^{156}Eu β^- decay 1974Kl09,1980Iw04,1976Ya11

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 113, 2537 (2012)	1-Mar-2012

Parent: ^{156}Eu: E=0; $J^\pi=0^+$; $T_{1/2}$=15.19 d *8*; $Q(\beta^-)$=2449 *5*; %β^- decay=100.0

^{156}Eu-J^π: Additional information 2.

^{156}Eu-$T_{1/2}$: Additional information 3.

^{156}Eu-$Q(\beta^-)$: Additional information 4.

Additional information 5.

There are many studies of this decay, including 1961Cl02, 1962Ba38, 1962Ew01, 1962Ju09, 1963Th02, 1964Ew04, 1964Pe17, 1966Da05, 1966Dz08, 1966Ha08, 1967Ge07, 1967Ha38, 1967Va23, 1968Al01, 1969GuZW, 1969Ni11, 1970Ra37, 1970Ru09, 1971Ru05, 1972Ha17, 1972Kl01, 1974Kl09, 1976Ya11, 1977Co22, 1980Iw04, 1981Bu24, 1981Ch07, and 1993Po19.

1974Kl09: ^{156}Eu from ^{154}Sm(2n,β^-) on enriched (99.54%) ^{154}Sm samples, followed by chemical separation. γ singles and $\gamma\gamma$ coincidences measured using Ge detectors. Report Eγ and Iγ for 95 γ's and multipolarities for 31 γ's from other ce data. See also 1972Ha17, 1972Kl01, and 1973HaWB by common authors.

1976Ya11: ^{156}Eu from ^{154}Sm(2n,β^-) on enriched (99.54%) ^{154}Sm samples followed by chemical separation. ce measured in magnetic spectrometer. Report 47 Eγ and multipolarities.

1980Iw04: ^{156}Eu from ^{154}Sm(2n,β^-) on enriched ^{154}Sm. γ singles measured using Ge detector. Report 89 Iγ (no Eγ). Also studied ^{156}Tb decay.

1993GrZU and 1995GrZY analyze previous ^{156}Eu β^- decay data and (n,γ) data to place previously unplaced γ's. They also propose J^π values for several levels.

Some other studies: 1961Cl02; 1962Ba38; 1962Ew01; 1962Ju09; 1963Th02; 1964Ew04; 1964Pe17; 1966Da05; 1966Dz08; 1966Ha08; 1967Ha38; 1967Va23; 1968Al01; 1969GuZW; 1969Ni11; 1970Ra37; 1970Ru09; 1971Ru05; 1972Ha17; 1972Kl01; 1972KlZV; 1973HaWB; 1977Co22; 1981Bu24; 1981Ch07; 1993Po19. For a brief discussion of the experimental details, see the ENSDF file.

From (n,γ) data, 1995GrZY reanalyze existing ^{156}Eu β^- decay data and place some previously unplaced γ's, leading to the introduction of several new levels into the level scheme. These proposals are generally adopted here, although those levels which are not expected to be directly populated by β^- transitions because of J^π considerations are shown as questionable.

^{156}Gd Levels

The coincidence data on the drawings are from 1974Kl09.

E(level)[‡]	J^π[#]	$T_{1/2}$[†]	Comments
0[@]	0^+	stable	
88.966[@] *10*	2^+	2.20 ns *3*	$T_{1/2}$: Weighted average of 2.22 ns *6* (1962Ba38), 2.17 ns *5* (1965Me08) and 2.22 ns *8* (1966Mc07).
288.182[@] *15*	4^+		
1049.41[&] *5*	0^+		
1129.38[&] *3*	2^+		
1154.13 *4*	2^+	<0.35 ns	Bandhead of the γ-vibrational band. $T_{1/2}$: From 1962Ba38.
1168.14[a] *4*	0^+		
1242.47[b] *3*	1^-		
1258.04[a] *3*	2^+		
1276.13?[b] *16*	3^-		
1319.63[b] *4*	2^-		
1366.45 *3*	1^-		Bandhead of the $K^\pi=0^-$ octupole-vibrational band.
1715.16[c] *4*	0^+		
1771.03[c] *6*	2^+		
1780	2^-		

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^{156}Eu β^- decay 1974Kl09,1980Iw04,1976Ya11 (continued)

^{156}Gd Levels (continued)

E(level)[‡]	J$^\pi$[#]	Comments
1827.48?	2^+	
1851.05 *12*	0^+	
1946.46 *8*	1^-	
1952.38 *4*	0^-	Proposed conf=π5/2[413]-π5/2[532] (2005Gr21).
1962	1^-	
1965.91 *3*	1^+	
1988.5 *2*	0^+	
2026.60 *4*	1^+	
2054.19 *21*	2^+	
2070.7 *4*	3^+	
2121.42 *11*	2^-	
2186.74 *4*	1^+	
2199.50 *13*	2^-	
2203.5 *6*	$1^-,2^-$	
2205.47 *5*	1^-	
2259.95 *14*	1^-	
2269.89 *3*	1^+	
2293.44 *12*	1^-	
2300.75 *8*	1^+	
2344.4 *4*	1^-	
2360.78 *15*	1^+	

[†] Data here are only from the ^{156}Eu decay; see ^{156}Gd Adopted Levels for a summary of all the level half-life results.
[‡] From a least-squares fit to the γ energies.
[#] From ^{156}Gd Adopted Levels.
[@] Band(A): K$^\pi$=0^+ g.s. band.
[&] Band(B): First excited K$^\pi$=0^+ band.
[a] Band(C): K$^\pi$=0^+ band.
[b] Band(D): K$^\pi$=1^- octupole-vibrational band.
[c] Band(E): K$^\pi$=0^+ band.

β^- radiations

E(decay)[†@]	E(level)	Iβ^-[‡#&]	Log *ft*	Comments
(88 *5*)	2360.78	0.026 *3*	8.00 *10*	av Eβ=23.4 *14*
(105 *5*)	2344.4	0.010 *2*	8.64 *11*	av Eβ=27.9 *14*
(148 *5*)	2300.75	0.123 *11*	8.02 *6*	av Eβ=40.1 *15*
(156 *5*)	2293.44	0.90 *7*	7.22 *6*	av Eβ=42.2 *15*
(179 *5*)	2269.89	4.2 *4*	6.74 *6*	av Eβ=49.0 *15*
(189 *5*)	2259.95	0.052 *5*	8.72 *6*	av Eβ=51.9 *15*
(244 *5*)	2205.47	2.2 *2*	7.44 *5*	av Eβ=68.2 *16*
(246 *5*)	2203.5	0.15 *4*	8.61 *12*	av Eβ=68.8 *16*
(250 *5*)	2199.50	0.079 *8*	8.57[1u] *6*	av Eβ=81.4 *17*
(262 *5*)	2186.74	10.3 *10*	6.87 *5*	av Eβ=73.9 *16*
(328 *5*)	2121.42	0.13 *1*	8.87[1u] *5*	av Eβ=107.6 *17*
(422 *5*)	2026.60	5.7 *6*	7.79 *5*	av Eβ=125.5 *17*
(483 *5*)	1965.91	29 *3*	7.28 *5*	av Eβ=146.1 *18*
(487 *5*)	1962	0.059 *13*	9.98 *10*	av Eβ=147.5 *18*
(497 *5*)	1952.38	0.92 *8*	8.82 *4*	av Eβ=150.8 *18*
(503 *5*)	1946.46	0.39 *4*	9.21 *5*	av Eβ=152.9 *18*

