Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 110, 1 (2009)	20-Nov-2008

Q(β^-)=−5356 *18*; S(n)=9748 *16*; S(p)=1602 *9*; Q(α)=4695.0 *18* 2017Wa10
Q(ε)=5130 *9*; S(2n)=18119 *16*; S(2p)=6712 *9*; Q(εp)=194 *11* 2017Wa10
Additional information 1.
Additional information 2.
Mass measurement (Penning trap): 2000Be42.
Nuclear structure calculations (and syst): 2008Al09, 1998Zh23, 1996Zh09, 1993To07, 1993Pa04, 1986Bl14.

^{151}Ho Levels

Cross Reference (XREF) Flags

A ^{151}Er ε decay (23.5 s)
B ^{151}Er ε decay (0.58 s)
C ^{155}Tm α decay (21.6 s)
D ^{155}Tm α decay (45 s)
E ^{127}I(^{29}Si,5nγ)
F ^{141}Pr(^{16}O,6nγ)

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$	XREF	Comments
0.0[#]	(11/2$^-$)	35.2 s *1*	ABC EF	%ε+%β^+=78 *3*; %α=22 *3* <r^2>$^{1/2}$=5.05 fm *3* (2004An14 evaluation). %α from weighted average of 28 *7* (1991To08), 22 *3* (1990Po13), 22 *3* (1982Ba75), 18 *5* (1974Sc19), 20 *5* (1963Ma17). T$_{1/2}$: α(t) (1982Bo04). Other: 34.0 s *5* (1993Al03). J$^\pi$: shell-model consideration and analogy to ^{153}Ho. Spin=11/2 from hyperfine structure using collinear laser spectroscopy (1988NeZZ), but no details are available.
41.0 *2*	(1/2$^+$)	47.2 s *13*	A CD	%α=80 *+15−20*; %ε+%β^+=20 *+20−15* Additional information 3. E(level): deduced from ^{151}Er ε decay (23.5 s) (1991To08). %α: from 1991To08. Others: 47 *8* (1990Po13), >40 (1982Ba75), 19 *4* (1974Sc19), 28 *+28−14* (1963Ma17). T$_{1/2}$: α(t): weighted average of 47.9 s *13* (1982Bo04) 42 s *4* (1963Ma17) and 47 s *2* (1970To16). J$^\pi$: α decay properties (1987Li09) and shell model consideration. Probable s$_{1/2}$ proton state. Spin=1/2 from hyperfine structure using collinear laser spectroscopy (1988NeZZ), but no details are available.
141.12 *22*	(3/2$^+$)		A	J$^\pi$: M1 γ to (1/2$^+$) and probable d$_{3/2}$ proton state.
397.60 *24*	(5/2$^+$)		A	J$^\pi$: M1 γ to (3/2$^+$), probable ε feeding from (7/2$^-$) and possible configuration=πd$_{5/2}$.
638.29 *9*	(7/2$^-$,9/2$^-$)		A	J$^\pi$: probable allowed ε feeding from (7/2$^-$) and γ to (11/2$^-$).
667.18 *10*	(7/2$^-$,9/2$^-$)		A	J$^\pi$: probable allowed ε feeding from (7/2$^-$) and γ to (11/2$^-$).
699.93 *24*	(7/2$^+$)		A	J$^\pi$: γ's to (3/2$^+$) and (5/2$^+$); probable g$_{7/2}$ proton state.
789.50[#] *10*	(15/2$^-$)		B EF	
861.7 *3*			A	
868.92 *10*			A	
910.0 *3*			A	
934.6 *3*			A	
1001.62 *24*			A	
1129.10 *16*			A	
1202.1 *5*			A	
1279.79 *12*			A	
1377.79 *13*			A	
1387.10[#] *15*	(19/2$^-$)		B EF	

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Adopted Levels, Gammas (continued)

