^{153}Eu(3n,γ) 1991Ba06

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

Additional information 1.

$J^\pi(^{155}Eu)=5/2^+$. configuration=π5/2[413].

Measurements of the γ and ce spectra following triple n capture in ^{153}Eu. γ's were measured in curved-crystal and pair spectrometers and the ce in a magnetic spectrometer. Isotopic assignments are from the grow-in of the ^{156}Eu lines and from their observation in spectra from the ^{154}Sm(n,γ)^{155}Sm(β^-)^{155}Eu(n,γ)^{156}Eu reaction.

^{156}Eu Levels

E(level)†	J^π‡#	Comments
0.0@	0^+	
22.5176@ 5	1^+	
47.6728@ 7	2^+	
87.4897& 3	1^-	
103.5942@ 8	3^+	
125.4568& 7	2^-	
145.6816a 11	5^+	
149.6725b 16	5^-	
159.7111@ 12	4^+	
175.1500c 10	4^+	
184.1966& 8	3^-	
214.9306d 10	4^-	
217.7761e 15	0^-	
250.1646@ 19	5^+	
258.1440& 12	4^-	
260.1834f 14	4^+	
266.947e 3	1^-	
268.7468e 11	2^-	
268.7478?c 15	5^+	
291.3037g 20	1^+	
313.0984d 16	5^-	
324.6951g 11	2^+	
343.3202e 19	3^-	
353.4406i 11	3^-	
368.5352h 19	5^-	
375.3660g 20	3^+	
386.3223e 22	4^-	
434.2302j 19	3^-	
435.5835i 20	4^-	
441.635g 7	4^+	E(level): 1991Ba06 show this level as questionable.
513.2906 28	1^-	Based entirely on which bandheads are to be expected in this energy region, 1991Ba06 assign this state as a member of a $K^\pi=0^-$ band, for which configuration=π3/2[411]-ν3/2[521], with a possible admixture of the conf π5/2[413]-ν5/2[523]. While J^π is well established, the band assignment may be questionable, especially since the 0^- bandhead has not been observed.

† From fit to γ energies by 1991Ba06.

‡ From detailed, model-dependent analysis of 1991Ba06. They argue that 3 Nilsson proton states and 3 neutron states should be

Continued on next page (footnotes at end of table)

^{153}Eu(3n,γ) 1991Ba06 (continued)

^{156}Eu Levels (continued)

present and use the arguments summarized in the ^{156}Eu Adopted Levels to assign the observed levels to these bands.

Additional information 2.

@ Band(A): $K^\pi=0^+$ g.s. band. configuration=π5/2[413]-ν5/2[642].

& Band(B): $K^\pi=1^-$ band. configuration=π5/2[413]-ν3/2[521].

a Band(C): $K^\pi=5^+$ bandhead. configuration=π5/2[413]+ν5/2[642].

b Band(D): $K^\pi=5^-$ bandhead. configuration=π5/2[532]+ν5/2[642].

c Band(E): $K^\pi=4^+$ band. configuration=π5/2[532]+ν3/2[521].

d Band(F): $K^\pi=4^-$ band. configuration=π5/2[413]+ν3/2[521].

e Band(G): $K^\pi=0^-$ band. configuration=π5/2[532]-ν5/2[642].

f Band(H): $K^\pi=4^+$ bandhead. configuration=π3/2[411]+ν5/2[642].

g Band(I): $K^\pi=1^+$ band. configuration=π5/2[532]-ν3/2[521]. 1991Ba06 suggest that there is an admixture of π7/2[523]-ν5/2[523] in this band.

h Band(J): $K^\pi=5^-$ bandhead. configuration=π5/2[413]+ν5/2[523]. This state may contain an admixture of the 5^- member of the $K^\pi=4^-$ band having configuration=π5/2[413]+ν3/2[521] (1991Ba06).

i Band(K): $K^\pi=3^-$ band. configuration=π3/2[411]+ν3/2[521].

j Band(L): $K^\pi=3^-$ band. configuration=π5/2[413]-ν11/2[505]. This band likely contains an admixture of π3/2[411]+ν3/2[521], whose main component is at 353 keV.