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^{156}Eu β^- decay 1974Kl09,1980Iw04,1976Ya11 (continued)

β^- radiations (continued)

E(decay)[†@]	E(level)	Iβ^-[‡#&]	Log *ft*	Comments
(669 *5*)	1780	0.022 *5*	11.13[1u] *10*	av Eβ=225.7 *18*
(734 *5*)	1715.16	0.032 *10*	10.86 *14*	av Eβ=236.7 *19*
(1083 *5*)	1366.45	2.1 *2*	9.65 *5*	av Eβ=373.2 *21*
(1129 *5*)	1319.63	0.28 *5*	11.21[1u] *8*	av Eβ=398.3 *20*
(1207 *5*)	1242.47	5.3 *5*	9.42 *5*	av Eβ=423.9 *21*
(1281 *5*)	1168.14	4.1 *4*	9.63 *5*	av Eβ=454.7 *21*
(1400 *5*)	1049.41	1.28 *12*	10.28 *5*	av Eβ=504.5 *22*
2450 *15*	0	32 *3*	9.83 *4*	av Eβ=964.7 *23* E(decay): Average of 2430 *16* (1962Ew01), 2460 *10* (1963Th02), and 2450 *15* (1964Pe17). Value from the mass evaluation of 2011AuZZ is 2449 *5*. Iβ^-: Average of 33 (1962Ew01), 32 (1963Th02), and 29.5 (1964Pe17). Uncertainty assigned by the evaluator.

† In all three available studies (1962Ew01,1963Th02,1964Pe17), the measured β^- spectrum has been decomposed into three or four components of approximately the same energy. For the branches to the excited states, the average endpoint energies are 1195 *20*, 485 *20*, and 300 *30* keV. Each of these components populates several levels in this decay scheme.

‡ The value for the ground state is from decomposition of the measured beta spectrum. Values for the excited levels are from γ-intensity balances and are, therefore, limited by the incompleteness of the decay scheme. There are unplaced γ's with Iγ up to 0.08%, so I(β^-) values less than this are omitted. Also, computed I(β^-) of 1% *5* and 0.13% *5* to the first two excited levels are omitted, since the assigned J^π's argue against any significant feeding of these levels.

From the decomposition of the measured beta spectrum (1962Ew01,1963Th02,1964Pe17), the average beta feedings are 12% *3*, 35% *3*, and 21% *3* for components to groups of levels near 1250, 1960, and 2150 keV. These values agree with those from the γ-intensity balances.

@ The spectral shape factor for the 0^+ to 0^+ beta decay to the ground state has been measured (1967Va23). The matrix elements for the beta decay to the 0^+ levels at 0 and 1049 keV have been calculated from theory. From experimental data, the matrix elements to three 0^+ levels have been deduced (1969Ni11).

& Absolute intensity per 100 decays.

γ(^{156}Gd)

Iγ normalization, I(γ+ce) normalization: Normalized to give 100% of decays to ground state with Iβ^-(0)=32% *3*.
Iγ normalization, I(γ+ce) normalization: Additional information 1.

E_γ[†]	I_γ[‡f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[g]	Comments
88.97 *1*	87 *9*	88.966	2$^+$	0	0$^+$	E2	3.88	α(K)=1.559 *22*; α(L)=1.79 *3*; α(M)=0.422 *6*; α(N+..)=0.1066 *15* α(N)=0.0942 *14*; α(O)=0.01229 *18*; α(P)=7.64$\times10^{-5}$ *11* E_γ: From 1959Ha07. Others: 88.9637 *24* (1970Ra37); 88.97 (1962Ew01). The values of 1959Ha07 and 1970Ra37 are from curved-crystal measurements. The third is from ce measurements. More precise values have been obtained from (n,γ)-based curved-crystal measurements. L1:L2:L3=168 *1*: 950 *4*: 1000 from weighted average of 170 *3*: 943 *10*: 1000 (1967Ge07) and 168 *1*: 952 *5*: 1000 (1981Bu24). Others: 1962Ew01 and 1964Pe17. M1:M2:M3=146 *2*: 909 *12*: 1000 from 1981Bu24. Other: (1962Ew01).
138.7 *2*	0.081 *9*	2259.95	1$^-$	2121.42	2$^-$			
160.2 *2*	0.106 *11*	2186.74	1$^+$	2026.60	1$^+$	[M1,E2]	0.50 *3*	α(K)=0.37 *8*; α(L)=0.10 *4*; α(M)=0.022 *9*; α(N+..)=0.0058 *21* α(N)=0.0050 *18*; α(O)=0.00071 *22*; α(P)=2.5$\times10^{-5}$ *9*
190.16 *8*	0.170 *16*	1319.63	2$^-$	1129.38	2$^+$	E1	0.0519	α(K)=0.0439 *7*; α(L)=0.00625 *9*; α(M)=0.001350 *19*; α(N+..)=0.000356 *5* α(N)=0.000307 *5*; α(O)=4.61$\times10^{-5}$ *7*; α(P)=2.67$\times10^{-6}$ *4*
199.214 *12*	7.6 *4*	288.182	4$^+$	88.966	2$^+$	E2	0.225	α(K)=0.1565 *22*; α(L)=0.0531 *8*; α(M)=0.01224 *18*; α(N+..)=0.00314 *5* α(N)=0.00275 *4*; α(O)=0.000378 *6*; α(P)=8.98$\times10^{-6}$ *13* E_γ: From 1970Ra37. Others: 199.19 *6* (1959Ha07); 199.19 *5* (1974Kl09); 199.19 (1962Ew01). The values from 1970Ra37 and 1959Ha07 are from curved-crystal measurements, that from 1974Kl09 is from Ge(Li)-based γ spectroscopy, and that from 1962Ew01 is from ce measurements. More precise values have been obtained from (n,γ)-based curved-crystal measurements. L1:L2:L3=100: 112: 100 from average of 98: 123: 100 (1962Ew01) and 102: 100: 100 (1964Pe17).
215.7[&] *2*	0.13 *3*	2269.89	1$^+$	2054.19	2$^+$			
[x]244.7 *3*	0.09 *3*							
281.4[&] *2*	0.08 *2*	2269.89	1$^+$	1988.5	0$^+$			
290.49[&] *15*	0.09 *2*	2360.78	1$^+$	2070.7	3$^+$			
317.30 *9*	0.62 *6*	2269.89	1$^+$	1952.38	0$^-$	E1	0.01385	α(K)=0.01178 *17*; α(L)=0.001626 *23*; α(M)=0.000351 *5*; α(N+..)=9.32$\times10^{-5}$ *13* α(N)=8.02$\times10^{-5}$ *12*; α(O)=1.220$\times10^{-5}$ *18*; α(P)=7.53$\times10^{-7}$ *11*
335.69[&] *11*	0.105[e] *14*	2186.74	1$^+$	1851.05	0$^+$			
348.27[&] *9*	0.14[e] *2*	1715.16	0$^+$	1366.45	1$^-$	E1	0.01101	α(K)=0.00937 *14*; α(L)=0.001288 *18*; α(M)=0.000278 *4*; α(N+..)=7.38$\times10^{-5}$ *11* α(N)=6.35$\times10^{-5}$ *9*; α(O)=9.68$\times10^{-6}$ *14*; α(P)=6.03$\times10^{-7}$ *9*
354.20[&] *9*	0.15[e] *2*	2300.75	1$^+$	1946.46	1$^-$			
434.40 *9*	2.15 *4*	2205.47	1$^-$	1771.03	2$^+$	E1	0.00650	α(K)=0.00554 *8*; α(L)=0.000753 *11*; α(M)=0.0001623 *23*; α(N+..)=4.32$\times10^{-5}$ *6* α(N)=3.72$\times10^{-5}$ *6*; α(O)=5.69$\times10^{-6}$ *8*; α(P)=3.62$\times10^{-7}$ *5*

