

$^{160}\text{Gd}(^9\text{Be},4n\gamma):E=42,45\text{ MeV}$ [2011Wa19,2011Wa25,2009Wa23](#)

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen		NDS 194,460 (2024)	31-Oct-2022

[2011Wa19](#), [2011Wa25](#), [2009Wa23](#): E=42, 45 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin using 11 Compton-suppressed HPGe detectors and two LEPS HPGe detectors at the HI-13 Tandem Accelerator of the China Institute of Atomic Energy, Beijing. Deduced E1 transition strengths and octupole collectivity. Discussed band properties in the framework of the cranked shell model. All the three papers are from the same experimental group.

 ^{165}Er Levels

E(level) [†]	J ^π [#]	Comments
0.0 [@]	5/2 ⁻	
47.0 ^a 5	5/2 ⁺	
62.7 ^b 4	7/2 ⁺	
77.7 ^{&} 4	7/2 ⁻	
98.0 ^a 5	9/2 ⁺	
167.4 ^b 5	11/2 ⁺	
176.2 [@] 4	9/2 ⁻	
238.0 ^a 5	13/2 ⁺	
295.9 ^{&} 5	11/2 ⁻	
372.5 ^b 5	15/2 ⁺	
435.0 [@] 5	13/2 ⁻	
463.4 ^a 6	17/2 ⁺	
551.8 ^d 5	11/2 ⁻	
595.7 ^{&} 5	15/2 ⁻	
677.9 ^b 6	19/2 ⁺	
707.5 ^c 6	(13/2 ⁻)	
769.8 ^a 6	21/2 ⁺	
771.9 [@] 6	17/2 ⁻	
883.6 ^d 6	(15/2 ⁻)	
970.7 ^{&} 6	19/2 ⁻	
1078.8 ^c 6	(17/2 ⁻)	
1079.9 ^b 6	23/2 ⁺	
1153.7 ^a 7	25/2 ⁺	
1178.9 [@] 6	21/2 ⁻	
1292.1 ^d 7	(19/2 ⁻)	
1318.7 ^{‡e} 6	(15/2 ⁻)	
1413.5 ^{&} 7	23/2 ⁻	
1507.1 ^{‡e} 6	(17/2 ⁻)	
1521.8 ^c 7	(21/2 ⁻)	
1570.7 ^b 7	27/2 ⁺	
1610.7 ^a 9	29/2 ⁺	
1647.8 [@] 7	25/2 ⁻	
1766.6 ^d 8	(23/2 ⁻)	
1824.1 [‡] 8	(19/2,21/2)	Possible 3-qp structure.
1914.6 ^{&} 7	27/2 ⁻	
2024.8 ^c 8	(25/2 ⁻)	
2134.2 ^a 10	33/2 ⁺	

Continued on next page (footnotes at end of table)

$^{160}\text{Gd}(^9\text{Be},4n\gamma):E=42,45\text{ MeV}$ **2011Wa19,2011Wa25,2009Wa23 (continued)** ^{165}Er Levels (continued)

E(level) [†]	J ^π #	E(level) [†]	J ^π #	E(level) [†]	J ^π #	E(level) [†]	J ^π #
2140.5 ^b 9	31/2 ⁺	2729.8 [@] 10	33/2 ⁻	3467.6 ^b 11	39/2 ⁺	4664.8? [@] 13	(45/2 ⁻)
2167.8 [@] 9	29/2 ⁻	2777.7 ^b 10	35/2 ⁺	3690.6 ^{&} 12	39/2 ⁻	4784.5 ^a 14	(49/2 ⁺)
2295.8 ^d 8	(27/2 ⁻)	2869.8 ^d 10	(31/2 ⁻)	3971.8 [@] 12	41/2 ⁻	4946.2? ^b 14	(47/2 ⁺)
2466.6 ^{&} 9	31/2 ⁻	3060.6 ^{&} 10	35/2 ⁻	4042.4 ^a 13	45/2 ⁺		
2577.7 ^c 9	(29/2 ⁻)	3329.8 [@] 11	37/2 ⁻	4193.2 ^b 13	(43/2 ⁺)		
2717.2 ^a 11	37/2 ⁺	3354.0 ^a 12	41/2 ⁺	4360.6 ^{&} 13	(43/2 ⁻)		

[†] From least-squares fit to E_γ data, assuming uncertainty of 0.5 keV for each E_γ value, when not stated.

