

^{157}Er ε decay [1978BrYV](#),[1977AnYX](#),[1979Al33](#)

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

Parent: ^{157}Er : $E=0$; $J^\pi=3/2^-$; $T_{1/2}=18.65$ min 10; $Q(\varepsilon)=3440$ 30; $\% \varepsilon + \% \beta^+$ decay=100.0

The decay scheme is primarily that of [1978BrYV](#) (a private communication) and is based on the γ data of [1977AnYX](#) (a thesis) and some level information from the ($^3\text{He},d$) and (α,t) reaction data of [1977Pa23](#).

This decay scheme is very tentative. There are several inconsistencies including some between the J^π and multipolarity assignments as well as with some spin and band assignments from the reaction data of [1977Pa23](#). Also, the decay scheme of [1979DzZZ](#), deduced from γ ce coincidence data, is quite different, but the latter information is not complete enough to use here.

For these studies, ^{157}Er has been produced by the reactions $\text{Ho}(p,xn)$, $\text{Dy}(^3\text{He},xn)$, $^{149}\text{Sm}(^{12}\text{C},4n)$, $^{141}\text{Pr}(^{20}\text{Ne},4n)^{157}\text{Tm}$ followed by ε decay, and spallation of Ta. Some studies used chemical or isotope separation. γ singles, $\gamma\gamma$ coincidences, γ ce coincidences, and lifetimes have been measured.

Experimental methods:

[1965Zh02](#): produced by spallation of Ta target with 660 MeV p. γ 's measured with NaI detector. Half-life of ^{157}Er determined from grow-in of ^{157}Dy .

[1966La11](#): produced by $\text{Ho}(p,xn)$ reaction with isotope separation. γ 's measured with NaI detector. 6 γ 's and half-life reported.

[1970LiZL](#): Conference report of J measurements; see [1969Ek01](#).

[1973AnYC](#): Progress report, describes methods used in [1977AnYX](#).

[1975AlYW](#): Conference abstract, report $T_{1/2}$, E_γ , I_γ , E_{β^+} and multipolarities.

[1975Gr44](#): Review of laboratory program; gives $T_{1/2}$ and level lifetime.

[1977AnZU](#): Abstract; see [1977AnYX](#) for complete measurement results.

[1977AnYX](#): produced by $^{149}\text{Sm}(^{12}\text{C},4n)$ on enriched (97.7%) target. γ singles and $\gamma\gamma$ coincidences were measured with Ge detectors. About 100 γ 's reported. Decay scheme only includes 14 γ 's and has been replaced by that of [1978BrYV](#).

[1977BoYR](#): produced by $\text{Dy}(^3\text{He},xn)$ with $E(^3\text{He})=80$ MeV followed by isotope separation. Measured γ singles, $\gamma\gamma$ coincidences.

[1978BrYV](#): private communication from D. S. Brenner to C. W. Reich, which consisted of a decay scheme drawing. This scheme replaces that of [1977AnYX](#) and it includes 41 γ 's. It uses the γ data from [1977AnYX](#) and to some extent makes use of the levels proposed by [1977Pa23](#) from ($^3\text{He},d$) and (α,t) studies.

[1979Al33](#): produced by spallation of Ta target with 660 MeV p beam. Lifetimes determined from $\text{cey}(t)$ coincidences.

[1979DzZZ](#): studied by cey coincidences; gives some results.

[1984GrZL](#): produced by decay of ^{157}Tm from $^{141}\text{Pr}(^{20}\text{Ne},4n)$ followed by chemical separation of Er. γ 's measured. $T_{1/2}$ determined, 25 γ 's observed.

[1987AlZP](#): Abstract, report $\delta(83)$.

[2012VaZY](#): give table of coincidences and a set of more than 20 new levels with no level scheme.

 ^{157}Ho Levels

Additional information 1.