γ(^{156}Eu)

Iγ normalization, I(γ+ce) normalization: From 1991Ba06, based on their assumption that 3000 relative units of intensity correspond to 100 n captures. However, the basis for this assumption is not clear. This normalization factor leads to a total feeding of the ^{156}Eu g.s. of 82.1%, which is similar to the values 83.42% and 83.0% for ^{154}Eu and ^{155}Eu, respectively, and >80%, expected from statistical considerations (see 1991Ba06).

E_γ †‡	I_γ ‡	E_i(level)	J_i^π	E_f	J_f^π	Mult.#@	α&	$I_{(\gamma+ce)}$	Comments
(3.99)		149.6725	5^-	145.6816	5^+	[E1]	72.7		E_γ: Computed from level energies. Placement deduced to explain decay of 149 level (1991Ba06).
22.525 *6*		22.5176	1^+	0.0	0^+	(M1)	22.6		E_γ: From ce data. I_γ: From I(ce(N_1)) and α(N_1) for M1 γ, Iγ≈31.
25.1550 *5*	86 *22*	47.6728	2^+	22.5176	1^+	(M1)	16.31		
29.478 *5*		175.1500	4^+	145.6816	5^+	E2	444	320 *6*	E_γ: From ce data; from ^{154}Sm reaction, value is 29.478 *2*. I_γ: From I(ce) and α, Iγ≈0.7. $I_{(\gamma+ce)}$: From ce data.
x30.6328 *3*	484 *38*								E_γ: May occur in ^{155}Eu or ^{156}Eu.
x30.6417 *3*	502 *39*								E_γ: May occur in ^{155}Eu or ^{156}Eu.
37.9681 *7*	85 *7*	125.4568	2^-	87.4897	1^-	M1	4.82		
39.7805c *4*	<21	87.4897	1^-	47.6728	2^+				E_γ: Reported by 1991Ba06 to be a part of a doublet, with most of its intensity placed elsewhere. These authors also point out that the energy fit corresponding to this placement is not particularly good. I_γ: 1991Ba06 state that less than 10% of the intensity of this peak is to be associated with this placement of the 39 G. Most of it depopulates the 214

Continued on next page (footnotes at end of table)

^{153}Eu(3n,γ) 1991Ba06 (continued)

γ(^{156}Eu) (continued)

