^{159}Ho ε decay 1982Vy02,1971Bo18

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 113, 157 (2012)	31-Dec-2010

Parent: ^{159}Ho: E=0; J$^{\pi}$=7/2$^-$; T$_{1/2}$=33.05 min *11*; Q(ε)=1837.6 *27*; %ε+%β^+ decay=100.0

Additional information 1.

^{159}Ho produced by 660-MeV proton spallation of Ta (1966Gr25,1968Ab15,1975GaYZ,1982Vy02), by Dy(p,xn) (1971Bo18,1972Ki21), and by Tb(α,4n) (1958To32). Measured γ singles, ce, β^+, and $\gamma\gamma$ coincidence spectra.

The decay scheme and all γ and ce data are from 1982Vy02, unless otherwise noted. Others, with many fewer γ's and without uncertainties: 1966Gr25, 1968Ab15, and 1971Bo18.

^{159}Dy Levels

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$[#]	Comments
0[@]	3/2$^-$		
56.625[@] *6*	5/2$^-$	0.21 ns *4*	
136.435[@] *6*	7/2$^-$		
177.616[&] *6*	5/2$^+$	9.2 ns *10*	T$_{1/2}$: other: 10.4 ns *10* (1975VaYX by same authors as 1978AlZC). 1972Ki21 report a half-life of 9 ns for a level at or above 177 keV and below 309 keV.
208.987[&] *6*	7/2$^+$	1.35 ns *7*	
235.853[@] *10*	9/2$^-$		
239.415[&] *10*	9/2$^+$		
309.590[a] *7*	5/2$^-$	<0.2 ns	T$_{1/2}$: 1975VaYX report 1.3 ns *2* for level at 309 keV. Since the same authors report this value for the 209-keV level in 1978AlZC, either the level energy is a typographical error or there was an error in the earlier measurement.
395.264[a] *7*	7/2$^-$		
504.972[a] *17*	9/2$^-$		
1016.236[b] *11*	5/2$^-$		
1075.837 *14*	5/2$^-$		
1090.560[b] *13*	7/2$^-$		
1153.674 *16*	5/2$^-$,7/2$^-$		
1201.921 *13*	5/2$^-$,7/2$^-$		
1286.92 *4*			
1370.684 *22*	5/2$^+$		

[†] From least-squares fit to γ energies.

[‡] From ^{159}Dy Adopted Levels.

[#] From 1978AlZC by eγ(t) and $\gamma\gamma$(t); others: 1975VaYX, by the same authors as 1978AlZC, 1972Ki21 and 1975Gr44, the latter two without uncertainties. Values are from ^{159}Ho ε decay only; see the ^{159}Dy Adopted Levels for additional data for the 177 level.

[@] Band(A): K$^{\pi}$=3/2$^-$, ν3/2[521] band.

[&] Band(B): K$^{\pi}$=5/2$^+$, ν5/2[642] band.

[a] Band(C): K$^{\pi}$=5/2$^-$, ν5/2[523] band.

[b] Band(D): K$^{\pi}$=5/2$^-$, ν5/2[512] band.

^{159}Ho ε decay 1982Vy02,1971Bo18 (continued)

ε,β^+ radiations

E(decay)†	E(level)	Iβ^+ ‡#	Iε‡#	Log *ft*	I($\varepsilon+\beta^+$)#	Comments
(467 *3*)	1370.684		0.136 *4*	6.43 *2*	0.136 *4*	εK= 0.8106; εL= 0.1455 *2*; εM+= 0.04389 *6*
(551 *3*)	1286.92		0.056 *3*	6.98 *2*	0.056 *3*	εK= 0.8158; εL= 0.1417; εM+= 0.04254
(636 *3*)	1201.921		0.66 *2*	6.04 *1*	0.66 *2*	εK= 0.8195; εL= 0.1389; εM+= 0.04156
(684 *3*)	1153.674		0.27 *1*	6.50 *2*	0.27 *1*	εK= 0.8212; εL= 0.1377; εM+= 0.04113
(747 *3*)	1090.560		1.11 *4*	5.96 *2*	1.11 *4*	εK= 0.8230; εL= 0.1363; εM+= 0.04065
(762 *3*)	1075.837		0.60 *2*	6.25 *2*	0.60 *2*	εK= 0.8234; εL= 0.1361; εM+= 0.04056
(821 *3*)	1016.236		7.2 *2*	5.24 *1*	7.2 *2*	εK= 0.8248; εL= 0.1350; εM+= 0.04020
(1333 *3*)	504.972		0.87 *4*	6.60 *2*	0.87 *4*	εK= 0.8310; εL= 0.1301; εM+= 0.03848
(1442 *3*)	395.264	0.017 *1*	13.8 *5*	5.47 *2*	13.8 *5*	av Eβ= 204.0 *14*; εK= 0.8311; εL= 0.1295; εM+= 0.03825 E(decay): E_{β^+}=460 *32* (1975GaYZ), 421 *+22−17* (1982Vy02), and 425 *6* (1976KrZG). From Q(ε), Eβ^+=419. Iβ^+: The measured I(β^+)=0.020% *4* (1982Vy02) and < 0.068% (1975GaYZ).
(1528 *3*)	309.590	0.180 *7*	70 *2*	4.81 *1*	70 *2*	av Eβ= 242.2 *14*; εK= 0.8305; εL= 0.1289; εM+= 0.03806 E(decay): E_{β^+}=516 *9* (1975GaYZ), 506 *3* (1982Vy02), and 508 *2* (1976KrZG). From Q(ε), Eβ^+=504. Iβ^+: The measured I(β^+)=0.209% *16* (1982Vy02) and 0.189% *40* (1975GaYZ).
(1598 *3*)	239.415	0.003 *2*	0.6 *5*	6.9 *3*	0.6 *5*	av Eβ= 273.0 *14*; εK= 0.8294; εL= 0.1284; εM+= 0.03790
(1602 *3*)	235.853	0.0016 *3*	0.37 *6*	7.13 *7*	0.37 *6*	av Eβ= 274.6 *14*; εK= 0.8294; εL= 0.1284; εM+= 0.03789
(1629 *3*)	208.987	0.001 *10*	0.2 *22*	≥6.4	0.2 *22*	av Eβ= 286.4 *14*; εK= 0.8288; εL= 0.1282; εM+= 0.03782
(1660 *3*)	177.616	0.012 *20*	1.6 *23*	≥6.1	1.6 *23*	av Eβ= 300.2 *14*; εK= 0.8281; εL= 0.1279; εM+= 0.03774
(1701 *3*)	136.435	0.017	2.1 *5*	6.43 *8*	2.1 *5*	av Eβ= 318.3 *14*; εK= 0.8269; εL= 0.1275; εM+= 0.03763 E(decay): See comment for 56 level. Iβ^+: See comment for 56 level.
(1781 *3*)	56.625	0.013 *40*	1.1 *30*	≥6.2	1.1 *30*	av Eβ= 353.3 *14*; εK= 0.8238; εL= 0.1268; εM+= 0.03738 E(decay): Eβ^+=805 *25* (1975GaYZ), 790 *40* (1982Vy02), and 773 *10* (1976KrZG), which would include the branches to the 56 and 136 levels. From Q(ε), Eβ^+=757 and 678 to these two levels. Iβ^+: For the 56 and 136 levels, the measured I(β^+)=0.0218% *23* (1982Vy02) and 0.019% *8* (1975GaYZ).
(1838 *3*)	0		≤0.0001		≤0.0001	Iε: Calculated from expected (1973Ra10) log *ft*≥11.0 for 2nd forbidden $\varepsilon+\beta^+$ decay.

