Study of shape phase transition using power index formula

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For well deformed even-even nuclei the level energies of ground state band can be evaluated by rotor formula [1]:

$E_I = AX$ (1)

where, $X = I(I+1)$, $A = \hbar^2/2\theta$ and θ is the moment of inertia (MOI). For shape transitional nuclei, energy can expressed in terms of powers of X:

$E_I = AX + B X^2 + C X^3 + \ldots$ (2)

For harmonic vibrator, the level energiesare given by:

$E_{(I)} = aI$ (3)

The energy expression for anharmonic vibrator was suggested by Das et al. [2]:

$E_{(I)} = aI + bI(I-2)$ (4)

Some other energy formulae, such as the soft rotor formula (SRF),variable moment of inertia (VMI)model, etc., are also used to calculate the level energies.These energy expressions are in the form of an expansion in powers of spin I, or its combinations, limited to two or more terms. However, Gupta et al. [3] proposed a single term and two parameter formula in the form of a power index, known as power index formula:

$E_{(I)} = aI^b$ (5)

The index "b" is a measure of the deformation of the nuclear core ($1 \leq b \leq 2$) and coefficient "a" is the inverse of MOI. The validity of this formula for light mass nuclei was verified by Mittal et al. [4]. Gupta and Hamilton [5] observed that the change in the slope of index "b" with spin represent the variation of nuclear structure with spin. Earlier, Kumar et al. [6] illustrated that the slope of kinetic MOI versus spin corresponds to the magnitude of index "b" of power index formula. In this paper, we illustrate the use of power index formula for the study of shape phase transition at N=60.

Here we illustrate the use of power index formula for light massnuclei (Sr-Cd). The experimental energy values have been taken from the website of nndc [7]. In figure 1, we plotted the average value of "b" and "a"calculated using power index formula for Sr - Cd isotopes against Z, N to study the physical relevance. We also linked the data for each isotonic series to illustrate the main role of neutron number N in producing the deformation of a nucleus for Z=38-48, N=56-66. The sharp change of nuclear shape between N=58-60 are well exhibited in the plots of average "b" and "a" (Fig. 1)and the simultaneous effect of proton number Z is also exhibited here.

Thus the use of power index formula in the study of shape phase change at N=60 in light mass nuclei is making more transparent in the plots of average "b" and "a".

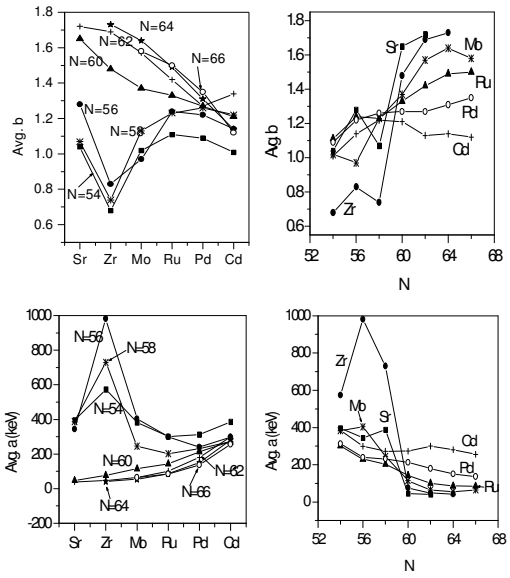

Figure 1. Plots of average "b" and average "a" for Sr - Cd.

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