD bands [3, 4] by using a 4-parameter formula [7]. In these bands, some kind of spin assignments are available. The fits are very good because the SD bands are very good rotors. The root mean square deviation has been calculated and shown in the results for each band. For a prolate ellipsoid, the transition quadrupole moment (Q_t) can be related to the major-to-minor axis ratio, x, by

$$Q_t = \frac{2}{5} Z R^2 \frac{x^2 - 1}{x^{2/3}} \times 10^{-2} eb. \quad (1)$$

So, the axes ratio can be estimated from Q_t in this way. For a prolate ellipsoid which give rigid rotation, it is possible to estimate the rigid body moment of inertia as [8]

$$J_{prolate} = \{\frac{A^{5/3}}{72} \frac{1 + x^2}{2x^{2/3}}\}[\hbar^2 MeV^{-1}]. \quad (2)$$

Higher order shape degrees of freedom and effect of triaxiality or necking have been ignored here.

We have compared the fitted values of J_0 of yrast and excited SD bands with the rigid rotor values of moment of inertia obtained from the measured-Q_t values. Those SD bands in which the Q_t measurements are not available, we have compared the fitted J_0 values with those obtained from the corresponding prolate shape of the SD nuclei.

We have plotted the fitted J_0 values vs. the mass number A for the yrast and the excited SD bands in Fig. 1 and 2 respectively. We have also plotted the rigid-rotor values from the measured Q_t - values and the axes ratio x. The fitted J_0 values generally follow the $A^{5/3}$ behavior across the different mass regions. But they also show a large spread within a given mass region and lie much below the corresponding rigid rotor values. It means that the γ-deformation may also be playing a role in some of the bands; there is evidence of

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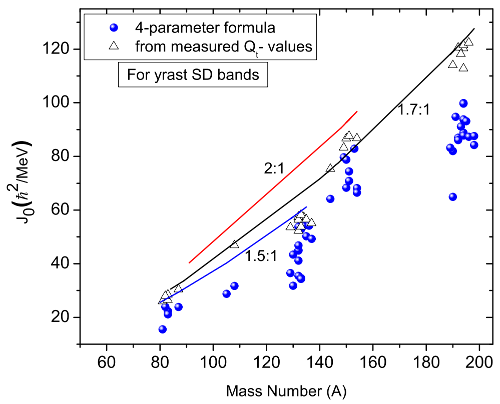

FIG. 1: (Color online) Band moment of inertia J_0 as a function of mass number A for yrast SD bands. Individual values of the rigid body moment of inertia J_0 as obtained from the measured Q_t values are compared with the values obtained from the 4- parameter fits. Also, the curves for 1.5:1, 1.7:1 and 2:1 are shown for comparison.

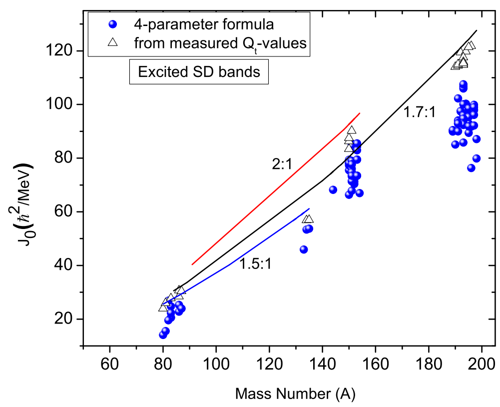

FIG. 2: (Color online) Same as Fig 1 but for excited SD bands.

some SD bands being triaxial in shape [10, 11]. As the γ-value increases from 0° to 60° (from prolate to oblate), the rigid body moment of inertia is known to decrease.

Conclusion

The 4-parameter formula has been used to obtain the band moment of inertia J_0 for the yrast and excited SD bands spread all over the nuclear chart. We found that the fitted values of J_0 of yrast and excited SD bands generally follow the $A^{5/3}$ behavior across the different mass regions. But they also show a large spread within a given mass region and lie much below the corresponding rigid rotor values. It means that the γ-deformation may also be playing a role in some of the bands.

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