

$^{160}\text{Gd}(\bar{7}\text{Li},\text{t3n}\gamma)$ **2003Ju02**

Type	Author	History
Full Evaluation	C. W. Reich	Citation
		NDS 112,2497 (2011)

Additional information 1.

Incomplete fusion reaction, $E(7\text{Li})=56$ MeV. ^{160}Gd target, thickness 3.9 mg/cm^2 , enrichment not given. γ radiation detected using the GASP array, consisting of 40 Compton-suppressed Ge detectors and an 80-element BGO inner ball. In addition, charged particles were detected using the Si ball ISIS, consisting of 40 Si ΔE -E telescopes. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$. In addition to ^{161}Dy , level schemes are given for ^{159}Dy and ^{163}Dy .

In an earlier study (2001Ju08) by many of the same authors, some information on the ^{161}Dy levels is presented.

 ^{161}Dy Levels

E(level) [†]	J ^π @	E(level) [†]	J ^π @	E(level) [†]	J ^π @	E(level) [†]	J ^π @
0.0 ^{&}	5/2 ⁺	586.7 ^d 1	13/2 ⁻	1470.3? ^f 1	(21/2 ⁻)	2703.4 ^b 1	33/2 ⁻
25.6 ^{‡b}	5/2 ⁻	616.9 ^c 1	15/2 ⁻	1599.7 ^a 1	27/2 ⁺	2787.1 ^a 1	35/2 ⁺
44 ^a	7/2 ⁺	641.6? ^f 1	(13/2 ⁻)	1626.0 ^e 1	23/2 ⁻	2838.8 ^{&} 2	37/2 ⁺
74.4 ^e	3/2 ⁻	717.7 ^a 4	19/2 ⁺	1645.8 ^b 1	25/2 ⁻	2849.2 ^d 2	33/2 ⁻
100.3 ^{&} 1	9/2 ⁺	761.3 ^e 1	15/2 ⁻	1691.0 ^{&} 1	29/2 ⁺	2954.6 ^c 1	35/2 ⁻
102.8 ^c 1	7/2 ⁻	787.6 ^b 2	17/2 ⁻	1724.1? ^g 1	(23/2 ⁻)	3271.3 ^b 2	37/2 ⁻
131.7 ^d 1	5/2 ⁻	819.1? ^g 1	(15/2 ⁻)	1838.1 ^d 1	25/2 ⁻	3478.5 ^a 2	39/2 ⁺
184.0 ^a	11/2 ⁺	825.3 ^{&} 1	21/2 ⁺	1897.1 ^c 1	27/2 ⁻	3503.9 ^{&} 2	41/2 ⁺
201.1 ^b 1	9/2 ⁻	941.0 ^d 1	17/2 ⁻	1994.1? ^f 1	(25/2 ⁻)	3528.4 ^c 2	39/2 ⁻
212.9 ^e 1	7/2 ⁻	985.4 ^c 1	19/2 ⁻	2138.1 ^e 2	27/2 ⁻	3866.2 ^b 2	41/2 ⁻
267.2 ^{&} 1	13/2 ⁺	1017.0? ^f 1	(17/2 ⁻)	2156.3 ^b 1	29/2 ⁻	4222.3 ^{&} 2	45/2 ⁺
314.8 ^d 1	9/2 ⁻	1117.1 ^a 1	23/2 ⁺	2158.3 ^a 1	31/2 ⁺	4225.4 ^a 2	43/2 ⁺
320.3 ^c 1	11/2 ⁻	1159.7 ^e 1	19/2 ⁻	2232.6 ^{&} 1	33/2 ⁺	4504.6 ^b 2	45/2 ⁻
406.3 ^a 1	15/2 ⁺	1186.4 ^b 1	21/2 ⁻	2280.2? ^g 2	(27/2 ⁻)	5025.0 ^a 2	47/2 ⁺
443.1 ^e 1	11/2 ⁻	1220.6 ^{&} 1	25/2 ⁺	2332.7 ^d 1	29/2 ⁻	5189.9 ^b 2	49/2 ⁻
456.9 ^b 1	13/2 ⁻	1234.4? ^g 1	(19/2 ⁻)	2413.1 ^c 1	31/2 ⁻		
485.56? ^{#g} 16	(11/2 ⁻)	1365.0 ^d 1	21/2 ⁻	2576.1 ^f 2	(29/2 ⁻)		
507.7 ^{&} 1	17/2 ⁺	1416.3 ^c 1	23/2 ⁻	2665.5 ^e 2	31/2 ⁻		

[†] From a least-squares fit using the listed $E\gamma$ values. γ rays whose energies differ by more than ≈ 1 keV from the respective level-energy differences were not included in this process. These γ 's are as follows: 58.9; 106.7; 166.9; 196.7; 239.8; 247.8 and 250.5. Because of the large reduced- χ^2 value of the least-squares fit, the evaluator has chosen to quote the uncertainties in the level energies to only the nearest 0.1 keV, unless noted otherwise.

[‡] Nominal value from the Adopted Values.

[#] Value from (d,t).

[@] From the Adopted Values. Values for the lower-spin band members are generally taken from other sources. Those for the higher-spin states seen here are based on these values together with the usual considerations of band structure populated in in-beam γ spectroscopic studies.

