^{154}Ho $\varepsilon+\beta^+$ decay (3.10 min) 1980Zo02

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 200,2 (2025)	22-Aug-2022

Parent: ^{154}Ho: E=243 *28*; $J^\pi=8^+$; $T_{1/2}$=3.10 min *14*; Q(ε)=5755 *10*; %ε+%β^+ decay=100
^{154}Ho-E: From 2021Ko07.
^{154}Ho-Additional information 1.
^{154}Ho-Q($\varepsilon+\beta^+$): From 2021Wa16.
^{154}Ho-%ε+%β^+ decay: From %α<0.001 (1974Sc19).
Additional information 2.
Experimental methods:
1968Wa12: Produced by ^{148}Sm(^{11}B,5n) and (^{10}B,4n) with E(^{11}B)=75 MeV and E(^{10}B)=60 MeV. γ singles and $\gamma\gamma$ coincidences measured with Ge and NaI(Tl) detectors. Report 19 γ's.
1974Sc19: Produced by ^{147}Sm(^{10}B,3n) with E(^{10}B)=41 and 45 MeV. γ's measured with Ge detector; report 19 γ's.
1980Zo02: Produced by ^{148}Sm(^{11}B,5n) with E(^{11}B)=83 MeV. Measured γ singles and $\gamma\gamma$ coincidences with Ge detectors and ce with Si(Li) detectors. Reported 32 γ's, 16 with multipolarities. Preliminary reports: 1975ZoZT and 1977ZoZY.
1983Al06, 1983AlZP: Measured β^+ end-point with Ge detector.
1983GaZR: Measured ce with Si(Li) detector and reported α_K and α_L values.
1991AlZY: Measured β^+ end-points with Ge detector to determine isomer excitation energy.

^{154}Dy Levels

E(level)[†]	J^π[‡]	$T_{1/2}$[#]	Comments
0.0[@]	0^+	3.0×10^6 y *15*	
334.50[@] *10*	2^+	27.5 ps *20*	
746.98[@] *13*	4^+	6.9 ps *5*	
905.29[&] *13*	2^+		
1224.07[@] *15*	6^+	2.4 ps *4*	
1251.80[&] *15*	4^+		
1334.27[a] *22*	(3^+)		
1545.9[b] *4*	(5^-)		
1658.71[&] *16*	6^+		
1739.98[a] *19*	5^+		
1747.83[@] *17*	(8^+)	1.5 ps *3*	
1819.2[c] *5*	(4^-)		
1885.5[a] *3*	(6^+)		
1964.67[b] *25*	7^-		
2163.4[&] *3*	8^+		
2183.43[a] *21*	7^+		E(level): Note that this is not the same as the 2183.9 level proposed to be populated in the decay of 11.76-m ^{154}Ho. See the comment in that data set.
2192.4 *4*	(8^+)		
2472.89[d] *17*	7^+		

[†] From least-squares fit to γ energies.
[‡] Values reported by 1980Zo02. Based on γ multipolarities and expected band structure, including the results of nuclear-model calculations. These values are also the adopted ones, except for the 1334, 1743, and 2192 levels, which are shown here in parentheses.
[#] From the adopted values.
[@] Band(A): Ground-state band.
[&] Band(B): First excited 2^+ band. Denoted as a quasi-β band by 1980Zo02.

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^{154}Ho $\varepsilon+\beta^+$ decay (3.10 min) 1980Zo02 (continued)

^{154}Dy Levels (continued)

[a] Band(C): Quasi-gamma band.
[b] Band(D): Octupole-based band, odd-spin states.
[c] Band(E): Octupole-related level sequence.
[d] Band(F): 7^+ bandhead, probable configuration is (ν 3/2[532])+(ν 11/2[505]).

ε,β^+ radiations

Additional information 3.
av Eβ: Additional information 4.

