Gd(α,xnγ) 1973Kl03

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 132, 1 (2016)	4-Dec-2015

Data are primarily from 1973Kl03 and secondarily from 1975Be34 and 1974An11.
Experimental methods:
1971KlZM, 1971KlZM, 1972KlZM, 1972KlZM: Progress reports, see 1973Kl03 for results.
1973AnZE: Abstract, see 1974An11 for later and complete results.
1973Kl03: ^{156}Gd(α,3nγ) with E_α=32-46 MeV, ^{155}Gd(α,2nγ) with E_α=28 MeV, and ^{159}Tb(p,3nγ) with E_p=30 MeV on enriched targets. Measured γ singles, $\gamma\gamma$ and $\gamma\gamma$(t) coincidences, $\gamma(\theta)$, and γ(t) with respect to beam with Ge detectors. $\gamma(\theta)$ coefficients given, but deduced multipolarities not quoted. $\gamma\gamma$ coincidence table given. Includes calculation of Coriolis and ΔN=2 mixing.
1974An11: ^{155}Gd(α,2nγ) with E_α=27 MeV on enriched (92%) target. γ's measured with NaI and Ge detectors. $T_{1/2}$ measured from beam-γ and $\gamma\gamma$ delayed coincidences.
1974DaZH: Abstract; see 1975Be34.
1974LiZC: Abstract; discusses backbending.
1975Be34: ^{160}Gd(α,7nγ) with E_α=90 and 98 MeV on enriched (99.99%) targets. γ singles, $\gamma\gamma$ coincidences, $\gamma(\theta)$, and γ(t) with respect to beam pulse measured with Ge detectors. Only reports levels in positive-parity band which has a mixed configuration (1973Kl03, 1975Be34). Lowest level given is the $13/2^+$ whose energy is taken from 1973Kl03.
1977Hj01: Calculation of parameters to fit rotational energies.
Additional information 1.

^{157}Dy Levels

Additional information 2.

E(level)[†]	J^π[‡#]	$T_{1/2}$[@]	Comments
0[b]	$3/2^-$		
61.1[b]	$5/2^-$		
147.7[b]	$7/2^-$		
161.9[d]	$9/2^+$	1.3[a] μs *2*	J^π: Calculated mixing for 3/2[651], 5/2[642] and 1/2[660] is 52%, 26% and 20%, respectively.
188.1[d]	$5/2^+$	1.00[a] ns *15*	J^π: Calculated mixing for 3/2[651] and 1/2[660] is 60% and 10%, respectively.
199.2[c]	$11/2^-$	21.6 ms *16*	$T_{1/2}$: From ^{157}Dy IT decay and based on values of 19.2 ms *5* (1973Kl03), 24 ms *1* (1971KiZQ), and 21 ms *3* (1970Bo02).
211.5[d]	$7/2^+$		J^π: Calculated mixing for 3/2[651] and 5/2[642] is 56% and 39%, respectively.
234.7[d]	$3/2^+$		J^π: Calculated mixing for 3/2[651] and 3/2[402] is 29% and 70%, respectively.
238.7[d]	$13/2^+$		J^π: Calculated mixing for 3/2[651], 5/2[642] and 1/2[660] is 47%, 23% and 28%, respectively.
257.5[b]	$9/2^-$		
297.1[d]	$11/2^+$		J^π: Calculated mixing for 3/2[651] and 5/2[642] is 51% and 43%, respectively.
308.0	$3/2^+$		J^π: Calculated mixing for 3/2[402] and 3/2[651] is 29% and 67%, respectively.
374.8[c]	$13/2^-$		
401.3[b]	$11/2^-$		
435.6[d]	$17/2^+$	<2[&] ns	J^π: Calculated mixing for 3/2[651], 5/2[642] and 1/2[660] is 43%, 21% and 34%, respectively.
511.7[d]	$15/2^+$		J^π: Calculated mixing for 3/2[651] and 5/2[642] is 48% and 44%, respectively.
525.3?			
527.4?			
548.4[b]	$13/2^-$		

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Gd(α,xnγ) 1973Kl03 (continued)

^{157}Dy Levels (continued)