[&] Band(A): 5/2[642] band, $\alpha=+1/2$ branch.

^a Band(a): 5/2[642] band, $\alpha=-1/2$ branch.

^b Band(B): 5/2[523] band, $\alpha=+1/2$ branch.

^c Band(b): 5/2[523] band, $\alpha=-1/2$ branch.

^d Band(C): 3/2[521] band, $\alpha=+1/2$ branch.

^e Band(c): 3/2[521] band, $\alpha=-1/2$ branch.

^f Band(D): 11/2[505] band, $\alpha=+1/2$ branch.

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

$^{160}\text{Gd}(^7\text{Li},\text{t3n}\gamma)$ 2003Ju02 (continued) **$\gamma(^{161}\text{Dy})$**

E_γ^\dagger	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
(25.6 <i>I</i>)		25.6	5/2 ⁻	0.0	5/2 ⁺	E_γ : nominal value. γ not reported by 2003Ju02.
44.0 <i>I</i>		44	7/2 ⁺	0.0	5/2 ⁺	
58.9 [±] <i>I</i>		131.7	5/2 ⁻	74.4	3/2 ⁻	E_γ : the nominal value of 57.19 <i>I</i> was used In the least-squares fit.
74.4 <i>I</i>		74.4	3/2 ⁻	0.0	5/2 ⁺	
77.1 <i>I</i>		102.8	7/2 ⁻	25.6	5/2 ⁻	
81.3 <i>I</i>		212.9	7/2 ⁻	131.7	5/2 ⁻	
83.0 <i>I</i>		267.2	13/2 ⁺	184.0	11/2 ⁺	
83.8 <i>I</i>		184.0	11/2 ⁺	100.3	9/2 ⁺	
91.2 <i>I</i>		1691.0	29/2 ⁺	1599.7	27/2 ⁺	
100.5 <i>I</i>		100.3	9/2 ⁺	0.0	5/2 ⁺	
101.8 <i>I</i>	46 3	507.7	17/2 ⁺	406.3	15/2 ⁺	
102.1 <i>I</i>		314.8	9/2 ⁻	212.9	7/2 ⁻	
103.6 <i>I</i>	4.2 7	1220.6	25/2 ⁺	1117.1	23/2 ⁺	
^x 106.7 [±] <i>I</i>						E_γ : placed by 2003Ju02 between the 201.1 and 102.8 levels, but the E_γ value differs by \approx 7 keV from the level-energy difference with this placement.
107.4 <i>I</i>	13.7 14	825.3	21/2 ⁺	717.7	19/2 ⁺	
119.3 <i>I</i>		320.3	11/2 ⁻	201.1	9/2 ⁻	
128.3 <i>I</i>	9.5 11	443.1	11/2 ⁻	314.8	9/2 ⁻	
136.6 <i>I</i>		456.9	13/2 ⁻	320.3	11/2 ⁻	
138.5 <i>I</i>		212.9	7/2 ⁻	74.4	3/2 ⁻	
138.6 [±] <i>I</i>	59 4	406.3	15/2 ⁺	267.2	13/2 ⁺	
139.8 <i>I</i>		184.0	11/2 ⁺	44	7/2 ⁺	
143.5 <i>I</i>	6.6 9	586.7	13/2 ⁻	443.1	11/2 ⁻	
156.0 <i>I</i>	13.1 13	641.6?	(13/2 ⁻)	485.56?	(11/2 ⁻)	
157.1 <i>I</i>		201.1	9/2 ⁻	44	7/2 ⁺	
159.8 <i>I</i>		616.9	15/2 ⁻	456.9	13/2 ⁻	
^x 166.9 [±] <i>I</i>						E_γ : placed by 2003Ju02 between the 787.6 and 616.9 levels, but the E_γ value differs by \approx 4 keV from the level-energy difference with this placement.
166.9 <i>I</i>	37 3	267.2	13/2 ⁺	100.3	9/2 ⁺	E_γ : level-energy difference is 170.7. This placement is not included In the Adopted Values.
174.5 <i>I</i>	4.2 7	761.3	15/2 ⁻	586.7	13/2 ⁻	
175.3 <i>I</i>		201.1	9/2 ⁻	25.6	5/2 ⁻	
177.3 <i>I</i>	9.5 11	819.1?	(15/2 ⁻)	641.6?	(13/2 ⁻)	
179.6 <i>I</i>	3.6 6	941.0	17/2 ⁻	761.3	15/2 ⁻	
182.8 <i>I</i>		314.8	9/2 ⁻	131.7	5/2 ⁻	
^x 196.7 [±] <i>I</i>						E_γ : placed by 2003Ju02 between the 1186.4 and 985.4 levels, but the E_γ value differs by \approx 5 keV from the level-energy difference with this placement.
197.8 <i>I</i>	7.3 9	1017.0?	(17/2 ⁻)	819.1?	(15/2 ⁻)	
205.2 <i>I</i>	2.3 5	1365.0	21/2 ⁻	1159.7	19/2 ⁻	
210.2 <i>I</i>	26.5 21	717.7	19/2 ⁺	507.7	17/2 ⁺	
211.9 <i>I</i>		1838.1	25/2 ⁻	1626.0	23/2 ⁻	
217.4 <i>I</i>	5.3 8	1234.4?	(19/2 ⁻)	1017.0?	(17/2 ⁻)	
217.5 <i>I</i>		320.3	11/2 ⁻	102.8	7/2 ⁻	
218.7 <i>I</i>	2.9 6	1159.7	19/2 ⁻	941.0	17/2 ⁻	
222.6 <i>I</i>	61 4	406.3	15/2 ⁺	184.0	11/2 ⁺	
230.0 <i>I</i>		1416.3	23/2 ⁻	1186.4	21/2 ⁻	
230.3 <i>I</i>	10.8 12	443.1	11/2 ⁻	212.9	7/2 ⁻	
235.9 <i>I</i>	3.6 5	1470.3?	(21/2 ⁻)	1234.4?	(19/2 ⁻)	
^x 239.8 [±] <i>I</i>						E_γ : placed by 2003Ju02 between the 1897.1 and 1645.8 levels, but the E_γ value differs by 10 keV from the level-energy