† The measured values are given in comments.

‡ The I(β^+)+I(ε) are from γ-intensity balances at the various levels, and the I(β^+) and I(ε) are then computed from the theoretical capture to positron ratios. The uncertainties do not include any contribution from the incompleteness of the decay scheme as indicated by the many unplaced γ rays. The measured I(β^+) values are given in comments for comparison, and are in good agreement.

Absolute intensity per 100 decays.

$\gamma(^{159}Dy)$

Iγ normalization: calculated to give 100% γ+ce feeding of the ground state. The β^+ and ε transition to the ground state is 2nd forbidden, hence negligible.

E_γ[†]	I_γ[‡#&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	δ[@]	α[a]	$I_{(\gamma+ce)}$[&]	Comments
30.427 *13*	0.367 *14*	239.415	9/2$^+$	208.987	7/2$^+$	M1+E2	0.13 *2*	20 *3*		α(L)=15.8 *20*; α(M)=3.6 *5*; α(N+..)=0.93 *12* α(N)=0.82 *11*; α(O)=0.110 *13*; α(P)=0.00402 *6*
31.378 *8*	1.38 *3*	208.987	7/2$^+$	177.616	5/2$^+$	M1+E2	0.19 *2*	26 *3*		α(L)=19.9 *24*; α(M)=4.6 *6*; α(N+..)=1.17 *14* α(N)=1.04 *13*; α(O)=0.134 *15*; α(P)=0.00361 *6*
41.182 *4*	3.17 *19*	177.616	5/2$^+$	136.435	7/2$^-$	E1		0.612		α(L)=0.480 *7*; α(M)=0.1059 *15*; α(N+..)=0.0267 *4* α(N)=0.0236 *4*; α(O)=0.00299 *5*; α(P)=0.0001021 *15*
56.626 *8*	14.3 *3*	56.625	5/2$^-$	0	3/2$^-$	M1+E2	0.19 *2*	12.76 *21*		α(K)=10.04 *16*; α(L)=2.12 *13*; α(M)=0.48 *3*; α(N+..)=0.125 *8* α(N)=0.110 *7*; α(O)=0.0151 *8*; α(P)=0.000637 *10*
61.77[b] *11*		239.415	9/2$^+$	177.616	5/2$^+$	E2		17.9	0.34 *4*	ce(K)/(γ+ce)=0.135 *3*; ce(L)/(γ+ce)=0.624 *8*; ce(M)/(γ+ce)=0.150 *3*; ce(N+)/(γ+ce)=0.0375 *9* ce(N)/(γ+ce)=0.0336 *8*; ce(O)/(γ+ce)=0.00396 *9*; ce(P)/(γ+ce)=7.07×10^{-6} *15* $I_{(\gamma+ce)}$: Value listed by author (1982Vy02), but no supporting Iγ or ce data given. Placement shown in table of γ data, but not in decay-scheme table.
^{x}68.79 *3*	0.115 *25*									
72.546 *4*	1.10 *4*	208.987	7/2$^+$	136.435	7/2$^-$	E1		0.723		α(K)=0.597 *9*; α(L)=0.0982 *14*; α(M)=0.0216 *3*; α(N+..)=0.00555 *8* α(N)=0.00487 *7*; α(O)=0.000650 *9*; α(P)=2.64×10^{-5} *4*
79.807 *3*	5.10 *16*	136.435	7/2$^-$	56.625	5/2$^-$	M1+E2	0.18 *2*	4.64		α(K)=3.79 *6*; α(L)=0.661 *23*; α(M)=0.148 *6*; α(N+..)=0.0390 *14* α(N)=0.0339 *13*; α(O)=0.00480 *15*; α(P)=0.000236 *4*
85.669 *9*	0.413 *23*	395.264	7/2$^-$	309.590	5/2$^-$	M1+E2	0.65 *10*	4.07 *10*		α(K)=2.69 *11*; α(L)=1.07 *14*; α(M)=0.25 *4*; α(N+..)=0.064 *8* α(N)=0.057 *8*; α(O)=0.0072 *9*; α(P)=0.000158 *9*
99.419 *10*	0.65 *3*	235.853	9/2$^-$	136.435	7/2$^-$	E2		2.77		α(K)=1.139 *16*; α(L)=1.255 *18*; α(M)=0.301 *5*; α(N+..)=0.0756 *11* α(N)=0.0674 *10*; α(O)=0.00810 *12*; α(P)=4.72×10^{-5} *7*
100.599 *8*	13.3 *5*	309.590	5/2$^-$	208.987	7/2$^+$	E1		0.304		α(K)=0.254 *4*; α(L)=0.0393 *6*; α(M)=0.00862 *12*; α(N+..)=0.00224 *4* α(N)=0.00196 *3*; α(O)=0.000267 *4*; α(P)=1.170×10^{-5} *17*
102.985 *22*	0.52 *6*	239.415	9/2$^+$	136.435	7/2$^-$	[E1]		0.285		α(K)=0.238 *4*; α(L)=0.0368 *6*; α(M)=0.00807 *12*; α(N+..)=0.00210 *3* α(N)=0.00183 *3*; α(O)=0.000250 *4*; α(P)=1.104×10^{-5} *16*
121.012 *14*	100.0 *18*	177.616	5/2$^+$	56.625	5/2$^-$	E1		0.185		α(K)=0.1553 *22*; α(L)=0.0235 *4*; α(M)=0.00515 *8*;

$^{159}_{66}Dy_{93}$-3

γ(^{159}Dy) (continued)