E_γ[†‡]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#@]	α[&]	Comments
								level. Mult.: The composite 39 peak is E1. For both of the proposed placements, mult=E1 is indicated.
39.7805[c] *4*	199	214.9306	4⁻	175.1500	4⁺	E1	0.606	I_γ: The intensity of both components of this doublet peak is 199 *19* (1991Ba06). These authors state that<10% of this intensity belongs to the other placement, so that Iγ for this placement is between 178 and 199 units.
42.0879 *8*	8.5 *10*	145.6816	5⁺	103.5942	3⁺	E2	76.6	
[x]42.3089 *10*	16.5 *27*							
43.0076 *8*	23 *3*	386.3223	4⁻	343.3202	3⁻			I_γ: If this placement is correct, intensity is too large (1991Ba06).
55.9208 *6*	83 *4*	103.5942	3⁺	47.6728	2⁺	M1	9.88	
56.1179 *20*	17.1 *22*	159.7111	4⁺	103.5942	3⁺	M1	9.78	E_γ: From ^{154}Sm reaction, value is 56.118 *1*.
58.7402 *6*	20.2 *16*	184.1966	3⁻	125.4568	2⁻	M1	8.58	
64.9725 *4*	27 *3*	87.4897	1⁻	22.5176	1⁺	E1	0.900	
71.5555 *5*	20.3 *15*	175.1500	4⁺	103.5942	3⁺	M1	4.84	
73.9501 *14*	12.0 *9*	258.1440	4⁻	184.1966	3⁻	M1	4.40	
[x]80.3217 *15*	5.4 *10*					M1	3.47	
80.7893 *28*	5.7 *12*	434.2302	3⁻	353.4406	3⁻	M1	3.41	
82.1396 *28*	4.5 *9*	435.5835	4⁻	353.4406	3⁻			
85.0345 *15*	6.2 *9*	260.1834	4⁺	175.1500	4⁺	M1	2.94	
87.4897 *3*	346 *9*	87.4897	1⁻	0.0	0⁺	E1	0.407	
90.4564 *18*	12.5 *20*	250.1646	5⁺	159.7111	4⁺	M1	2.46	E_γ: From ce value is 90.4634 *16*.
93.5972[d] *12*	4.1 *7*	268.7478?	5⁺	175.1500	4⁺	M1	2.23	
99.7855 *20*	2.6 *6*	368.5352	5⁻	268.7478?	5⁺			
102.9361 *15*	39 *9*	125.4568	2⁻	22.5176	1⁺	E1	0.262	
110.5106 *8*	35.0 *11*	260.1834	4⁺	149.6725	5⁻	E1	0.217	
112.0381 *13*	2.5 *3*	159.7111	4⁺	47.6728	2⁺	[E2]	1.607	Mult.: Mult=M1,E2 from ce data, but placement requires E2.
114.5018 *16*	5.2 *6*	260.1834	4⁺	145.6816	5⁺	M1	1.253	
117.2242 *20*	4.8 *9*	375.3660	3⁺	258.1440	4⁻	E1	0.185	
127.478 *3*	1.9 *4*	175.1500	4⁺	47.6728	2⁺	[E2]	1.015	Mult.: Mult=M1,E2 from ce data, but placement requires E2.
132.6885 *23*	2.0 *5*	258.1440	4⁻	125.4568	2⁻	E2	0.881	
136.1584 *13*	8.2 *12*	386.3223	4⁻	250.1646	5⁺	E1	0.1231	
136.5234 *29*	5.2 *15*	184.1966	3⁻	47.6728	2⁺	E1	0.1222	
137.9447 *29*	4.5 *5*	313.0984	5⁻	175.1500	4⁺			
138.5097 *5*	28.0 *12*	353.4406	3⁻	214.9306	4⁻	M1	0.731	I_γ: Authors′ value is 280, but corresponding value in authors′ table 2 and conversion coefficient both indicate 28.0.
140.4983 *8*	16.0 *25*	324.6951	2⁺	184.1966	3⁻	E1	0.1130	
146.563 *4*	2.1 *5*	250.1646	5⁺	103.5942	3⁺	E2	0.622	
154.5454 *20*	8.3 *11*	258.1440	4⁻	103.5942	3⁺	E1	0.0874	
165.1527 *7*	49 *4*	268.7468	2⁻	103.5942	3⁺	E1	0.0731	
165.8452 *24*	30 *5*	291.3037	1⁺	125.4568	2⁻	E1	0.0723	
167.4175 *13*	8.4 *15*	313.0984	5⁻	145.6816	5⁺	E1	0.0705	
174.0466 *19*	7.7 *10*	434.2302	3⁻	260.1834	4⁺	E1	0.0635	
178.2918 *11*	72 *6*	353.4406	3⁻	175.1500	4⁺	E1	0.0595	
183.6048 *23*	20.9 *23*	343.3202	3⁻	159.7111	4⁺	E1	0.0550	
191.177 *13*	1.6 *3*	375.3660	3⁺	184.1966	3⁻			
193.3852 *26*	4.6 *7*	368.5352	5⁻	175.1500	4⁺	E1	0.0479	
195.2586 *15*	62 *4*	217.7761	0⁻	22.5176	1⁺	E1	0.0467	
[x]196.424 *3*	3.4 *5*							
[x]197.860 *5*	1.7 *4*					E2	0.223	

Continued on next page (footnotes at end of table)

^{153}Eu(3n,γ) 1991Ba06 (continued)

γ(^{156}Eu) (continued)