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$^{160}\text{Gd}(^7\text{Li},\text{t}3\text{n}\gamma)$ 2003Ju02 (continued) **$\gamma(^{161}\text{Dy})$ (continued)**

E_γ^\dagger	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
240.6 <i>I</i>	75 5	507.7	17/2 ⁺	267.2	13/2 ⁺	difference with this placement. The listed $E\gamma$ value May contain a misprint.
^x 247.8 [#] <i>I</i>						
^x 250.5 [#] <i>I</i>						E_γ : placed by 2003Ju02 between the 1645.8 and 1416.3 levels, but the $E\gamma$ value differs by ≈ 4 keV from the level-energy difference with this placement.
253.7 <i>I</i>	2.4 5	1724.1?	(23/2 ⁻)	1470.3?	(21/2 ⁻)	E_γ : placed by 2003Ju02 between the 985.4 and 787.6 levels, but the $E\gamma$ value differs by ≈ 53 keV from the level-energy difference with this placement.
256.1 <i>I</i>	11.4 12	456.9	13/2 ⁻	201.1	9/2 ⁻	
260.7 <i>I</i>		1626.0	23/2 ⁻	1365.0	21/2 ⁻	
270.4 <i>I</i>	2.0 5	1994.1?	(25/2 ⁻)	1724.1?	(23/2 ⁻)	
272.0 <i>I</i>	11.5 12	586.7	13/2 ⁻	314.8	9/2 ⁻	
272.9 <i>I</i>	5.8 8	456.9	13/2 ⁻	184.0	11/2 ⁺	
285.5 [#] <i>I</i>	1.3 4	2280.2?	(27/2 ⁻)	1994.1?	(25/2 ⁻)	
291.7 <i>I</i>	12.7 13	1117.1	23/2 ⁺	825.3	21/2 ⁺	
294.9 [#] <i>I</i>	1.0 3	2576.1	(29/2 ⁻)	2280.2?	(27/2 ⁻)	
296.5 <i>I</i>	8.3 10	616.9	15/2 ⁻	320.3	11/2 ⁻	
311.3 <i>I</i>	60 4	717.7	19/2 ⁺	406.3	15/2 ⁺	
317.8 <i>I</i>	100 6	825.3	21/2 ⁺	507.7	17/2 ⁺	
318.2 <i>I</i>	15.6 15	761.3	15/2 ⁻	443.1	11/2 ⁻	
330.8 <i>I</i>	13.8 14	787.6	17/2 ⁻	456.9	13/2 ⁻	
333.5 <i>I</i>	2.6 5	819.1?	(15/2 ⁻)	485.56?	(11/2 ⁻)	
349.8 <i>I</i>	4.8 7	616.9	15/2 ⁻	267.2	13/2 ⁺	
354.2 <i>I</i>	13.0 13	941.0	17/2 ⁻	586.7	13/2 ⁻	
368.5 <i>I</i>	11.4 12	985.4	19/2 ⁻	616.9	15/2 ⁻	
375.5 <i>I</i>	2.9 6	1017.0?	(17/2 ⁻)	641.6?	(13/2 ⁻)	
379.0 <i>I</i>	5.9 8	1599.7	27/2 ⁺	1220.6	25/2 ⁺	
381.0 <i>I</i>	5.3 8	787.6	17/2 ⁻	406.3	15/2 ⁺	
395.4 <i>I</i>	74 5	1220.6	25/2 ⁺	825.3	21/2 ⁺	
398.4 <i>I</i>	15.2 13	1159.7	19/2 ⁻	761.3	15/2 ⁻	
398.7 <i>I</i>	21.3 18	1186.4	21/2 ⁻	787.6	17/2 ⁻	
399.3 <i>I</i>	55 4	1117.1	23/2 ⁺	717.7	19/2 ⁺	
415.3 <i>I</i>	3.6 6	1234.4?	(19/2 ⁻)	819.1?	(15/2 ⁻)	
424.1 <i>I</i>	14.5 14	1365.0	21/2 ⁻	941.0	17/2 ⁻	
430.9 <i>I</i>	7.9 10	1416.3	23/2 ⁻	985.4	19/2 ⁻	
453.4 <i>I</i>	3.1 6	1470.3?	(21/2 ⁻)	1017.0?	(17/2 ⁻)	
459.4 <i>I</i>	15.7 15	1645.8	25/2 ⁻	1186.4	21/2 ⁻	
466.2 <i>I</i>	10.8 12	1626.0	23/2 ⁻	1159.7	19/2 ⁻	
467.5 <i>I</i>	2.3 5	2158.3	31/2 ⁺	1691.0	29/2 ⁺	
468.8 <i>I</i>	6.9 9	1186.4	21/2 ⁻	717.7	19/2 ⁺	
470.6 <i>I</i>	53 4	1691.0	29/2 ⁺	1220.6	25/2 ⁺	
473.3 <i>I</i>		1838.1	25/2 ⁻	1365.0	21/2 ⁻	
477.7 <i>I</i>	6.6 9	985.4	19/2 ⁻	507.7	17/2 ⁺	
480.8 <i>I</i>	9.1 11	1897.1	27/2 ⁻	1416.3	23/2 ⁻	
482.6 <i>I</i>	39 3	1599.7	27/2 ⁺	1117.1	23/2 ⁺	
489.7 <i>I</i>	3.3 6	1724.1?	(23/2 ⁻)	1234.4?	(19/2 ⁻)	
494.5 <i>I</i>		2332.7	29/2 ⁻	1838.1	25/2 ⁻	
510.5 <i>I</i>		2156.3	29/2 ⁻	1645.8	25/2 ⁻	
512.1 <i>I</i>		2138.1	27/2 ⁻	1626.0	23/2 ⁻	
516.0 <i>I</i>	5.0 8	2413.1	31/2 ⁻	1897.1	27/2 ⁻	
516.5 <i>I</i>		2849.2	33/2 ⁻	2332.7	29/2 ⁻	
523.8 <i>I</i>	2.4 5	1994.1?	(25/2 ⁻)	1470.3?	(21/2 ⁻)	
527.4 <i>I</i>		2665.5	31/2 ⁻	2138.1	27/2 ⁻	