^{151}Ho Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	$T_{1/2}$	XREF	Comments
1541.58 *23*			A	
1563.32 *14*			A	E(level): the adopted level energy is the average of two values obtained from the (poorly fitted) 694.4γ and 898.0γ.
1684.32[#] *18*	(23/2$^-$)		B EF	
1791.09[#] *22*	(21/2$^-$)		B EF	
1832.79 *12*	(5/2$^-$,7/2$^-$)		A	J$^{\pi}$: probable allowed ε feeding from (7/2$^-$) and γ to (5/2$^+$).
1860.92 *22*			A	
1946.9 *4*			A	
2098.41 *20*	(25/2$^-$)		B EF	Configuration=$(\pi h^3_{11/2})\otimes(\nu f_{7/2})(\nu h_{9/2})$; seniority=3.
2227.22 *21*	(27/2$^-$)		B EF	Configuration=$(\pi h^3_{11/2})\otimes(\nu f_{7/2})(\nu h_{9/2})$; seniority=1.
2615.40 *21*	(27/2)		EF	Configuration=$(\pi h^3_{11/2})(^{150}$Gd 3$^-)\otimes(\nu f^2_{7/2})$ $(\nu f_{7/2})(\nu i_{13/2})$.
2851.4?[@] *3*	(27/2$^-$)		EF	
2880.11 *23*	(29/2)		EF	Configuration=$(\pi h^3_{11/2})(^{150}$Gd 3$^-)\otimes(\nu f^2_{7/2})$ $(\nu f_{7/2})(\nu i_{13/2})$.
3144.33 *23*	(29/2)		EF	
3155.37 *25*	(31/2)		EF	Configuration=$(\pi h^3_{11/2})\otimes(\nu f_{7/2})(\nu i_{13/2})$.
3314.5 *3*	(33/2)		EF	
3522.67 *24*	(33/2)		EF	
3623.94[@] *23*	(31/2$^-$)		EF	
3970.1 *4*	(35/2)		E	Configuration=$(\pi h^2_{11/2})\otimes(\nu d_{3/2})(\nu f^2_{7/2})$.
4109.86[@] *24*	(35/2$^-$)		EF	
4355.9[@] *3*	(39/2$^-$)		EF	
4561.7 *5*	(39/2)		E	Configuration=$(\pi h^2_{11/2})\otimes(\nu d_{3/2})(\nu f_{7/2})(\nu h_{9/2})$.
4811.5 *3*	(43/2$^-$)	≈1 ns	EF	Configuration=$(\pi h^3_{11/2})\otimes(\nu f_{7/2})(\nu h_{9/2})$, seniority=3. $T_{1/2}$: from γ(t) in ^{127}I(^{29}Si,5nγ) (1994Zh08).
5293.5 *4*	(41/2)		EF	
5578.2? *4*	(43/2)		EF	
5642.5 *4*	(45/2)		EF	
5835.9 *4*	(45/2)		EF	
5875.3 *4*	(47/2)		EF	Configuration=$(\pi h^3_{11/2})\otimes(\nu h_{9/2})(\nu i_{13/2})$.
6184.0 *4*	(49/2)		EF	Configuration=$(\pi h^3_{11/2})\otimes(\nu h_{9/2})(\nu i_{13/2})$.
6225.4 *4*			EF	
6513.7 *4*			E	
6522.7? *5*			E	
6534.6 *5*			EF	
6659.8 *4*			EF	
6805.7? *5*			E	
6850.5? *5*			E	
6907.5 *4*			E	
7071.2 *5*			EF	
7099.2 *5*			EF	
7128.8? *5*			E	
7192.4 *4*			EF	
7326.4? *5*			E	
7754.3 *4*			E	
8025.5? *6*			E	
8340.9 *5*	(≥57/2)	9.2 ns *20*	EF	$T_{1/2}$: γ(t) in ^{127}I(^{29}Si,5nγ) (1994Zh08). Other: 14 ns *3* (1981Gi12). J$^{\pi}$: from multiplicity=17±2 and assumption (by 1994Zh08) that an average yrast transition removes 1.65±0.16 units of angular momentum. J(isomer)=J(g.s.)+1.65(multiplicity)=(67/2)±5.
8651.7 *6*			E	
9053.5? *6*			E	
9531.9? *7*			EF	
9958.7? *7*			E	

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Adopted Levels, Gammas (continued)

^{151}Ho Levels (continued)

† From least-squares fit to Eγ's. The 898γ from 1564 level was was omitted from the least-squares fitting procedure as it resulted in a poor fit with normalized χ^2=7.5.

‡ For high-spin (J>11/2) levels, the assignments are mainly based on multipolarities of selected transitions (about 12 in all) from γ(θ), γ(lin pol) and intensity-balance arguments. The shell-model predictions are also used. Ascending spins are assumed as the excitation energy rises.

Band(A): $\pi h^3_{11/2}\otimes\nu f^2_{7/2}$. Multiplet of states with seniority=1.

@ Band(B): $\pi h^3_{11/2}\otimes\nu f^2_{7/2}$. Multiplet of states with seniority=3.