E(decay)	E(level)	Iβ^+ ‡	Iε‡	Log *ft*	I($\varepsilon+\beta^+$)†‡	Comments
(3525 *30*)	2472.89	22.174	36.826	4.9	59	av Eβ=1125 *14*; εK=0.522 *8*; εL=0.0775 *12*; εM+=0.02419 *29*
(3806 *30*)	2192.4	0.49818	0.60182	6.7	1.1	av Eβ=1252 *14*; εK=0.458 *7*; εL=0.0678 *11*; εM+=0.02116 *27*
(3815 *30*)	2183.43	0.77396	0.92604	6.5	1.7	av Eβ=1256 *14*; εK=0.456 *7*; εL=0.0675 *11*; εM+=0.02108 *27*
(4033 *30*)	1964.67	1.2266	1.1734	6.5	2.4	av Eβ=1355 *14*; εK=0.409 *7*; εL=0.0606 *10*; εM+=0.01889 *25*
(4250 *30*)	1747.83	3.3715	2.6285	6.2	6	av Eβ=1454 *14*; εK=0.367 *6*; εL=0.0542 *9*; εM+=0.01691 *23* E(decay): 4340 *80* (1983Al06).

† Values are from computed γ-transition intensity balances. However, values for levels with J≤6 are set to 0. As a result of the method of normalizing the γ intensities and these deletions, the sum of the $\varepsilon+\beta^+$ intensities given is only 70%. Although other explanations are possible, most likely many γ transitions have not been seen. This idea is supported by the fact that many lower spin levels have positive computed feedings which could be eliminated by γ feeding from higher-lying levels. As a result of this ambiguity, no uncertainties are given.
‡ Absolute intensity per 100 decays.

$\gamma(^{154}Dy)$

Iγ normalization: Calculated to give 100% for γ feeding of ground state for ε decays. See footnote on I($\varepsilon+\beta^+$) values for added comments.

E$_\gamma$†‡	I$_\gamma$†[b]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.#	α[c]	Comments
280.4	1.4 *2*	2472.89	7^+	2192.4	(8^+)	[M1,E2]	0.11@ *3*	α(K)=0.09 *3*; α(L)=0.0163 *3*; α(M)=0.00366 *8*; α(N+..)=0.000961 *15* α(N)=0.000839 *13*; α(O)=0.000116 *7*; α(P)=5.0×10^{-6} *21* %Iγ=1.32 *19*
289.3 *2*	5.2 *4*	2472.89	7^+	2183.43	7^+	E0+M1,E2	0.23& *3*	%Iγ=4.9 *4* α(K)exp: 0.191 *21* (1980Zo02).
309.5 *2*	4.1 *3*	2472.89	7^+	2163.4	8^+	M1	0.1039	α(K)=0.0877 *13*; α(L)=0.01262 *18*; α(M)=0.00277 *4*; α(N+..)=0.000740 *11* α(N)=0.000640 *9*; α(O)=9.39×10^{-5} *14*; α(P)=5.41×10^{-6} *8* %Iγ=3.9 *3* α(K)exp: 0.094 *11* (1980Zo02).
334.6 *1*	100	334.50	2^+	0.0	0^+	E2	0.0464	α(K)=0.0355 *5*; α(L)=0.00850 *12*; α(M)=0.00195

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^{154}Ho $\varepsilon+\beta^+$ decay (3.10 min) 1980Zo02 (continued)

$\gamma(^{154}Dy)$ (continued)