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	Comments
0 [@]	$7/2^-$		
53.05 ^{&} 2	$5/2^+$	20 ns 1	$T_{1/2}$: from 1979Al33 .
66.91 ^a 2	$7/2^+$		
83.4 [@] 1	$9/2^-$	≤ 0.3 ns	E(level): Level added by evaluator based on (HI,xny) data and ^{157}Er ε decay schemes of 1979Al33 , 1979DzZZ , and 1987AlZP . $T_{1/2}$: from 1979Al33 .
91.13 ^b 12	$(3/2^+)$		Transitions depopulating this level have not been observed.
150.5 ^b 3	$(5/2^+)$		
174.44 8	$(3/2^+)$	0.58 ns 8	$T_{1/2}$: Weighted average of values measured for 121-keV γ , 0.54 ns 5 (1979Al33) and 0.75 ns 10 (1975Gr44).
177.00 10			E(level): Transitions depopulating this level have not been observed. J^π : Assigned $3/2, 1/2[411]$ with bandhead at 174 keV by 1978BrYV in ^{157}Er ε decay.

Continued on next page (footnotes at end of table)

^{157}Er ε decay [1978BrYV](#),[1977AnYX](#),[1979Al33](#) (continued) ^{157}Ho Levels (continued)

E(level) [†]	J ^π [‡]	Comments
271.03 <i>19</i>		J ^π : Assigned 5/2,1/2[411] with bandhead at 174 keV by 1978BrYV in ^{157}Er ε decay.
375.86 <i>14</i>		
391.32 ^c <i>9</i>	5/2 ⁻	
482.21 <i>13</i>	(1/2,3/2) ⁻	
527.81 ^d <i>10</i>		J ^π : Assigned (3/2 ⁻) by 1978BrYV , but not adopted.
531.46 <i>16</i>		
549.09 ^e <i>7</i>	(3/2 ⁻ ,5/2)	J ^π : Assigned both (5/2 ⁺),5/2[413] and 3/2 ⁻ in ^{157}Er ε decay.
570.39 <i>17</i>		
573.33 <i>17</i>		
584.06 <i>9</i>		
1195.92 <i>12</i>	(5/2 ⁻ ,7/2,9/2 ⁺)	
1203.28 <i>16</i>		
1403.34 <i>23</i>		
1487.13 <i>19</i>		

[†] From least-squares fit to γ energies, with uncertain γ 's omitted.

[‡] From ^{157}Ho Adopted Levels; significantly different assignments by [1978BrYV](#) are noted.

Values are from ^{157}Er ε decay only; measured by $\beta\gamma(t)$.

@ Band(A): 7/2[523] band.

& Band(B): 5/2[402] bandhead.

^a Band(C): 7/2[404] bandhead.

^b Band(D): 3/2[411] band.

^c Band(E): 5/2[532] bandhead

^d Band(F): $K^{\pi}=3/2^-$ band from K-2 γ -vibration built on 7/2⁻ g.s.

^e Band(G): 5/2[413] bandhead.

 ε, β^+ radiations

E(decay)	E(level)	$I\beta^+$ [‡]	$I\varepsilon^+$ [‡]	Log ft	$I(\varepsilon+\beta^+)$ ^{†‡}	Comments
(2.89×10^3) <i>3</i>	549.09	0.66 <i>8</i>	2.7 <i>3</i>	6.57 <i>6</i>	3.4 <i>4</i>	av $E\beta=845$ <i>14</i> ; $\varepsilon K=0.673$ <i>7</i> ; $\varepsilon L=0.1027$ <i>11</i> ; $\varepsilon M+=0.0303$ <i>3</i>
(3.05×10^3) <i>3</i>	391.32	3.5 <i>5</i>	11 <i>2</i>	6.00 <i>6</i>	15 <i>2</i>	av $E\beta=916$ <i>14</i> ; $\varepsilon K=0.638$ <i>7</i> ; $\varepsilon L=0.0971$ <i>11</i> ; $\varepsilon M+=0.0287$ <i>4</i>
(3.27×10^3) <i>3</i>	174.44	7.1 <i>18</i>	17 <i>4</i>	5.89 <i>11</i>	24 <i>6</i>	av $E\beta=1013$ <i>14</i> ; $\varepsilon K=0.587$ <i>8</i> ; $\varepsilon L=0.0891$ <i>12</i> ; $\varepsilon M+=0.0263$ <i>4</i>
						$I(\varepsilon+\beta^+)$: Value assumes that no more than 50% of 83 γ is from 174 level.