γ(^{151}Ho)

E_i(level)	J^π_i	E_γ †	I_γ †	E_f	J^π_f	Mult.	α&	Comments
141.12	(3/2$^+$)	100.1 *1*	100	41.0	(1/2$^+$)	M1	2.60	α(K)=2.19 *4*; α(L)=0.325 *5*; α(M)=0.0718 *11*; α(N+..)=0.0192 *3* α(N)=0.01667 *24*; α(O)=0.00242 *4*; α(P)=0.0001357 *20* Mult.: from α(K)exp and K/L ratio in ^{151}Er ε decay (23.5 s).
397.60	(5/2$^+$)	256.5 *1*	100	141.12	(3/2$^+$)	M1	0.187	α(K)=0.1577 *23*; α(L)=0.0230 *4*; α(M)=0.00508 *8*; α(N+..)=0.001360 *20* α(N)=0.001179 *17*; α(O)=0.0001718 *25*; α(P)=9.70×10^{-6} *14* Mult.: from α(K)exp in ^{151}Er ε decay (23.5 s).
638.29	(7/2$^-$,9/2$^-$)	638.3 *1*	100	0.0	(11/2$^-$)			
667.18	(7/2$^-$,9/2$^-$)	667.2 *1*	100	0.0	(11/2$^-$)			
699.93	(7/2$^+$)	302.4 *2*	52 *4*	397.60	(5/2$^+$)			
		558.8 *1*	100 *10*	141.12	(3/2$^+$)			
789.50	(15/2$^-$)	789.5 *1*	100	0.0	(11/2$^-$)			
861.7		720.6 *2*	100	141.12	(3/2$^+$)			
868.92		230.7 *2*	9.7 *12*	638.29	(7/2$^-$,9/2$^-$)			
		868.9 *1*	100 *9*	0.0	(11/2$^-$)			
910.0		768.9 *2*	100	141.12	(3/2$^+$)			
934.6		537.0 *2*	100	397.60	(5/2$^+$)			
1001.62		860.5 *1*	100	141.12	(3/2$^+$)			
1129.10		462.0 *2*	38 *3*	667.18	(7/2$^-$,9/2$^-$)			
		987.9 *2*	100 *14*	141.12	(3/2$^+$)			
1202.1		1061.0 *4*	100	141.12	(3/2$^+$)			
1279.79		641.5 *1*	100	638.29	(7/2$^-$,9/2$^-$)			
1377.79		739.5 *1*	100	638.29	(7/2$^-$,9/2$^-$)			
1387.10	(19/2$^-$)	597.6 *1*	100	789.50	(15/2$^-$)			
1541.58		874.4 *2*	100	667.18	(7/2$^-$,9/2$^-$)			
1563.32		694.4 *1*	100 *11*	868.92				
		898.0 *2*	62 *10*	667.18	(7/2$^-$,9/2$^-$)			E_γ: poor fit. Level-energy difference=896.1. This γ energy was not included in the least-squares fitting procedure.
1684.32	(23/2$^-$)	297.2 *1*	100	1387.10	(19/2$^-$)	(E2)@	0.0687	α(K)=0.0508 *8*; α(L)=0.01385 *20*; α(M)=0.00322 *5*; α(N+..)=0.000831 *12* α(N)=0.000733 *11*; α(O)=9.53×10^{-5} *14*; α(P)=2.62×10^{-6} *4*
1791.09	(21/2$^-$)	106.6 *3*		1684.32	(23/2$^-$)	(M1)@	2.17 *4*	α(K)=1.83 *3*; α(L)=0.271 *5*; α(M)=0.0599 *10*; α(N+..)=0.0160 *3*

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Adopted Levels, Gammas (continued)

