^{163}Dy(n,γ) E=th 1964Sc25,1966Ha34,1993Va17

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen[#]	NDS 147, 1 (2018)	30-Nov-2017

1964Sc25: measured Eγ, Iγ, secondary γ rays.
1966Ha34: measured Eγ, Iγ of primary γ rays.
1980Hu06: measured Eγ, Iγ, $\gamma\gamma(\theta)$ of secondary γ rays.
1993Va17(also 1999Su03,1999Bo14,1997Su29): measured Eγ, Iγ, two-quantum cascades, deduced branching ratios.
1998Le03: measured lifetime for 2^+ member of β-vibrational band by γ-ray induced Doppler broadening.
1997Co18: measured Eγ, Iγ and $T_{1/2}$ (by γ-ray induced Doppler broadening) for the decay of a 4^+ level at 2173 keV.
1982Is05: measured Eγ of three strong primary γ rays and deduced neutron-separation energy.
1973He15: measured Eγ, Iγ, secondary γ rays.
1966Ne06: measured Eγ of four strong primary γ rays.
1967Pr08: atlas of γ rays from thermal-neutron capture.
Additional information 1.
1993Va17 report a large number (≈235) of two-quantum cascades, which suggests that the level scheme from (n,γ) is much more complex than the one given here. New intermediate levels proposed by 1993Va17 are listed, but only those gammas are quoted here which are above≈5100 (67% of S(n)=7658) and can be considered as primary transitions.

^{164}Dy Levels

E(level)[†]	J^π[‡]	$T_{1/2}$	Comments
0.0	0^+		
73.392 5	2^+		
242.230 7	4^+		
501.32 2	6^+		
761.80 8	2^+		
828.19 8	3^+		
915.98 8	4^+		
976.88 8	2^-		J^π: 3^- ruled out by $\gamma\gamma(\theta)$ (1980Hu06).
1024.63 8	5^+		
1039.30 8	3^-		
1122.76 8	4^-		
1155.5 10	$(6)^+$		
1225.15 8	$(5)^-$		
1587.80 8	$(4)^-$		
1715.9	$(2,3)^+$	1.2[@] ps +15−4	
1790.6?[a]			
1798			
1804.8?[a]			
1842			
1853.8?[a]			
1921.5			
1932			
1978			
2052.9?[a]			
2114.2?[a]			
2124.2?[a]			
2151.7?[a]			
2173.0	$(4)^+$	0.28[#] ps +19−9	
2202.7?[a]			
2242.3?[a]			
2249.0?[a]			
2252			

Continued on next page (footnotes at end of table)

^{163}Dy(n,γ) E=th 1964Sc25,1966Ha34,1993Va17 (continued)

^{164}Dy Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	Comments
2256.0?[a]		
2270.6?[a]		
2302.4?[a]		
2307		
2350.7?[a]		
2440.5?[a]		
2460		
2523.1?[a]		
2531.6?[a]		
2536.5?[a]		
2581.3?[a]		
2612.0?[a]		
2665.2?[a]		
2737.5?[a]		
2753.6?[a]		
2860.4?[a]		
2985.2?[a]		
3058.8?[a]		
3097.7?[a]		
3126.8?[a]		
3160.1?[a]		
3185.4?[a]		
3308.4?[a]		
3356.8?[a]		
3403.0?[a]		
3512.7?[a]		
3520.1?[a]		
3538.2?[a]		
3603.2?[a]		
3661.1?[a]		
3914.9?[a]		
4189.0?[a]		
4214.0?[a]		
4393.7?[a]		
4485.3?[a]		
4588.5?[a]		
4622.9?[a]		
4654.7?[a]		
4694.6?[a]		
4757.7?[a]		
4788.8?[a]		
4824.0?[a]		
4964.6?[a]		
(7658.11 *12*)	$2^-,3^-$[&]	S(n)=7658.11 *7* (2017Wa10).

† From least-squares fit to Eγ data.

‡ From Adopted Levels. Arguments of $\gamma\gamma(\theta)$ from this dataset are given under comments.

\# From 1997Co18, Doppler broadening of second order of reflection in the curved-crystal spectrometer. Statistical assumptions of

Continued on next page (footnotes at end of table)

^{163}Dy(n,γ) E=th 1964Sc25,1966Ha34,1993Va17 (continued)

^{164}Dy Levels (continued)

initial recoil velocity was used in the analysis. $T_{1/2}$=0.076-0.53 ps if extreme conditions are used for the initial recoil velocity.