E(level)[†]	J$^\pi$[‡#]	T$_{1/2}$[@]	Comments
570.7[c]	15/2$^-$		
746.7[d]	21/2$^+$	<2[&] ns	J$^\pi$: Calculated mixing for 3/2[651], 5/2[642] and 1/2[660] is 41%, 19% and 38%, respectively.
749.7[b]	15/2$^-$		
784.6[c]	17/2$^-$		
844.3[d]	19/2$^+$		J$^\pi$: Calculated mixing for 3/2[651] and 5/2[642] is 45% and 44%, respectively.
920.9[b]	17/2$^-$		
1016.1[c]	19/2$^-$		
1157.4[d]	25/2$^+$	<2[&] ns	J$^\pi$: Calculated mixing for 3/2[651], 5/2[642] and 1/2[660] is 39%, 18% and 41%, respectively.
1174.2[b]	19/2$^-$		
1262.4[c]	21/2$^-$		
1281.5[d]	23/2$^+$		J$^\pi$: Calculated mixing for 3/2[651] and 5/2[642] is 44% and 44%, respectively.
1360.2[b]	21/2$^-$		
1521.8[c]	23/2$^-$		
1652.6[d]	29/2$^+$	<2[&] ns	J$^\pi$: Calculated mixing for 3/2[651], 5/2[642] and 1/2[660] is 38%, 17% and 43%, respectively.
1792.0[c]	25/2$^-$		
2218.9[d]	33/2$^+$	<2[&] ns	J$^\pi$: Calculated mixing for 3/2[651], 5/2[642] and 1/2[660] is 37%, 16% and 45%, respectively.
2844.8[d]	37/2$^+$	<2[&] ns	
3521.2[d]	41/2$^+$	<2[&] ns	
4241.8[d]	45/2$^+$	<2[&] ns	
5004.1[d]	49/2$^+$	<2[&] ns	

[†] From fit to γ energies with uncertain γ's omitted.
[‡] From multipolarities of the γ and expected rotational-band structure; assignments agree with those in ^{157}Dy Adopted Levels.
[#] For the positive-parity band with a mixed configuration, the calculated mixtures from 1973Kl03 are given.
[@] Values are from in-beam studies only; see ^{157}Dy Adopted Levels for combined results from all measurements. Values measured by $\gamma\gamma$(t) (1974An11) and α(beam pulse)γ(t) (1975Be34).
[&] From 1975Be34.
[a] From 1974An11.
[b] Band(A): K^π=3/2$^-$ band, based on 3/2[521] state.
[c] Band(B): K^π=11/2$^-$ band, based on 11/2[505] state.
[d] Band(C): Positive-parity band with mixture of 3/2[651], 5/2[642], and 1/2[660].

$\gamma(^{157}Dy)$

See 1973Kl03 for $\gamma\gamma$ coincidence data shown in drawing. These authors also give $\gamma(\theta)$ data for many of the unplaced γ's.
Additional information 3.

E$_\gamma$[†‡]	I$_\gamma$[#@]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	E$_\gamma$[†‡]	I$_\gamma$[#@]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$
14.2[c]		161.9	9/2$^+$	147.7	7/2$^-$	[x]59.6	4.3				
37.3		199.2	11/2$^-$	161.9	9/2$^+$	61.2	37.	61.1	5/2$^-$	0	3/2$^-$
51.5[c]		199.2	11/2$^-$	147.7	7/2$^-$	[x]63.0	1.7				
[x]55.2	2.6					[x]64.5	1.2				
[x]56.4	1.6					[x]65.4	2.5				
57.8[g]	1.5[d]	297.1	11/2$^+$	238.7	13/2$^+$	[x]65.9	2.1				

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Gd(α,xnγ) 1973Kl03 (continued)

$\gamma(^{157}Dy)$ (continued)