E_{γ}[†]	I_{γ}[‡#&]	E_i(level)	J_i^{π}	E_f	J_f^{π}	Mult.[@]	δ[@]	α[a]	$I_{(\gamma+ce)}$[&]	Comments
										α(N+..)=0.001341 19; α(N)=0.001172 17; α(O)=0.0001615 23; α(P)=7.36×10^{-6} 11
131.973 10	65.2 12	309.590	5/2⁻	177.616	5/2⁺	E1		0.1470		α(K)=0.1234 18; α(L)=0.0185 3; α(M)=0.00405 6; α(N+..)=0.001056 15; α(N)=0.000922 13; α(O)=0.0001276 18; α(P)=5.91×10^{-6} 9
136.438 20	1.15 4	136.435	7/2⁻	0	3/2⁻	E2		0.879		α(K)=0.486 7; α(L)=0.303 5; α(M)=0.0720 10; α(N+..)=0.0182 3; α(N)=0.01618 23; α(O)=0.00198 3; α(P)=2.12×10^{-5} 3
152.375 13	2.94 16	208.987	7/2⁺	56.625	5/2⁻	E1		0.1000		α(K)=0.0841 12; α(L)=0.01245 18; α(M)=0.00272 4; α(N+..)=0.000712 10; α(N)=0.000622 9; α(O)=8.66×10^{-5} 13; α(P)=4.11×10^{-6} 6
155.851 13	5.36 18	395.264	7/2⁻	239.415	9/2⁺	E1		0.0941		α(K)=0.0792 11; α(L)=0.01170 17; α(M)=0.00256 4; α(N+..)=0.000670 10; α(N)=0.000584 9; α(O)=8.15×10^{-5} 12; α(P)=3.89×10^{-6} 6
159.426 16	1.00 5	395.264	7/2⁻	235.853	9/2⁻	M1		0.637		α(K)=0.537 8; α(L)=0.0785 11; α(M)=0.01724 25; α(N+..)=0.00461 7; α(N)=0.00399 6; α(O)=0.000584 9; α(P)=3.34×10^{-5} 5
173.155 17	5.92 14	309.590	5/2⁻	136.435	7/2⁻	M1		0.506		α(K)=0.426 6; α(L)=0.0623 9; α(M)=0.01367 20; α(N+..)=0.00365 6; α(N)=0.00316 5; α(O)=0.000463 7; α(P)=2.65×10^{-5} 4
177.608 10	14.8 6	177.616	5/2⁺	0	3/2⁻	E1		0.0665		α(K)=0.0560 8; α(L)=0.00820 12; α(M)=0.00179 3; α(N+..)=0.000470 7; α(N)=0.000410 6; α(O)=5.74×10^{-5} 8; α(P)=2.80×10^{-6} 4
179.250 22	0.35 4	235.853	9/2⁻	56.625	5/2⁻	E2		0.342		α(K)=0.220 3; α(L)=0.0942 14; α(M)=0.0222 4; α(N+..)=0.00564 8; α(N)=0.00500 7; α(O)=0.000626 9; α(P)=1.021×10^{-5} 15
186.274 9	9.3 4	395.264	7/2⁻	208.987	7/2⁺	E1		0.0586		α(K)=0.0494 7; α(L)=0.00720 10; α(M)=0.001575 22; α(N+..)=0.000413 6; α(N)=0.000360 5; α(O)=5.06×10^{-5} 7; α(P)=2.48×10^{-6} 4
195.40 5	0.122 17	504.972	9/2⁻	309.590	5/2⁻	E2		0.255		α(K)=0.1701 24; α(L)=0.0659 10; α(M)=0.01548 22; α(N+..)=0.00394 6; α(N)=0.00349 5; α(O)=0.000441 7; α(P)=8.07×10^{-6} 12
217.647 8	10.1 3	395.264	7/2⁻	177.616	5/2⁺	E1		0.0390		α(K)=0.0329 5; α(L)=0.00475 7; α(M)=0.001037 15; α(N+..)=0.000273 4; α(N)=0.000238 4; α(O)=3.35×10^{-5} 5; α(P)=1.682×10^{-6} 24
252.963 8	37.8 11	309.590	5/2⁻	56.625	5/2⁻	M1		0.179		α(K)=0.1507 22; α(L)=0.0218 3; α(M)=0.00478 7; α(N+..)=0.001278 18; α(N)=0.001106 16; α(O)=0.0001622 23; α(P)=9.32×10^{-6} 13
258.822 11	5.08 17	395.264	7/2⁻	136.435	7/2⁻	M1		0.1679		α(K)=0.1417 20; α(L)=0.0205 3; α(M)=0.00449 7; α(N+..)=0.001200 17; α(N)=0.001039 15; α(O)=0.0001524 22; α(P)=8.76×10^{-6} 13
265.56 6	0.56 3	504.972	9/2⁻	239.415	9/2⁺	E1		0.0234		α(K)=0.0198 3; α(L)=0.00282 4; α(M)=0.000615 9; α(N+..)=0.0001621 23; α(N)=0.0001410 20; α(O)=2.00×10^{-5} 3; α(P)=1.031×10^{-6} 15
269.11 5	0.229 24	504.972	9/2⁻	235.853	9/2⁻	M1		0.1511		α(K)=0.1276 18; α(L)=0.0184 3; α(M)=0.00404 6;

γ(^{159}Dy) (continued)