γ(^{151}Ho) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.	α[&]	Comments
								α(N)=0.01390 *23*; α(O)=0.00202 *4*; α(P)=0.0001133 *19* I_γ: from assumed (by evaluator) intensity balance at 1684 level in ^{151}Er ε decay, I(γ+ce)(106.6γ)/Iγ(404γ)≈100/57.
1791.09	(21/2$^-$)	404.1 *3*		1387.10	(19/2$^-$)			
1832.79	(5/2$^-$,7/2$^-$)	455.0 *2*	32.6 *22*	1377.79				
		553.0 *1*	97 *8*	1279.79				
		1194.5 *2*	100 *7*	638.29	(7/2$^-$,9/2$^-$)			
		1435.2 *2*	99 *7*	397.60	(5/2$^+$)			
1860.92		992.0 *2*	100	868.92				
1946.9		1549.3 *3*	100	397.60	(5/2$^+$)			
2098.41	(25/2$^-$)	307.3 *2*	23 *7*	1791.09	(21/2$^-$)			I_γ: from ^{151}Er ε (0.58 s). Other: 42 *7* in high spin data.
		414.1 *1*	100 *7*	1684.32	(23/2$^-$)	M1+E2[‡]	0.039 *14*	α(K)=0.032 *12*; α(L)=0.0054 *10*; α(M)=0.00120 *20*; α(N+..)=0.00032 *6* α(N)=0.00028 *5*; α(O)=3.9×10^{-5} *9*; α(P)=1.9×10^{-6} *8* δ: −0.19 *2* or −3.4 *5*.
2227.22	(27/2$^-$)	128.8 *1*	100 *7*	2098.41	(25/2$^-$)	M1(+E2)[‡]	1.19 *8*	α(K)=0.82 *25*; α(L)=0.29 *14*; α(M)=0.07 *4*; α(N+..)=0.017 *9* α(N)=0.015 *8*; α(O)=0.0020 *8*; α(P)=4.5×10^{-5} *21* δ: 0.5 *3* or 1.8 *+16−6*.
		542.9 *3*	26	1684.32	(23/2$^-$)			
2615.40	(27/2)	517.0 *1*	100	2098.41	(25/2$^-$)			
2851.4?	(27/2$^-$)	624.2 *3*	100	2227.22	(27/2$^-$)			
2880.11	(29/2)	264.7 *1*		2615.40	(27/2)	(M1)[@]	0.1719	α(K)=0.1448 *21*; α(L)=0.0211 *3*; α(M)=0.00466 *7*; α(N+..)=0.001248 *18* α(N)=0.001082 *16*; α(O)=0.0001576 *23*; α(P)=8.90×10^{-6} *13*
		653.0 *3*		2227.22	(27/2$^-$)			
3144.33	(29/2)	529.0 *3*		2615.40	(27/2)			
		917.1 *1*		2227.22	(27/2$^-$)			
3155.37	(31/2)	(11)		3144.33	(29/2)			
		275.3 *3*	100	2880.11	(29/2)	(E1)[@]	0.0221	α(K)=0.0187 *3*; α(L)=0.00268 *4*; α(M)=0.000589 *9*; α(N+..)=0.0001558 *23* α(N)=0.0001357 *20*; α(O)=1.92×10^{-5} *3*; α(P)=9.68×10^{-7} *14*
		540.0 *3*	60	2615.40	(27/2)			
3314.5	(33/2)	159.1 *3*		3155.37	(31/2)			
		434.4 *3*		2880.11	(29/2)			
3522.67	(33/2)	208.3 *3*		3314.5	(33/2)			
		367.3 *1*		3155.37	(31/2)	(M1)	0.0717	α(K)=0.0605 *9*; α(L)=0.00875 *13*; α(M)=0.00193 *3*; α(N+..)=0.000517 *8* α(N)=0.000448 *7*;

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Adopted Levels, Gammas (continued)