$\gamma(^{156}$Gd) (continued)

E_γ [†]	I_γ [‡f]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	α [g]	$I_{(\gamma+ce)}$ [@f]	Comments
472.70 *6*	1.49 *4*	1715.16	0^+	1242.47	1^-	E1	0.00535		α(K)=0.00456 *7*; α(L)=0.000618 *9*; α(M)=0.0001331 *19*; α(N+..)=3.54×10^{-5} *5* α(N)=3.05×10^{-5} *5*; α(O)=4.67×10^{-6} *7*; α(P)=3.00×10^{-7} *5*
490.34 *6*	1.65 *4*	2205.47	1^-	1715.16	0^+	E1	0.00492		α(K)=0.00420 *6*; α(L)=0.000567 *8*; α(M)=0.0001222 *18*; α(N+..)=3.26×10^{-5} *5* α(N)=2.80×10^{-5} *4*; α(O)=4.30×10^{-6} *6*; α(P)=2.76×10^{-7} *4*
494.90[&] *15*	0.15 *4*	1771.03	2^+	1276.13?	3^-	E1	0.00482		α(K)=0.00412 *6*; α(L)=0.000555 *8*; α(M)=0.0001197 *17*; α(N+..)=3.19×10^{-5} *5* α(N)=2.74×10^{-5} *4*; α(O)=4.21×10^{-6} *6*; α(P)=2.71×10^{-7} *4*
498.88 *6*	0.68 *4*	2269.89	1^+	1771.03	2^+	M1,E2	0.020 *6*		α(K)=0.017 *6*; α(L)=0.0025 *5*; α(M)=0.00055 *10*; α(N+..)=0.00015 *3* α(N)=0.000127 *23*; α(O)=1.9×10^{-5} *4*; α(P)=1.2×10^{-6} *4*
554.66[&] *6*	0.18 *4*	2269.89	1^+	1715.16	0^+				
585.90[h] *6*	0.060[h] *17*	1715.16	0^+	1129.38	2^+	[E2]			I_γ: Iγ=0.60 *5* for the composite peak. Split of intensity is that of the evaluator deduced from the intensities of the 472.7, 585.8 and 709.9 γ′s from the 1715 and 1952, 0^-, levels in (n,γ) with corresponding values in β^- decay.
585.90[h] *6*	0.54[h] *12*	1952.38	0^-	1366.45	1^-	M1	0.01694		α(K)=0.01441 *21*; α(L)=0.00199 *3*; α(M)=0.000430 *6*; α(N+..)=0.0001155 *17* α(N)=9.91×10^{-5} *14*; α(O)=1.542×10^{-5} *22*; α(P)=1.051×10^{-6} *15* I_γ: Iγ=0.60 *5* for the composite peak. Split of intensity is that of the evaluator deduced from the intensities of the 472.7, 585.8 and 709.9 γ′s from the 1952, 0^-, and 1715 levels in (n,γ) with corresponding values in β^- decay. Mult.: From decomposition by the evaluator of α(K)exp=0.0112 *9* for the composite peak in (n,γ), assuming mult=E2 for the other component. a small component of E2 is not ruled out.
599.47 *5*	21.49 *11*	1965.91	1^+	1366.45	1^-	E1	0.00316		α(K)=0.00270 *4*; α(L)=0.000361 *5*; α(M)=7.78×10^{-5} *11*; α(N+..)=2.08×10^{-5} *3* α(N)=1.784×10^{-5} *25*; α(O)=2.75×10^{-6} *4*; α(P)=1.79×10^{-7} *3*
626[&c]	0.23 *4*	1780	2^-	1154.13	2^+	E1			
632.79 *8*	0.40 *5*	1952.38	0^-	1319.63	2^-	E2	0.00769		α(K)=0.00636 *9*; α(L)=0.001040 *15*; α(M)=0.000229 *4*; α(N+..)=6.06×10^{-5} *9* α(N)=5.23×10^{-5} *8*; α(O)=7.85×10^{-6} *11*; α(P)=4.34×10^{-7} *6*
646.29 *5*	64.73 *28*	1965.91	1^+	1319.63	2^-	E1	0.00270		α(K)=0.00231 *4*; α(L)=0.000307 *5*; α(M)=6.61×10^{-5} *10*; α(N+..)=1.764×10^{-5} *25* α(N)=1.516×10^{-5} *22*; α(O)=2.34×10^{-6} *4*; α(P)=1.534×10^{-7} *22*
660[&c]	0.14 *4*	2026.60	1^+	1366.45	1^-				
665.8[ba] *3*	<0.06	1715.16	0^+	1049.41	0^+	[E0]		0.0016 *8*	I_γ: From 1976Ya11; value from 1980Iw04 is <0.18.
707.1 *2*	0.67 *5*	2026.60	1^+	1319.63	2^-				E_γ: Authors′ table has misprint of 701.1. Value is correct in authors′ figure.
709.86 *5*	9.03 *7*	1952.38	0^-	1242.47	1^-	M1	0.01051		α(K)=0.00895 *13*; α(L)=0.001227 *18*; α(M)=0.000265 *4*;