E_γ [†]	I_γ [‡#&]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [@]	δ [@]	α [a]	Comments
									α(N+..)=0.001080 *16* α(N)=0.000935 *13*; α(O)=0.0001371 *20*; α(P)=7.88×10^{-6} *11*
295.939 *23*	1.49 *6*	504.972	9/2$^-$	208.987	7/2$^+$	[E1]		0.01779	α(K)=0.01507 *22*; α(L)=0.00213 *3*; α(M)=0.000465 *7*; α(N+..)=0.0001228 *18* α(N)=0.0001068 *15*; α(O)=1.523×10^{-5} *22*; α(P)=7.94×10^{-7} *12* E_γ: Reported as 295.393 *23* in one table, but the listed value is given in another table.
309.594 *18*	47.6 *16*	309.590	5/2$^-$	0	3/2$^-$	M1		0.1038	α(K)=0.0877 *13*; α(L)=0.01261 *18*; α(M)=0.00276 *4*; α(N+..)=0.000739 *11* α(N)=0.000640 *9*; α(O)=9.38×10^{-5} *14*; α(P)=5.41×10^{-6} *8*
^{x}326.30 *4*	0.046 *4*								
338.63 *3*	2.22 *19*	395.264	7/2$^-$	56.625	5/2$^-$	M1+E2	0.65 *20*	0.071 *5*	α(K)=0.059 *5*; α(L)=0.0094 *3*; α(M)=0.00208 *5*; α(N+..)=0.000552 *15* α(N)=0.000480 *13*; α(O)=6.86×10^{-5} *25*; α(P)=3.5×10^{-6} *4*
^{x}353.68 *18*	0.067 *10*								
^{x}372.00 *13*	0.033 *8*								
^{x}385.38 *15*	0.037 *6*								
395.258 *14*	0.97 *3*	395.264	7/2$^-$	0	3/2$^-$	E2		0.0287	α(K)=0.0225 *4*; α(L)=0.00482 *7*; α(M)=0.001096 *16*; α(N+..)=0.000285 *4* α(N)=0.000250 *4*; α(O)=3.38×10^{-5} *5*; α(P)=1.224×10^{-6} *18*
^{x}412.3 *9*	0.026 *5*								
^{x}417.45 *16*	0.032 *6*					E1,E2			
448.46 *4*	0.031 *4*	504.972	9/2$^-$	56.625	5/2$^-$	E2		0.0202	α(K)=0.01610 *23*; α(L)=0.00321 *5*; α(M)=0.000726 *11*; α(N+..)=0.000189 *3* α(N)=0.0001659 *24*; α(O)=2.27×10^{-5} *4*; α(P)=8.91×10^{-7} *13*
^{x}453.21 *9*	0.043 *8*					E2		0.0197	α(K)=0.01567 *22*; α(L)=0.00311 *5*; α(M)=0.000702 *10*; α(N+..)=0.000183 *3* α(N)=0.0001604 *23*; α(O)=2.19×10^{-5} *3*; α(P)=8.68×10^{-7} *13*
^{x}472.53 *15*	0.108 *5*								
^{x}543.51 *9*	0.056 *13*								
^{x}546.25 *17*	0.93 *7*								
^{x}565.85 *10*	0.094 *5*					E2		0.01106	α(K)=0.00900 *13*; α(L)=0.001603 *23*; α(M)=0.000359 *5*; α(N+..)=9.42×10^{-5} *14* α(N)=8.23×10^{-5} *12*; α(O)=1.146×10^{-5} *16*; α(P)=5.09×10^{-7} *8*
^{x}580.75 *20*	0.097 *9*								
585.54 *6*	0.086 *5*	1090.560	7/2$^-$	504.972	9/2$^-$	M1		0.0199	α(K)=0.01685 *24*; α(L)=0.00237 *4*; α(M)=0.000519 *8*; α(N+..)=0.0001388 *20* α(N)=0.0001201 *17*; α(O)=1.765×10^{-5} *25*; α(P)=1.027×10^{-6} *15*
^{x}603.08 *12*	0.074 *5*								
^{x}608.69 *17*	0.046 *5*								
^{x}618.0 *5*	0.062 *10*								
620.95 *4*	0.76 *4*	1016.236	5/2$^-$	395.264	7/2$^-$	M1+E2	0.59 *16*	0.0150 *9*	α(K)=0.0127 *8*; α(L)=0.00184 *9*; α(M)=0.000403 *19*;

$^{159}_{66}$Dy$_{93}$-5

γ(^{159}Dy) (continued)

E_γ[†]	I_γ[‡#&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	δ[@]	α[a]	Comments
									α(N+..)=0.000107 *5* α(N)=9.3×10^{-5} *5*; α(O)=1.36×10^{-5} *7*; α(P)=7.6×10^{-7} *5*
649.42	0.039 *8*	1153.674	5/2$^-$,7/2$^-$	504.972	9/2$^-$	[M1,E2]		0.012 *4*	E_γ: Uncertainty reported as 0.06 keV, but energy differs by 0.68 keV from level energy difference. The large difference suggests γ might be misplaced or Eγ value incorrectly given.
^{x}658.11 *12*	0.068 *5*					(M1)		0.01483	α(K)=0.01258 *18*; α(L)=0.001765 *25*; α(M)=0.000386 *6*; α(N+..)=0.0001031 *15* α(N)=8.92×10^{-5} *13*; α(O)=1.312×10^{-5} *19*; α(P)=7.65×10^{-7} *11*
680.79 *6*	0.052 *3*	1075.837	5/2$^-$	395.264	7/2$^-$	[M1,E2]		0.010 *4*	
695.25 *3*	0.189 *27*	1090.560	7/2$^-$	395.264	7/2$^-$	M1		0.01293	α(K)=0.01097 *16*; α(L)=0.001536 *22*; α(M)=0.000336 *5*; α(N+..)=8.98×10^{-5} *13* α(N)=7.77×10^{-5} *11*; α(O)=1.142×10^{-5} *16*; α(P)=6.66×10^{-7} *10*
706.648 *15*	3.26 *7*	1016.236	5/2$^-$	309.590	5/2$^-$	M1		0.01242	α(K)=0.01054 *15*; α(L)=0.001475 *21*; α(M)=0.000322 *5*; α(N+..)=8.62×10^{-5} *12* α(N)=7.46×10^{-5} *11*; α(O)=1.096×10^{-5} *16*; α(P)=6.40×10^{-7} *9*
758.330 *24*	0.165 *6*	1153.674	5/2$^-$,7/2$^-$	395.264	7/2$^-$	M1+E2	0.87 *5*	0.00832 *19*	α(K)=0.00702 *16*; α(L)=0.001019 *21*; α(M)=0.000224 *5*; α(N+..)=5.96×10^{-5} *12* α(N)=5.17×10^{-5} *11*; α(O)=7.52×10^{-6} *16*; α(P)=4.19×10^{-7} *10*
766.12 *5*	0.323 *8*	1075.837	5/2$^-$	309.590	5/2$^-$	M1+E2	0.59 *13*	0.0089 *5*	α(K)=0.0076 *4*; α(L)=0.00108 *5*; α(M)=0.000236 *10*; α(N+..)=6.3×10^{-5} *3* α(N)=5.46×10^{-5} *22*; α(O)=8.0×10^{-6} *4*; α(P)=4.55×10^{-7} *23* E_γ: Uncertainty increased from 0.022 keV, due to inconsistency with other γ′s from this level.
780.99 *3*	0.134 *5*	1090.560	7/2$^-$	309.590	5/2$^-$	M1+E2	0.77 *20*	0.0080 *6*	α(K)=0.0068 *5*; α(L)=0.00097 *6*; α(M)=0.000214 *13*; α(N+..)=5.7×10^{-5} *4* α(N)=4.9×10^{-5} *3*; α(O)=7.2×10^{-6} *5*; α(P)=4.1×10^{-7} *4*
807.236 *16*	3.54 *7*	1016.236	5/2$^-$	208.987	7/2$^+$	E1		0.00188	α(K)=0.001606 *23*; α(L)=0.000215 *3*; α(M)=4.67×10^{-5} *7*; α(N+..)=1.243×10^{-5} *18* α(N)=1.078×10^{-5} *15*; α(O)=1.570×10^{-6} *22*; α(P)=8.92×10^{-8} *13*
838.625 *18*	10.61 *25*	1016.236	5/2$^-$	177.616	5/2$^+$	E1		1.75×10^{-3}	α(K)=0.001491 *21*; α(L)=0.000199 *3*; α(M)=4.33×10^{-5} *6*; α(N+..)=1.152×10^{-5} *17* α(N)=9.98×10^{-6} *14*; α(O)=1.455×10^{-6} *21*; α(P)=8.29×10^{-8} *12*