E_γ [†‡]	I_γ [#@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	δ[a]	Comments
[x]67.1	6.3							
[x]68.9	12.1							
[x]73.4								
[x]75.2	2.2							
76.1	8.9	511.7	$15/2^+$	435.6	$17/2^+$			
76.8	48.	238.7	$13/2^+$	161.9	$9/2^+$			
[x]77.9	3.3							
[x]79.9	2.2							
[x]84.6	16.8							
85.4[g]	5.3	297.1	$11/2^+$	211.5	$7/2^+$			
[x]85.9	11.1							
86.7	137.	147.7	$7/2^-$	61.1	$5/2^-$			
[x]90.0	48.							
[x]92.6	6.3							
[x]94.8	3.9							
[x]96.1	3.1							
97.5	3.5	844.3	$19/2^+$	746.7	$21/2^+$			
[x]97.9	7.9							
[x]98.4	8.5							
[x]102.7	9.1							
[x]103.8	8.8							
[x]104.8	12.9							
[x]105.6	24.7							
[x]106.5	4.4							
[x]108.8	18.1							
109.8	42.	257.5	$9/2^-$	147.7	$7/2^-$			Mult.: A_2=−0.33 *10* (1973Kl03).
[x]111.9	4.9							
[x]114.8	4.3							
[x]119.2	7.1							
[x]120.2	2.3							
[x]121.0	17.0							
[x]122.0	15.3							
[x]123.2	3.4							
[x]125.2	9.8							
126.1[g]	8.1	527.4?		401.3	$11/2^-$			
[x]130.1	8.7							
[x]131.6	4.6							
135.2	4.3	297.1	$11/2^+$	161.9	$9/2^+$			
[x]136.0	6.7							
[x]137.1	1.6							
[x]142.2	11.9							
[x]143.0	2.9							
143.7	18.0[de]	401.3	$11/2^-$	257.5	$9/2^-$	M1+E2	−0.9 *+19−7*	Mult.: A_2=−0.53 *11* (1973Kl03).
146.8	17.5	548.4	$13/2^-$	401.3	$11/2^-$			
147.6	72.	147.7	$7/2^-$	0	$3/2^-$			
[x]149.8	5.7							
150.4[f]	5.2[f]	211.5	$7/2^+$	61.1	$5/2^-$			
150.4[fg]	5.2[f]	525.3?		374.8	$13/2^-$			
[x]159.0	6.5							
[x]161.5	7.0							
[x]162.2	5.0							
[x]164.1								
[x]165.7	4.8							
[x]170.9	5.4							
171.4	12.1	920.9	$17/2^-$	749.7	$15/2^-$			
173.6		234.7	$3/2^+$	61.1	$5/2^-$			

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Gd(α,xnγ) 1973Kl03 (continued)

$\gamma(^{157}Dy)$ (continued)

