Nuclear structure of ^{160}Er in IBM and DPPQ model

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Introduction

Critical symmetry point X(5) on U(5)-SU(3) path has analytical solution [1] The CBS model [2] enables to deal with nuclei more deformed than X(5). ^{160}Er with energy ratio $R_{4/2}$=3.10 lies between X(5) [1] and the ideal rotor limit. It served as a test case [3] for CBS rotor model. Dusling et al. [3] conducted γ-ray spectroscopy of ^{160}Er and set new levels (even spin) in the K=0, 2 bands. They calculated B(E2) ratios and compared with the predictions from CBS model [2] and IBM-1 [4]. However, there is wide variation between the results from IBM, CBS and X(5).We have studied low energy levels of ^{160}Er in IBM-1 and the microscopic dynamic pairing plus quadrupole model [5].

Results

We have derived the B(E2) ratios using the γ-ray energies E_γ and relative intensities I_γ from nndc [6] and from [3]. These agree with Dusling et al. EX values [3]. The IBM-1 parameters are given in Table 1. The level energies from our IBM fit agree well with experiment (Table 2). The relative B(E2) values for E2 transitions from K=2 γ-band, and K=0_2 β-band are compared with Dusling et al. values and with CBS model (Table 3, 5). For γ-g E2 transitions, our IBM values agree with EX. For 5_γ our value is noticeably better than CBS, X(5) and IBM [3]. The same is true for 4_γ and 6_γ.

Table 1. Input parameters (PHINT notation) (keV) for IBM and DPPQM

Parameter	EPS	QQ	PAIR	ELL	X	F_B
Value	027	-22.0	5.1	31.2l	66.0	3.2

Table 2. Level energies (keV) in N=92 ^{160}Er from experiment (nndc) and theory.

	0_2	2_g	2_γ	2_β	3_γ	4_g	4_γ	4_β	5_γ	6_g	6_γ	6_β
EX	894	126	854	1008	987	390	1129	1230	1317	766	1499	1542
IBM	855	119	881	975	1000	397	1159	1254	1358	833	1597	1689
PPQ	971	123	1149	1251	1293	305	1390	1601	1568	564	1728	2054

Table 3. K –components (K=0, 2) in % predicted in DPPQM.

	g-band	K=2 band	K=0_2 band
I=2	99.9+0.1	25.8 +74.2	72.9+27.1
I=4	99.7+0.29	22.6+75.7	72.7+27.1
I=6	98.8+1.1	25.1+68.8	67.0+32.2

Table 4. The γ-g B(E2) ratios in ^{160}Er. The CBS and X(5) values are from Ref. [3]

BE2 ratio	EX Nndc	EX [3]	IBM present	IBM [3]	DPPQ	CBS	X(5)	Alaga
$2_\gamma \rightarrow 0/2$ $\rightarrow 2/4$	0.28 7		0.63		1.19 0.85			0.7 20
3 $\rightarrow 2/4$	0.67 25		1.92		1.24			2.5
$4_2 \rightarrow 4/2_\gamma$ $\rightarrow 4/6$		0.064 18	0.096 6.8	0.27	0.17 38	0.032	0.033	2.94
5 $\rightarrow 4/3$		0.023 3	0.046	4.42	0.057	1.76	1.79	1.67
6 $\rightarrow 6/4_\gamma$		0.10 2	0.048	0.14	0.09	0.0167	0.0168	1.54

Table 5. The K=0_2-band –g B(E2) ratios in ^{160}Er. CBS and X(5) values are from Ref. [3]

K=0	EX [6]	EX[3]	DPPQ	IBM	IBM[3]	CBS	X(5)	Alaga
$2_3 \rightarrow 2/4$ $\rightarrow 0/4$	0.23 6 0.14 3	<0.26 0.14 3	0.0001[a] 0.31	0.44 0.27	0.025 0.17	0.25 0.095	0.23 0.06	0.55 0.39
$4_3 \rightarrow 4/2$	2.8[c] 9		1-E05[b]	1.53	0.031	3.97	6.36	0.91
$6_3 \rightarrow 4/4_3$ $\rightarrow 6/4_3$		0.006 2 0.0009 2	0.006 0.0001	0.0013 0.0026	0.0033 0.0008	0.0050 0.032	0.0044 0.034	0.01 0.0081

[a]Slight change in quadrupole strength X yields 0.04. [b]Slight change in X yields 0.25.
[c]In nndc 1230.3 keV is assigned $(2, 3, 4)^+$, in [3] 1229.6 keV is listed as 4_β.

In DPPQ model, the predicted K-components listed in Table, indicate large admixtures in the K=2 γ-band and K=0_2 β-band to the extent of 25% in I=2 states and slightly higher in I=4, 6 states. This strong γ-g coupling is in accord with B(E2) ratios in Table 4. E(0_2) is slightly low but 2_β is above 2_γ as in EX. Our predicted B(E2) ratios in DPPQM are listed in Table 4, 5. Except for B(E2, 2_γ-0/2), our γ-g B(E2) ratios agree fairly with experiment. For 4_γ, 5_γ and 6_γ our IBM values are better than of [3]. Same is true for DPPQM values. CBS and X(5) values are far off.

For β-g E2 transition (Table 5) thee is much variation between various theoretical values and with experiment. The 4_β-4_g and 2_β-2_g E2 transitions are very weak and vary by several orders of magnitude with slight variation in input quadrupole strength X-parameter in DPPQM (see foot note Table 5). So the concerned evaluated ratios are uncertain. Other BE2) ratios in β-g are fairly predicted.

Discussion

Our calculated energies and inter-band B(E2) ratios for K=2 γ-band and K=0_2 β-band in deformed ^{160}Er are in fair agreement with experiment and show improvement over IBM values in [3].

References

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[+]Associated