E_γ[†‡]	I_γ[†b]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α[c]	Comments
								3; α(N+..)=0.000504 *7* α(N)=0.000443 *7*; α(O)=5.89×10^{-5} *9*; α(P)=1.88×10^{-6} *3* %Iγ=93.9 *3*
346.5 *1*	10.5 *7*	1251.80	4$^+$	905.29	2$^+$	E2	0.0419	α(K)exp: 0.036 (1980Zo02). α(K)=0.0322 *5*; α(L)=0.00752 *11*; α(M)=0.001721 *25*; α(N+..)=0.000446 *7* α(N)=0.000392 *6*; α(O)=5.22×10^{-5} *8*; α(P)=1.720×10^{-6} *25* %Iγ=9.9 *7*
405.8 *4*	3.1 *5*	1739.98	5$^+$	1334.27	(3$^+$)	[E2]	0.0266	α(K)=0.0209 *3*; α(L)=0.00442 *7*; α(M)=0.001004 *15*; α(N+..)=0.000261 *4* α(N)=0.000229 *4*; α(O)=3.10×10^{-5} *5*; α(P)=1.144×10^{-6} *17* %Iγ=2.9 *5*
406.9 *1*	20.2 *14*	1658.71	6$^+$	1251.80	4$^+$	E2	0.0264	α(K)exp: 0.019 *2* (1980Zo02), includes 404.8γ. α(K)=0.0208 *3*; α(L)=0.00438 *7*; α(M)=0.000995 *14*; α(N+..)=0.000259 *4* α(N)=0.000227 *4*; α(O)=3.08×10^{-5} *5*; α(P)=1.137×10^{-6} *16* %Iγ=19.0 *13*
412.4 *1*	84 *5*	746.98	4$^+$	334.50	2$^+$	E2	0.0255	α(K)exp: 0.019 *2* (1980Zo02), includes 404.8γ. α(K)=0.0201 *3*; α(L)=0.00419 *6*; α(M)=0.000952 *14*; α(N+..)=0.000248 *4* α(N)=0.000217 *3*; α(O)=2.95×10^{-5} *5*; α(P)=1.099×10^{-6} *16* %Iγ=79 *5*
434.7 *2*	2.7 *3*	1658.71	6$^+$	1224.07	6$^+$	E2+E0(+M1)	0.27[&] *3*	α(K)exp: 0.0205 *17* (1980Zo02). %Iγ=2.5 *3*
443.4 *2*	5.5 *4*	2183.43	7$^+$	1739.98	5$^+$	E2	0.0209	α(K)exp: 0.23 *3* (1980Zo02). α(K)=0.01658 *24*; α(L)=0.00333 *5*; α(M)=0.000753 *11*; α(N+..)=0.000196 *3* α(N)=0.0001719 *25*; α(O)=2.35×10^{-5} *4*; α(P)=9.16×10^{-7} *13* %Iγ=5.2 *4*
477.1 *1*	59 *3*	1224.07	6$^+$	746.98	4$^+$	E2	0.01714	α(K)exp: 0.015 *4* (1980Zo02). α(K)=0.01373 *20*; α(L)=0.00265 *4*; α(M)=0.000598 *9*; α(N+..)=0.0001562 *22* α(N)=0.0001367 *20*; α(O)=1.88×10^{-5} *3*; α(P)=7.65×10^{-7} *11* %Iγ=55 *3*
≈504.6	≈3.9	2163.4	8$^+$	1658.71	6$^+$	[E2]	0.01480	α(K)exp: 0.012 *2* (1980Zo02). α(K)≈0.01192; α(L)≈0.00224; α(M)≈0.000504; α(N+..)≈0.0001318 α(N)≈0.0001152; α(O)≈1.591×10^{-5}; α(P)≈6.68×10^{-7} %Iγ≈3.66
≈504.8	≈13.5	1251.80	4$^+$	746.98	4$^+$	E0+E2,M1	0.094[a] *15*	α(K)exp: 0.0626 *52* (1980Zo02), includes 504.8γ. %Iγ≈12.7
515.6 *3*	2.0 *3*	1739.98	5$^+$	1224.07	6$^+$	[M1,E2]	0.021 *7*	α(K)exp: 0.0626 *52* (1980Zo02), includes 504.6γ. α(K)=0.018 *7*; α(L)=0.0027 *7* %Iγ=1.9 *3*

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^{154}Ho $\varepsilon+\beta^+$ decay (3.10 min) 1980Zo02 (continued)

$\gamma(^{154}Dy)$ (continued)