γ(^{156}Gd) (continued)

E_γ[†]	I_γ[‡f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[#]	α[g]	Comments
									α(N+..)=7.12×10^{-5} *10* α(N)=6.11×10^{-5} *9*; α(O)=9.51×10^{-6} *14*; α(P)=6.50×10^{-7} *10*
723.47 *5*	55.86 *25*	1965.91	1$^+$	1242.47	1$^-$	E1		0.00214	α(K)=0.00183 *3*; α(L)=0.000242 *4*; α(M)=5.21×10^{-5} *8*; α(N+..)=1.391×10^{-5} *20* α(N)=1.194×10^{-5} *17*; α(O)=1.84×10^{-6} *3*; α(P)=1.220×10^{-7} *17*
768.56 *7*	0.90 *4*	2026.60	1$^+$	1258.04	2$^+$				
778[&ci]	0.27 *4*	1827.48?	2$^+$	1049.41	0$^+$	E2			
784.14 *10*	0.51 *4*	2026.60	1$^+$	1242.47	1$^-$				
797.73 *6*	1.12 *5*	1965.91	1$^+$	1168.14	0$^+$				Mult.: Placement requires M1.
811.77 *5*	100.0 *4*	1965.91	1$^+$	1154.13	2$^+$	M1+E2	−0.055 *20*	0.00756	α(K)=0.00644 *9*; α(L)=0.000879 *13*; α(M)=0.000190 *3*; α(N+..)=5.10×10^{-5} *8* α(N)=4.37×10^{-5} *7*; α(O)=6.81×10^{-6} *10*; α(P)=4.67×10^{-7} *7*
820.36 *7*	1.74 *5*	2186.74	1$^+$	1366.45	1$^-$				
836.52 *7*	0.84 *5*	1965.91	1$^+$	1129.38	2$^+$				
839.0 *2*	0.31 *5*	2205.47	1$^-$	1366.45	1$^-$	M1		0.00698	α(K)=0.00595 *9*; α(L)=0.000811 *12*; α(M)=0.0001752 *25*; α(N+..)=4.71×10^{-5} *7* α(N)=4.03×10^{-5} *6*; α(O)=6.29×10^{-6} *9*; α(P)=4.31×10^{-7} *6*
841.16 *10*	2.14 *5*	1129.38	2$^+$	288.182	4$^+$	E2		0.00399	α(K)=0.00335 *5*; α(L)=0.000503 *7*; α(M)=0.0001098 *16*; α(N+..)=2.92×10^{-5} *4* α(N)=2.52×10^{-5} *4*; α(O)=3.83×10^{-6} *6*; α(P)=2.31×10^{-7} *4*
858.36 *12*	2.11 *5*	2026.60	1$^+$	1168.14	0$^+$	M1		0.00661	α(K)=0.00563 *8*; α(L)=0.000767 *11*; α(M)=0.0001657 *24*; α(N+..)=4.45×10^{-5} *7* α(N)=3.81×10^{-5} *6*; α(O)=5.94×10^{-6} *9*; α(P)=4.08×10^{-7} *6*
865.8[b] *3*	1.94 *11*	1154.13	2$^+$	288.182	4$^+$	E2		0.00374	α(K)=0.00315 *5*; α(L)=0.000470 *7*; α(M)=0.0001024 *15*; α(N+..)=2.73×10^{-5} *4* α(N)=2.35×10^{-5} *4*; α(O)=3.57×10^{-6} *5*; α(P)=2.17×10^{-7} *3*
867.01 *8*	13.69 *13*	2186.74	1$^+$	1319.63	2$^-$	E1		0.00149	α(K)=0.001277 *18*; α(L)=0.0001678 *24*; α(M)=3.60×10^{-5} *5*; α(N+..)=9.64×10^{-6} *14* α(N)=8.27×10^{-6} *12*; α(O)=1.280×10^{-6} *18*; α(P)=8.56×10^{-8} *12*
872.39 *9*	0.41 *5*	2026.60	1$^+$	1154.13	2$^+$	[M1,E2]		0.0050 *14*	α(K)=0.0043 *12*; α(L)=0.00060 *14*; α(M)=0.00013 *3*; α(N+..)=3.5×10^{-5} *8* α(N)=3.0×10^{-5} *7*; α(O)=4.6×10^{-6} *11*; α(P)=3.0×10^{-7} *9*
903.62 *10*	0.41 *5*	2269.89	1$^+$	1366.45	1$^-$				
916.4 *4*	0.33 *6*	1965.91	1$^+$	1049.41	0$^+$				
928.8 *4*	0.29 *5*	2186.74	1$^+$	1258.04	2$^+$				
944.35 *7*	13.72 *9*	2186.74	1$^+$	1242.47	1$^-$	E1		0.00127	α(K)=0.001085 *16*; α(L)=0.0001419 *20*; α(M)=3.05×10^{-5} *5*; α(N+..)=8.15×10^{-6} *12* α(N)=7.00×10^{-6} *10*; α(O)=1.084×10^{-6} *16*; α(P)=7.28×10^{-8} *11*
947.46 *15*	3.01 *6*	2205.47	1$^-$	1258.04	2$^+$				
960.50[d] *8*	14.9 *3*	1049.41	0$^+$	88.966	2$^+$	E2		0.00300	α(K)=0.00253 *4*; α(L)=0.000369 *6*; α(M)=8.02×10^{-5} *12*;

γ(^{156}Gd) (continued)