E_γ[†‡]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#@]	α[&]	Comments
203.818 *3*	50 *4*	291.3037	1^+	87.4897	1^-	E1	0.0417	E_γ: From ^{154}Sm reaction, value is 203.812 *2*.
218.885 *7*	5.2 *8*	368.5352	5^-	149.6725	5^-	M1	0.0205	E_γ: From ce, value is 218.897 *6*.
219.277 *3*	55 *4*	266.947	1^-	47.6728	2^+	E1	0.0344	
220.6563 *24*	19 *2*	435.5835	4^-	214.9306	4^-	M1	0.201	
237.218[a] *6*	48 *7*	324.6951	2^+	87.4897	1^-	E1	0.0280	E_γ: From ^{154}Sm reaction, value is 237.197 *4*.
[x]240.837 *12*	10.0 *15*					E2	0.1168	E_γ: From ce, value is 240.817 *4*. From ^{154}Sm reaction, value is 240.829 *8*.
244.0[b] *8*		291.3037	1^+	47.6728	2^+	[M1,E2]	0.132 *21*	
244.540 *3*	15 *3*	513.2906	1^-	268.7468	2^-	M1	0.1521	
246.223 *4*	122 *12*	268.7468	2^-	22.5176	1^+	E1	0.0254	E_γ: From ^{154}Sm reaction, value is 246.229 *3*.
249.900[a] *4*	32 *6*	375.3660	3^+	125.4568	2^-	E1	0.0244	
257.438 *7*	16.1 *13*	441.635	4^+	184.1966	3^-	E1	0.0226	
259.082 *5*	4.0 *8*	434.2302	3^-	175.1500	4^+	E1	0.0223	
260.425 *7*	14.2 *17*	435.5835	4^-	175.1500	4^+	E1	0.0220	E_γ: From ce, value is 260.426 *6*.
266.937 *6*	21 *4*	266.947	1^-	0.0	0^+			E_γ: From ce, value is 266.942 *4*. From ^{154}Sm reaction, value is 266.928 *3*.
268.5[b] *8*		291.3037	1^+	22.5176	1^+	[M1,E2]	0.100 *18*	
[x]275.374 *7*	33 *3*					E1	0.0190	E_γ: From ce, value is 275.369 *3*. From ^{154}Sm reaction, value is 275.373 *6*.
282.717 *5*	51 *6*	386.3223	4^-	103.5942	3^+	E1	0.01788	E_γ: From ce, value is 282.724 *3*.
291.0[b] *8*		291.3037	1^+	0.0	0^+	[M1]	0.0954 *15*	
295.517 *6*	15.4 *12*	513.2906	1^-	217.7761	0^-	M1	0.0915	E_γ: From ce, value is 295.502 *5*.
295.6528 *26*	54 *6*	343.3202	3^-	47.6728	2^+	E1	0.01589	
302.177 *7*	9.5 *9*	324.6951	2^+	22.5176	1^+	M1	0.0863	E_γ: From ce, value is 302.172 *5*.
[x]318.993 *4*	22 *2*					E1	0.01313	
[x]338.246 *5*	18.5 *18*					M1	0.0640	
[x]344.677[a] *6*	6.0 *20*							
[x]365.139[a] *4*	17 *2*					E1	0.00942	
[x]370.672[a] *11*	3.0 *3*							
[x]376.600 *9*	4.6 *14*							
387.863 *12*	4.3 *6*	513.2906	1^-	125.4568	2^-	E2	0.0270	
425.808 *9*	13.8 *12*	513.2906	1^-	87.4897	1^-	M1	0.0352	
[x]434.825 *14*	7.5 *6*							
[x]458.020 *15*	3.0 *3*							
[x]467.722 *19*	4.6 *5*							
[x]475.020 *5*	10.0 *16*					M1	0.0266	E_γ: From ce, value is 475.018 *4*.
[x]490.046 *8*	20.0 *15*					M1	0.0246	
[x]496.473 *18*	5.2 *4*							
[x]531.159 *17*	10.8 *8*					M1	0.0200	E_γ: From ^{154}Sm reaction, value is 531.149 *13*.
[x]537.761 *10*	9.9 *13*					M1	0.0194	
[x]542.397 *10*	9.1 *19*					M1	0.0190	
[x]543.147 *18*	9.7 *9*					E2	0.01078	E_γ: From ^{154}Sm reaction, value is 543.195 *16*.
[x]562.027[a] *6*	7.7 *8*							
[x]567.552 *10*	10.8 *11*					M1	0.01695	
[x]594.057[a] *22*	7.5							E_γ: From ce, value is 594.035 *4*.
[x]624.563 *13*	5.9 *7*					E1	0.00277	
[x]655.000 *12*	14.7 *9*					M1	0.01186	
[x]662.84 *3*	5.6 *10*					M1	0.01152	
[x]670.658[a] *15*	9.4 *17*					M1	0.01119	E_γ: From ^{154}Sm reaction, value is 670.664 *14*.