[‡] Level from 2011Wa25.

As given in 2011Wa19 and 2011Wa25, based on earlier assignments for low-lying and medium-spin levels, and from band structures in the present work for high-spin ($J \geq 17/2$) states.

@ Band(A): $\nu 5/2[523], \alpha = +1/2$. Band crossing at $\hbar\omega \approx 0.28$ MeV due to AB, $i_{13/2}$ neutron alignment.

& Band(a): $\nu 5/2[523], \alpha = -1/2$. Band crossing at $\hbar\omega \approx 0.28$ MeV due to AB, $i_{13/2}$ neutron alignment.

^a Band(B): $\nu 5/2[642], \alpha = +1/2$.

^b Band(b): $\nu 5/2[642], \alpha = -1/2$. Band crossing at $\hbar\omega \approx 0.35$ MeV due to AD, $i_{13/2}$ neutron alignment.

^c Band(C): $\nu 11/2[505], \alpha = +1/2$.

^d Band(c): $\nu 11/2[505], \alpha = -1/2$.

^e Band(D): γ -vibrational band built on 11/2[505]. Band from 2011Wa25.

 $\gamma(^{165}\text{Er})$

B(E1) values under comments are from 2009Wa23, deduced based on measured γ -ray branching ratios in this work and an assumed value of $Q_1^2 = 50\text{ b}^2$ from systematics in this region (2009Wa23).

$E_i(\text{level})$	J_i^π	E_γ [†]	I_γ [‡]	E_f	J_f^π	Mult.	Comments
47.0	5/2 ⁺	47 [#]		0.0	5/2 ⁻		
62.7	7/2 ⁺	63 [#]		0.0	5/2 ⁻		
77.7	7/2 ⁻	77.6 [#]		0.0	5/2 ⁻		
167.4	11/2 ⁺	69 [#]		98.0	9/2 ⁺		
		105		62.7	7/2 ⁺		
176.2	9/2 ⁻	98.5 [#]		77.7	7/2 ⁻		
		176		0.0	5/2 ⁻		
238.0	13/2 ⁺	71		167.4	11/2 ⁺		
		140.4		98.0	9/2 ⁺		
295.9	11/2 ⁻	120.1 [#]		176.2	9/2 ⁻		
		197.8	100	98.0	9/2 ⁺	[E1]	B(E1)= 1.80×10^{-6} 22.
		218	232 27	77.7	7/2 ⁻		
372.5	15/2 ⁺	134.4		238.0	13/2 ⁺		
		205.2		167.4	11/2 ⁺		
435.0	13/2 ⁻	259	219 20	176.2	9/2 ⁻		
		267.6	100	167.4	11/2 ⁺	[E1]	B(E1)= 2.30×10^{-6} 22.
463.4	17/2 ⁺	225.3		238.0	13/2 ⁺		
551.8	11/2 ⁻	315 [#]		238.0	13/2 ⁺		
		375 [#]		176.2	9/2 ⁻		
		384 [#]		167.4	11/2 ⁺		
		474 [#]		77.7	7/2 ⁻		

Continued on next page (footnotes at end of table)