E_γ[†]	I_γ[‡f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[#]	α[g]	$I_{(\gamma+ce)}$[@f]	Comments
										α(N+..)=2.14×10^{-5} *3* α(N)=1.84×10^{-5} *3*; α(O)=2.81×10^{-6} *4*; α(P)=1.748×10^{-7} *25*
961.0[d] *6*	1.5 *3*	2203.5	1$^-$,2$^-$	1242.47	1$^-$					
^{x}963[c]	0.35 *5*									
969.83 *6*	3.85 *6*	1258.04	2$^+$	288.182	4$^+$	E2		0.00294		α(K)=0.00248 *4*; α(L)=0.000361 *5*; α(M)=7.84×10^{-5} *11*; α(N+..)=2.09×10^{-5} *3* α(N)=1.80×10^{-5} *3*; α(O)=2.75×10^{-6} *4*; α(P)=1.713×10^{-7} *24*
1011.87 *5*	3.24 *6*	2269.89	1$^+$	1258.04	2$^+$	M1		0.00444		α(K)=0.00379 *6*; α(L)=0.000514 *8*; α(M)=0.0001109 *16*; α(N+..)=2.98×10^{-5} *5* α(N)=2.55×10^{-5} *4*; α(O)=3.98×10^{-6} *6*; α(P)=2.74×10^{-7} *4*
1018.50 *10*	0.87 *5*	2186.74	1$^+$	1168.14	0$^+$	M1		0.00438		α(K)=0.00373 *6*; α(L)=0.000506 *7*; α(M)=0.0001091 *16*; α(N+..)=2.93×10^{-5} *5* α(N)=2.51×10^{-5} *4*; α(O)=3.92×10^{-6} *6*; α(P)=2.69×10^{-7} *4*
1027.39 *8*	1.32 *5*	2269.89	1$^+$	1242.47	1$^-$					
1037	0.55 *5*	2205.47	1$^-$	1168.14	0$^+$					E_γ: From level energies, Eγ=1037.33.
1040.44 *7*	5.17 *5*	1129.38	2$^+$	88.966	2$^+$	E2+E0+M1	−5.9 *+14−28*	0.0143		α: Computed as α(K)exp×(α/α(K)).
1049.36[b] *8*		1049.41	0$^+$	0	0$^+$	E0			0.089 *3*	
1065.14 *5*	50.74 *20*	1154.13	2$^+$	88.966	2$^+$	E2+M1	−16 *5*	0.00242		α(K)=0.00205 *3*; α(L)=0.000293 *5*; α(M)=6.35×10^{-5} *9*; α(N+..)=1.695×10^{-5} *24* α(N)=1.457×10^{-5} *21*; α(O)=2.24×10^{-6} *4*; α(P)=1.419×10^{-7} *21*
1076	3.48 *7*	2205.47	1$^-$	1129.38	2$^+$					E_γ: From level energies, Eγ=1076.06.
1079.16 *5*	47.31 *19*	1168.14	0$^+$	88.966	2$^+$	E2		0.00235		α(K)=0.00199 *3*; α(L)=0.000284 *4*; α(M)=6.16×10^{-5} *9*; α(N+..)=1.643×10^{-5} *23* α(N)=1.413×10^{-5} *20*; α(O)=2.17×10^{-6} *3*; α(P)=1.378×10^{-7} *20*
1101.80 *11*	0.43 *6*	2269.89	1$^+$	1168.14	0$^+$					
1115.78 *7*	0.52 *5*	2269.89	1$^+$	1154.13	2$^+$					
1129.47 *7*	1.39 *6*	1129.38	2$^+$	0	0$^+$	E2		0.00214		α(K)=0.00181 *3*; α(L)=0.000257 *4*; α(M)=5.57×10^{-5} *8*; α(N+..)=1.574×10^{-5} *22* α(N)=1.278×10^{-5} *18*; α(O)=1.96×10^{-6} *3*; α(P)=1.258×10^{-7} *18*; α(IPF)=8.71×10^{-7} *13*
1140.51 *5*	2.92 *6*	2269.89	1$^+$	1129.38	2$^+$	M1,E2		0.0027 *7*		α(K)=0.0023 *6*; α(L)=0.00032 *7*; α(M)=6.9×10^{-5} *15*; α(N+..)=2.0×10^{-5} *4* α(N)=1.6×10^{-5} *4*; α(O)=2.5×10^{-6} *6*; α(P)=1.6×10^{-7} *5*; α(IPF)=1.31×10^{-6} *8*

γ(^{156}Gd) (continued)

E_γ[†]	I_γ[‡f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[#]	α[g]	$I_{(\gamma+ce)}$[@f]	Comments
1153.67[b] *10*	70.0 *6*	1242.47	1^-	88.966	2^+	E1		8.83×10^{-4}		α(K)=0.000750 *11*; α(L)=9.73×10^{-5} *14*; α(M)=2.09×10^{-5} *3*; α(N+..)=1.510×10^{-5} *22* α(N)=4.80×10^{-6} *7*; α(O)=7.44×10^{-7} *11*; α(P)=5.05×10^{-8} *7*; α(IPF)=9.51×10^{-6} *14*
1154.08[b] *10*	48.8 *4*	1154.13	2^+	0	0^+	E2		0.00205		α(K)=0.001738 *25*; α(L)=0.000245 *4*; α(M)=5.31×10^{-5} *8*; α(N+..)=1.605×10^{-5} *23* α(N)=1.220×10^{-5} *17*; α(O)=1.88×10^{-6} *3*; α(P)=1.205×10^{-7} *17*; α(IPF)=1.86×10^{-6} *3*
1156	1.35[e] *20*	2205.47	1^-	1049.41	0^+					E_γ: From level energies, Eγ=1156.06.
1164.2 *3*	0.67 *6*	2293.44	1^-	1129.38	2^+					
1167.9[b] *1*		1168.14	0^+	0	0^+	E0			0.025 *1*	
1169.12 *5*	2.74 *5*	1258.04	2^+	88.966	2^+	M1+E2(+E0)	+0.38 *6*	0.0031 *8*		α: Computed as α(K)exp×(α/α(K)).
1187.3[&i] *5*	0.15[e] *7*	1276.13?	3^-	88.966	2^+	E1				
1220.50 *11*	0.20 *5*	2269.89	1^+	1049.41	0^+					
1230.71 *6*	82.3 *3*	1319.63	2^-	88.966	2^+	E1				
1242.42 *5*	68.05 *24*	1242.47	1^-	0	0^+	E1		8.09×10^{-4}		α(K)=0.000657 *10*; α(L)=8.51×10^{-5} *12*; α(M)=1.82×10^{-5} *3*; α(N+..)=4.86×10^{-5} *7* α(N)=4.19×10^{-6} *6*; α(O)=6.51×10^{-7} *10*; α(P)=4.43×10^{-8} *7*; α(IPF)=4.37×10^{-5} *7*
1258.03 *7*	0.98 *3*	1258.04	2^+	0	0^+	E2		0.00174		α(K)=0.001466 *21*; α(L)=0.000204 *3*; α(M)=4.42×10^{-5} *7*; α(N+..)=2.49×10^{-5} *4* α(N)=1.014×10^{-5} *15*; α(O)=1.563×10^{-6} *22*; α(P)=1.017×10^{-7} *15*; α(IPF)=1.309×10^{-5} *19*
1277.43 *5*	29.75 *12*	1366.45	1^-	88.966	2^+	E1				
1366.41 *5*	16.21 *9*	1366.45	1^-	0	0^+	E1				
1626.29 *14*	0.47 *6*	1715.16	0^+	88.966	2^+					
1682.10 *12*	2.80 *8*	1771.03	2^+	88.966	2^+	M1				
1857.42 *11*	2.47 *7*	1946.46	1^-	88.966	2^+	E1				
1873[&c]	0.61 *12*	1962	1^-	88.966	2^+	E1				
1877.03 *15*	15.59 *12*	1965.91	1^+	88.966	2^+	M1+E2	+0.36 *6*			
1937.71 *11*	20.04 *14*	2026.60	1^+	88.966	2^+	M1+E2	−0.60 *4*			
1946.34 *13*	1.70 *7*	1946.46	1^-	0	0^+	E1				
1965.95 *12*	39.90 *20*	1965.91	1^+	0	0^+	M1				
2026.65 *11*	33.73 *17*	2026.60	1^+	0	0^+	M1				