Continued on next page (footnotes at end of table)

^{153}Eu(3n,γ) 1991Ba06 (continued)

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

E_γ †‡	I_γ ‡	E_i(level)	Mult.#@	α&	Comments
x695.932[a] *15*	11.3				
x738.64[a] *5*	7.7 *8*		M1	0.00882	E_γ: From ce, value is 738.43 *4*.
x795.638 *18*	10.0 *7*		M1	0.00736	

† From the γ spectrum from the ^{153}Eu(3n,γ) reaction, unless otherwise noted. Where more precise values are deduced from the ce spectra or the ^{154}Sm(n,γ)^{155}Sm(β^-)^{155}Eu(n,γ) reaction, these values are given in comments.

‡ Additional information 3.

From the ce data of 1991Ba06.

@ Additional information 4.

& Measured conversion coefficients are given for≈70 γ's by 1991Ba06. However, these authors do not give the basis for the normalization of the ce and γ intensity scales. The listed values are theoretical ones, computed from the deduced multipolarities.

a Authors indicate γ is from more than one isotope.

b γ observed in the ^{156}Sm β^- decay only (1991Ba06).

c Multiply placed.

d Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

^{153}Eu(3n,γ) 1991Ba06

Level Scheme

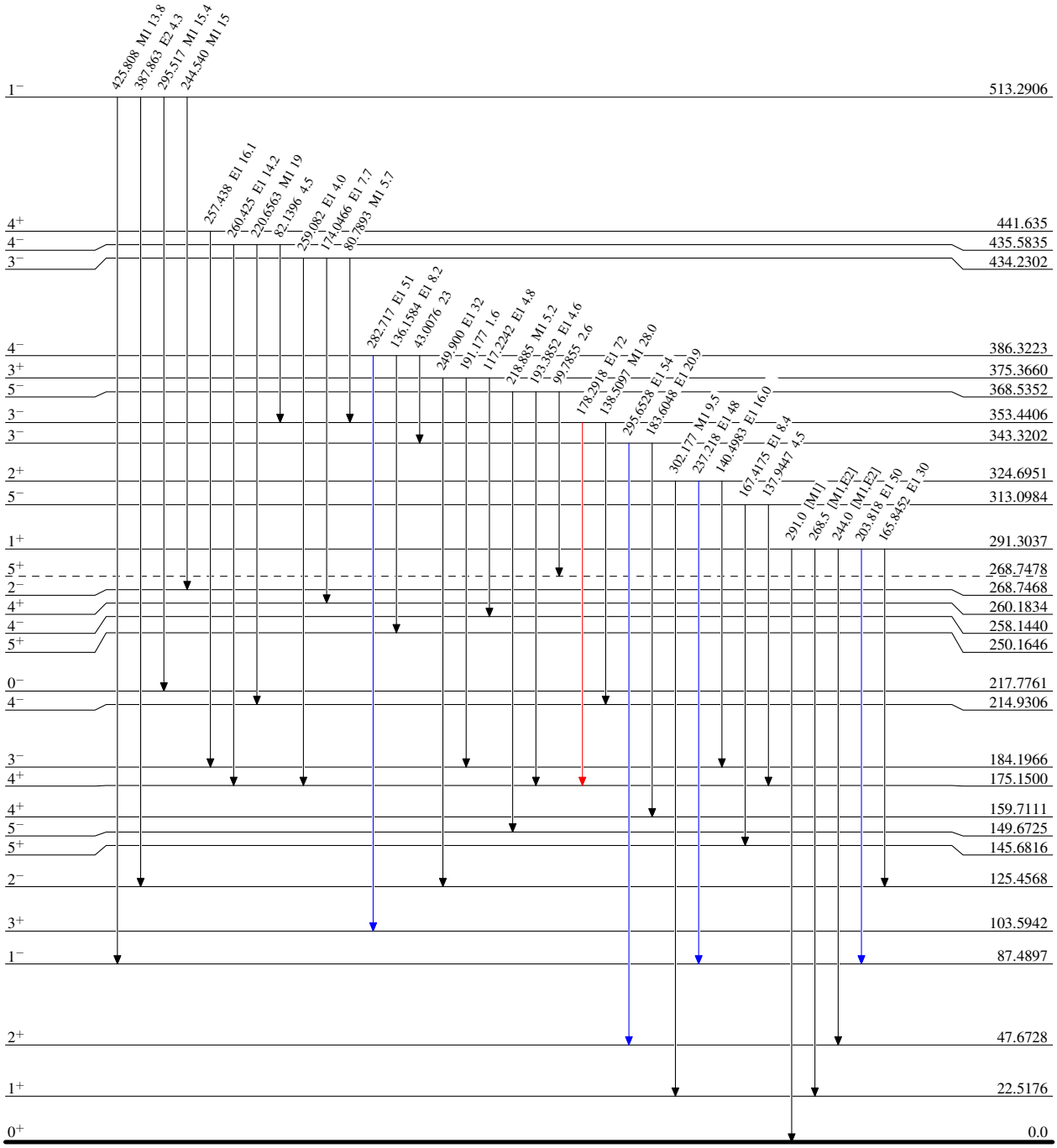
Intensities: γ's per 100 neutron captures

Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

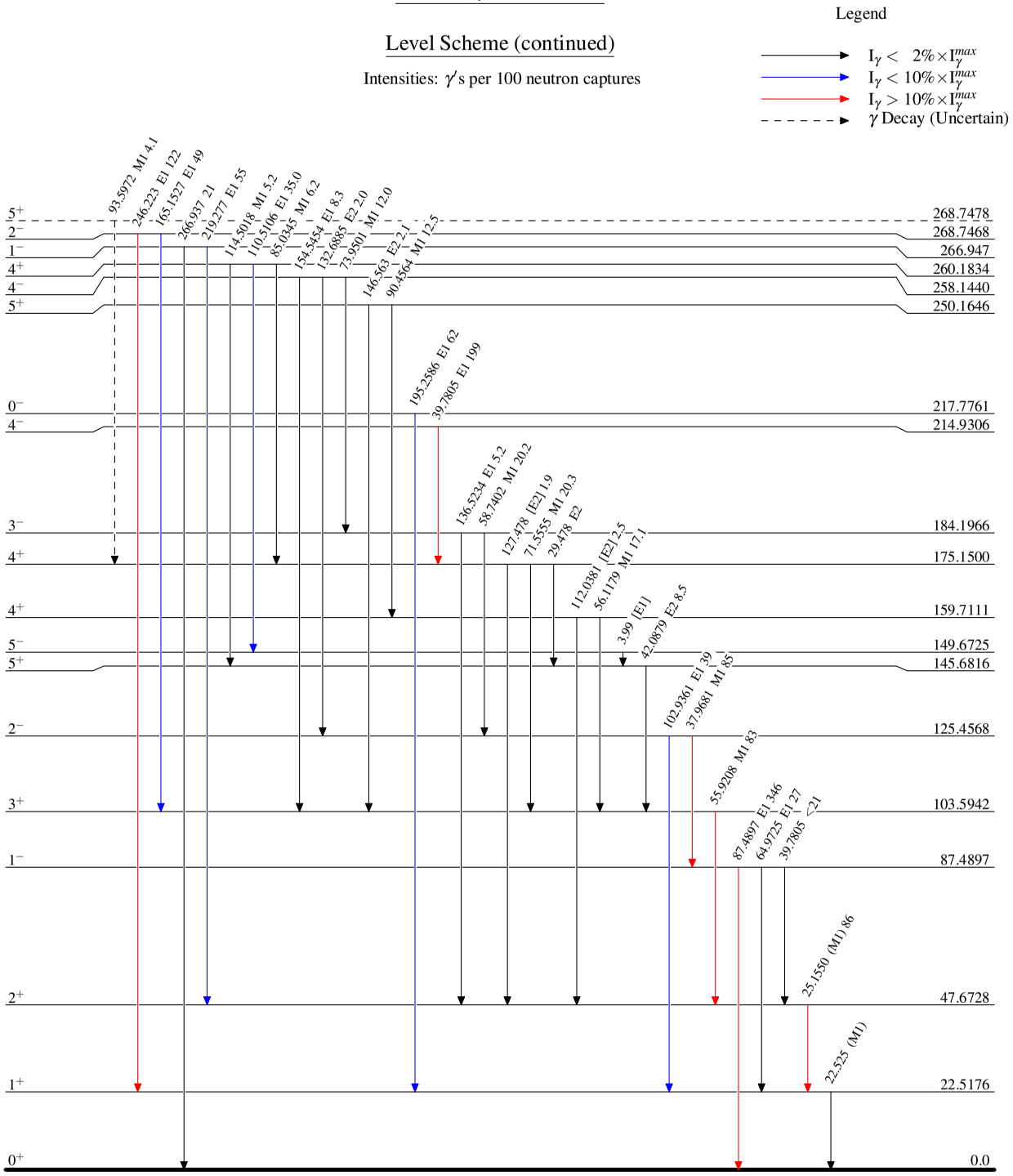


