Identical bands in superdeformed $A = 190$ mass region

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Introduction

The study of identical bands (IBs) found in both superdeformed (SD) and normal deformed (ND) bands has become an exciting challenges in nuclear structure [1]

Bands in two different nuclei with nearly same transition energies E_γ and identical dynamical moments of inertia $J^{(2)}$ are classified as identical bands. The existence of such bands found at both low and high spins. Khalaf et al. [2] studied these bands with N_pN_n scheme for normal deformed even-even nuclei.

In the present paper, we extend the same idea by studying variable moment of inertia (VMI) model with N_pN_n scheme for the SD bands in A=190 region. We have explored $A = 190$ mass region for the identical bands and found $^{195}Tl(b1)$ and $^{197}Bi(b1)$ bands have all the identical band symmetry parameters equal using N_pN_n scheme. A brief description of our approach are presented in section 2. In section 3 we present the results and finally conclusion is given in the last section 4.

Identical Band Correlation Parameters

To study the identical band pairs, it is important to compare the dynamical moment of inertia and the transition energies of the two bands. Here, we first use variable moment of inertia model [3] to find out the band head spins of $^{195}Tl(b1)$ and $^{197}Bi(b1)$ bands and then calculated the dynamical moment of inertia $J^{(2)}$. The expression for $J^{(2)}$ is given as:

$$J^{(2)} = \hbar^2 \left(\frac{d^2E}{d\widehat{I}^2} \right)^{-1}$$

$$\simeq \frac{4}{E_\gamma(I+2 \rightarrow I) - E_\gamma(I \rightarrow I-2)} \quad (1)$$

In the above equation $J^{(2)}$ moment of inertia is obtained from γ ray transition energies. A concept of F-spin is brought into the limelight [4], in which the N_π proton bosons and N_ν neutron bosons are assigned intrinsic quantum number called F-spin $F = 1/2$, with projection $F_0 = +1/2$ for proton bosons and $F_0 = -1/2$ for neutrons bosons respectively.

Mathematically, F-spin and its projection are determined as:

$$F = \frac{1}{2}(N_\pi + N_\nu) \quad (2)$$

and

$$F_0 = \frac{1}{2}(N_\pi - N_\nu) \quad (3)$$

To study the identical bands we used N_pN_n scheme. The SF and SP are called the structure factor and saturation parameter given by

$$SF = N_pN_n(N_p + N_n), \quad (4)$$

$$SP = \left[1 + \frac{SF}{(SF)_{max}} \right]^{-1}, \quad (5)$$

For the calculation of SF parameter, the experimental data has been taken from the Nuclear data tables of Singh et al. [5] and from National Nuclear Data Centre [6]. The other correlation factors for the selected pair are given in Table I. In this paper we have applied the above stated formulas in $A = 190$ mass region and observes F_0 symmetry by using the concept of F-spin and N_pN_n scheme.

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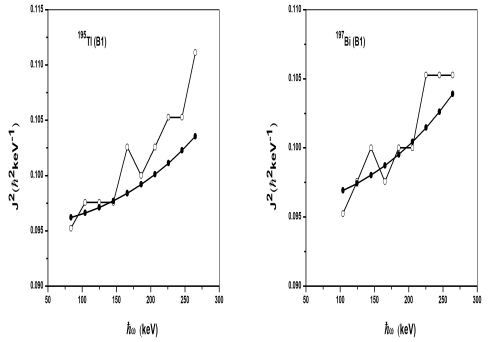

FIG. 1: The experimental and calculated result result of dynamical moment of inertia as a function of the rotational frequency of the SD band $^{195}Tl(b1)$ and $^{197}Bi(b1)$.The circles stand for the experimental data and the filled circle for the calculated results.

	^{195}Tl	^{197}Bi
J_0	0.0955	0.0958
(N_π, N_ν)	(0.5,6)	(0.5,6)
N_pN_n	12	12
F	3.25	3.25
F_0	-2.75	-2.75
P	0.9231	0.9231
SF	156	156
SP	0.71942	0.71942
$J^{(2)}_{SF}$	0.095	0.095
$R(4/2)$	1.436	1.354
$R(6/2)$	1.8617	1.7074

TABLE I: The calculated correlation factors for selected pair in A=190 mass region having identical band.

Result

The problem of identical bands (IBs) in superdeformed nuclei is treated. The parameter J_0 of the VMI model results from the fitting procedure for our selected pair IBs is listed in Table I. We investigated a pair of identical band ($^{195}Tl(b1)$, $^{197}Bi(b1)$) with the same F spin and projections $\pm F_0$ values have identical product of valence proton and neutron numbers N_pN_n values. Also the values of dynamical moment of inertia $J^{(2)}$ for this IB pair are same. We extracted all the IB symmetry parameters like p-factor, saturation factor SF, structure factor SP etc. which all depending on the valence proton and neutron numbers and presented in Table I.

Figure 1 illustrates the dynamic moment of inertia $J^{(2)}$ is represented by open circle and calculated $J^{(2)}$ is shown by dark filled circle as a function of rotational frequency $\hbar\omega$. The calculated $J^{(2)}$ gives the smooth increase with increasing frequency while the experimental $J^{(2)}$ shows the staggering. The reason for this might be that the VMI model is not incorporating coupling terms which is responsible for staggering but the two bands have the same dynamic moment of inertia which can be investigated from Figure 1.

Conclusions

In the framework of the apllied theoretical model, the dynamic $J^{(2)}$ moment of inertia corresponding to the frequency $\hbar\omega$ have been extracted. The existence of identical bands in the pair (^{195}Tl,^{197}Bi) are investigated. The Table and Figure manifest that both the γ-ray energies and the dynamical moment of inertia of the identical SD band ($^{195}Tl(b1)$, $^{197}Bi(b1)$) have been simultaneously reproduced well. The other correlation factors for the selected pair are calculated which are in excellent agreement with each other and justify the identicality of the selected pair.

References

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