γ(^{159}Dy) (continued)

E_γ [†]	I_γ [‡#&]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [@]	α [a]	Comments
								E_γ: From the decay-scheme table (table 5) of 1982Vy02, but given as 838.635 *18* in the table of γ radiation (table 2) of the same reference.
843.78 *7*	0.073 *11*	1153.674	5/2$^-$,7/2$^-$	309.590	5/2$^-$	[M1,E2]	0.0062 *19*	E_γ: Uncertainty reported as 0.07 keV, but energy differs by 0.32 keV from level energy difference. The large difference suggests γ might be misplaced or Eγ value incorrectly given.
851.133 *19*	0.696 *16*	1090.560	7/2$^-$	239.415	9/2$^+$	E1	1.70×10^{-3}	α(K)=0.001449 *21*; α(L)=0.000194 *3*; α(M)=4.20×10^{-5} *6*; α(N+..)=1.119×10^{-5} *16* α(N)=9.69×10^{-6} *14*; α(O)=1.413×10^{-6} *20*; α(P)=8.06×10^{-8} *12*
^{x}862.94 *6*	0.060 *5*							
866.82 *4*	0.109 *4*	1075.837	5/2$^-$	208.987	7/2$^+$	[E1]	1.64×10^{-3}	α(K)=0.001399 *20*; α(L)=0.000187 *3*; α(M)=4.05×10^{-5} *6*; α(N+..)=1.079×10^{-5} *16* α(N)=9.35×10^{-6} *13*; α(O)=1.363×10^{-6} *19*; α(P)=7.78×10^{-8} *11*
^{x}874.67 *6*	0.063 *9*					(M1)	0.00735	α(K)=0.00624 *9*; α(L)=0.000867 *13*; α(M)=0.000189 *3*; α(N+..)=5.06×10^{-5} *7* α(N)=4.38×10^{-5} *7*; α(O)=6.44×10^{-6} *9*; α(P)=3.77×10^{-7} *6*
879.55 *20*	0.248 *7*	1016.236	5/2$^-$	136.435	7/2$^-$	E2	0.00399	α(K)=0.00334 *5*; α(L)=0.000511 *8*; α(M)=0.0001129 *16*; α(N+..)=2.99×10^{-5} *5* α(N)=2.60×10^{-5} *4*; α(O)=3.72×10^{-6} *6*; α(P)=1.92×10^{-7} *3* E_γ: Uncertainty increased from 0.04 keV, due to inconsistency with energy of 1016 γ from this level.
881.55 *3*	1.034 *22*	1090.560	7/2$^-$	208.987	7/2$^+$	E1	1.58×10^{-3}	α(K)=0.001354 *19*; α(L)=0.000181 *3*; α(M)=3.92×10^{-5} *6*; α(N+..)=1.044×10^{-5} *15* α(N)=9.04×10^{-6} *13*; α(O)=1.319×10^{-6} *19*; α(P)=7.53×10^{-8} *11*
892.288 *23*	0.252 *8*	1201.921	5/2$^-$,7/2$^-$	309.590	5/2$^-$	M1	0.00700	α(K)=0.00595 *9*; α(L)=0.000825 *12*; α(M)=0.000180 *3*; α(N+..)=4.82×10^{-5} *7* α(N)=4.17×10^{-5} *6*; α(O)=6.13×10^{-6} *9*; α(P)=3.59×10^{-7} *5*
898.167 *25*	0.135 *3*	1075.837	5/2$^-$	177.616	5/2$^+$	E1	1.53×10^{-3}	α(K)=0.001306 *19*; α(L)=0.0001742 *25*; α(M)=3.78×10^{-5} *6*; α(N+..)=1.006×10^{-5} *14* α(N)=8.72×10^{-6} *13*; α(O)=1.272×10^{-6} *18*; α(P)=7.27×10^{-8} *11*
913.119	0.741 *15*	1090.560	7/2$^-$	177.616	5/2$^+$	E1	1.48×10^{-3}	α(K)=0.001266 *18*; α(L)=0.0001687 *24*; α(M)=3.66×10^{-5} *6*; α(N+..)=9.75×10^{-6} *14* α(N)=8.44×10^{-6} *12*; α(O)=1.232×10^{-6} *18*; α(P)=7.05×10^{-8} *10* E_γ: Uncertainty reported as 0.020 keV, but energy differs by 0.12 keV from level-energy difference. The large difference suggests γ might be misplaced or Eγ value incorrectly given.
939.45 *3*	0.137 *4*	1075.837	5/2$^-$	136.435	7/2$^-$	E2	0.00347	α(K)=0.00291 *4*; α(L)=0.000439 *7*; α(M)=9.66×10^{-5} *14*; α(N+..)=2.56×10^{-5} *4* α(N)=2.22×10^{-5} *4*; α(O)=3.20×10^{-6} *5*; α(P)=1.676×10^{-7} *24*
944.85 *4*	0.118 *5*	1153.674	5/2$^-$,7/2$^-$	208.987	7/2$^+$	E1	1.39×10^{-3}	α(K)=0.001187 *17*; α(L)=0.0001579 *23*; α(M)=3.43×10^{-5} *5*; α(N+..)=9.12×10^{-6} *13* α(N)=7.90×10^{-6} *11*; α(O)=1.154×10^{-6} *17*; α(P)=6.61×10^{-8} *10*

$^{159}_{66}Dy_{93}$-7

γ(^{159}Dy) (continued)