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$^{160}\text{Gd}({}^7\text{Li}, \text{t3n}\gamma)$ **2003Ju02 (continued)** $\gamma(^{161}\text{Dy})$ (continued)

E_γ^\dagger	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	E_γ^\dagger	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π
528.7 <i>I</i>	6.3 9	1645.8	25/2 ⁻	1117.1	23/2 ⁺	628.8 <i>I</i>	6.9 9	2787.1	35/2 ⁺	2158.3	31/2 ⁺
541.0 [‡] <i>I</i>	25.2 20	2232.6	33/2 ⁺	1691.0	29/2 ⁺	638.4 <i>I</i>		4504.6	45/2 ⁻	3866.2	41/2 ⁻
542.1 [‡] <i>I</i>		2954.6	35/2 ⁻	2413.1	31/2 ⁻	665.1 <i>I</i>	3.0 6	3503.9	41/2 ⁺	2838.8	37/2 ⁺
544.9 <i>I</i>		2703.4	33/2 ⁻	2158.3	31/2 ⁺	676.5 <i>I</i>	6.3 9	1897.1	27/2 ⁻	1220.6	25/2 ⁺
547.3 <i>I</i>		2703.4	33/2 ⁻	2156.3	29/2 ⁻	685.3 <i>I</i>		5189.9	49/2 ⁻	4504.6	45/2 ⁻
555.8 [‡] <i>I</i>	2.0 5	2280.2?	(27/2 ⁻)	1724.1?	(23/2 ⁻)	689.6 <i>I</i>		3528.4	39/2 ⁻	2838.8	37/2 ⁺
556.8 <i>I</i>	6.7 9	2156.3	29/2 ⁻	1599.7	27/2 ⁺	691.4 <i>I</i>	2.3 5	3478.5	39/2 ⁺	2787.1	35/2 ⁺
558.2 <i>I</i>	17.0 16	2158.3	31/2 ⁺	1599.7	27/2 ⁺	718.4 <i>I</i>	0.6 3	4222.3	45/2 ⁺	3503.9	41/2 ⁺
567.9 <i>I</i>		3271.3	37/2 ⁻	2703.4	33/2 ⁻	721.1 <i>I</i>		1838.1	25/2 ⁻	1117.1	23/2 ⁺
573.9 <i>I</i>		3528.4	39/2 ⁻	2954.6	35/2 ⁻	721.5 [‡] <i>I</i>		2954.6	35/2 ⁻	2232.6	33/2 ⁺
583.0 [‡] <i>I</i>	1.4 4	2576.1	(29/2 ⁻)	1994.1?	(25/2 ⁻)	722.8 [‡] <i>I</i>		2413.1	31/2 ⁻	1691.0	29/2 ⁺
590.9 <i>I</i>	4.9 7	1416.3	23/2 ⁻	825.3	21/2 ⁺	733.0 <i>I</i>		2332.7	29/2 ⁻	1599.7	27/2 ⁺
594.9 <i>I</i>		3866.2	41/2 ⁻	3271.3	37/2 ⁻	746.9 <i>I</i>	0.6 3	4225.4	43/2 ⁺	3478.5	39/2 ⁺
606.1 <i>I</i>	12.6 13	2838.8	37/2 ⁺	2232.6	33/2 ⁺	799.6 <i>I</i>		5025.0	47/2 ⁺	4225.4	43/2 ⁺

[†] Uncertainties In the E_γ values are nominally 0.1 keV (2003Ju02). However, the reduced χ^2 value of the least-squares fit to deduce the level energies is much larger than expected, suggesting that At least some of these uncertainties are underestimated.