$\gamma(^{151}Ho)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.	α[&]	Comments
								α(O)=6.53×10^{-5} *10*; α(P)=3.70×10^{-6} *6*
3623.94	(31/2$^-$)	772.6 *3*	14	2851.4?	(27/2$^-$)			
		1396.7 *1*	100 *14*	2227.22	(27/2$^-$)	(E2)[‡]	1.69×10^{-3}	α(K)=0.001392 *20*; α(L)=0.000198 *3*; α(M)=4.34×10^{-5} *6*; α(N+..)=5.29×10^{-5} *8* α(N)=1.006×10^{-5} *14*; α(O)=1.455×10^{-6} *21*; α(P)=7.99×10^{-8} *12*; α(IPF)=4.13×10^{-5} *6*
3970.1	(35/2)	655.6 *3*		3314.5	(33/2)			
		814.7 *3*		3155.37	(31/2)			
4109.86	(35/2$^-$)	485.9 *1*	100 *16*	3623.94	(31/2$^-$)			
		587.2 *1*	100 *11*	3522.67	(33/2)			
4355.9	(39/2$^-$)	246.0 *1*	100	4109.86	(35/2$^-$)	(E2)[‡@]	0.1241	α(K)=0.0875 *13*; α(L)=0.0282 *4*; α(M)=0.00661 *10*; α(N+..)=0.001700 *24* α(N)=0.001504 *22*; α(O)=0.000192 *3*; α(P)=4.35×10^{-6} *7*
4561.7	(39/2)	591.6 *3*		3970.1	(35/2)			
4811.5	(43/2$^-$)	455.6 *1*	100	4355.9	(39/2$^-$)	(E2)[‡]	0.0202	B(E2)(W.u.)≈0.6 α(K)=0.01598 *23*; α(L)=0.00325 *5*; α(M)=0.000740 *11*; α(N+..)=0.000194 *3* α(N)=0.0001698 *24*; α(O)=2.30×10^{-5} *4*; α(P)=8.81×10^{-7} *13*
5293.5	(41/2)	937.6 *3*	100	4355.9	(39/2$^-$)			
5578.2?	(43/2)	284.6 *3*	100	5293.5	(41/2)			
5642.5	(45/2)	831.1 *3*	100	4811.5	(43/2$^-$)	D[#]		
5835.9	(45/2)	257.6 *3*	62 *12*	5578.2?	(43/2)			
		1024.4 *2*	100 *15*	4811.5	(43/2$^-$)	D[#]		
5875.3	(47/2)	39.3 *3*		5835.9	(45/2)			
		232.8 *1*		5642.5	(45/2)	D[#]		
		1063.9 *3*		4811.5	(43/2$^-$)			γ reported only by 1994Zh08.
6184.0	(49/2)	308.7 *1*	100	5875.3	(47/2)	D+Q[‡]		δ: −0.45 *25* or −1.9 *+6−20*.
6225.4		41.4 *3*		6184.0	(49/2)			
		350.1 *3*		5875.3	(47/2)			
6513.7		329.7 *3*		6184.0	(49/2)			
6522.7?		338.7 *3*		6184.0	(49/2)			
6534.6		(21)		6513.7				
		309.1 *3*		6225.4				
6659.8		125.3 *3*		6534.6				
		146.1 *3*		6513.7				
		434.4 *3*		6225.4				
6805.7?		621.7 *3*		6184.0	(49/2)			
6850.5?		1014.6 *3*		5835.9	(45/2)			
6907.5		723.4 *3*		6184.0	(49/2)			
		1071.8 *3*		5835.9	(45/2)			
7071.2		887.2 *3*		6184.0	(49/2)			
7099.2		564.6 *3*	100	6534.6				
7128.8?		944.8 *3*		6184.0	(49/2)			
7192.4		1008.4 *3*		6184.0	(49/2)			
7326.4?		1142.4 *3*		6184.0	(49/2)			
7754.3		561.9 *3*		7192.4				
		1094.5 *3*		6659.8				

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Adopted Levels, Gammas (continued)

$\gamma(^{151}Ho)$ (continued)

E_i(level)	J_i^π	E_γ[†]	E_f	J_f^π	E_i(level)	J_i^π	E_γ[†]	E_f	J_f^π
7754.3		1528.9 *3*	6225.4		8651.7		310.8 *3*	8340.9	(≥57/2)
		1570.3 *3*	6184.0	(49/2)	9053.5?		712.6 *3*	8340.9	(≥57/2)
8025.5?		954.3 *3*	7071.2		9531.9?		478.4 *3*	9053.5?	
8340.9	(≥57/2)	586.6 *3*	7754.3		9958.7?		1307.0 *3*	8651.7	
		1241.7 *3*	7099.2						

[†] From ^{151}Er ε decay (23.5 s) for γ rays from low-spin (J<11/2) states and primarily from ^{141}Pr(^{16}O,6nγ) for γ rays from high-spin (J>9/2) states. Other two high-spin datasets: ^{151}Er ε decay (0.58 s) and ^{127}I(^{29}Si,5nγ) are also considered in obtaining weighted averages when a level is populated in more than one of these three datasets.

[‡] From $\gamma(\theta)$ and linear polarization in ^{141}Pr(^{16}O,6nγ).

[#] $\gamma(\theta)$ consistent with $\Delta J=1$.

[@] From intensity-balance arguments in ^{127}I(^{29}Si,5nγ).

[&] 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.