$^{160}\text{Gd}(^9\text{Be},4n\gamma):E=42,45\text{ MeV}$ [2011Wa19,2011Wa25,2009Wa23](#) (continued) $\gamma(^{165}\text{Er})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult.	Comments
595.7	15/2 ⁻	300	249 33	295.9	11/2 ⁻		
		357.5	100	238.0	13/2 ⁺	[E1]	B(E1)=2.0×10 ⁻⁶ 3.
677.9	19/2 ⁺	214.6		463.4	17/2 ⁺		
		305.5		372.5	15/2 ⁺		
707.5	(13/2 ⁻)	155.7		551.8	11/2 ⁻		
769.8	21/2 ⁺	306.3		463.4	17/2 ⁺		
771.9	17/2 ⁻	337	342 32	435.0	13/2 ⁻		
		399.3	100	372.5	15/2 ⁺	[E1]	B(E1)=2.06×10 ⁻⁶ 20.
883.6	(15/2 ⁻)	176.1		707.5	(13/2 ⁻)		
		332		551.8	11/2 ⁻		
970.7	19/2 ⁻	375	282 48	595.7	15/2 ⁻		
		507.4	100	463.4	17/2 ⁺	[E1]	B(E1)=2.3×10 ⁻⁶ 4.
1078.8	(17/2 ⁻)	195.4		883.6	(15/2 ⁻)		
		371.3		707.5	(13/2 ⁻)		
1079.9	23/2 ⁺	310.0		769.8	21/2 ⁺		
		401.9		677.9	19/2 ⁺		
1153.7	25/2 ⁺	383.9		769.8	21/2 ⁺		
1178.9	21/2 ⁻	407	472 55	771.9	17/2 ⁻		
		501.1	100	677.9	19/2 ⁺	[E1]	B(E1)=2.2×10 ⁻⁶ 3.
1292.1	(19/2 ⁻)	213.4		1078.8	(17/2 ⁻)		
		408.4		883.6	(15/2 ⁻)		
1318.7	(15/2 ⁻)	611.4		707.5	(13/2 ⁻)		
		766.6		551.8	11/2 ⁻		
1413.5	23/2 ⁻	442.9	324 50	970.7	19/2 ⁻		
		643.5	100	769.8	21/2 ⁺	[E1]	B(E1)=2.4×10 ⁻⁶ 4.
1507.1	(17/2 ⁻)	188.3		1318.7	(15/2 ⁻)		
		623.5		883.6	(15/2 ⁻)		
		799.7		707.5	(13/2 ⁻)		
1521.8	(21/2 ⁻)	229.8		1292.1	(19/2 ⁻)		
		442.9		1078.8	(17/2 ⁻)		
1570.7	27/2 ⁺	417.0		1153.7	25/2 ⁺		
		490.8		1079.9	23/2 ⁺		
1610.7	29/2 ⁺	457		1153.7	25/2 ⁺		
1647.8	25/2 ⁻	469	65×10 ¹ 12	1178.9	21/2 ⁻		
		567.8	100	1079.9	23/2 ⁺	[E1]	B(E1)=2.4×10 ⁻⁶ 4.
1766.6	(23/2 ⁻)	244.7		1521.8	(21/2 ⁻)		
		474.4		1292.1	(19/2 ⁻)		
1824.1	(19/2,21/2)	317.0		1507.1	(17/2 ⁻)		
1914.6	27/2 ⁻	501	438 88	1413.5	23/2 ⁻		
		761.0	100	1153.7	25/2 ⁺	[E1]	B(E1)=2.1×10 ⁻⁶ 4.
2024.8	(25/2 ⁻)	258		1766.6	(23/2 ⁻)		
		503.2		1521.8	(21/2 ⁻)		
2134.2	33/2 ⁺	523.5		1610.7	29/2 ⁺		
2140.5	31/2 ⁺	569.8		1570.7	27/2 ⁺		
2167.8	29/2 ⁻	520		1647.8	25/2 ⁻		
2295.8	(27/2 ⁻)	271		2024.8	(25/2 ⁻)		
		529.2		1766.6	(23/2 ⁻)		
2466.6	31/2 ⁻	552		1914.6	27/2 ⁻		
2577.7	(29/2 ⁻)	552.9		2024.8	(25/2 ⁻)		
2717.2	37/2 ⁺	583.0		2134.2	33/2 ⁺		
2729.8	33/2 ⁻	562		2167.8	29/2 ⁻		
2777.7	35/2 ⁺	637.2		2140.5	31/2 ⁺		
2869.8	(31/2 ⁻)	574		2295.8	(27/2 ⁻)		
3060.6	35/2 ⁻	594		2466.6	31/2 ⁻		
3329.8	37/2 ⁻	600		2729.8	33/2 ⁻		

