Z(5) Critical Point Symmetry in ^{76}Se

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Introduction

Like normal phase transition, some nuclei also have critical points where they show symmetries which is described by group theories. Nucleus with γ deformation parameter at γ =30^0 exhibits a transition from SU(3) prolate ($\gamma = 0^0$) to $\overline{SU(3)}$ oblate($\gamma = 60^0$) shape. Using Interaction Boson Approximation (IBA) Hamiltonian [1] at critical point where the potential has a minima, and taking an infinite potential well in β variable and a harmonic oscillator potential in γ variable, the energy and B(E2) transition rates are found to be near to the experimental data.

The ^{76}Se nucleus was produced through the reaction of the α projectile at 28-MeV with the ^{Nat}Ge target. The α beam was obtained from the K-130 cyclotron facility at the Variable Energy Cyclotron Centre, Kolkata.

Primary motivation of the present work is to investigate the prolate to oblate phase transitional behaviour in the ^{76}Se nucleus. This has been explored using the Z(5) model [2] where the total energy can be expressed as [3],

$$E(s, n_w, L, n_\gamma) = E_0 + A(x^2_{s,v}) + Cn_\gamma. \quad (1)$$

Here,n_w is wobbling quantum number, n_γ = 0, 1, 2 ... , $x_{s,v}$ is the sth zero of the Bessels function $\mathcal{J}_v(z)$, A and C are constant. B(E2) transition rates [2, 4] are given by

$$B(E2; L_i, \alpha_i \rightarrow L_f, \alpha_f) = \frac{5}{16\pi}\frac{2L_f+1}{2L_i+1} \left[\frac{\langle L_f\alpha_f|T^{(E2)}_\mu|L_i\alpha_i\rangle}{(L_i 2L_f|\alpha_i\mu\alpha_f)}\right]^2 \quad (2)$$

TABLE I: Comparison of the Z(5) predicted energy levels (for ground state and even-odd γ_1 bands) with experimental levels for ^{76}Se.

L_{s,n_w}	Z(5)	^{76}Se	L_{s,n_w}	Z(5)	^{76}Se
$4_{1,0}$	2.350	2.380	$2_{1,2}$	1.837	2.175
$6_{1,0}$	3.984	4.047	$4_{1,2}$	4.420	3.624
$8_{1,0}$	5.877	5.850	$6_{1,2}$	7.063	5.324
$10_{1,0}$	8.021	7.690	$3_{1,1}$	2.597	3.020
$5_{1,1}$	4.634	4.453	$7_{1,1}$	6.869	6.140

Result and discussion

The proposed partial level structure of ^{76}Se obtained from the present work has been de-

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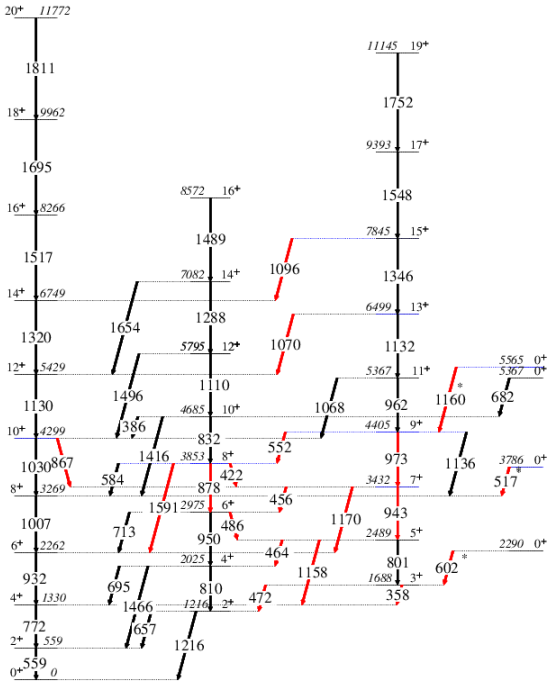

FIG. 1: Partial proposed level scheme of ^{76}Se. New γ's are red coloured and marked by asterisk.

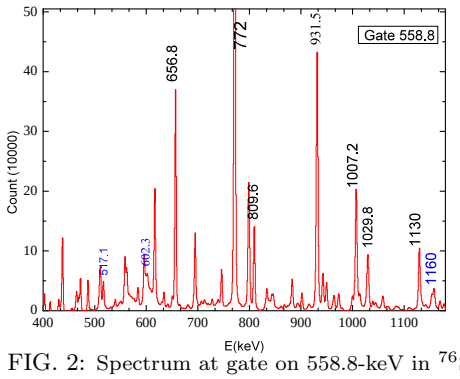

FIG. 2: Spectrum at gate on 558.8-keV in ^{76}Se.

picted in FIG. 1. The new transitions are labeled with blue in the gated spectrum of 558.8 keV presented in FIG. 2. The Z(5) predicted energy for ground state, even-odd γ_1 bands are overlapped with their experimental values up to the $10_{1,0}$, $4_{1,2}$, and $7_{1,1}$ states, respectively (Table I). The B(E2) transition rates

TABLE II: Comparison of the Z(5) predicted B(E2) with experimental values of B(E2) for ^{76}Se.

L^i_{s,n_w}	L^f_{s,n_w}	Z(5)	^{76}Se
$4_{1,0}$	$2_{1,0}$	1.590	1.530
$6_{1,0}$	$4_{1,0}$	2.203	1.616
$8_{1,0}$	$6_{1,0}$	2.635	1.812
$10_{1,0}$	$8_{1,0}$	2.967	1.159
$4_{1,2}$	$2_{1,2}$	0.736	0.780
$6_{1,2}$	$4_{1,2}$	1.031	0.646
$5_{1,1}$	$3_{1,1}$	1.235	1.497
$7_{1,1}$	$5_{1,1}$	1.851	0.894

are also well reproduced up to the $8_{1,0} \rightarrow 6_{1,0}$ for ground state band, $6_{1,2} \rightarrow 4_{1,2}$ for even γ_1 band, and $7_{1,1} \rightarrow 5_{1,1}$ for odd γ_1 band (Table II). The well agreement between the experimental energy and B(E2) values with the calculated results using the Z(5) model predicts that Z(5) symmetry may exist in the ^{76} nucleus.

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