[@] From 1998Le03, Doppler broadening of second order of reflection in the curved-crystal spectrometer. Statistical assumptions of initial recoil velocity was used in the analysis. $T_{1/2}$=0.35-5.7 ps if extreme conditions are used for the initial recoil velocity.

[&] s-wave capture in $5/2^-$.

[a] Tentative intermediate level from the analysis of two-quantum cascades (1993Va17).

γ(^{164}Dy)

E_γ[†]	I_γ[†c]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[a]	δ[b]	α[d]	Comments
^{x}49.122 *10*	0.014 *6*								
73.392 *5*	8.5 *10*	73.392	2^+	0.0	0^+	E2		8.89	α(K)=2.15 *3*; α(L)=5.18 *8*; α(M)=1.245 *18* α(N)=0.279 *4*; α(O)=0.0331 *5*; α(P)=9.41×10^{-5} *14* I_γ: weighted average of 9.3 *19* (1964Sc25) and 8.00 *96* (1966Ne06).
^{x}74.56 *3*	0.02								
98.127 *6*	0.20 *3*	1122.76	4^-	1024.63	5^+				
^{x}122.07 *8*	0.008								
^{x}122.77 *5*	0.008								
123.32 *1*	0.93 *14*	1039.30	3^-	915.98	4^+				
^{x}123.73 *9*	0.012								
^{x}131.21 *6*	0.021 *4*								
145.88 *2*	0.078 *16*	1122.76	4^-	976.88	2^-				
148.696 *10*	1.9 *3*	976.88	2^-	828.19	3^+				I_γ: from 1966Ne06. Other: 2.0 *3* (1964Sc25).
154.18 *3*	0.060 *12*	915.98	4^+	761.80	2^+				
^{x}159.32 *8*	0.05 *2*								
^{x}163.36 *10*	0.02								
168.838 *5*	21.5 *23*	242.230	4^+	73.392	2^+	E2		0.419	α(K)=0.262 *4*; α(L)=0.1210 *17*; α(M)=0.0286 *4* α(N)=0.00644 *9*; α(O)=0.000802 *12*; α(P)=1.200×10^{-5} *17* I_γ: unweighted average of 23.0 *23* (1964Sc25) and 20.0 *24* (1966Ne06). Mult.: consistent with γγ(θ) results.
185.86 *5*	0.12 *4*	1225.15	$(5)^-$	1039.30	3^-				
^{x}199.0 *2*	0.03								
200.52 *3*	0.21 *6*	1225.15	$(5)^-$	1024.63	5^+				
^{x}205.8 *1*	0.04								
206.78 *2*	1.0 *2*	1122.76	4^-	915.98	4^+				
^{x}208.07 *2*	0.08								
211.108 *15*	3.8 *6*	1039.30	3^-	828.19	3^+	E1		0.0422	(211γ)(585γ)(θ): A_2=−0.08 *13*, A_4=−0.22 *21*. (211γ)(755γ)(θ): A_2=0.00 *12*, A_4=+0.27 *17*.
^{x}212.16 *3*	0.62 *19*								
215.08 *15*	13.3 *17*	976.88	2^-	761.80	2^+	E1(+M2)	−0.03 *8*	0.041 *16*	α(K)=0.035 *13*; α(L)=0.005 *3*; α(M)=0.0011 *6* α(N)=0.00026 *14*; α(O)=3.6×10^{-5} *19*; α(P)=1.8×10^{-6} *10* I_γ: unweighted average of 15.0 *15* (1964Sc25) and 11.6 (1966Ne06). (215γ)(762γ)(θ): A_2=+0.28 *5*, A_4=−0.01 *8*. (215γ)(688γ)(θ): A_2=−0.050 *25*, A_4=+0.02 *4*.
^{x}225.6 *2*	0.02								
^{x}226.5 *2*	0.02								
^{x}227.7 *2*	0.03								
^{x}241.4 *2*	0.04								
^{x}248.35 *10*	0.02								
259.090 *15*	2.0 *2*	501.32	6^+	242.230	4^+	E2		0.1018	α(K)=0.0739 *11*; α(L)=0.0216 *3*; α(M)=0.00502 *7*