E_γ[†]	I_γ[‡#&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	α[a]	Comments
[x]951.37 *10*	0.040 *3*							
954.19 *9*	0.034 *3*	1090.560	7/2⁻	136.435	7/2⁻	E0+(M1,E2)		Mult.: %E0≈1.0, with deduced value depending on M1,E2 mixture.
959.66 *5*	0.089 *4*	1016.236	5/2⁻	56.625	5/2⁻	E0+(M1,E2)		Mult.: %E0≈1.0, with deduced value depending on M1,E2 mixture.
976.09 *4*	0.127 *6*	1153.674	5/2⁻,7/2⁻	177.616	5/2⁺	(E1)	1.31×10^{-3}	α(K)=0.001116 *16*; α(L)=0.0001483 *21*; α(M)=3.22×10^{-5} *5*; α(N+..)=8.57×10^{-6} *12* α(N)=7.42×10^{-6} *11*; α(O)=1.084×10^{-6} *16*; α(P)=6.23×10^{-8} *9*
[x]981.80 *5*	0.059 *4*							
992.940 *25*	0.213 *5*	1201.921	5/2⁻,7/2⁻	208.987	7/2⁺	E1	1.26×10^{-3}	α(K)=0.001081 *16*; α(L)=0.0001436 *20*; α(M)=3.11×10^{-5} *5*; α(N+..)=8.29×10^{-6} *12* α(N)=7.18×10^{-6} *10*; α(O)=1.049×10^{-6} *15*; α(P)=6.03×10^{-8} *9*
[x]1002.23 *22*	0.024 *2*							
1016.356	1.32 *3*	1016.236	5/2⁻	0	3/2⁻	M1	0.00510	α(K)=0.00434 *6*; α(L)=0.000600 *9*; α(M)=0.0001309 *19*; α(N+..)=3.50×10^{-5} *5* α(N)=3.03×10^{-5} *5*; α(O)=4.46×10^{-6} *7*; α(P)=2.62×10^{-7} *4* E_γ: Uncertainty reported as 0.021 keV, but energy differs by 0.10 keV from level energy difference. The large difference suggests γ might be misplaced or Eγ value incorrectly given.
1019.20 *3*	0.543 *13*	1075.837	5/2⁻	56.625	5/2⁻	E0+(M1,E2)		Mult.: %E0≈0.9, with deduced value depending on M1,E2 mixture.
1024.317 *24*	0.675 *15*	1201.921	5/2⁻,7/2⁻	177.616	5/2⁺	E1	1.19×10^{-3}	α(K)=0.001021 *15*; α(L)=0.0001353 *19*; α(M)=2.94×10^{-5} *5*; α(N+..)=7.82×10^{-6} *11* α(N)=6.77×10^{-6} *10*; α(O)=9.90×10^{-7} *14*; α(P)=5.70×10^{-8} *8*
1034.00 *3*	0.146 *3*	1090.560	7/2⁻	56.625	5/2⁻	E2	0.00284	α(K)=0.00239 *4*; α(L)=0.000353 *5*; α(M)=7.76×10^{-5} *11*; α(N+..)=2.06×10^{-5} *3* α(N)=1.79×10^{-5} *3*; α(O)=2.58×10^{-6} *4*; α(P)=1.379×10^{-7} *20*
[x]1038.33 *10*	0.0197 *14*							
1047.62 *10*	0.0196 *20*	1286.92		239.415	9/2⁺			
1061.11 *4*	0.065 *2*	1370.684	5/2⁺	309.590	5/2⁻			
1065.43 *6*	0.044 *3*	1201.921	5/2⁻,7/2⁻	136.435	7/2⁻	E2	0.00267	α(K)=0.00225 *4*; α(L)=0.000330 *5*; α(M)=7.25×10^{-5} *11*; α(N+..)=1.92×10^{-5} *3* α(N)=1.671×10^{-5} *24*; α(O)=2.41×10^{-6} *4*; α(P)=1.298×10^{-7} *19* Mult.: Given as E2 in the table of γ radiation (table 2), but not listed in the decay-scheme table (table 5).
1075.87 *3*	0.349 *8*	1075.837	5/2⁻	0	3/2⁻	E2	0.00262	α(K)=0.00221 *3*; α(L)=0.000323 *5*; α(M)=7.10×10^{-5} *10*; α(N+..)=1.88×10^{-5} *3* α(N)=1.635×10^{-5} *23*; α(O)=2.36×10^{-6} *4*; α(P)=1.273×10^{-7} *18*
1078.0 *5*	0.020 *4*	1286.92		208.987	7/2⁺			

γ(^{159}Dy) (continued)

E_γ [†]	I_γ [‡#&]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [@]	α [a]	Comments
1097.03 *6*	0.051 *2*	1153.674	5/2⁻,7/2⁻	56.625	5/2⁻	[M1,E2]	0.0034 *9*	
1109.48 *9*	0.029 *2*	1286.92		177.616	5/2⁺			
1145.32 *3*	0.160 *4*	1201.921	5/2⁻,7/2⁻	56.625	5/2⁻	E2	0.00231	α(K)=0.00195 *3*; α(L)=0.000282 *4*; α(M)=6.18×10^{-5} *9*; α(N+..)=1.779×10^{-5} *25* α(N)=1.425×10^{-5} *20*; α(O)=2.06×10^{-6} *3*; α(P)=1.124×10^{-7} *16*; α(IPF)=1.368×10^{-6} *20*
1150.50 *8*	0.028 *2*	1286.92		136.435	7/2⁻			
1153.68 *3*	0.176 *4*	1153.674	5/2⁻,7/2⁻	0	3/2⁻	E2	0.00228	α(K)=0.00192 *3*; α(L)=0.000278 *4*; α(M)=6.09×10^{-5} *9*; α(N+..)=1.79×10^{-5} *3* α(N)=1.403×10^{-5} *20*; α(O)=2.03×10^{-6} *3*; α(P)=1.108×10^{-7} *16*; α(IPF)=1.752×10^{-6} *25*
1161.68 *5*	0.061 *2*	1370.684	5/2⁺	208.987	7/2⁺			
[x]1188.6 *3*	0.015 *5*							
1193.07 *3*	0.178 *4*	1370.684	5/2⁺	177.616	5/2⁺	E2	0.00213	α(K)=0.00180 *3*; α(L)=0.000258 *4*; α(M)=5.66×10^{-5} *8*; α(N+..)=1.97×10^{-5} *3* α(N)=1.305×10^{-5} *19*; α(O)=1.89×10^{-6} *3*; α(P)=1.038×10^{-7} *15*; α(IPF)=4.63×10^{-6} *7* E_γ: From the decay-scheme table (table 5) of 1982Vy02, but given as 1193.06 *3* in the table of γ radiations (table 2) in this reference. Mult.: Given as E2 in the decay-scheme table (table 5) of 1982Vy02, but no mult entry given in the table of γ radiations (table 2) of this reference.
[x]1199.31 *11*	0.028 *5*							
1201.93 *3*	0.488 *10*	1201.921	5/2⁻,7/2⁻	0	3/2⁻	E2	0.00210	α(K)=0.001771 *25*; α(L)=0.000254 *4*; α(M)=5.57×10^{-5} *8*; α(N+..)=2.03×10^{-5} *3* α(N)=1.284×10^{-5} *18*; α(O)=1.86×10^{-6} *3*; α(P)=1.023×10^{-7} *15*; α(IPF)=5.52×10^{-6} *8*
[x]1218.50 *13*	0.0156 *22*							
1230.19 *5*	0.059 *2*	1286.92		56.625	5/2⁻			
1234.26 *13*	0.0158 *24*	1370.684	5/2⁺	136.435	7/2⁻			
1313.88 *23*	0.0146 *13*	1370.684	5/2⁺	56.625	5/2⁻			
1370.53 *11*	0.0398 *16*	1370.684	5/2⁺	0	3/2⁻			
[x]1399.98 *25*	0.0094 *22*							
[x]1437.4 *3*	0.0058 *14*							
[x]1466.21 *23*	0.0102 *15*							
[x]1555.6 *3*	0.007 *4*							

[†] Several uncertainties were increased due to inconsistencies among the energies.