E_γ †‡	I_γ †b	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	αc	Comments
523.8 *1*	19.5 *11*	1747.83	(8^+)	1224.07	6^+	E2	0.01344	α(K)=0.01087 *16*; α(L)=0.00200 *3*; α(M)=0.000450 *7*; α(N+..)=0.0001179 *17* α(N)=0.0001031 *15*; α(O)=1.427×10^{-5} *20*; α(P)=6.11×10^{-7} *9* %Iγ=18.3 *10* α(K)exp: 0.011 *2* (1980Zo02).
570.7 *1*	11.2 *6*	905.29	2^+	334.50	2^+	E0+E2,M1	0.025& *3*	%Iγ=10.5 *6* α(K)exp: 0.021 *3* (1980Zo02).
587.3d *3*	0.6d *2*	1334.27	(3^+)	746.98	4^+	[M1,E2]	0.015@ *5*	α(K)=0.012 *5*; α(L)=0.0019 *5*; α(M)=0.00042 *10*; α(N+..)=0.00011 *3* α(N)=9.7×10^{-5} *23*; α(O)=1.4×10^{-5} *4*; α(P)=7 %Iγ=0.56 *19* I_γ: Measured Iγ=1.3 *2* for doubly placed γ, decomposed by evaluator based on data from ^{154}Ho ε decay (11.8 m).
587.3de *3*	0.7d *4*	2472.89	7^+	1885.5	(6^+)	[M1,E2]	0.015@ *5*	α(K)=0.012 *5*; α(L)=0.0019 *5*; α(M)=0.00042 *10*; α(N+..)=0.00011 *3* α(N)=9.7×10^{-5} *23*; α(O)=1.4×10^{-5} *4*; α(P)=7 %Iγ=0.7 *4* I_γ: Intensity divided by evaluator, see 587 γ from 1334 level.
661.5 *3*	1.9 *5*	1885.5	(6^+)	1224.07	6^+	M1,E2	0.011@ *4*	α(K)=0.009 *3*; α(L)=0.0014 *4*; α(M)=0.00031 *8*; α(N+..)=8.2×10^{-5} *21* α(N)=7.1×10^{-5} *18*; α(O)=1.0×10^{-5} *3*; α(P)=5.6×10^{-7} *20* %Iγ=1.8 *5* α(K)exp: 0.013 *8* (1980Zo02).
725.1 *1*	13.3 *8*	2472.89	7^+	1747.83	(8^+)	M1+E2	0.009@ *3*	α(K)=0.0075 *25*; α(L)=0.0011 *3*; α(M)=0.00024 *6*; α(N+..)=6.4×10^{-5} *17* α(N)=5.6×10^{-5} *14*; α(O)=8.1×10^{-6} *22*; α(P)=4.5×10^{-7} *16* %Iγ=12.5 *8* α(K)exp: 0.0069 *12* (1980Zo02).
732.8 *2*	3.3 *3*	2472.89	7^+	1739.98	5^+	[E2]	0.00597	α(K)=0.00495 *7*; α(L)=0.000800 *12*; α(M)=0.0001775 *25*; α(N+..)=4.69×10^{-5} *7* α(N)=4.08×10^{-5} *6*; α(O)=5.78×10^{-6} *9*; α(P)=2.84×10^{-7} *4* %Iγ=3.1 *3*
740.6 *2*	2.5 *3*	1964.67	7^-	1224.07	6^+	[E1]	0.00223	α(K)=0.00191 *3*; α(L)=0.000256 *4*; α(M)=5.57×10^{-5} *8*; α(N+..)=1.481×10^{-5} *21* α(N)=1.284×10^{-5} *18*; α(O)=1.87×10^{-6} *3*; α(P)=1.056×10^{-7} *15* %Iγ=2.4 *3*
798.9 *3*	1.5 *3*	1545.9	(5^-)	746.98	4^+	[E1]	0.00192	α(K)=0.001639 *23*; α(L)=0.000220 *3*; α(M)=4.77×10^{-5} *7*; α(N+..)=1.270×10^{-5} *18* α(N)=1.100×10^{-5} *16*; α(O)=1.603×10^{-6} *23*; α(P)=9.10×10^{-8} *13* %Iγ=1.4 *3*

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^{154}Ho $\varepsilon+\beta^+$ decay (3.10 min) 1980Zo02 (continued)

$\gamma(^{154}Dy)$ (continued)