[†] Values are from γ intensity balances, with uncertain γ 's omitted. Due to the tentative nature of the decay scheme, only values over 2% and to levels above 155 keV are given. Values for lower energy levels are not meaningful since the γ transitions from the 91- and 177-keV have not been seen. These calculated values are not in conflict with the γ -intensity normalization ([1984GrZL](#)). The total $ec+\beta^+$ intensity given is 42%.

[‡] Absolute intensity per 100 decays.

$\gamma(^{157}\text{Ho})$

I_γ normalization: from [1984GrZL](#), measured relative to γ 's in granddaughter. Normalization by 100% feeding of the ground state is not practical since the decay scheme is very tentative and for two strong γ 's that populate the ground state, the multipolarity assignments are in question.

E_γ [†]	I_γ ^{‡f}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [#]	δ [@]	α^e	Comments
53.05 2	≈170	53.05	5/2 ⁺	0	7/2 ⁻	(E1)		0.312	$\alpha(\text{L})=0.244$ 4; $\alpha(\text{M})=0.0541$ 8 $\alpha(\text{N})=0.01220$ 18; $\alpha(\text{O})=0.001566$ 22; $\alpha(\text{P})=5.65\times10^{-5}$ 8 I_γ : value is taken from 1975AlYW since it gives better intensity balance at this level; 1977AnYX gives ≈ 100.
^x 57.06&	1.4&					M1		13.02	$\alpha(\text{K})=10.89$ 16; $\alpha(\text{L})=1.668$ 24; $\alpha(\text{M})=0.368$ 6 $\alpha(\text{N})=0.0855$ 12; $\alpha(\text{O})=0.01242$ 18; $\alpha(\text{P})=0.000693$ 10
66.91 2	20.9 18	66.91	7/2 ⁺	0	7/2 ⁻	E1		0.912	$\alpha(\text{K})=0.749$ 11; $\alpha(\text{L})=0.1277$ 18; $\alpha(\text{M})=0.0282$ 4 $\alpha(\text{N})=0.00639$ 9; $\alpha(\text{O})=0.000838$ 12; $\alpha(\text{P})=3.24\times10^{-5}$ 5 E_γ : 1977BoYR suggest this γ is doublet with second component having lifetime of 0.3 s. Mult.: Multipolarity assignment of (M1+E2) by 1975AlYW and 1977BoYR is inconsistent with J^π assignments.
^x 68.60&	1.2&								
^x 71.3&	0.6&								
83.4 ^g 1	12.2 ^g 16	83.4	9/2 ⁻	0	7/2 ⁻	(M1+E2)	-0.16 4	4.43	$\alpha(\text{K})=3.64$ 6; $\alpha(\text{L})=0.61$ 4; $\alpha(\text{M})=0.137$ 9 $\alpha(\text{N})=0.0317$ 20; $\alpha(\text{O})=0.00450$ 22; $\alpha(\text{P})=0.000226$ 4 E_γ : Placement made by evaluator and based on lifetime of 1979Al33.
83.4 ^{gh} 1	12.2 ^g 16	174.44	(3/2 ⁺)	91.13?	(3/2 ⁺)	(M1+E2)	-0.16 4	4.43	$\alpha(\text{K})=3.64$ 6; $\alpha(\text{L})=0.61$ 4; $\alpha(\text{M})=0.137$ 9 $\alpha(\text{N})=0.0317$ 20; $\alpha(\text{O})=0.00450$ 22; $\alpha(\text{P})=0.000226$ 4 E_γ : Placement of this γ here is doubtful since the associated $T_{1/2}$ is different from that of 121-keV γ .
^x 88.6&	0.9&								
^x 117.4 3	3.3 7								
121.4 1	71 14	174.44	(3/2 ⁺)	53.05	5/2 ⁺	(M1)		1.500	$\alpha(\text{K})=1.261$ 18; $\alpha(\text{L})=0.187$ 3; $\alpha(\text{M})=0.0412$ 6 $\alpha(\text{N})=0.00958$ 14; $\alpha(\text{O})=0.001393$ 20; $\alpha(\text{P})=7.81\times10^{-5}$ 11
^x 136.6&	1.2&								
^x 142.0 3	0.88 22								
^x 144.3 3	1.7 3								
150.4 ^h 1	21 4	150.5?	(5/2 ⁺)	0	7/2 ⁻	[E1]		0.1067	$\alpha(\text{K})=0.0896$ 13; $\alpha(\text{L})=0.01344$ 19; $\alpha(\text{M})=0.00296$ 5 $\alpha(\text{N})=0.000677$ 10; $\alpha(\text{O})=9.35\times10^{-5}$ 14; $\alpha(\text{P})=4.32\times10^{-6}$ 6 Mult.: Multipolarity assignment of (M1+E2) by 1977BoYR is inconsistent with J^π values which require E1. $\alpha(\text{M1+E2})=0.74$ 10.
^x 154.4&	1.2&								