γ(^{164}Dy) (continued)

E_γ [†]	I_γ [†c]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [a]	δ [b]	α [d]	Comments
									α(N)=0.001137 *16*; α(O)=0.0001474 *21*; α(P)=3.74×10^{-6} *6* (259γ)(169γ)(θ): A_2=+0.18 *9*, A_4=−0.14 *14*.
277.50 *2*	7.3 *7*	1039.30	3$^-$	761.80	2$^+$				
294.58 *2*	5.2 *10*	1122.76	4$^-$	828.19	3$^+$	E1			(295γ)(585γ)(θ): A_2=−0.01 *14*, A_2=−0.02 *21*. (295γ)(755γ)(θ): A_2=−0.050 *26*, A_4=0.00 *4*.
309.12 *3*	1.6 *3*	1225.15	(5)$^-$	915.98	4$^+$	E1			(309γ)(674γ)(θ): A_2=+0.01 *13*, A_4=−0.07 *20*.
^{x}325.62 *10*	0.25								
415.00 *50*	6.2 *30*	915.98	4$^+$	501.32	6$^+$				I_γ: based on Iγ(415γ)/Iγ(673.7γ)=0.62 *14* and Iγ(415γ)/Iγ(843.2γ)=0.91 *17* (1980Hu06).
519.4 *4*	0.35	761.80	2$^+$	242.230	4$^+$				
548.54 *20*	1.0	1587.80	(4)$^-$	1039.30	3$^-$				
585.90 *10*	6.0 *12*	828.19	3$^+$	242.230	4$^+$	E2+M1	+5.4 *+32−15*	0.0105 *4*	I_γ: from Iγ(585.9γ)/Iγ(754.8γ)=0.26 *4* (1980Hu06). (586γ)(169γ)(θ): A_2=−0.14 *6*, A_4=−0.17 *9*.
610.98 *20*	1.0	1587.80	(4)$^-$	976.88	2$^-$				(611γ)(215γ)(θ): A_2=+0.09 *10*, A_4=−0.08 *15* is consistent with mult(611γ)=E2, if J$^\pi$(1588)=4.
653.8 *10*	0.2	1155.5	(6)$^+$	501.32	6$^+$				I_γ: from 1980Hu06. Iγ(653.8γ)/Iγ(911.3γ)=0.076 *19* (1980Hu06).
673.7 *2*	10 *3*	915.98	4$^+$	242.230	4$^+$	M1+E2	+0.87 *+13−11*	0.0111 *5*	(674γ)(169γ)(θ): A_2=−0.088 *23*, A_4=+0.06 *4*.
688.44 *15*	24 *7*	761.80	2$^+$	73.392	2$^+$				δ: 16.3<δ<−31.5, chosen on the basis of model-dependent arguments. I_γ: Iγ(688.4γ)/Iγ(761.7γ)=0.99 *8* (1980Hu06).
754.80 *15*	23 *7*	828.19	3$^+$	73.392	2$^+$				δ: 6.7<δ<−56.5, chosen on the basis of model-dependent arguments.
761.7 *2*	18 *5*	761.80	2$^+$	0.0	0$^+$				
782.4 *3*	1.3 *4*	1024.63	5$^+$	242.230	4$^+$	E2+M1	−5.5 *+21−61*		(782γ)(169γ)(θ): A_2=−0.25 *6*, A_4=+0.03 *10*.
^{x}819.0 *10*	0.5								
^{x}832.0 *10*	0.9								
843.2 *4*	3.4 *10*	915.98	4$^+$	73.392	2$^+$				I_γ: Iγ(843.2γ)/Iγ(673.7γ)=0.67 *14* (1980Hu06).
^{x}858.3 *10*	0.6								
911.3 *10*	2.7	1155.5	(6)$^+$	242.230	4$^+$				I_γ: from 1980Hu06.
966[e] *2*	0.7	1039.30	3$^-$	73.392	2$^+$				
^{x}973.8[@] *4*									
^{x}1004.0[@] *9*									
^{x}1103.0[@] *7*									
1345.29[#] *18*	0.24[#] *5*	2173.0	(4)$^+$	828.19	3$^+$	E2			α(K)exp=0.0011 *4* (1997Co18)
1411.30[#] *11*	0.82[#] *21*	2173.0	(4)$^+$	761.80	2$^+$				
1642.54		1715.9	(2,3)$^+$	73.392	2$^+$				E_γ: from 1998Le03.
1930.88[#] *11*	0.263[#] *20*	2173.0	(4)$^+$	242.230	4$^+$				
5121.0[&]		(7658.11)	2$^-$,3$^-$	2536.5?					
5127.2[&]		(7658.11)	2$^-$,3$^-$	2531.6?					
5137.6[&]		(7658.11)	2$^-$,3$^-$	2523.1?					