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$\gamma(^{156}$Gd) (continued)

E_γ†	I_γ‡f	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	δ#	Comments
2032.51 *12*	1.35 *5*	2121.42	2^-	88.966	2^+	E1		
2097.70 *11*	39.27 *19*	2186.74	1^+	88.966	2^+	M1+E2	−1.1 *4*	
2110.52& *13*	0.81 *3*	2199.50	2^-	88.966	2^+	E1		
2116.49 *13*	1.18 *3*	2205.47	1^-	88.966	2^+			
2121.3 *4*	0.048 *23*	2121.42	2^-	0	0^+			
2170.86 *20*	0.332 *24*	2259.95	1^-	88.966	2^+	E1		
2180.91 *12*	22.08 *13*	2269.89	1^+	88.966	2^+	M1+E2	−0.65 *+8−6*	
2186.71 *11*	35.93 *18*	2186.74	1^+	0	0^+	M1		
2205.38 *13*	9.05 *7*	2205.47	1^-	0	0^+	E1		E_γ: This is the placement given by 1974Kl09; and the multipolarity agrees. 1974Kl09 also show coincidences with the 88 γ, which suggests an additional placement from the 2293 level.
2205.4i		2293.44	1^-	88.966	2^+	E1		E_γ: Placement is by evaluator. This γ is placed from the 2205 level by 1974Kl09 and the multipolarity agrees. 1974Kl09 also show coincidences with the 88 γ, which suggests this additional placement from the 2293 level.
2211.83 *12*	1.014 *24*	2300.75	1^+	88.966	2^+			
2255.5 *5*	0.062 *11*	2344.4	1^-	88.966	2^+			
2259.8 *3*	0.118 *12*	2259.95	1^-	0	0^+			Mult.: Mult=M1 from (n,γ), but placement requires E1.
2269.90 *12*	10.63 *8*	2269.89	1^+	0	0^+			
2293.40 *12*	0.231 *12*	2293.44	1^-	0	0^+			
2301.0 *2*	0.107 *9*	2300.75	1^+	0	0^+			
2344.3 *7*	0.041 *7*	2344.4	1^-	0	0^+			
2361.2 *3*	0.173 *11*	2360.78	1^+	0	0^+			

† From 1974Kl09, unless otherwise noted.

‡ From 1980Iw04 for Eγ above 300 keV and 1974Kl09 below this energy, unless otherwise noted. There are many partial sets of Iγ values, but these two are the only complete sets.

\# From ^{156}Gd Adopted γ Radiations and based on studies of this decay (1961Cl02,1962Ba38,1962Ew01,1964Pe17,1966Dz08,1967Ha38, 1969Ni11,1970Ru09,1972Ha17,1973HaWB,1977Co22,1976Ya11), as well as those from ^{156}Tb $\varepsilon+\beta^+$ decay and the (HI,xnγ) and (n,γ) reactions and Coul. ex.

@ Computed from Ice(K) from 1976Ya11.

& Placement is that of 1995GrZY.

a From ^{156}Gd Adopted γ radiations.

b From 1976Ya11.

c From 1980Iw04.

d Decomposition of doublet (960.5+961.0) intensity from 1974Kl09.

e From 1974Kl09.

f For absolute intensity per 100 decays, multiply by 0.097 *8*.

g 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.

$^{156}_{64}$Gd$_{92}$-9

$\gamma(^{156}$Gd) (continued)

[h] Multiply placed with intensity suitably divided.
[i] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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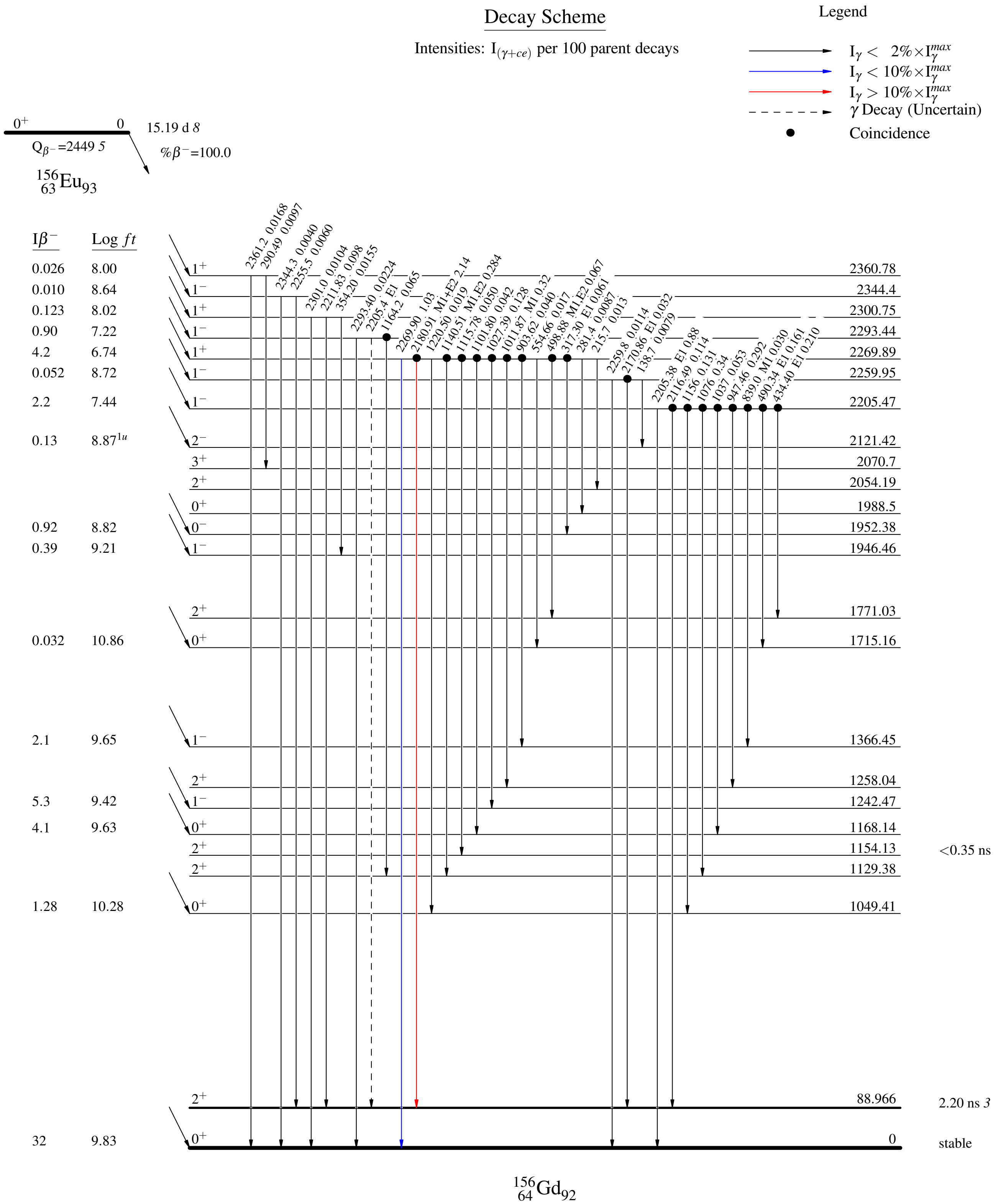
^{156}Eu β^- decay 1974Kl09,1980Iw04,1976Ya11