E_γ [†‡]	I_γ [#@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	δ[a]	Comments
[x]174.6	9.2							
175.7	100	374.8	13/2$^-$	199.2	11/2$^-$	M1+E2	−0.39 *+50−18*	Mult.: A_2=−0.66 *4* (1973Kl03).
[x]177.9	3.7							
[x]178.9								
188.1	7.9	188.1	5/2$^+$	0	3/2$^-$			Mult.: A_2=−0.13 *17* (1973Kl03).
[x]194.6								
195.9	92.	570.7	15/2$^-$	374.8	13/2$^-$			Mult.: A_2=−0.25 *10* (1973Kl03); may include 2 γ's.
196.5	117.	257.5	9/2$^-$	61.1	5/2$^-$			
196.9[b] *3*	356.[d]	435.6	17/2$^+$	238.7	13/2$^+$	E2		Mult.: A_2=0.195 *8*, A_4=−0.072 *9* (1975Be34).
[x]199.3	20.9							
201.3	10.3	749.7	15/2$^-$	548.4	13/2$^-$	M1+E2	−0.9 *+12−6*	Mult.: A_2=−0.9 *3* (1973Kl03).
[x]204.0	14.8							
210.5[g]	3.0	211.5	7/2$^+$	0	3/2$^-$			Mult.: A_2=0.06 *10* (1973Kl03).
213.8	37.	784.6	17/2$^-$	570.7	15/2$^-$			
214.6	48.	511.7	15/2$^+$	297.1	11/2$^+$			
[x]215.9	15.0							
[x]217.5	16.1							
[x]224.7	6.1							
231.6	36.	1016.1	19/2$^-$	784.6	17/2$^-$	M1+E2	−0.46 *+44−21*	Mult.: A_2=−0.80 *5* (1973Kl03).
234.7		234.7	3/2$^+$	0	3/2$^-$			
[x]238.5	9.9							
246.5	25.2	1262.4	21/2$^-$	1016.1	19/2$^-$	M1+E2	−0.12 *+6−5*	Mult.: A_2=−0.64 *9* (1973Kl03).
[x]251.0	12.3							
253.6[f]	54.[f]	401.3	11/2$^-$	147.7	7/2$^-$			
253.6[f g]	54.[f]	1174.2	19/2$^-$	920.9	17/2$^-$			
259.2	21.6	1521.8	23/2$^-$	1262.4	21/2$^-$	M1+E2	−0.30 *+38−19*	Mult.: A_2=−0.45 *16* (1973Kl03).
270.3[g]	20.8	1792.0	25/2$^-$	1521.8	23/2$^-$			Mult.: A_2=−0.32 *6* (1973Kl03).
273.0	32.	511.7	15/2$^+$	238.7	13/2$^+$			Mult.: A_2=0.04 *3* (1973Kl03).
[x]274.2								
[x]280.2	6.5							
[x]288.1	6.5							
291.0	51.	548.4	13/2$^-$	257.5	9/2$^-$	(E2)		Mult.: A_2=0.36 *3* (1973Kl03).
[x]300.3								
[x]303.2	7.0							
[x]307.0	15.6							
308.0		308.0	3/2$^+$	0	3/2$^-$			
311.1[b] *3*	246.	746.7	21/2$^+$	435.6	17/2$^+$	E2		Mult.: A_2=0.38 *3* (1973Kl03) and A_2=0.295 *11*, A_4=−0.080 *13* (1975Be34).
[x]331.3	20.7							
332.7	80.	844.3	19/2$^+$	511.7	15/2$^+$	(E2)		Mult.: A_2=0.32 *2* (1973Kl03).
[x]339.8	7.0							
[x]343.4	8.2							
[x]346.3	6.2							
348.6	50.	749.7	15/2$^-$	401.3	11/2$^-$	(E2)		Mult.: A_2=0.29 *2* (1973Kl03).
[x]351.9	21.7							
[x]356.4	6.6							
[x]358.0	18.0							
[x]359.7	12.9							
[x]370.0	9.5							
371.4	≤73.	570.7	15/2$^-$	199.2	11/2$^-$			I_γ: I_γ(371.4)+I_γ(372.2)=73.
372.2	≤73	920.9	17/2$^-$	548.4	13/2$^-$			I_γ: I_γ(371.4)+I_γ(372.2)=73.
[x]374.2	5.5							
[x]381.3	18.4							
[x]387.8	15.7							

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Gd(α,xnγ) 1973Kl03 (continued)

$\gamma(^{157}Dy)$ (continued)