[‡] Poor energy fit.

Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

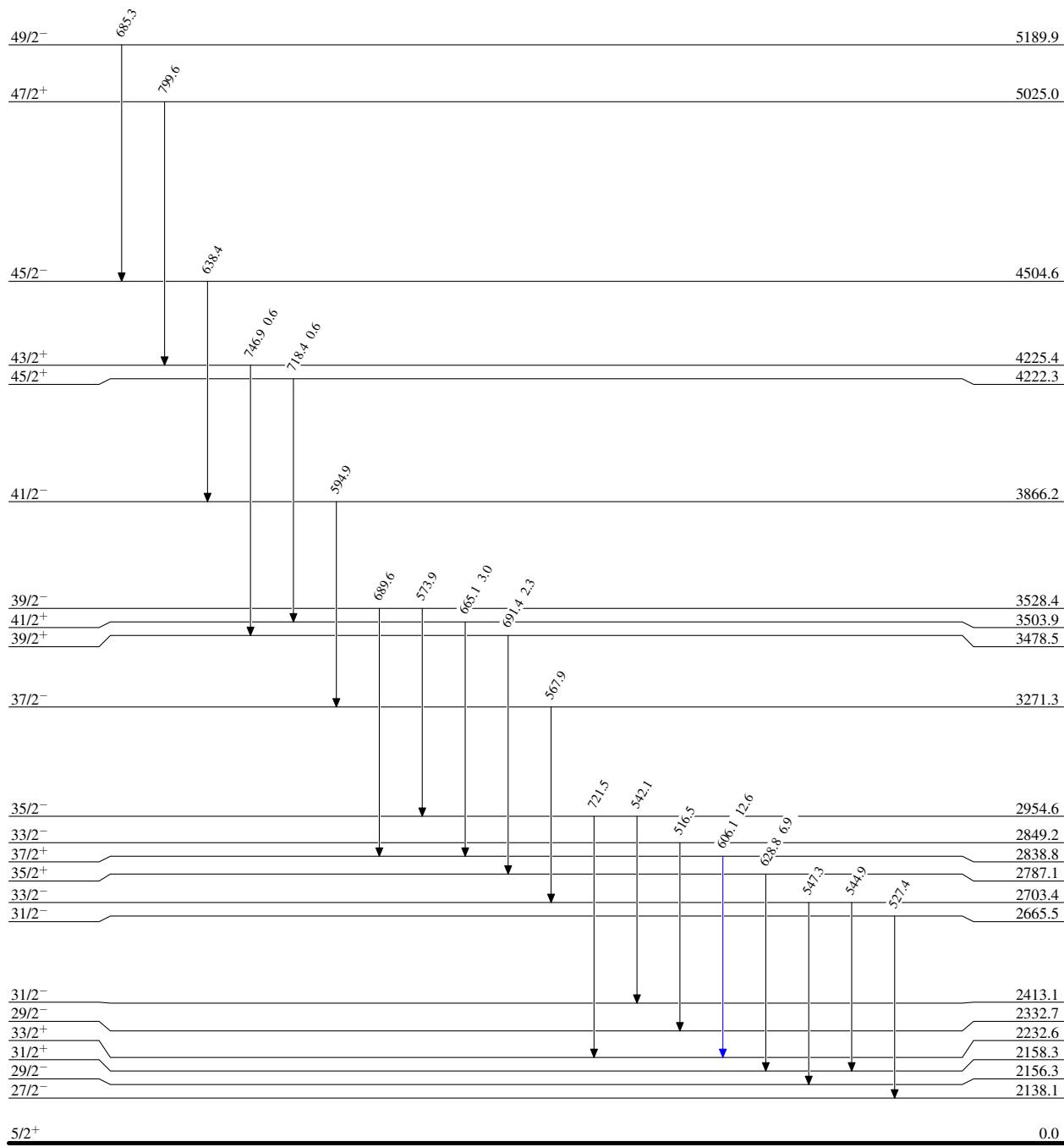
$^{160}\text{Gd}(^7\text{Li},\text{t3n}\gamma) \quad 2003\text{Ju02}$