E_γ [†‡]	I_γ [†b]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	α [c]	Comments
814.2 *2*	15.0 *9*	2472.89	7^+	1658.71	6^+	M1+E2	0.0067 [@] *21*	α(K)=0.0057 *18*; α(L)=0.00083 *21*; α(M)=0.00018 *5*; α(N+..)=4.8×10^{-5} *13* α(N)=4.2×10^{-5} *11*; α(O)=6.1×10^{-6} *17*; α(P)=3.4×10^{-7} *12* %Iγ=14.1 *9* α(K)exp: 0.0057 *10* (1980Zo02).
905.2 *3*	1.8 *3*	905.29	2^+	0.0	0^+	[E2]	0.00375	α(K)=0.00314 *5*; α(L)=0.000478 *7*; α(M)=0.0001054 *15*; α(N+..)=2.79×10^{-5} *4* α(N)=2.43×10^{-5} *4*; α(O)=3.48×10^{-6} *5*; α(P)=1.81×10^{-7} *3* %Iγ=1.7 *3*
959.1 *3*	2.6 *3*	2183.43	7^+	1224.07	6^+	[M1,E2]	0.0046 [@] *13*	α(K)=0.0039 *11*; α(L)=0.00055 *14*; α(M)=0.00012 *3*; α(N+..)=3.2×10^{-5} *8* α(N)=2.8×10^{-5} *7*; α(O)=4.1×10^{-6} *11*; α(P)=2.3×10^{-7} *7* %Iγ=2.4 *3*
968.3 *3*	2.7 *3*	2192.4	(8^+)	1224.07	6^+	[E2]	0.00325	α(K)=0.00273 *4*; α(L)=0.000409 *6*; α(M)=9.01×10^{-5} *13*; α(N+..)=2.39×10^{-5} *4* α(N)=2.07×10^{-5} *3*; α(O)=2.98×10^{-6} *5*; α(P)=1.575×10^{-7} *22* %Iγ=2.5 *3*
992.9 *3*	5.3 *5*	1739.98	5^+	746.98	4^+	[M1,E2]	0.0042 [@] *12*	α(K)=0.0036 *10*; α(L)=0.00051 *13*; α(M)=0.00011 *3*; α(N+..)=3.0×10^{-5} *8* α(N)=2.6×10^{-5} *7*; α(O)=3.8×10^{-6} *10*; α(P)=2.1×10^{-7} *7* %Iγ=5.0 *5*
999.7 *3*	2.5 *3*	1334.27	(3^+)	334.50	2^+	[M1,E2]	0.0042 [@] *12*	α(K)=0.0035 *10*; α(L)=0.00050 *13*; α(M)=0.00011 *3*; α(N+..)=2.9×10^{-5} *8* α(N)=2.5×10^{-5} *7*; α(O)=3.7×10^{-6} *10*; α(P)=2.1×10^{-7} *7* %Iγ=2.4 *3*
1072.2 *4*	0.3 *1*	1819.2	(4^-)	746.98	4^+	[E1]	1.10×10^{-3}	α(K)=0.000938 *14*; α(L)=0.0001242 *18*; α(M)=2.69×10^{-5} *4*; α(N+..)=7.17×10^{-6} *10* α(N)=6.21×10^{-6} *9*; α(O)=9.09×10^{-7} *13*; α(P)=5.24×10^{-8} *8* %Iγ=0.28 *10*
1138.5 *3*	1.0 *2*	1885.5	(6^+)	746.98	4^+	[E2]	0.00234	α(K)=0.00197 *3*; α(L)=0.000286 *4*; α(M)=6.26×10^{-5} *9*; α(N+..)=1.775×10^{-5} *25* α(N)=1.444×10^{-5} *21*; α(O)=2.09×10^{-6} *3*; α(P)=1.138×10^{-7} *16*; α(IPF)=1.105×10^{-6} *19* %Iγ=0.94 *19*
1250.1 *7*	18.9 *10*	2472.89	7^+	1224.07	6^+	M1	0.00312	α(K)=0.00265 *4*; α(L)=0.000363 *6*; α(M)=7.92×10^{-5} *12*;

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^{154}Ho $\varepsilon+\beta^+$ decay (3.10 min) 1980Zo02 (continued)

$\gamma(^{154}Dy)$ (continued)

E_γ †‡	E_i(level)	Comments
		α(N+..)=3.46×10^{-5} *5* α(N)=1.83×10^{-5} *3*; α(O)=2.70×10^{-6} *4*; α(P)=1.591×10^{-7} *23*; α(IPF)=1.338×10^{-5} *22* %Iγ=17.8 *10* α(K)exp: 0.0032 *8* (1980Zo02).