E_γ[†‡]	I_γ[#@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	δ[a]	Comments
[x]397.2	7.8							
408.7	33.	844.3	$19/2^+$	435.6	$17/2^+$	M1+E2	+0.22 *5*	Mult.: A_2=0.11 *7* (1973Kl03).
409.6[g]		784.6	$17/2^-$	374.8	$13/2^-$			
410.7[b] *3*	190.	1157.4	$25/2^+$	746.7	$21/2^+$	E2		Mult.: A_2=0.36 *4* (1973Kl03) and A_2=0.307 *12*, A_4=−0.088 *14* (1975Be34).
[x]421.9	6.2							
424.5	37.	1174.2	$19/2^-$	749.7	$15/2^-$	(E2)		Mult.: A_2=0.29 *5* (1973Kl03).
[x]426.7								
[x]433.5	17.3							
437.2	≤74	1281.5	$23/2^+$	844.3	$19/2^+$			I_γ: I_γ(437.2)+I_γ(437.9)=74.5.
[x]437.9	<74							I_γ: I_γ(437.2)+I_γ(437.9)=74.5.
439.3	33.	1360.2	$21/2^-$	920.9	$17/2^-$	(E2)		Mult.: A_2=0.50 *7* (1973Kl03).
445.6	52.[d]	1016.1	$19/2^-$	570.7	$15/2^-$			
[x]450.0	7.8							
[x]462.5	8.3							
[x]465.9	6.9							
[x]468.8	12.8							
477.5	23.1	1262.4	$21/2^-$	784.6	$17/2^-$	(E2)		Mult.: A_2=0.50 *7* (1973Kl03).
[x]481.8	20.5							
[x]487.3	6.7							
[x]491.0	22.6							
495.2[b] *3*	80.	1652.6	$29/2^+$	1157.4	$25/2^+$	E2		Mult.: A_2=0.42 *6* (1973Kl03) and A_2=0.318 *15*, A_4=−0.088 *18* (1975Be34).
[x]497.4	7.2							
505.8	54.	1521.8	$23/2^-$	1016.1	$19/2^-$	(E2)		Mult.: A_2=0.22 *4* (1973Kl03).
[x]522.9	11.3							
[x]526.8	46.							
529.6[g]	79.	1792.0	$25/2^-$	1262.4	$21/2^-$	(E2)		Mult.: A_2=0.35 *5* (1973Kl03).
[x]532.5	10.3							
[x]535.0	18.8							
[x]545.4	11.0							
[x]550.6	15.7							
[x]556.7	7.5							
[x]563.1	36.							
566.3[b] *3*	46.	2218.9	$33/2^+$	1652.6	$29/2^+$	E2		Mult.: A_2=0.35 *7* (1973Kl03) and A_2=0.287 *18*, A_4=−0.110 *23* (1975Be34).
[x]577.2	9.3							
[x]582.9	11.2							
[x]589.5	32.							
[x]624.9	11.4							
625.9[b] *3*		2844.8	$37/2^+$	2218.9	$33/2^+$	E2		Mult.: A_2=0.36 *3*, A_4=−0.14 *4* (1975Be34).
[x]640.4	9.9							
[x]646.7	11.6							
[x]657.4	11.4							
[x]666.1	15.4							
[x]668.3	15.1							
676.4[b] *3*		3521.2	$41/2^+$	2844.8	$37/2^+$	E2		Mult.: A_2=0.29 *5*, A_4=−0.07 *6* (1975Be34).
720.6[b] *5*		4241.8	$45/2^+$	3521.2	$41/2^+$	E2		Mult.: A_2=0.36 *11*, A_4=−0.07 *15* (1975Be34).
762.3[b] *7*		5004.1	$49/2^+$	4241.8	$45/2^+$	E2		Mult.: A_2=0.38 *16* (1975Be34).

[†] From 1973Kl03, unless otherwise noted. Uncertainties given (1973Kl03) only as from <0.3 keV for strong, well-resolved peaks up to almost 1.0 for peaks with poor statistics or barely visible next to strong peaks. The evaluator has not converted these

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Gd(α,xnγ) 1973Kl03 (continued)

$\gamma(^{157}Dy)$ (continued)

statements to specific values.

‡ Unplaced γ's (1973Kl03) that are uncertain or may belong in other nuclides have been omitted; there are ≈ 30 such γ's.

From $^{156}Gd(\alpha,3n\gamma)$ at $E_\alpha \approx 35$ MeV and 125° (1973Kl03). Uncertainties given (1973Kl03) only as from 10% for strong, well-resolved peaks and up to almost 100% for peaks with poor statistics or next to strong peaks. The evaluator has not converted these statements to specific values.

@ Other sets of values are available from $^{159}Tb(p,3n\gamma)$ (1973Kl03) and $^{160}Gd(\alpha,7n\gamma)$ (1975Be34).

& The "E2" are stretched electric quadrupole character assigned from $\gamma(\theta)$ (1975Be34). The "(E2)" are assigned by evaluator from A_2 values of 1973Kl03 where a value >+0.2 is interpreted as indicating a quadrupole transition and is taken as E2.

a From 1976Kr21 analysis of A_2 data of 1973Kl03.

b From 1975Be34.

c Observed in ^{157}Dy IT decay (21.6 ms).

d Value includes contribution from another reaction.

e A portion of the observed peak is ascribed to the ε decay to ^{157}Tb. If part of this 143 γ and all of the 83 γ come from the 143 level of ^{157}Tb, the corrected $I_\gamma(143) \approx 16.9$.

f Multiply placed with undivided intensity.

g Placement of transition in the level scheme is uncertain.