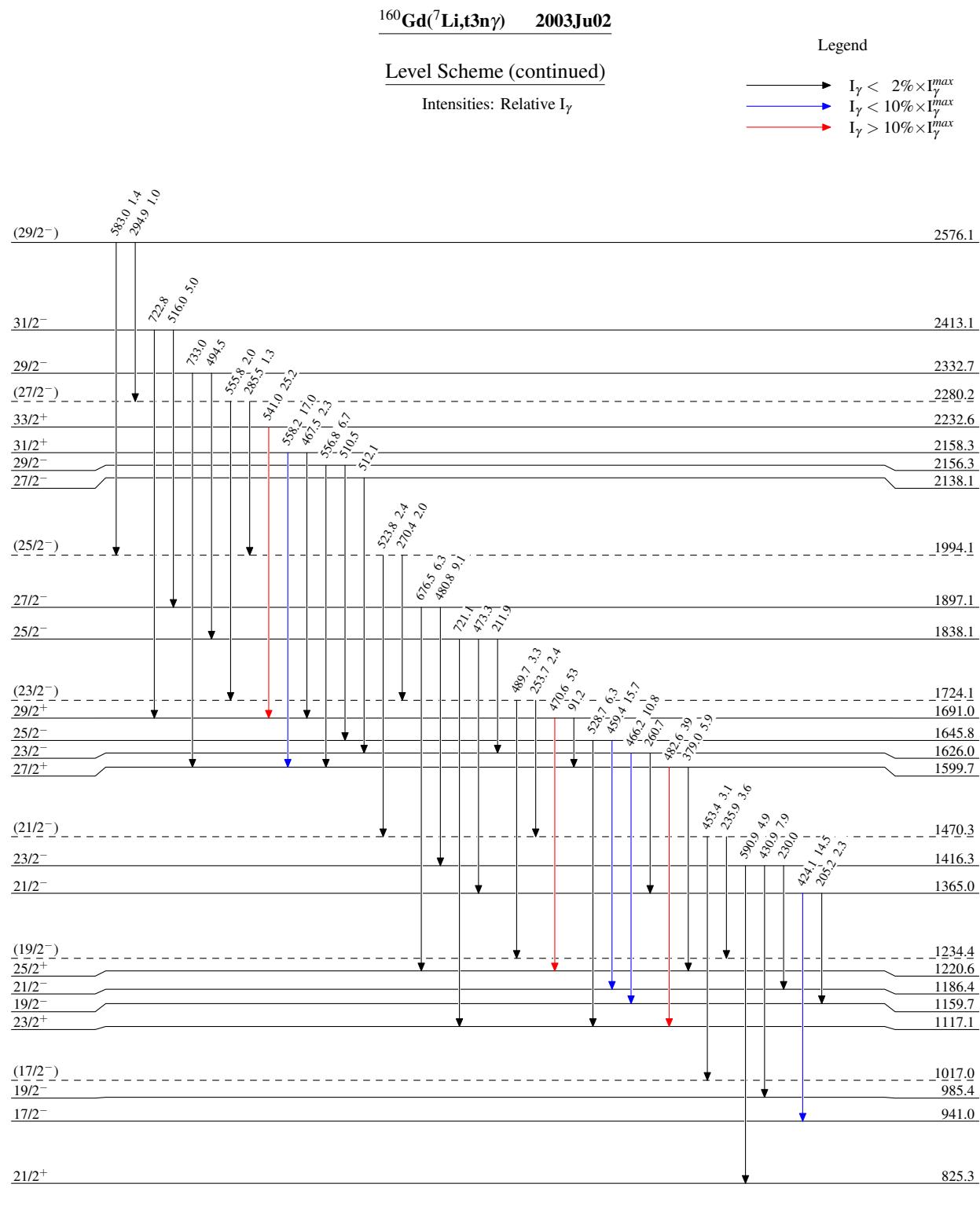
Legend

Level Scheme

Intensities: Relative I_γ

- $I_\gamma < 2\% \times I_\gamma^{\max}$
- $I_\gamma < 10\% \times I_\gamma^{\max}$
- $I_\gamma > 10\% \times I_\gamma^{\max}$