Decay Scheme

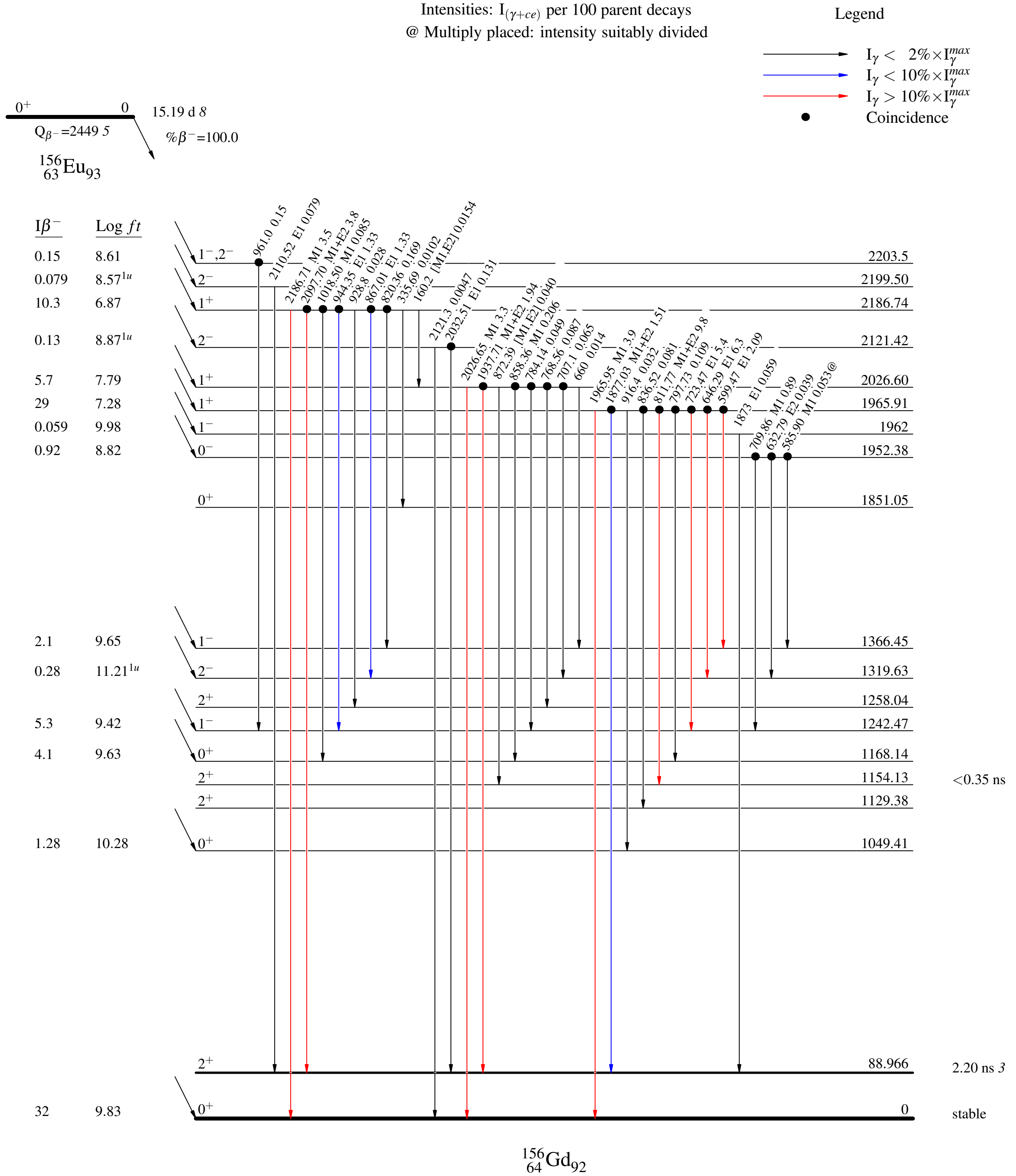
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays



^{156}Eu β^- decay 1974Kl09,1980Iw04,1976Ya11

Decay Scheme (continued)