¹⁵⁷Er ε decay [1978BrYV](#),[1977AnYX](#),[1979Al33](#) (continued)

γ(¹⁵⁷Ho) (continued)

E _γ †	I _γ ‡,f	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. #	α ^e	Comments
157.8 2	1.11 18	549.09	(3/2 ⁻ ,5/2)	391.32	5/2 ⁻			
^x 160.6 3	4.5 5							
^x 168.9 &	1.5 &							
^x 174.6 &	2.0 &							
179.8 2	8.3 4	271.03		91.13?	(3/2 ⁺)			
^x 182.3 ^c	3.8 &							
^x 183.6 &	2.6 &							
199.0 2	0.4	375.86		177.00				
201.4 2	1.5 4	375.86		174.44	(3/2 ⁺)			
^x 205.6 &	2.6 &							
^x 211.8 &	1.8 &							
^x 238.3 5	1.6							
^x 264.7 &	2.6 &							
284.6 2	0.86 11	375.86		91.13?	(3/2 ⁺)			
302.2 2	2.4 4	573.33		271.03				
^x 303.6 1	8.7 8							
305.1 1	3.2 5	482.21	(1/2,3/2) ⁻	177.00				
308.2 2	2.6 6	482.21	(1/2,3/2) ⁻	174.44	(3/2 ⁺)	[E1]	0.01671	α(K)=0.01413 20; α(L)=0.00201 3; α(M)=0.000442 7 α(N)=0.0001018 15; α(O)=1.443×10 ⁻⁵ 21; α(P)=7.39×10 ⁻⁷ 11
^x 317.6 2	3.6 4							
^x 347.7 1	11.3 9							
^x 349.5 3	1.4 4							
354.6 3	1.7 3	531.46		177.00				
357.0 2	3.5 6	531.46		174.44	(3/2 ⁺)			
372.1 1	1.80 20	549.09	(3/2 ⁻ ,5/2)	177.00				
374.6 1	0.61 13	549.09	(3/2 ⁻ ,5/2)	174.44	(3/2 ⁺)			
391.32 9	100 6	391.32	5/2 ⁻	0	7/2 ⁻	(M1)	0.0607	α(K)=0.0513 8; α(L)=0.00740 11; α(M)=0.001628 23 α(N)=0.000378 6; α(O)=5.52×10 ⁻⁵ 8; α(P)=3.13×10 ⁻⁶ 5
398.9 2	1.0 3	573.33		174.44	(3/2 ⁺)			
^x 411.7 2	0.31 11							
422.8 2	2.1 4	573.33		150.5?	(5/2 ⁺)			
^x 431.0 1	5.2 10							
436.7 2	0.70 23	527.81		91.13?	(3/2 ⁺)			
440.2 3	1.2 4	531.46		91.13?	(3/2 ⁺)			
^x 442.7 3	1.9 6							
^x 443.6 3	1.5 5							
^x 456.2 1	1.01 25							
^x 460.5 2	2.9 6							
^x 474.4 2	1.3 4							
^x 481.0 4	≈0.5							
482.4 ^g 3	1.0 ^g	549.09	(3/2 ⁻ ,5/2)	66.91	7/2 ⁺			
482.4 ^g 3	1.0 ^g	573.33		91.13?	(3/2 ⁺)			

¹⁵⁷Er ε decay [1978BrYV](#),[1977AnYX](#),[1979Al33](#) (continued)