† From evaluator′s average of the data of 1968Wa12, 1974Sc19, and 1980Zo02, but primarily from 1980Zo02.
‡ The 157.8 and 471.9 γ′s reported by 1968Wa12 are assigned to ^{152}Tb (4.2 m) by 1980Zo02.
# Assignments are from Adopted Gammas. However, they are primarily from this decay mode from α_K(exp) data (1980Zo02). Other: 1983GaZR.
@ Value computed assuming δ=1, with no uncertainty.
& Based on α_K(exp) (1980Zo02).
[a] Based on α_K(exp) (1980Zo02) from 11.76-m decay, where γ is not multiply placed.
[b] For absolute intensity per 100 decays, multiply by 0.939 *3*.
[c] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with "Frozen Orbitals" approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
[d] Multiply placed with intensity suitably divided.
[e] Placement of transition in the level scheme is uncertain.

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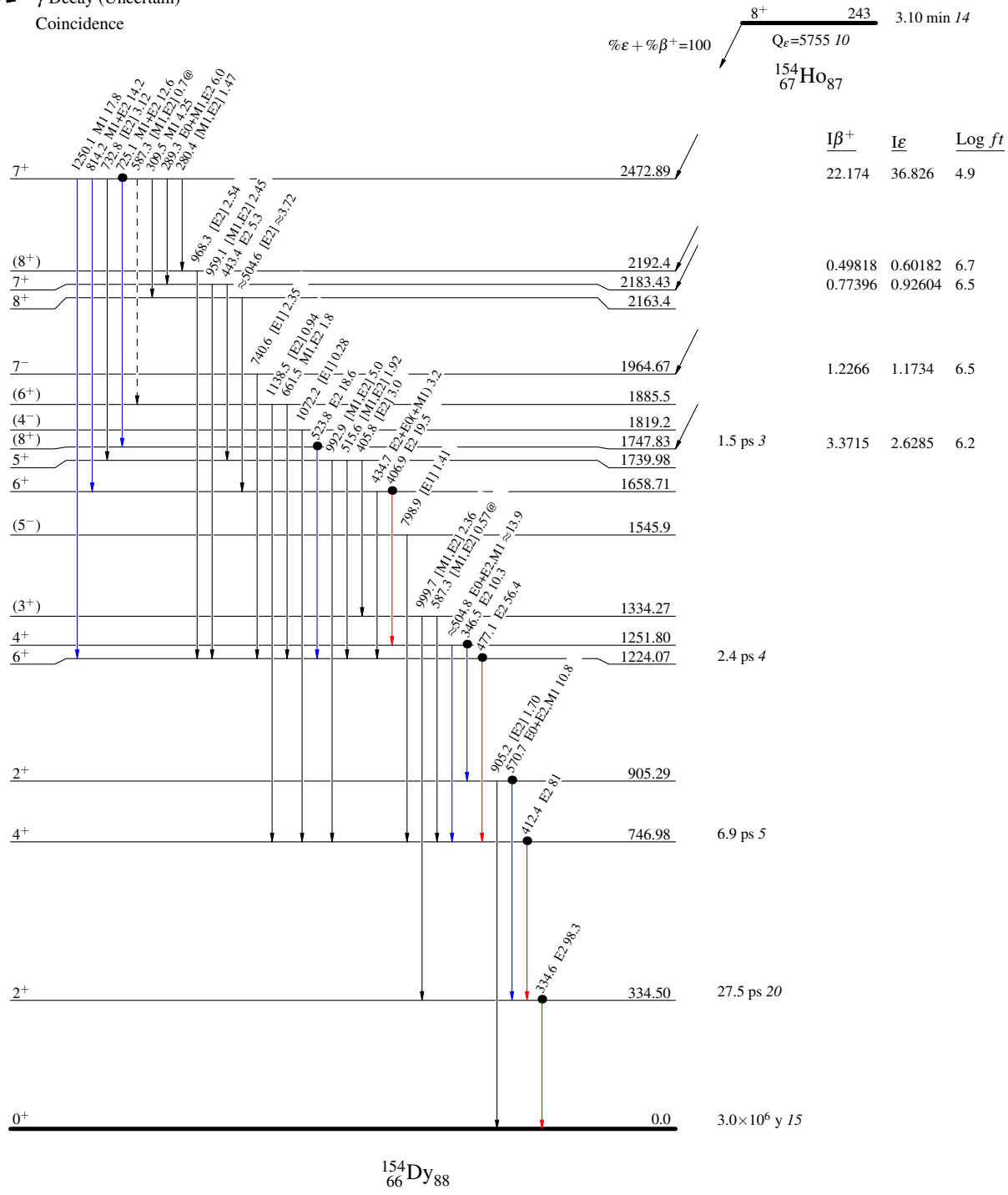
Decay Scheme