^{163}Dy(n,γ) E=th 1964Sc25,1966Ha34,1993Va17 (continued)

γ(^{164}Dy) (continued)

E_γ[†]	I_γ[†c]	E_i(level)	J^π_i	E_f	E_γ[†]	I_γ[†c]	E_i(level)	J^π_i	E_f	J^π_f
5199 *3*	0.63	(7658.11)	$2^-,3^-$	2460	5724.5[&]	1.14	(7658.11)	$2^-,3^-$	1932	
5217.4[&]		(7658.11)	$2^-,3^-$	2440.5?	5736.2[&]	0.78	(7658.11)	$2^-,3^-$	1921.5	
5308.7[&]		(7658.11)	$2^-,3^-$	2350.7?	5802.6[&]		(7658.11)	$2^-,3^-$	1853.8?	
5355.9[&]	0.22	(7658.11)	$2^-,3^-$	2302.4?	5815.0[&]	0.13	(7658.11)	$2^-,3^-$	1842	
5387.6[&]		(7658.11)	$2^-,3^-$	2270.6?	5854.5[&]		(7658.11)	$2^-,3^-$	1804.8?	
5403.2[&]		(7658.11)	$2^-,3^-$	2256.0?	5861.8[&]	1.26	(7658.11)	$2^-,3^-$	1798	
5408.6[&]	0.28	(7658.11)	$2^-,3^-$	2249.0?	5867.7[&]		(7658.11)	$2^-,3^-$	1790.6?	
5415.8[&]		(7658.11)	$2^-,3^-$	2242.3?	5941.8[&]	0.35	(7658.11)	$2^-,3^-$	1715.9	$(2,3)^+$
5453.8[&]		(7658.11)	$2^-,3^-$	2202.7?	6620 *4*	0.10	(7658.11)	$2^-,3^-$	1039.30	3^-
5504.8[&]		(7658.11)	$2^-,3^-$	2151.7?	6681.21[‡]	0.16	(7658.11)	$2^-,3^-$	976.88	2^-
5534.2[&]		(7658.11)	$2^-,3^-$	2124.2?	6830.09[‡]	0.71	(7658.11)	$2^-,3^-$	828.19	3^+
5542.8[&]		(7658.11)	$2^-,3^-$	2114.2?	6895.2[&]	0.26	(7658.11)	$2^-,3^-$	761.80	2^+
5606.0[&]		(7658.11)	$2^-,3^-$	2052.9?	7415.80[‡]	0.49	(7658.11)	$2^-,3^-$	242.230	4^+
5679.6[&]	0.94	(7658.11)	$2^-,3^-$	1978	7584 *3*	0.33	(7658.11)	$2^-,3^-$	73.392	2^+