$\gamma(^{157}\text{Ho})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^{\ddagger f}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$I_\gamma^{\ddagger f}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
493.1 2	1.11 23	584.06		91.13?	(3/2 ⁺)	^x 942.0 2	1.8 4				
^x 502.5 3	1.9 4					^x 960.7 2	1.5 5				
503.5 2	5.9 4	570.39		66.91	7/2 ⁺	^x 972.2 2	<i>d</i>				
517.3 ^g 3	1.8 ^g 5	570.39		53.05	5/2 ⁺	^x 980.5 2	0.80 17				
517.3 ^g 3	1.8 ^g 5	584.06		66.91	7/2 ⁺	1026.4 2	1.1 3	1203.28		177.00	
^x 518.5 3	2.4 7					1028.7 2	0.8 4	1203.28		174.44	(3/2 ⁺)
^x 524.4 ^{&}	6.5 ^{&}					^x 1114.7 1	1.33 20				
527.8 1	4.8 6	527.81		0	7/2 ⁻	1129.0 2	1.2 4	1195.92	(5/2 ⁻ , 7/2, 9/2 ⁺)	66.91	7/2 ⁺
^x 538.1 3	≤1.1					^x 1137.8 2	0.40 13				
549.1 1	19.2 21	549.09	(3/2 ⁻ , 5/2)	0	7/2 ⁻	^x 1141.2 2	<i>d</i>				
^x 560.9 3	0.6 2					1142.8 2	1.9 5	1195.92	(5/2 ⁻ , 7/2, 9/2 ⁺)	53.05	5/2 ⁺
^x 564.4 1	1.52 23					^x 1148.3 3	<1.5				
^x 569.0 ^a						^x 1154.0 3	1.2 4				
^x 574.0 1	3.2 4					^x 1184.5 3	0.42 17				
584.0 1	3.7 4	584.06		0	7/2 ⁻	1196.0 2	2.1 4	1195.92	(5/2 ⁻ , 7/2, 9/2 ⁺)	0	7/2 ⁻
^x 611.0 1	4.8 5					^x 1205.5 3	1.3 4				
^x 614.7 1	0.9 3					1226.2 5	≤0.6	1403.34		177.00	
^x 641.0 ^b	2.0 ^b 2					1228.9 3	1.7 4	1403.34		174.44	(3/2 ⁺)
^x 651.8 1	3.3 4					^x 1238.1 1	1.7 5				
^x 672.0 2	1.68 25					^x 1242.7 1	3.3 6				
^x 673.5 2	2.2 3					^x 1246.9 2	<i>d</i>				
^x 694.6 1	1.3 5					^x 1278.8 2	1.4 5				
^x 719.5 5	1.0					1310.2 2	1.1 4	1487.13		177.00	
^x 735.6 2	<1.0					1312.5 3	0.7 3	1487.13		174.44	(3/2 ⁺)
^x 747.5 ^b	3.5 ^b 3					^x 1373.7 2	1.8 5				
^x 785.8 2	2.0 4					^x 1378.4 3	1.4 4				
^x 792.6 2	1.99 23					^x 1391.7 2	1.8 5				
^x 796.0 2	1.10 20					^x 1396.4 3	1.3 4				
^x 807.5 ^b	2.4 ^b 3					^x 1398.2 2	1.8 5				
^x 816.7 2	<i>d</i>					1403.4 4	1.0	1403.34		0	7/2 ⁻
^x 824.8 2	<i>d</i>					^x 1422.5 2	6.3 9				
^x 889.7 ^a						^x 1433.1 2	3.1 6				
^x 910.6 3	1.8 5					^x 2170.0 5	3.5 4				
^x 921.1 1	0.53 7					^x 2217.5 3	2.2 3				

[†] From [1977AnYX](#), unless noted as from [1975AlYW](#), [1977BoYR](#), or [1984GrZL](#); these latter three articles list only a few γ 's.

[‡] From [1977AnYX](#), unless noted as from [1975AlYW](#) or [1984GrZL](#).

[#] From ¹⁵⁷Ho Adopted γ radiations, but primarily from this ε decay ([1975AlYW](#), [1977BoYR](#)), where no supporting data are given by the authors.

$\gamma(^{157}\text{Ho})$ (continued)

@ From ¹⁵⁷Ho Adopted γ radiations.

& From [1975AlYW](#) only.

^a From [1977BoYR](#) only.

^b From [1984GrZL](#) only.

^c From [1975AlYW](#) and [1977BoYR](#).

^d Weak ([1977AnYX](#)).

^e [Additional information 2](#).

^f For absolute intensity per 100 decays, multiply by 0.142 *IO*.