[‡] The measured K x-ray intensities (energies) are 110 *4* (Kα_2 x ray 45.207 keV), 197 *5* (Kα_1 x ray 45.998), 66 *3* (Kβ_1 x ray 52.1), and 17.2 *8* (Kβ_2 x ray 53.5).

From ENSDF

$\gamma(^{159}$Dy) (continued)

[#] The measured annihilation radiation intensity is 0.053 *5*. This value is unreasonably low if the β^+ were stopped at the source, since it implies a total I(β^+)≈0.11% compared with the measured total of 0.251% *7* (1982Vy02) and > 0.20% (1975GaYZ). So, it is reasonable to conclude that β^+ were not stopped in the source.

[@] From ^{159}Dy Adopted γ radiations, but based on measured data from this decay (1982Vy02). Others: 1966Gr25, 1968Ab15, and 1971Bo18.

[&] For absolute intensity per 100 decays, multiply by 0.362 *9*.

[a] 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.

[b] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

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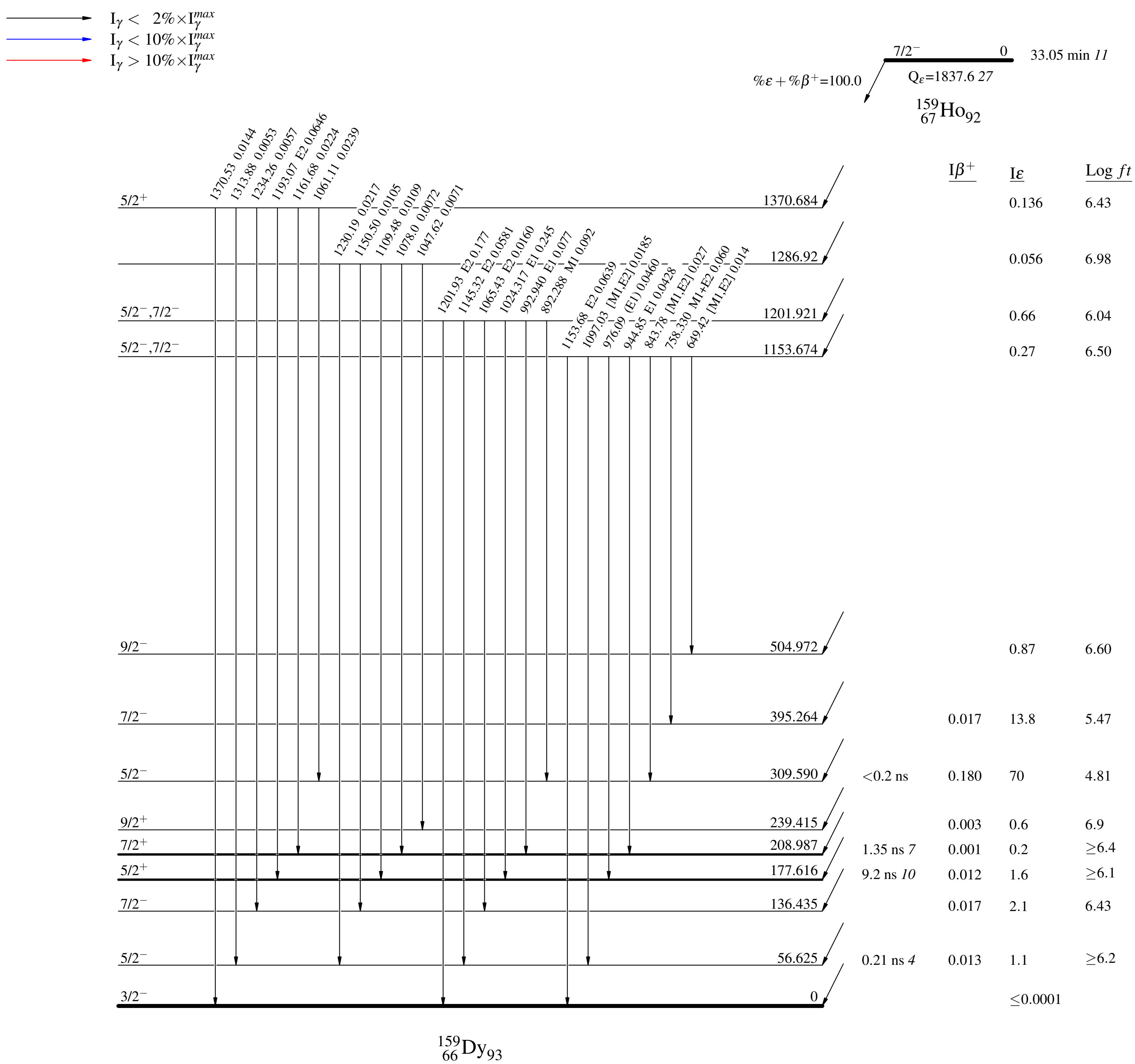
^{159}Ho ε decay 1982Vy02,1971Bo18