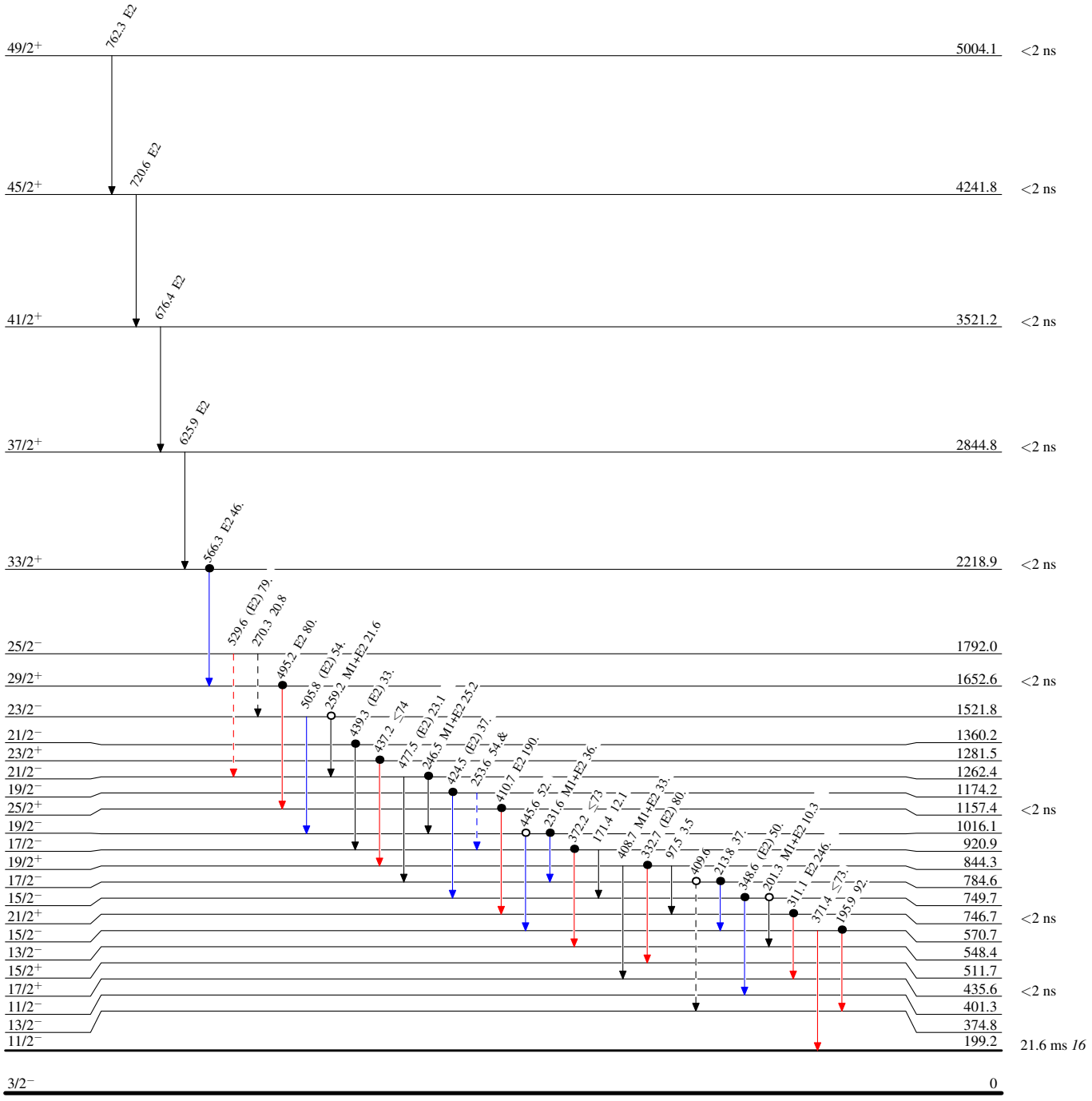
x γ ray not placed in level scheme.