^g Multiply placed with undivided intensity.

^h Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

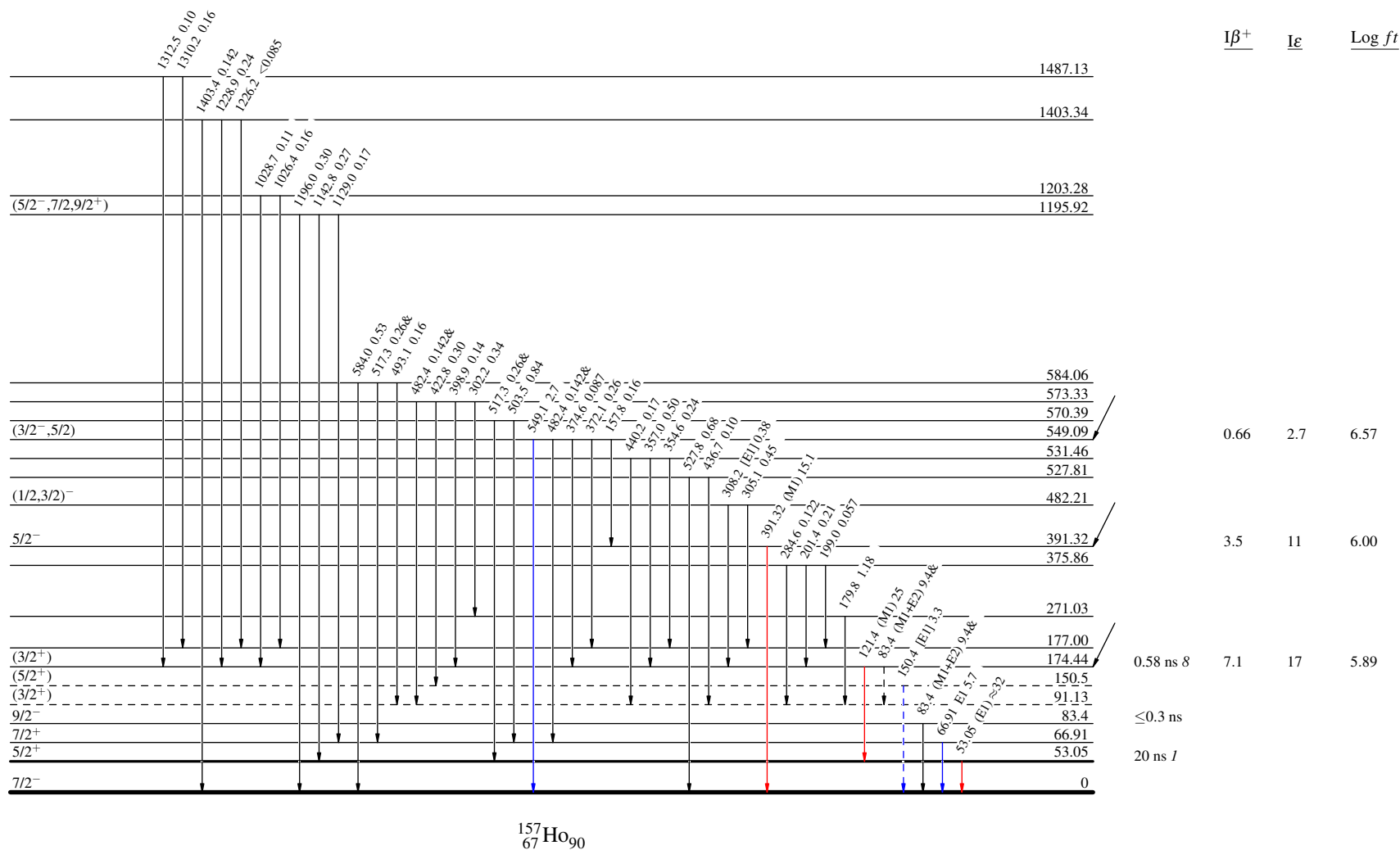
¹⁵⁷Er ε decay ¹⁹⁷⁸BrYV,¹⁹⁷⁷AnYX,¹⁹⁷⁹Al33

