Nature of $K^{\pi}=0_2^+$ band in ^{162}Er

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The level structure in N=88-100 isotopes of $^{156-168}$Er under goes a profound change with N. The $K^{\pi}=0_2^+$ band moves from below K=2_1 γ-band to above it at N=92 and lies highest at N=98. These isotopes have been studied intensively in regard to the collective nature of the K=0_2 band. Recently, Caprio et al. [1] studied the excited states of ^{162}Er populated in β-decay, in high statistics coincidences with TRIUMF ISAC facility, and resolved several doublets The absolute B(E2) strength for excitation of 0_2 state was determined precisely, as also for some other transitions, important to determine the nature of K=0_2 band, were measured.

Earlier [2], we studied the γ-g transitions in the decay of ^{162}Er, using the algebraic Interacting Boson Model [3], which enables a phenomenological fit to level energy data and possibly, also to some E2 transition rates. The DPPQ model [4] provides a microscopic approach without the need of fitting to data. Here we present the results from our DPPQ model analysis for the γ-g, K=0_2 –g and from K,I=4,4 state and discuss the nature of K=0_2 band in ^{162}Er. The previous IBM-1 results are also included.

Table -1 The absolute B(E2) (e^2b^2) in ^{162}Er and other static quantities.

Transition	EX	IBM QQ=22.9, PAIR=11.7	DPPQ X=68.0 F_b=2.0	DPPQ X=66.5, F_b= 2.0
$0_g \rightarrow 2_g$	4.50 7	4.95	5.16	4.70
$\rightarrow 2_\gamma$	0.104 8	0.118	0.117	0.112
$\rightarrow 2_\beta$	0.042 10	0.0065	0.093	0.100
$0_2 \rightarrow 2_g$		0.0080	0.09	0.137
$\rightarrow 2_\gamma$		0.065	0.46	0.59
Q(2_1)		-2.01	-2.05	-1.95
β			0.267	0.267

In DPPQ model we predict the predominant K=0 component in g-band and (2_3, 4_3) states and K=2 for 2_2, 4_2 and 6_2 states. We also obtain predominant K=4 component in the fourth $I^{\pi}=4^+$ state. Caprio et al. [1] obtained the B(E2, 0_g-2_3) strength of 8(2) WU (~0.042 e^2b^2), supporting the collective β-vibration. It is well known that IBM-1 predicts a low β-excitation strength generally, as also obtained by us here (Table-1). Using the E_γ, I_γ values from Ref. [5], we deduced the B(E2) ratios in Table 2, 3. The nndc data includes the updated NDS of (2007). However, some values of Ref. [1] are not included by the evaluator. These are marked here (Table 3) by asterisk

The B(E2, 0_g-2_g) and B(E2, 0_g-2_γ) are well given in IBM-1 and DPPQM (Table 1). The excitation strength of 2_β exceeds the experimental value, signifying larger β-g mixing in DPPQM. The 2_2-4_1 E2 transition is very weak in DPPQ calculation and is very sensitive to slight parameterization. In RTR model, B(E2, 2_γ-4_g) is zero for γ=0° and 30° and is 0.020 at 10°. There is large deviation for B(E2) ratios involving such weak transitions, from theory. To illustrate this, two sets of DPPQM value are cited here (Tables 1-3). Other γ-g B(E2) ratios are reproduced in IBM-1 and DPPQM. For E2 transitions from 2_3=2_β (Table 3) there is agreement with EX, except for 2_3-2_2/3.

For the K=4, I=4 state the B(E2, 4—3/2_2) agrees with experiment in both models. But for 4_2/2_2 ratio DPPQ value is larger

Table 2. B(E2) ratios for γ-g in ^{162}Er.

Transition	EX	Alaga	IBM [2]	DPPQ -1	DPPQ -2	RVM [1]
2_2 →0/2	0.42 2	0.70	0.65	0.31	0.235	
→4/2	0.12 8	0.05	0.064	0.016-E03	0.0045	
3 →2/4	0.71 9	2.50	2.03	1.46	1.32	1.01
4_2 →2/4	0.077 20	0.34	0.29	0.075	0.060	0.05
→6/4	1.29 20	0.09	0.13	0.0017	0.0022	0.055
→2_2/4	10*		11.5	7.0	6.0	
5 →4/6	0.58 6	1.75	1.26	0.85	0.75	0.47
→4/4_2	0.0014		0.044	0.055	0.066	
6_2 →4/6	0.11 2	0.27	0.216	0.028	0.21	
→6/4_2	0.036 5		0.044	0.068	0.081	
→4_2/5	0.19 5		1.7	2.30	2.28	

*4_2-2_2 I_γ is not listed in [5]. If a relative intensity of 1 is assumed, it yields the ratio=10 in agreement with theory.

Table 3. B(E2) ratios for β-g in ^{162}Er.

Transition	EX	[1] W.u	IBM [2]	DPPQ -1	DPPQ-2
2_3 →0	0.008	1.6 3	0.0013	0.019	0.020
→2	0.0012	2.5 5	0.0021	0.0071	0.0057
→4	0.0025	4.9	0.0047	0.082	0.090
→2_2	0.18	<37	0.0164	0.140	0.18
→3	3.3*	<660*	0.032	0.23	0.33
0_2 →2_g/2_2	0.007 2		0.12	0.20	0.23
2_3 →0/2	0.63 6		0.62	1.58	3.5
→2_2/2_1	< 14.3 *		7.8	4.57	31.5
→4/0	3.1 2		3.6	4.60	4.50
→2_2/3	0.054*		1.96	0.30	0.545
4_4 →3/2_2	1.07 11		0.610	1.04	1.21
→4_2/2_2	0.26 16		0.24	0.76	1.03

*Values from [1]. The 2_3-3_1 I_γ assumed in [1] yields too large B(E2) due to large E_γ^5 ratio.

Discussion

The level structure and B(E2) values, as well as γ-g and β-g transitions are well given in IBM-1 and DPPQM. Our study supports the K=0_2 band to be beta band and 4_4 state as predominantly K=4.

References

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