Decay Scheme

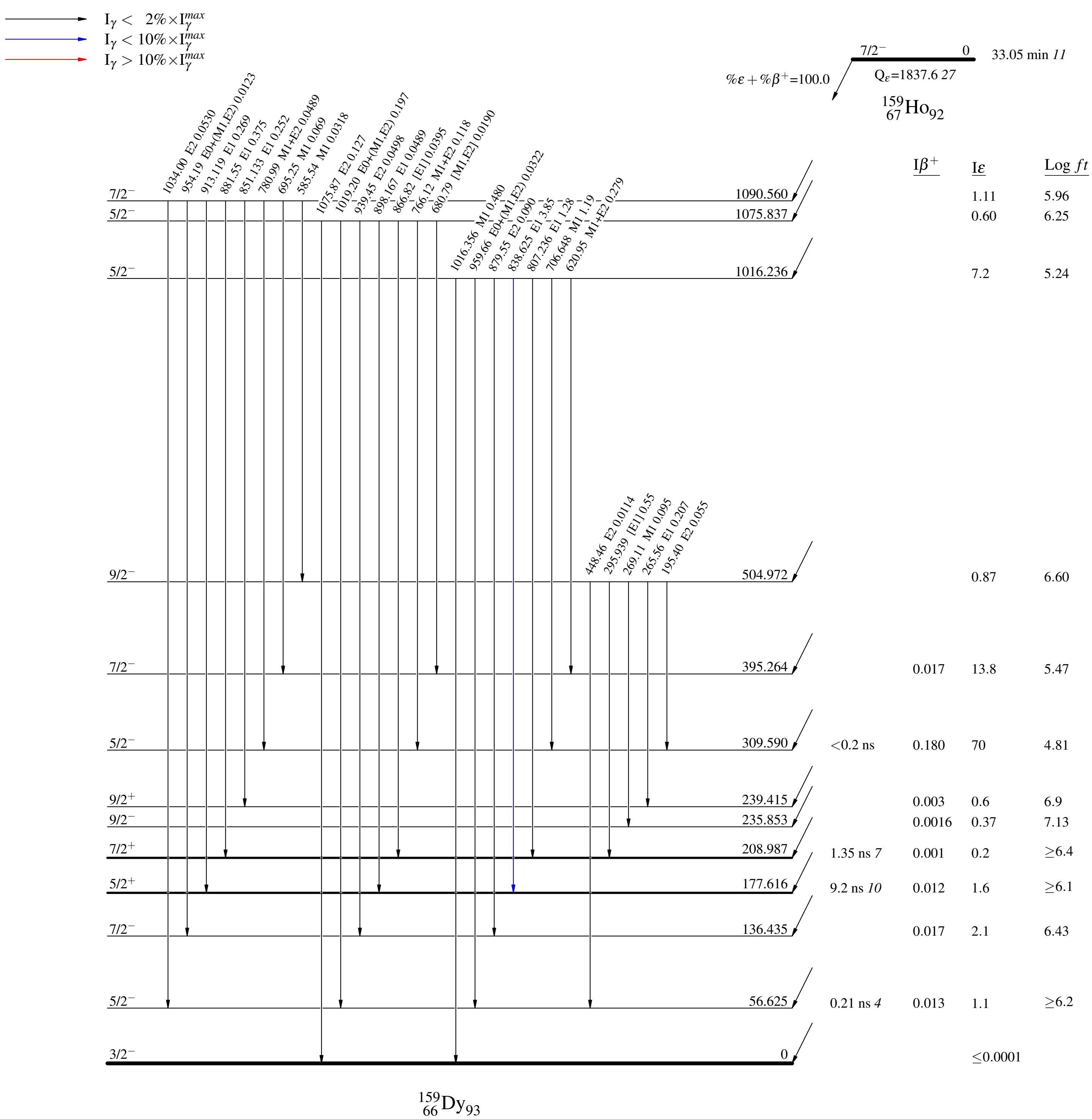
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays



^{159}Ho ε decay 1982Vy02,1971Bo18

Decay Scheme (continued)

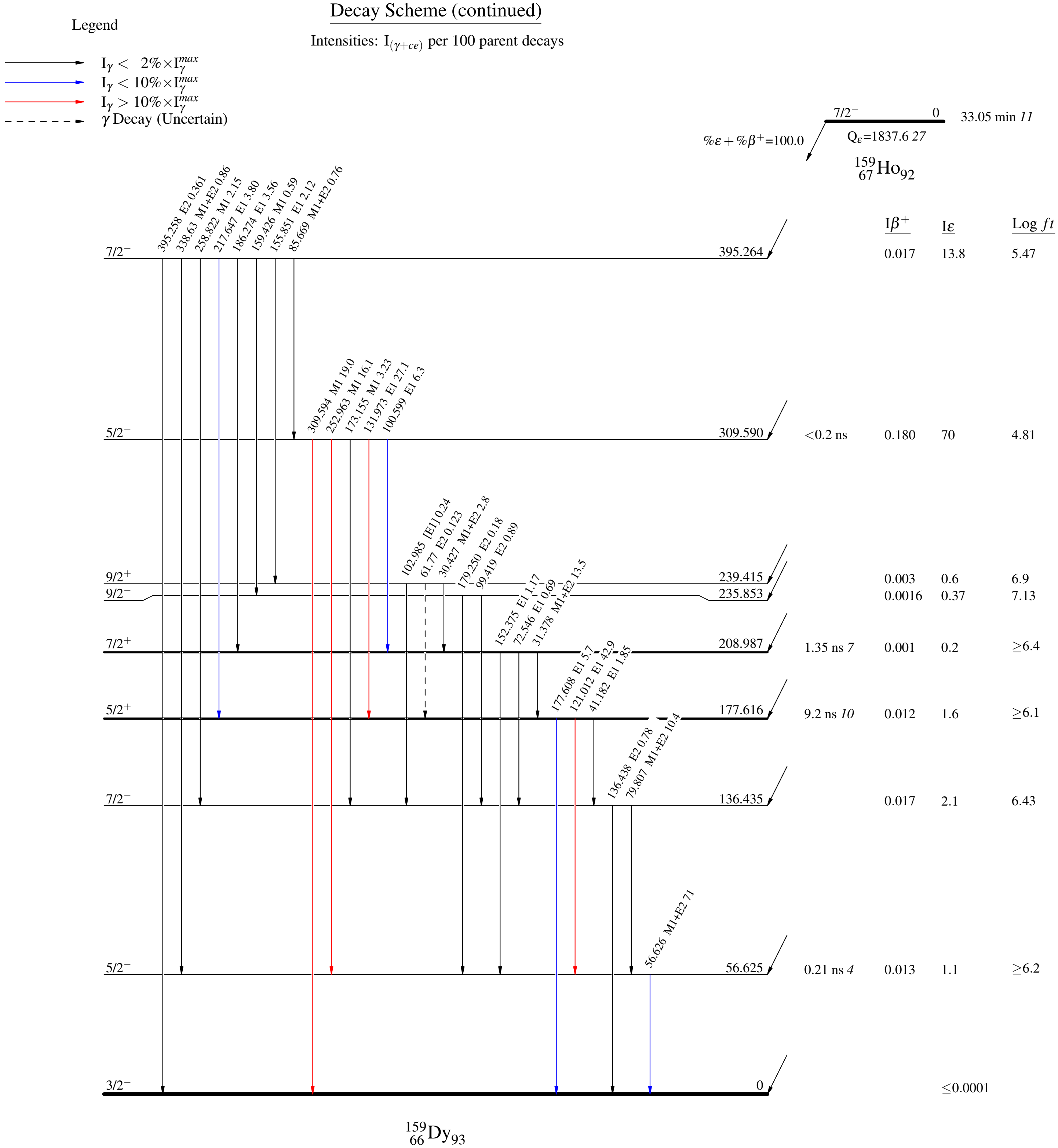
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays



^{159}Ho ε decay 1982Vy02,1971Bo18

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays



^{159}Ho ε decay 1982Vy02,1971Bo18