Decay Scheme

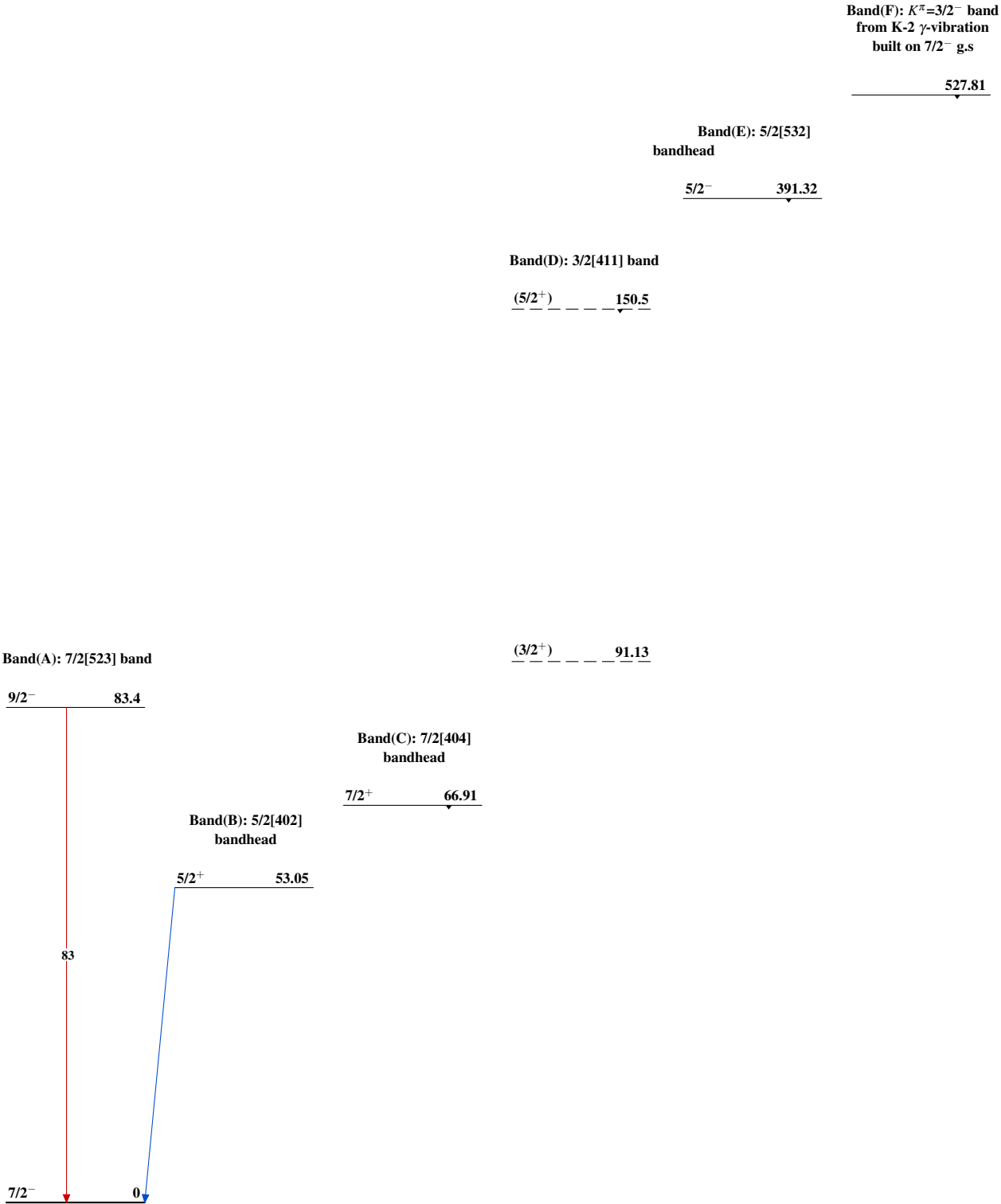
Intensities: I_(γ+ce) per 100 parent decays
& Multiply placed: undivided intensity given

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - γ Decay (Uncertain)



^{157}Er ϵ decay 1978BrYV,1977AnYX,1979Al33



^{157}Er ε decay **1978BrYV,1977AnYX,1979Al33 (continued)**

Band(G): 5/2[413]
bandhead

$(3/2^-, 5/2)$	<u>549.09</u>
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$^{157}_{67}\text{Ho}_{90}$