Continued on next page (footnotes at end of table)

 $^{160}\text{Gd}(^9\text{Be},4\text{n}\gamma):\text{E}=42,45\text{ MeV}$ [2011Wa19](#),[2011Wa25](#),[2009Wa23](#) (continued)

 $\gamma(^{165}\text{Er})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	E_f	J_f^π
3354.0	41/2 ⁺	636.8	2717.2	37/2 ⁺	4193.2	(43/2 ⁺)	725.6	3467.6	39/2 ⁺
3467.6	39/2 ⁺	689.9	2777.7	35/2 ⁺	4360.6	(43/2 ⁻)	670	3690.6	39/2 ⁻
3690.6	39/2 ⁻	630	3060.6	35/2 ⁻	4664.8?	(45/2 ⁻)	693 [@]	3971.8	41/2 ⁻
3971.8	41/2 ⁻	642	3329.8	37/2 ⁻	4784.5	(49/2 ⁺)	742.1	4042.4	45/2 ⁺
4042.4	45/2 ⁺	688.4	3354.0	41/2 ⁺	4946.2?	(47/2 ⁺)	753 [@]	4193.2	(43/2 ⁺)

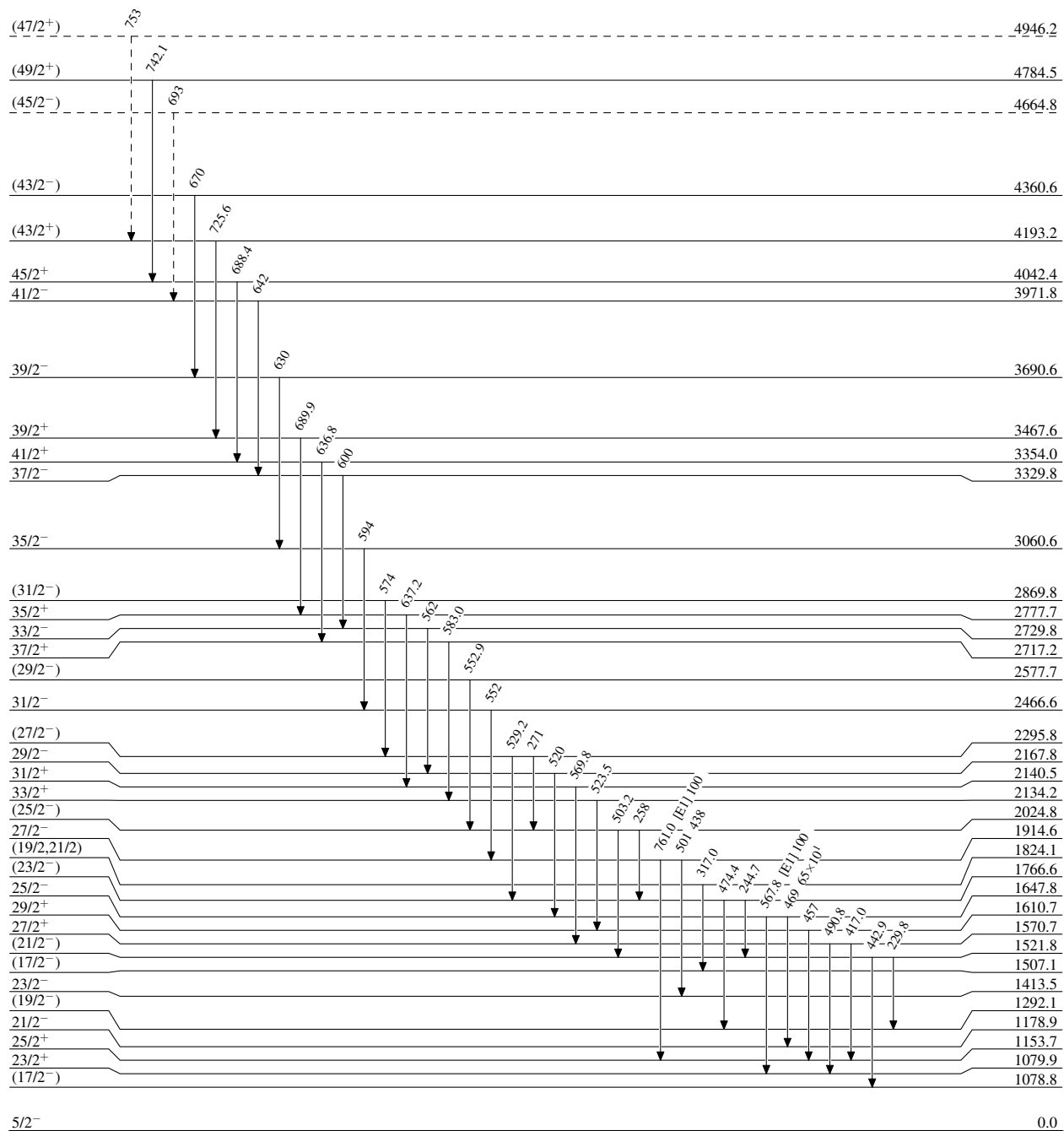
[†] From Figs. 1 and 2 in [2011Wa19](#), Fig. 2 in [2011Wa25](#), and text in both papers.[‡] From Table 1 in [2009Wa23](#).# Taken by [2011Wa19](#) from [1974An04](#) and/or [1970Hj02](#).[@] Placement of transition in the level scheme is uncertain.

$^{160}\text{Gd}(^9\text{Be},4n\gamma):E=42,45\text{ MeV}$ 2011Wa19,2011Wa25,2009Wa23