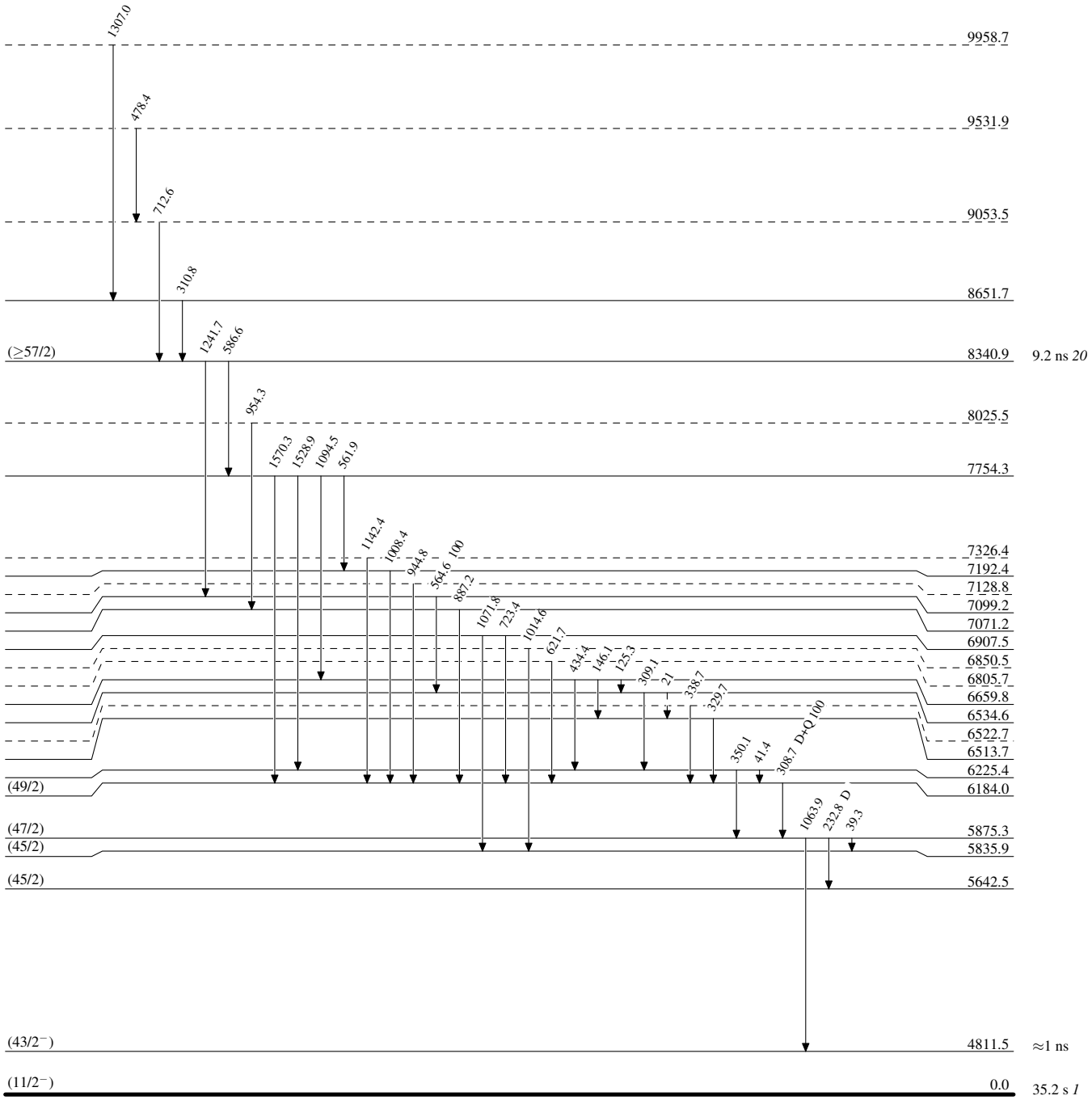
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{151}_{67}Ho_{84}$