$^{156}_{63}Eu_{93}$

^{153}Eu(3n,γ) 1991Ba06

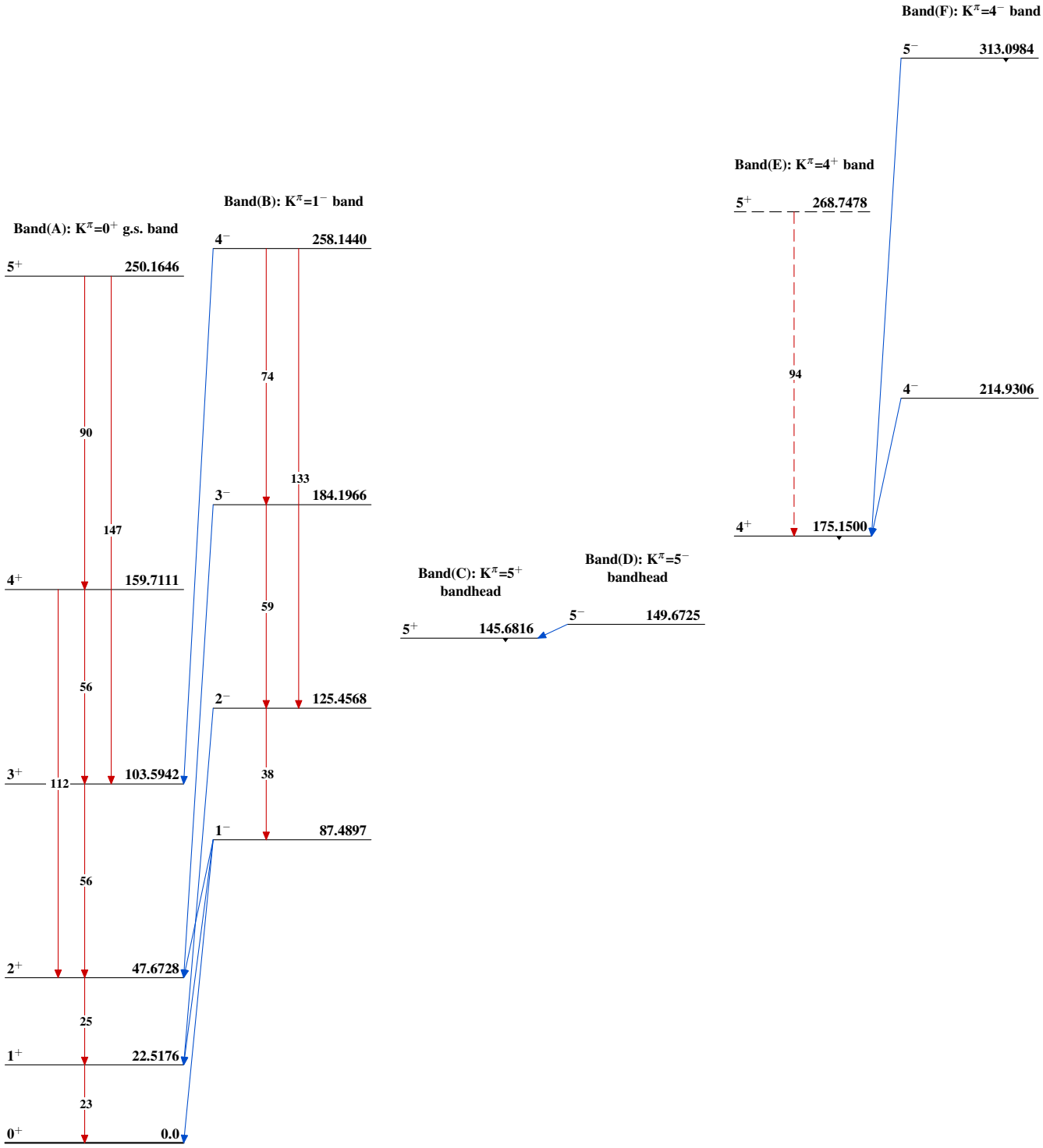
Level Scheme (continued)