Legend

Level Scheme

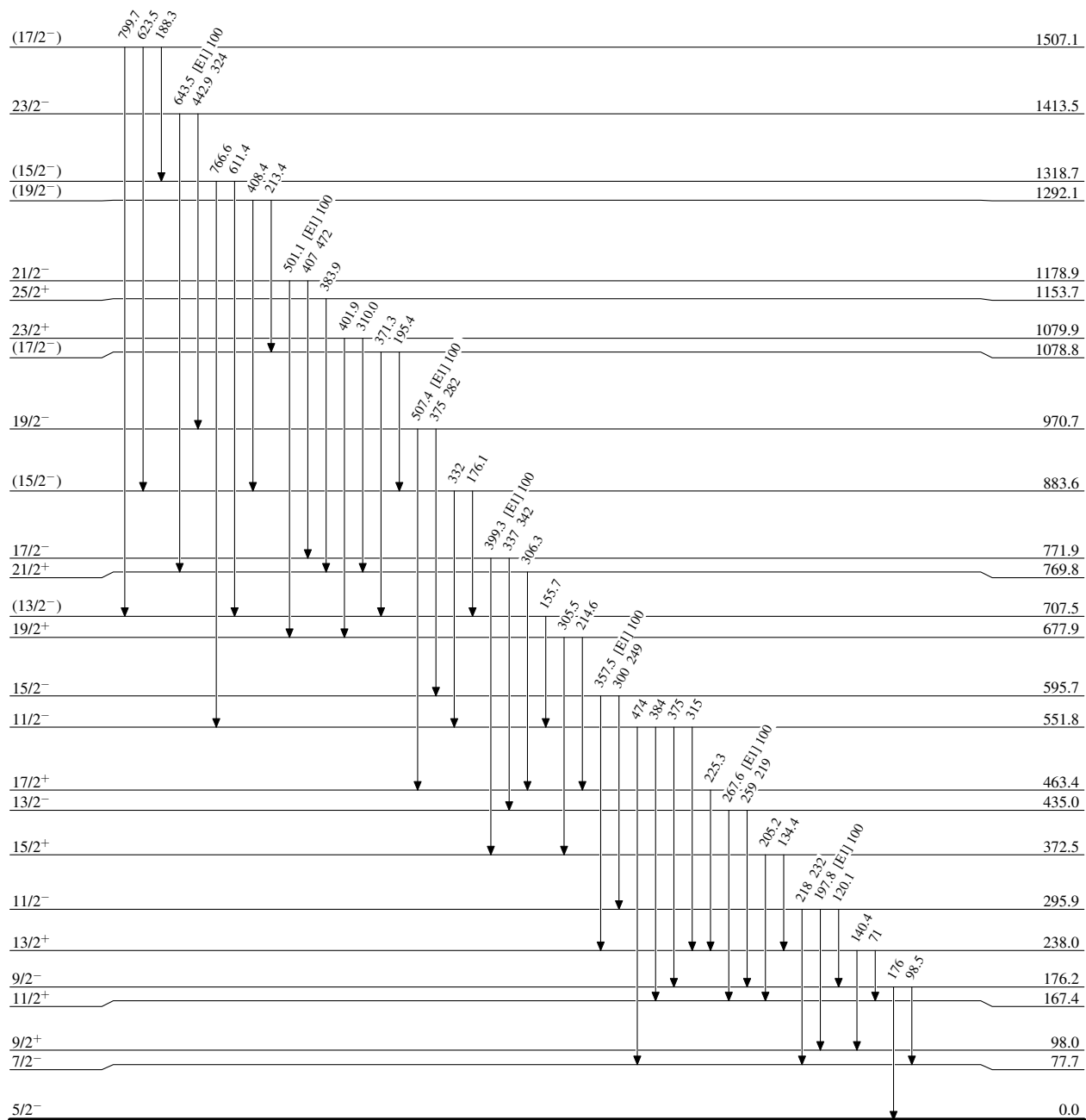
Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain)

$^{160}\text{Gd}(^9\text{Be},4n\gamma):E=42,45\text{ MeV}$ 2011Wa19,2011Wa25,2009Wa23

Level Scheme (continued)

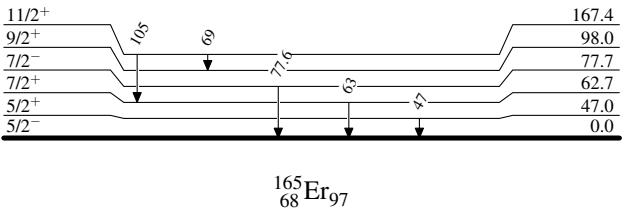
Intensities: Relative photon branching from each level