[†] From 1964Sc25 for secondary γ rays, from 1966Ha34 (but adjusted upwards by 3 keV) for primary γ rays, unless otherwise indicated.
[‡] From 1982Is05.
[#] From 1997Co18.
[@] From 1980Hu06.
[&] From 1993Va17, uncertainty is probably about 1-2 keV. Only selected γ rays from 1993Va17 are listed here. See 1993Va17 for about 200 additional γ-ray cascades, and for intensities of these cascades.
[a] From Adopted Gammas.
[b] From $\gamma\gamma(\theta)$ (1980Hu06).
[c] Intensity per 100 neutron captures.
[d] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
[e] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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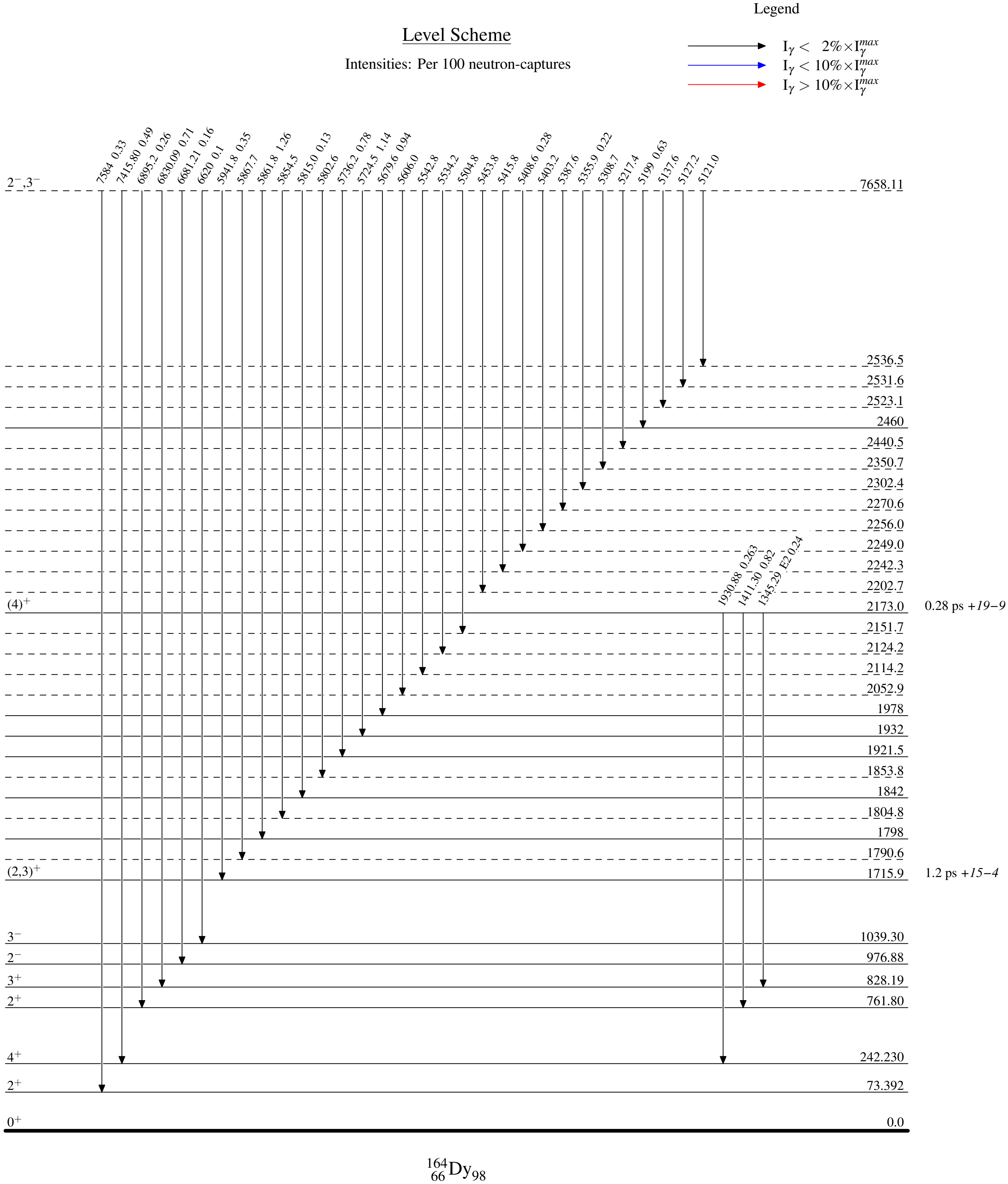