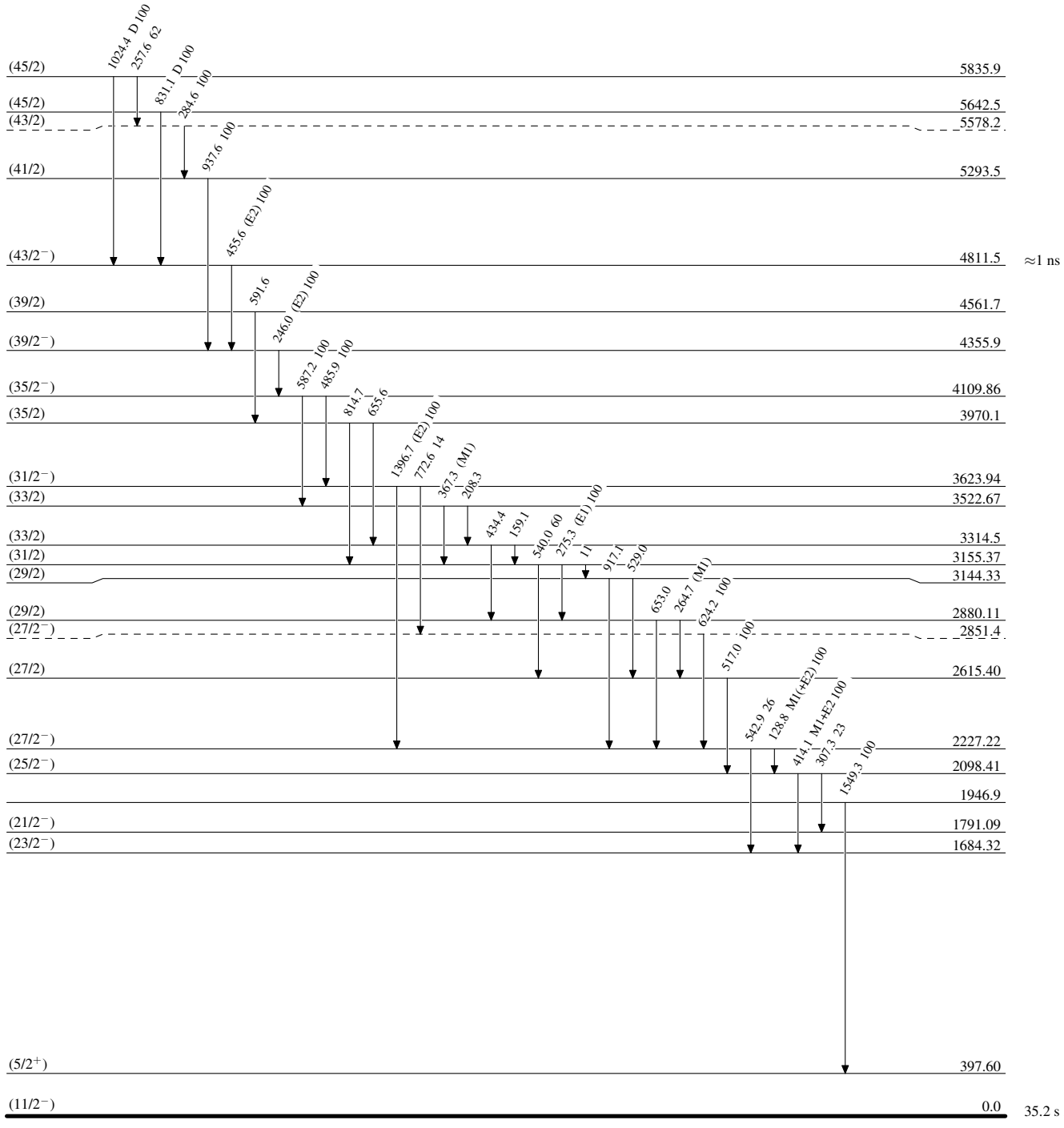
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

γ Decay (Uncertain)