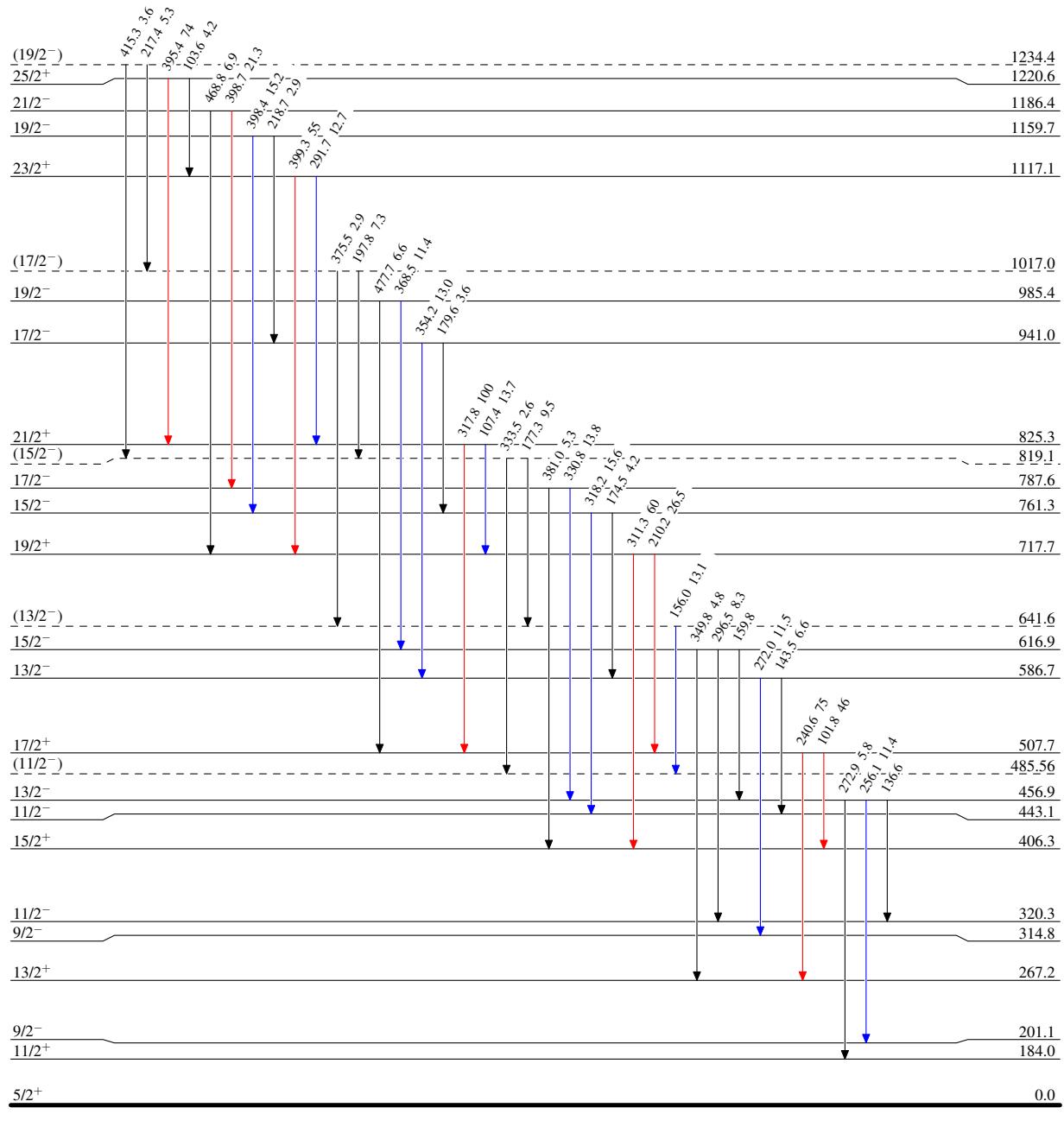
$^{160}\text{Gd}(^7\text{Li},t\text{,3n}\gamma)$ 2003Ju02

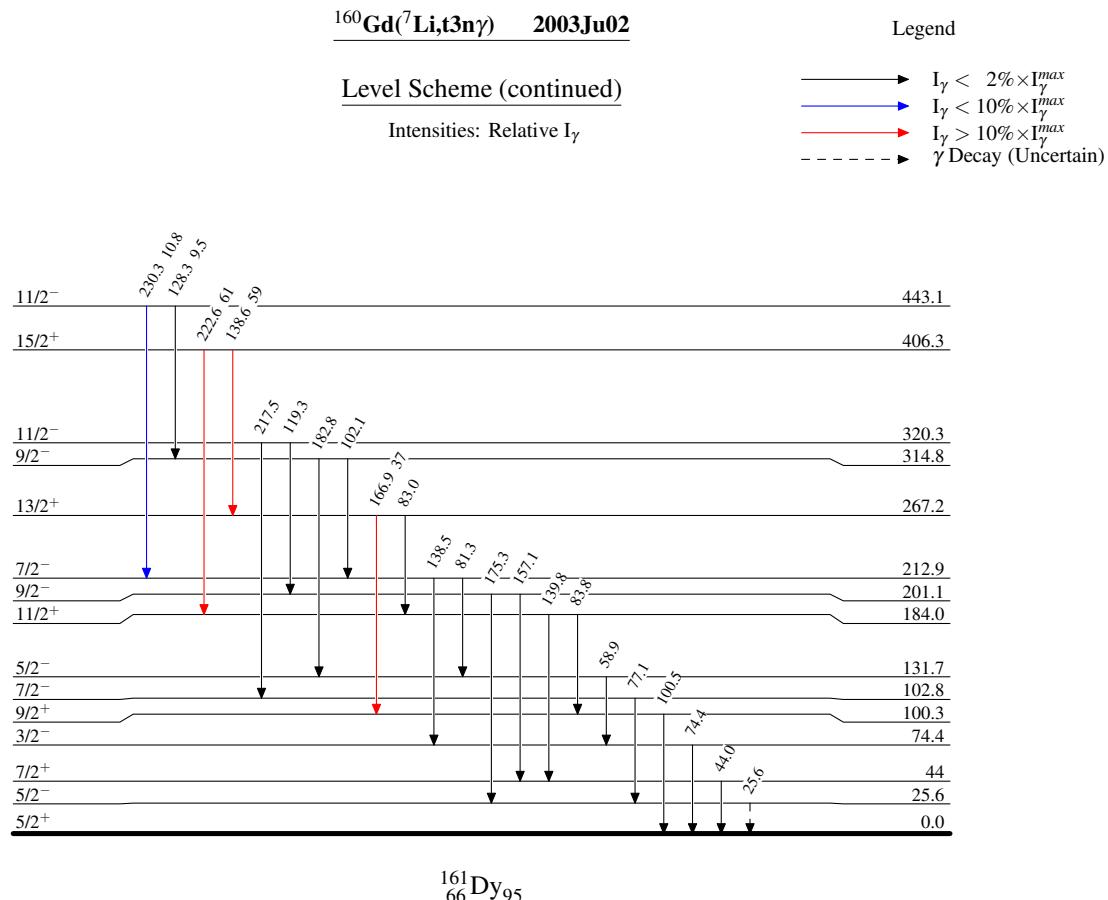
Level Scheme (continued)