Gd(α,xnγ) 1973Kl03

Level Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)
Coincidence
Coincidence (Uncertain)



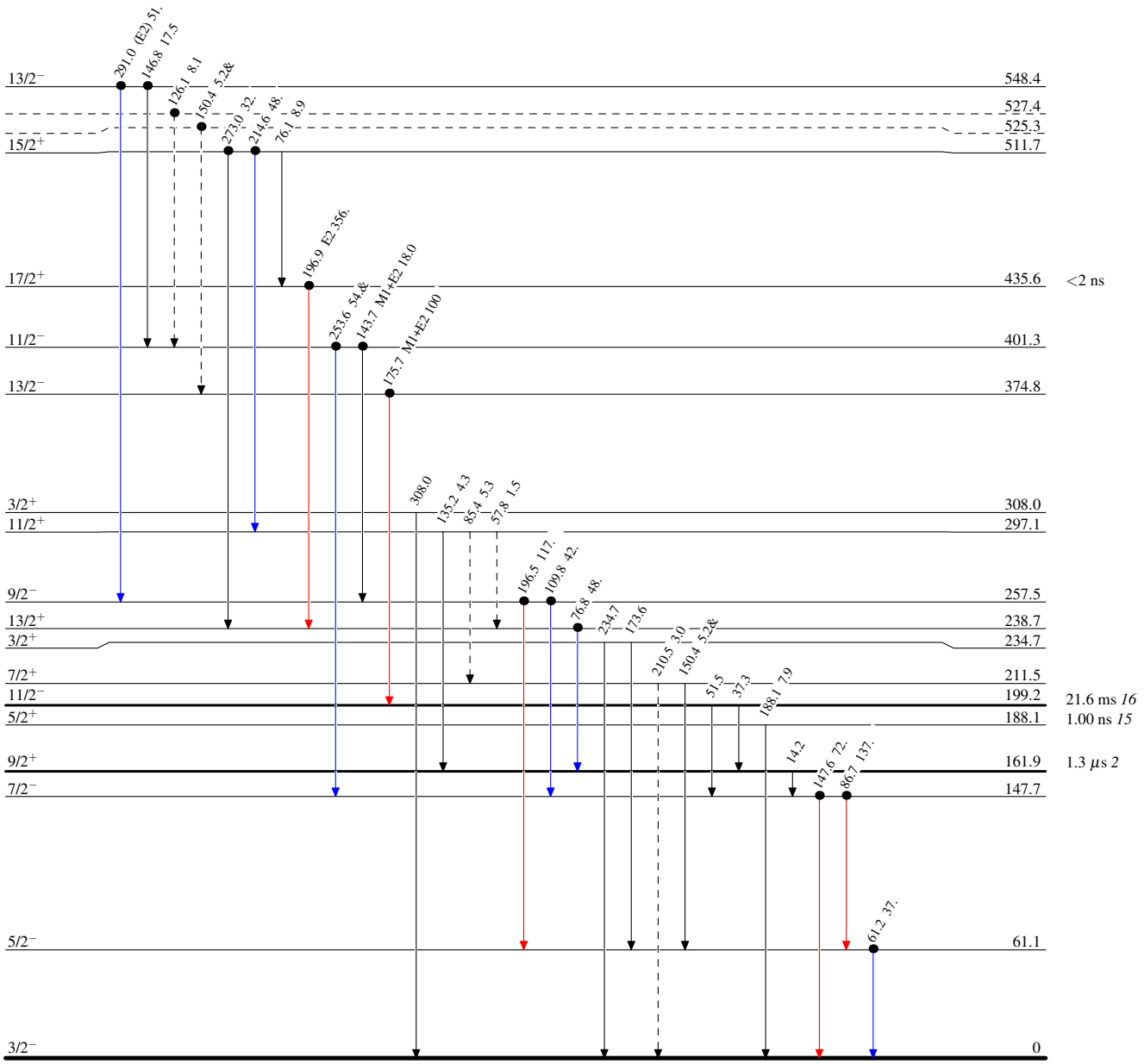
$^{157}_{66}Dy_{91}$

Gd(α,xnγ) 1973Kl03

Level Scheme (continued)