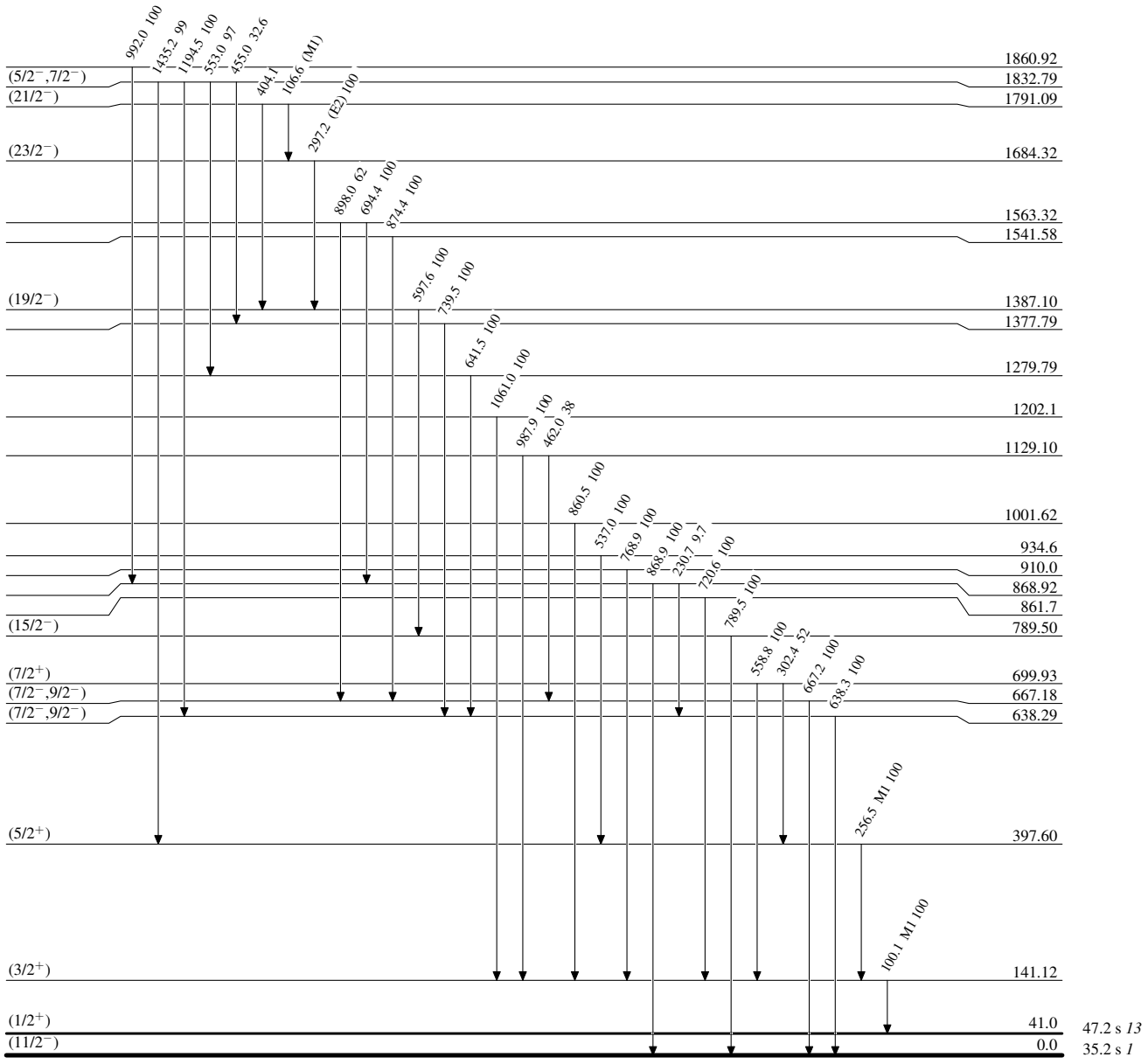


$^{151}_{67}Ho_{84}$

Adopted Levels, Gammas

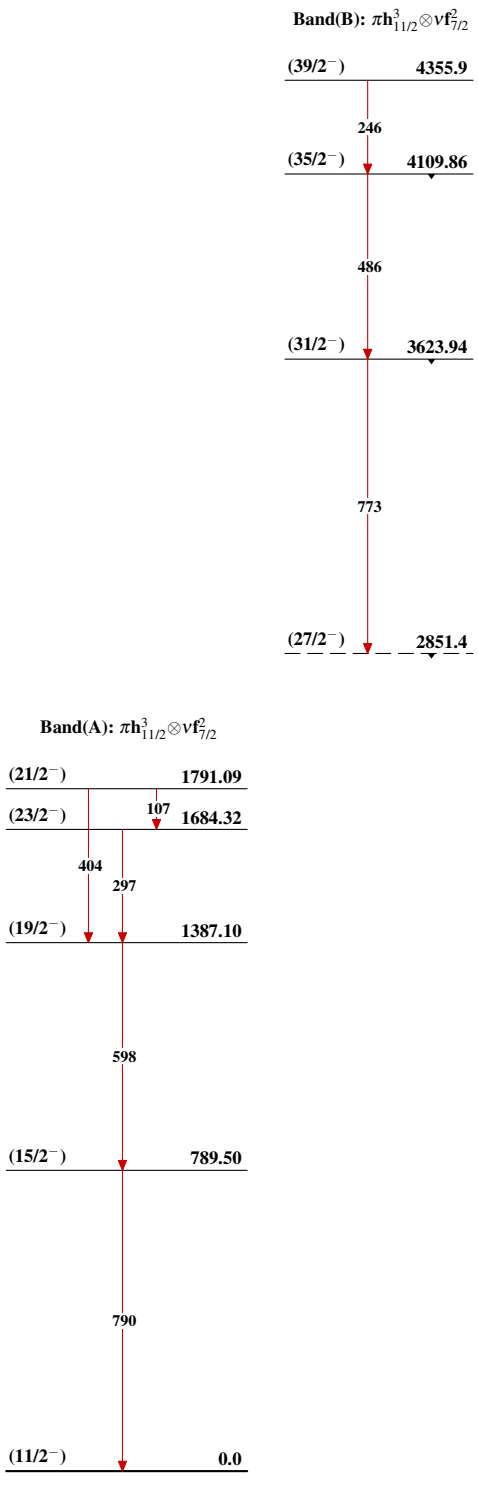
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{151}_{67}Ho_{84}$

Adopted Levels, Gammas



$^{151}_{67}Ho_{84}$