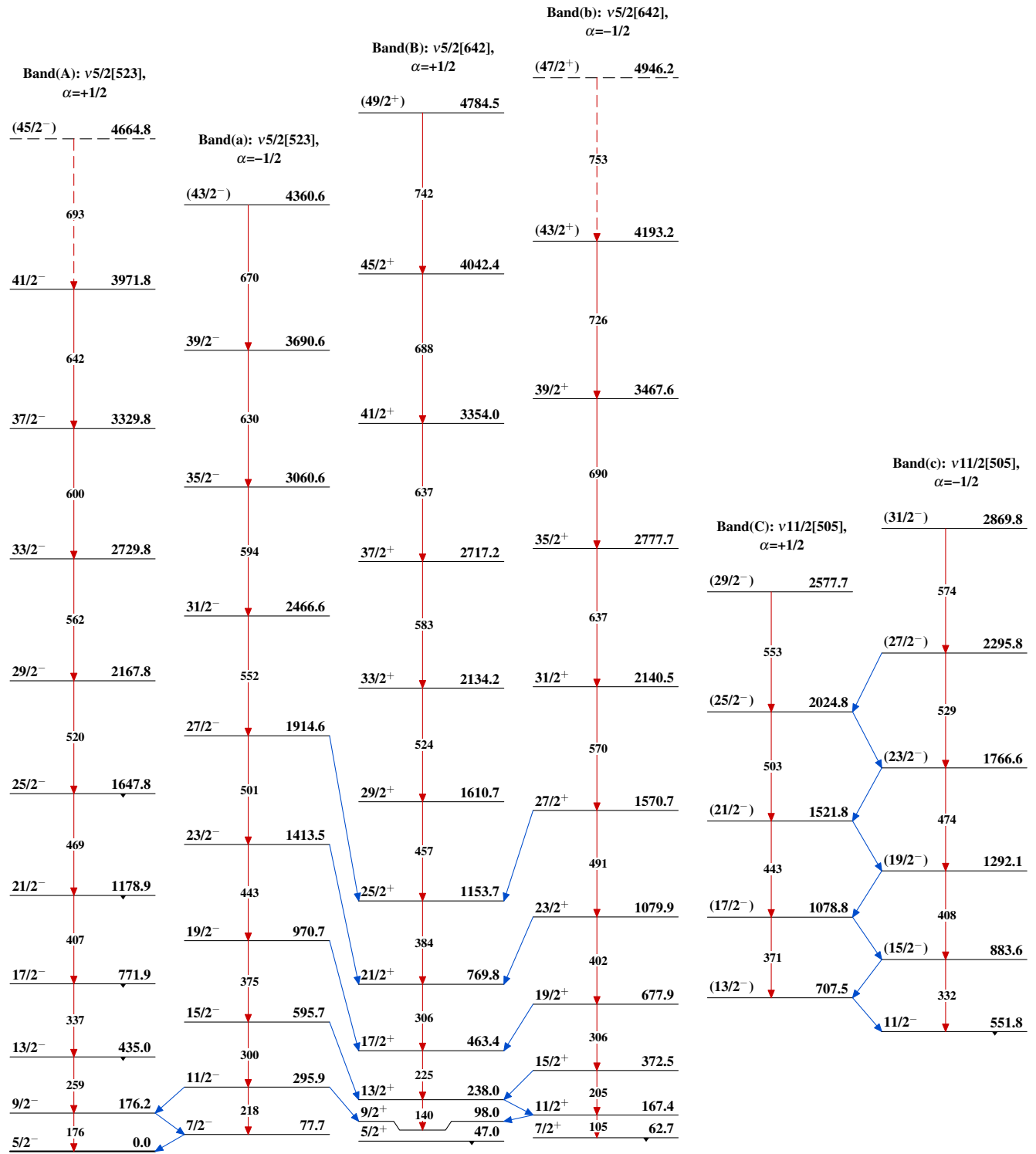
 $^{165}_{68}\text{Er}_{97}$

$^{160}\text{Gd}(^9\text{Be},4\text{n}\gamma):\text{E}=42,45\text{ MeV}$ **2011Wa19,2011Wa25,2009Wa23**

Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{160}\text{Gd}(^9\text{Be},4n\gamma); E=42,45 \text{ MeV}$ 2011Wa19,2011Wa25,2009Wa23

$^{160}\text{Gd}(^9\text{Be},4n\gamma):E=42,45\text{ MeV}$ 2011Wa19,2011Wa25,2009Wa23 (continued)

Band(D): γ -vibrational
band built on 11/2[505]

(17/2⁻) 1507.1

188

(15/2⁻) 1318.7

$^{165}_{68}\text{Er}_{97}$