The systematics study of power law parameters of γ-Band and comparison with ground state band for medium mass region

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Introduction

The energy levels of nuclei consist of various bands as lowest band -ground state band, for symmetrical rotation $K^{\pi}= 0^{+}$ β-band and for asymmetrical rotation $K^{\pi}= 2^{+}$ γ-band as well as other higher bands and non bands [1]. Several empirical energy expressions are used [2-8] to calculate the theoretical energies and compared with experimental data [9]. The well known energy expression for rotational spectra:

$$E = \frac{\hbar^2}{2\theta} I(I+1)\ . \qquad (1)$$

Where, θ and I are the moment of inertia and spin, respectively. The Bohr Mottelson energy expression for deformed nuclei is:

$$E(I) = AX + BX^2 + CX^3 + \cdots \qquad (2)$$

Where, X= I(I+1), as a series expansions of the spin. For harmonic vibrator, the energy can be expressed as:

$$E(I) = aI\ . \qquad (3)$$

Das et al. [2] suggested the energy expression for an-harmonic vibrator:

$$\mathrm{E(I)} = \mathrm{aI} + \mathrm{bI(I-2)} \qquad (4)$$

For the transitional–medium mass region A=150-200 Gupta et al. [3] proposed a single term expression for ground state energy as:

$$E = aI^{b}\ . \qquad (5)$$

Where, a, b and I are scaling coefficient, power index parameter and spin, respectively. The single term expression is used for low mass region by Mittal et al. [4]. For ground state band, in both regions, the index and coefficient are fairly constant and are independent of level spin. Kumar et al. [5] showed the correlation of kinetic moment inertia with power formula index in 100≤A ≤150 mass region. Also Gupta and Hamilton [6] illustrated the use of this formula to determine the degree of deformation of shape transitional nuclei.

Due to simple interpretation of this expression, it is used here for γ-band by subtracting band head difference as suggested by Gupta et al. [7]. The energy levels for this band were obtained by Gupta [8]. Here, the coefficients and indices of the different spins are obtained using equation (5) after subtracting band head difference $E(2^{+}_{2})$. The ‘a’ and ‘b’ parameters of γ-band and ground band nuclei are compared for ^{156}Gd, $^{156,162-164}$Dy, $^{162-170}$Er, ^{178}Hf and ^{186}Pt. These nuclei are having the energies in γ-band up to spin $I^{\pi} = 10^{+}$.

Results

The scaling parameter ‘a’ and power index ‘b’ of γ-band and ground band are spin independent (see Fig. 1 and Fig. 2). The behaviour of scaling parameter ‘a’ and power index ‘b’ for γ-band and g- band are similar [3].

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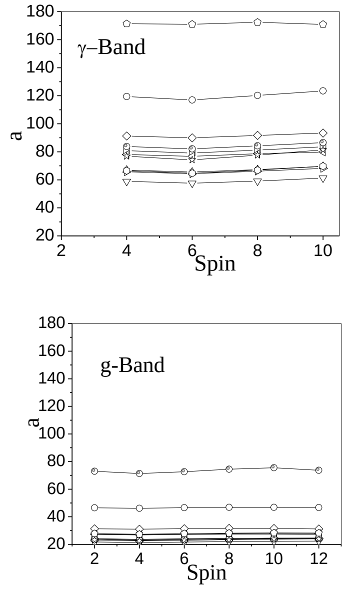

Fig. 1: The variation of scaling parameter 'a' versus spin for γ-band and g-band.

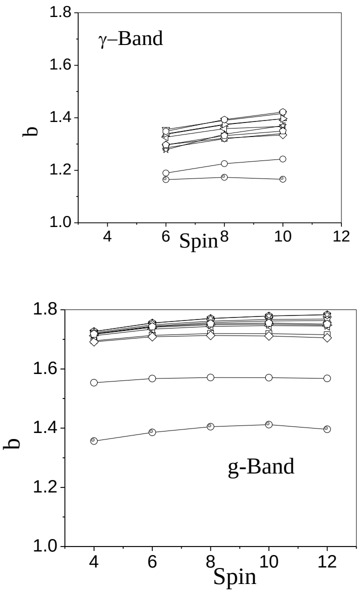

Fig. 2: The variation of power index parameter 'b' versus spin for γ-band and g- band.

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