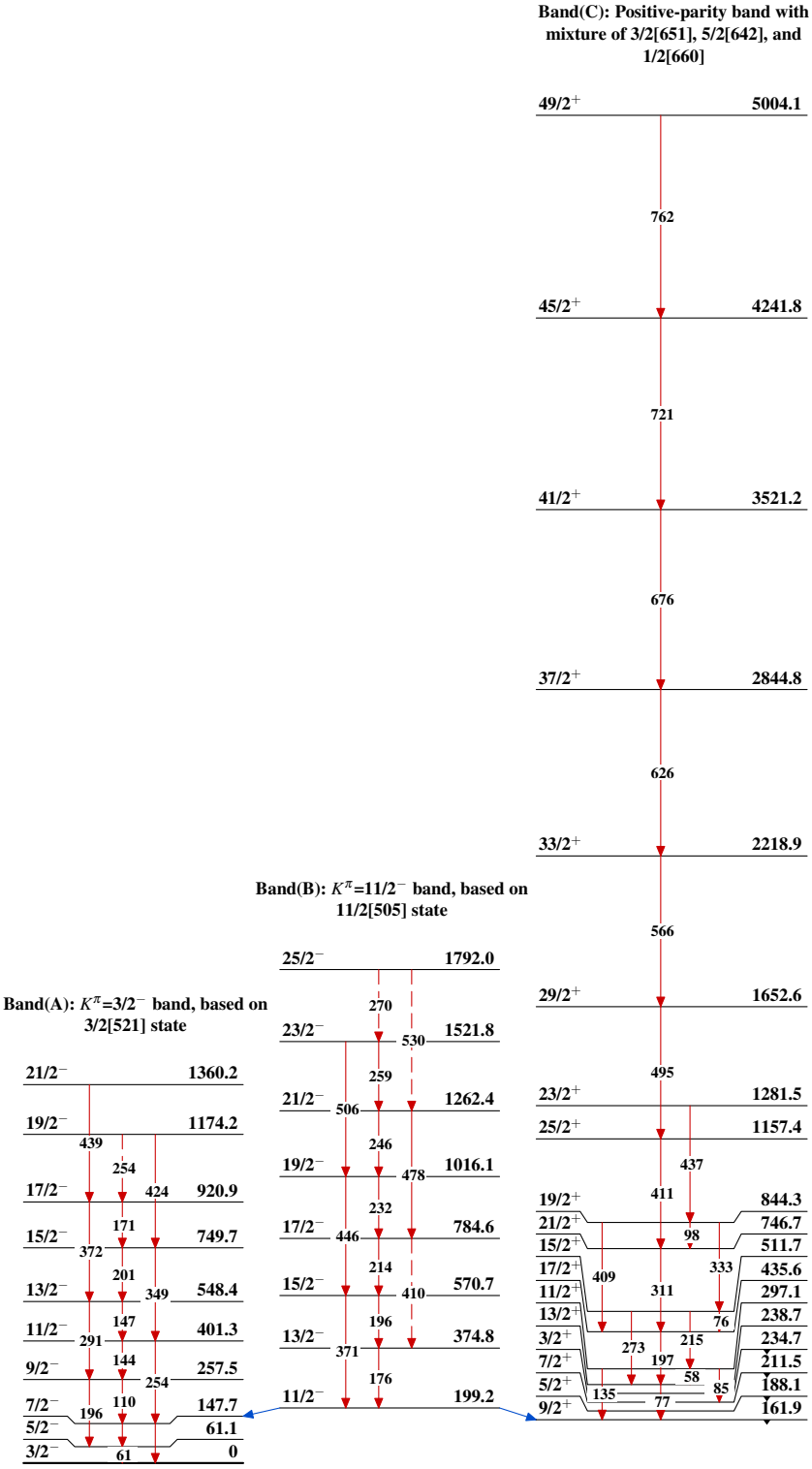
Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)
Coincidence



$^{157}_{66}Dy_{91}$

Gd(α,xnγ) 1973Kl03



$^{157}_{66}Dy_{91}$