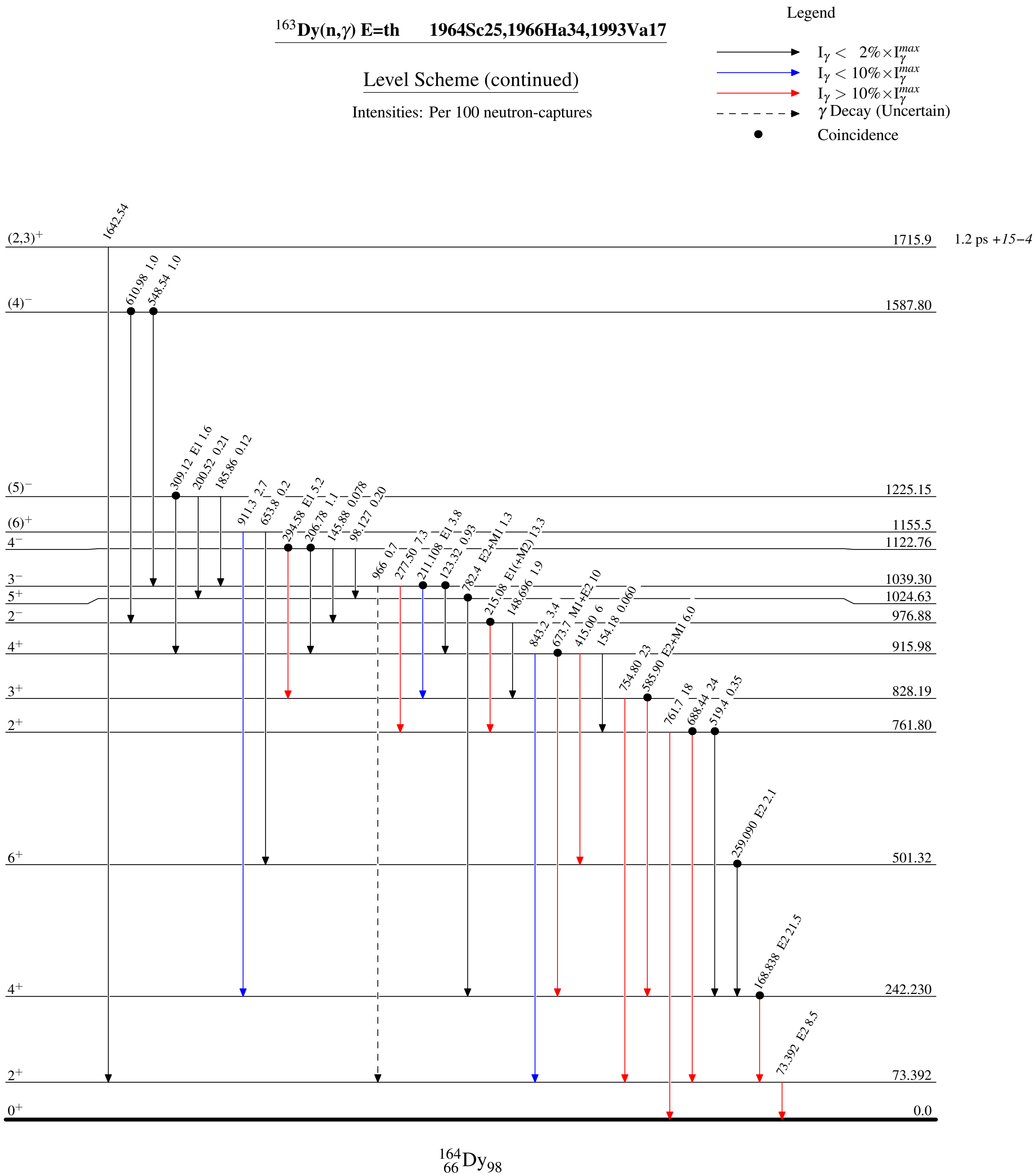
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Level Scheme (continued)
Intensities: Per 100 neutron-captures
Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)
Coincidence
(2,3)+ 1715.9 1.2 ps +15−4
(4)− 1587.80
(5)− 1225.15
(6)+ 1155.5
4− 1122.76
3− 1039.30
5+ 1024.63
2− 976.88
4+ 915.98
3+ 828.19
2+ 761.80
6+ 501.32
4+ 242.230
2+ 73.392
0+ 0.0
1642.54
610.98 1.0
548.54 1.0
309.12 E1 1.6
200.52 0.21
185.86 0.12
911.3 2.7
653.8 0.2
294.58 E1 5.2
206.78 1.1
145.88 0.078
98.127 0.20
966 0.7
277.50 7.3
211.108 E1 3.8
123.32 0.93
782.4 E2+M1 1.3
215.08 E1(+M2) 13.3
148.696 1.9
843.2 3.4
673.7 M1+E2 10
415.00 6
154.18 0.060
754.80 23
585.90 E2+M1 6.0
761.7 18
688.44 24
519.4 0.35
259.090 E2 2.1
168.838 E2 21.5
73.392 E2 8.5
$^{164}_{66}Dy_{98}$