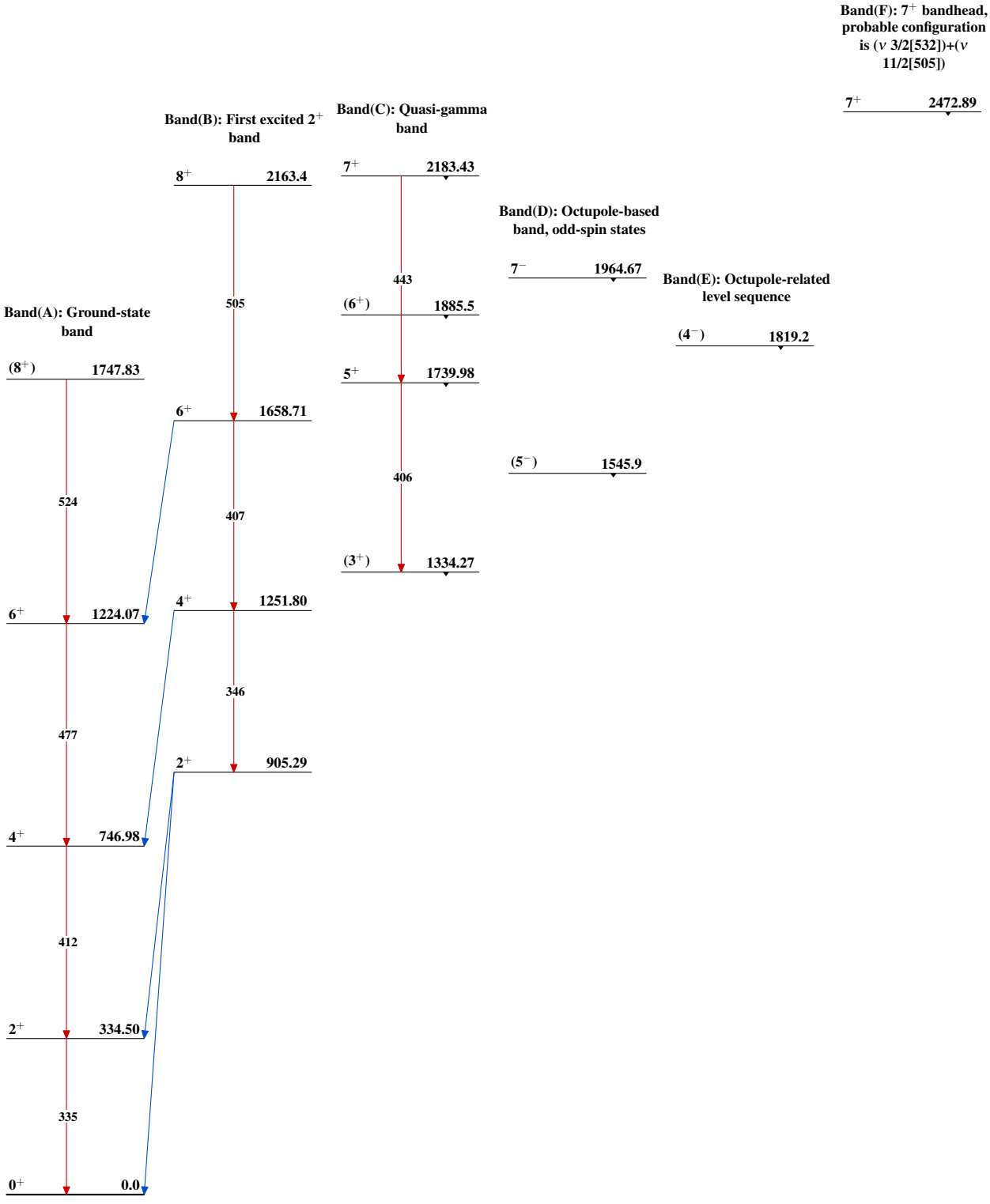
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
@ Multiply placed: intensity suitably divided

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



$^{154}_{66}Dy_{88}$

^{154}Ho ε decay (3.10 min) 1980Zo02



$^{154}_{66}Dy_{88}$