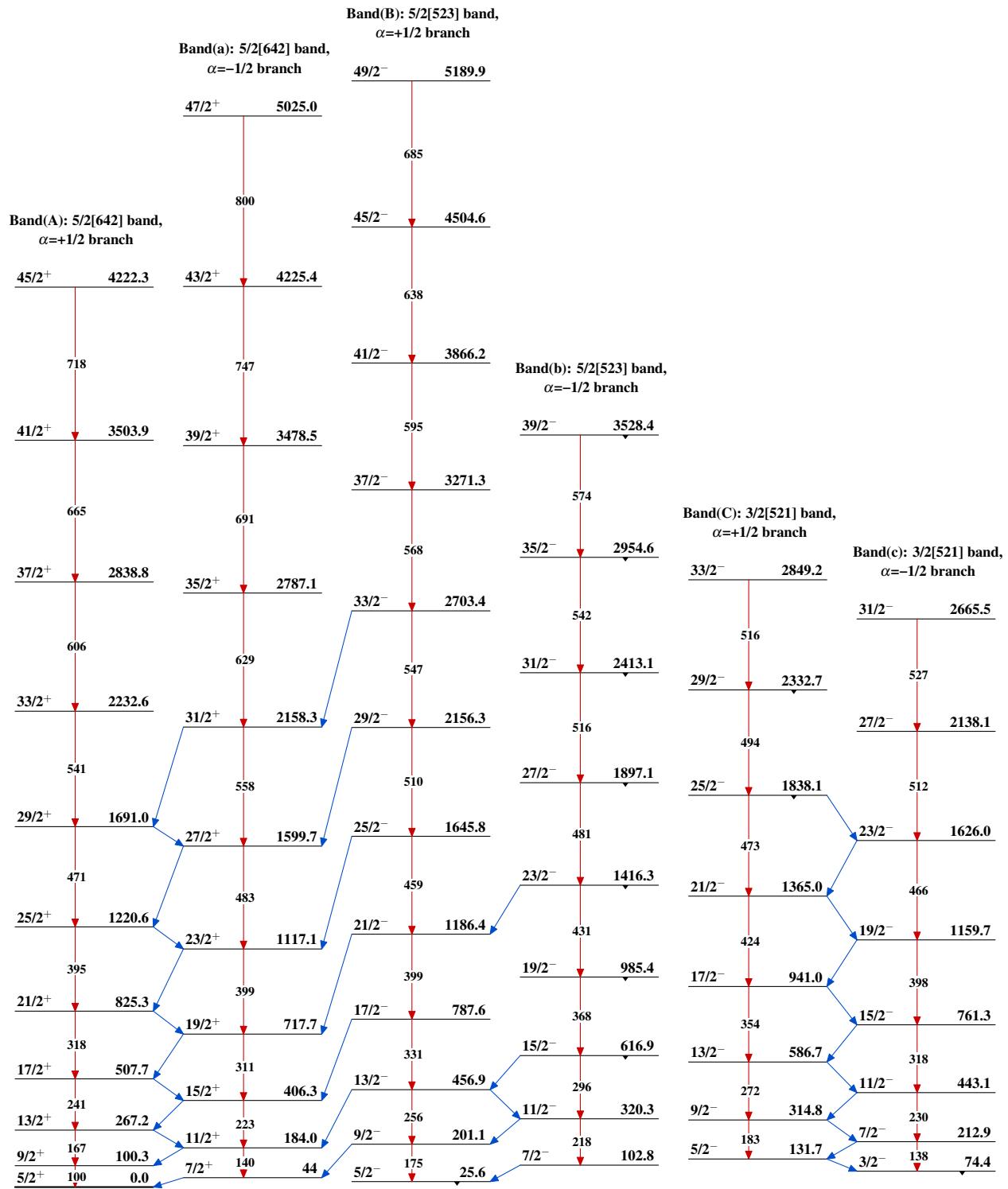
Intensities: Relative I_γ

Legend

- $\textcolor{black}{\longrightarrow}$ $I_\gamma < 2\% \times I_\gamma^{\max}$
- $\textcolor{blue}{\longrightarrow}$ $I_\gamma < 10\% \times I_\gamma^{\max}$
- $\textcolor{red}{\longrightarrow}$ $I_\gamma > 10\% \times I_\gamma^{\max}$





$^{160}\text{Gd}(^7\text{Li},\text{t3n}\gamma)$ 2003Ju02

$^{160}\text{Gd}({}^7\text{Li},\text{t3n}\gamma)$ 2003Ju02 (continued)

Band(D): 11/2[505] band,
 $\alpha=+1/2$ branch