Intensities: γ's per 100 neutron captures



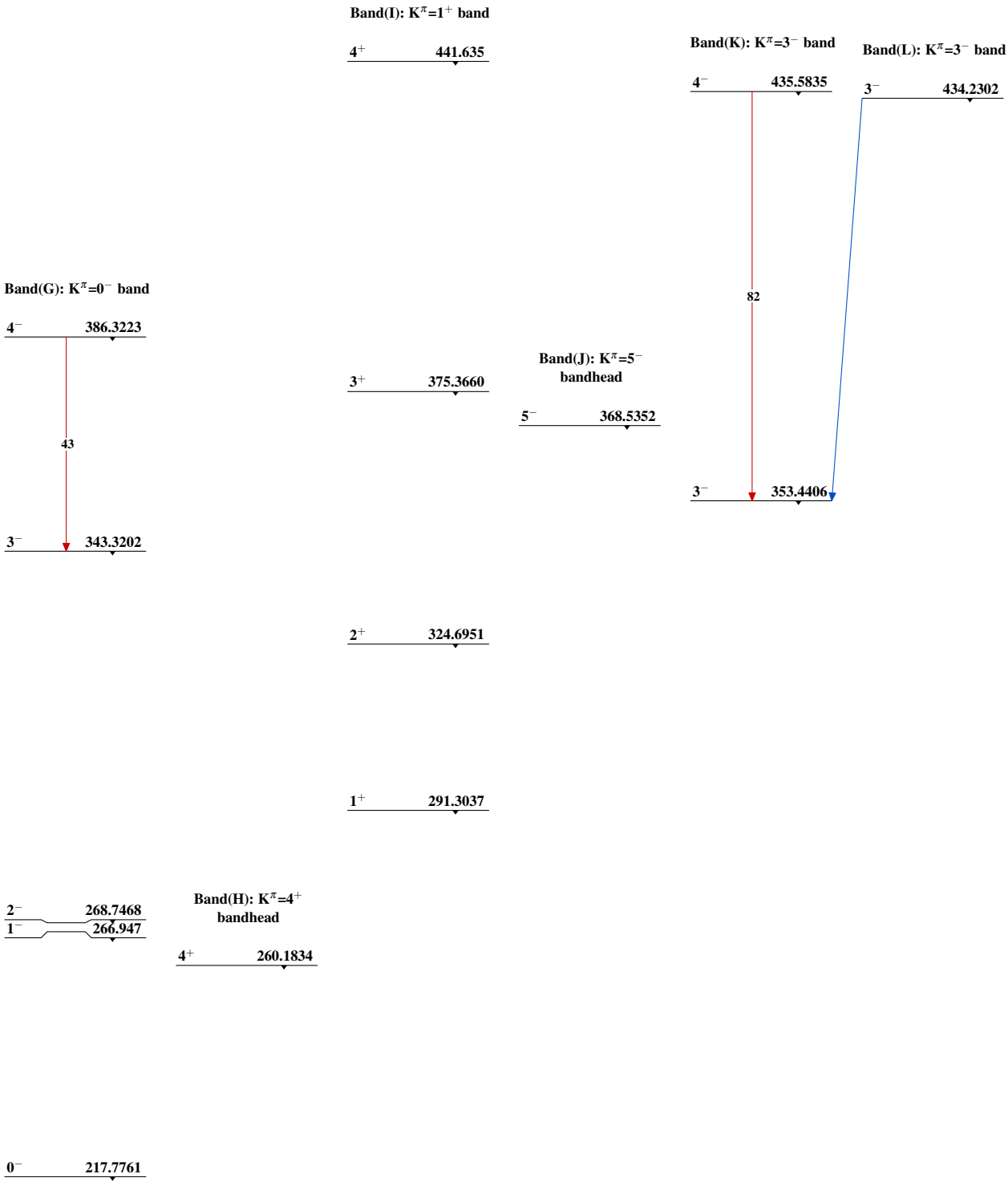
$^{156}_{63}Eu_{93}$

^{153}Eu(3n,γ) 1991Ba06



$^{156}_{63}Eu_{93}$

^{153}Eu(3n,γ) 1991Ba06 (continued)



$^{156}_{63}Eu_{93}$