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

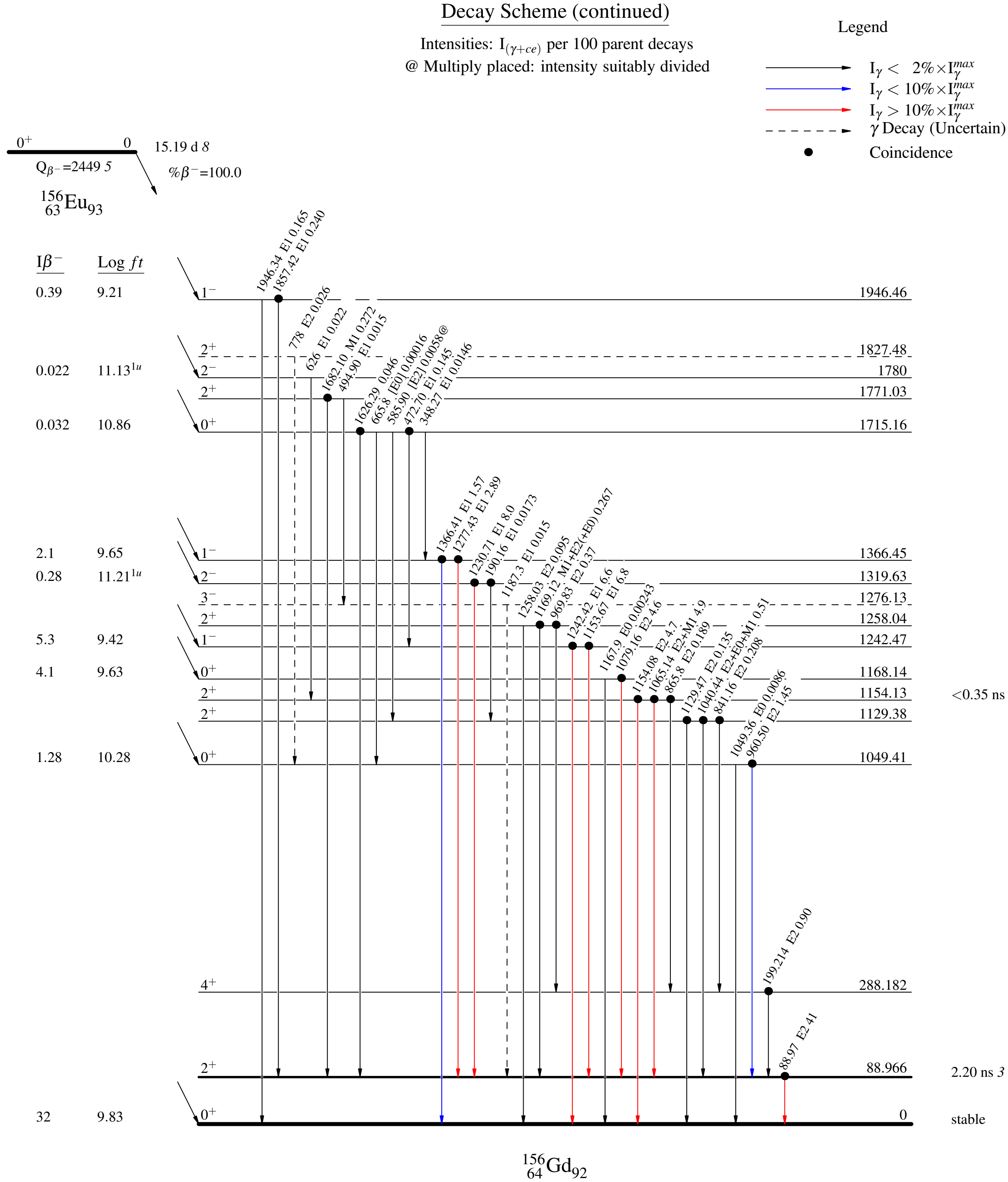


^{156}Eu β^- decay 1974Kl09,1980Iw04,1976Ya11

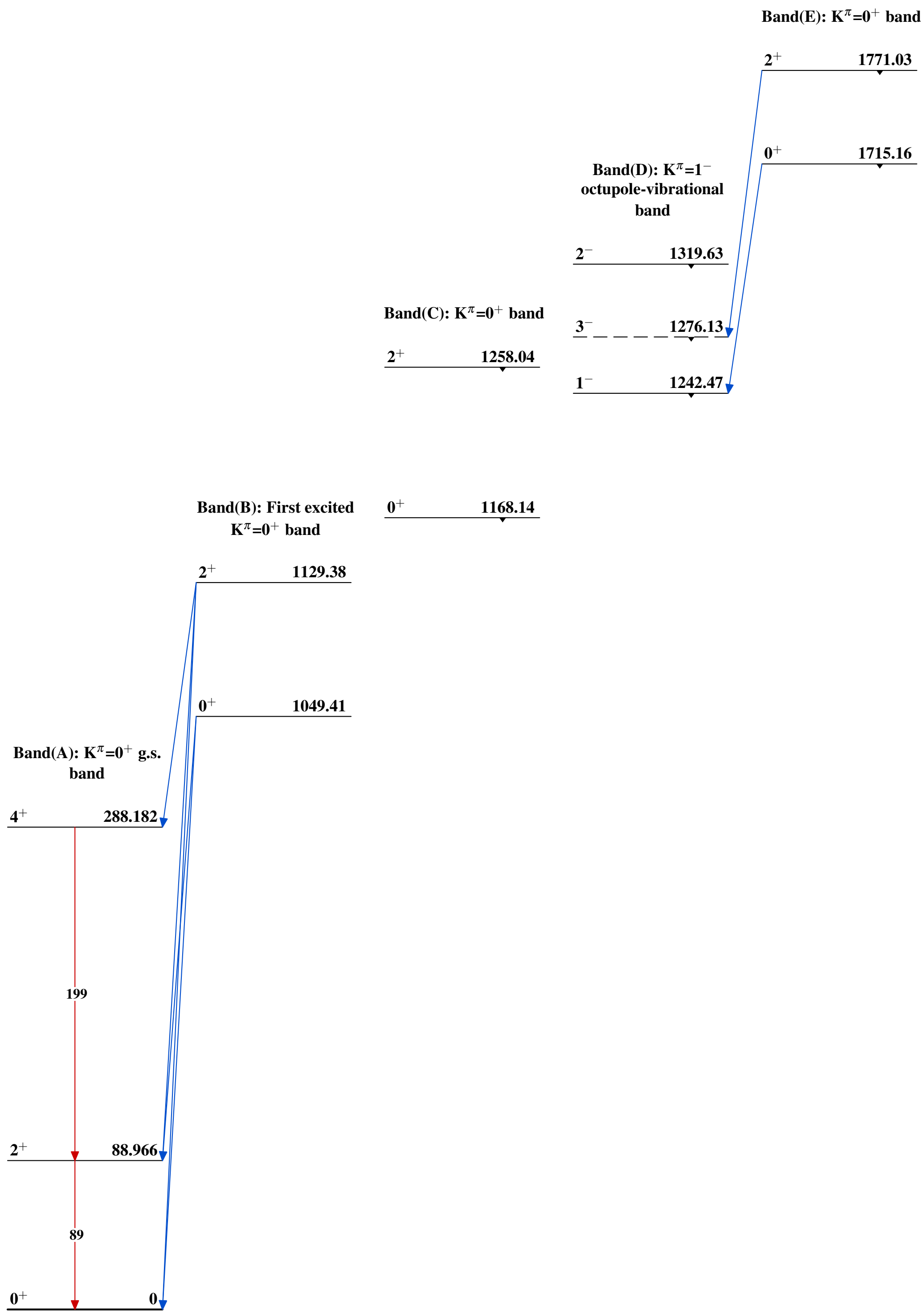
Decay Scheme (continued)

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

@ Multiply placed: intensity suitably divided



^{156}Eu β^- decay 1974Kl09,1980Iw04,1976Ya11



$^{156}_{64}Gd_{92}$