Systematics of band moment of inertia of superdeformed bands in A = 80 mass region

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I. Introduction

The observation of the first high-spin superdeformed (SD) band in ^{152}Dy [1], have been intensively studied in several mass regions A ~ 190, 150, 130 and 80. However, the intraband energies are easy to detect with modern Ge arrays, it is difficult to observe the link between the SD band and normal deformed (ND) states with known spins. Therefore, the exact excitations energies, spins, and parities of SD bands remain unknown. The discrete γ rays connecting states of the yrast SD band ^{194}Hg(1) to ND states with known spins were discovered [2] the spins and excitations energies of all members of ^{194}Hg(1) were established experimentally. Recently, a link between SD and ND bands has been observed in ^{190}Hg by Wilson et al. [3]. Therefore, the measured spins of these SD bands provide a significant test of the validity of these approaches. It is noted that all the available approaches profit from the comparison of the calculated transition energies or moments of inertia with the experimental results and usually are referred to as the best fit method (BFM).

II. Formalism

Bohr and Mottelson [4] pointed out that the rotational energy of K=0 band in even-even nuclei can be expanded in power series of I(I+1):

$$E(I) = A(I(I+1)) + B(I(I+1))^2 + C(I(I+1))^3 + D(I(I+1)^4 \quad (1)$$

The energy may also be written in the form as [5],

$$E(I) = \frac{1}{2J_0}((I(I+1)) - \frac{1}{2}\sigma(I(I+1))^2 + \sigma^2(I(I+1))^3 - 3\sigma^3(I(I+1))^4 \quad (2)$$

where σ is softness parameter and J_0 is band moment of inertia. Comparison of equation (1) and (2) suggests that, $A=\frac{1}{2J_0}$, J_0=1/2A. In fact, J_0 thus extracted may be considered as another equivalent parameter characterizing a rotational band, and depends on the intrinsic structure of a rotational band. By using the measured spins or suggested spins made by the BFM, S.X. Liu and J.Y. Zeng [6] had studied the systematics of bandhead moments of inertia of SD bands.

(a) Signature partner SD bands

We have calculated the band moment of inertia for all the SD bands in A=80 mass region by using 4-parameter formula. By fitting the γ-ray transition energies and spin in 4-parameter formula (1), we have calculated the parameters A, B, C and D and ultimately the band moment of inertia. The root mean square deviation (RMSD) has also been calculated for each band and shown in Table I. The data has been taken from Ref. [7,8]. It is interesting to note that the band moment of inertia of each signature partner SD bands is almost identical [see Table I]. Therefore, if there exists a significant difference in J_0 values of two SD bands, it is very hard to consider them as a pair of signature partner.

(b) Identical SD bands

Identical band is the phenomenon which everyone wants to understand. The yrast SD band ^{192}Hg(1) was considered as identical to the excited SD band ^{194}Hg(3), because the observed sequence of E2 transition energies are almost identical in the spin range I ~ 20 - 40 [9]. Which implies their dynamical moment of inertia $J^{(2)}$ are almost identical in this spin range. As we know that the two rotational bands having same dynamical and kinematic moments of inertia are considered to be as identical to each other. This fact seems to suggest that the band moment of inertia of these bands should be same. We have calculated the band moment of inertia for all the SD bands in A=80 mass region by using 4-parameter formula. The values of band moment of inertia for the pair of identical SD bands in A-80 mass region are shown in Table II.

Table I. The systematics of band moment of inertia of Signature partner SD bands in A=80 mass region. The experimental data of transition energies and spins are taken from Ref. [7, 8].

SD band	Shape	J_0	RMSD
^{83}Zr(1)	1.7	21.11	2.92
^{83}Zr(2)	1.7	22.31	1.83
^{86}Zr(2)	1.5	25.28	2.51
^{86}Zr(3)	1.7	22.76	3.14
^{83}Y(1)	1.5	20.68	4.22
^{83}Y(4)	1.5	20.52	3.31
^{82}Y(2)	1.7	23.88	2.59
^{82}Y(3)	1.7	22.54	1.78

Table II. The systematics of band moment of inertia of identical SD bands in A=80 mass region. The experimental data of transition energies and spins are taken from Ref. [7, 8].

SD band	Shape	J_0	RMSD
^{83}Sr	1.5	22.30	1.92
^{83}Zr(2)	1.7	22.31	1.83
^{87}Nb(2)	1.5	23.95	3.72
^{82}Y(1)	1.7	23.96	3.58
^{81}Sr(2)	1.5	15.53	4.81
^{80}Sr(4)	1.5	14.08	3.12
^{83}Zr(2)	1.7	22.31	1.83
^{86}Zr(3)	1.7	22.76	3.14
^{82}Y(1)	1.7	23.96	3.58
^{83}Y(3)	1.5	24.72	2.88

III. Summary

The systematics of band moment of inertia of SD bands in A=80 mass region are investigated. The systematic of signature partner SD bands and identical SD bands are studied in detail

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