^{230}Fr β^- decay 1986KuZL,1987Ku04

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. Morse	NDS 197,259 (2024).	26-Sep-2023

Parent: ^{230}Fr: E=0.0; J$^\pi$=(3); $T_{1/2}$=19.1 s *4*; Q(β^-)=4970 *12*; %β^- decay=100

^{230}Fr-Q(β^-): From 2021Wa16.

The ^{230}Fr β^- decay scheme is presented as given in 1987Ku04 based on coincidence data and γ-ray energy adjustments between levels. Forty six γ rays have not been placed in the decay scheme. Although a number of them can be placed by considering differences between γ-ray energies, since coincidence data are not available, such placements could not be confirmed; thus these transitions have been left unplaced in the decay scheme.

The previous evaluation arrived at a normalization factor of 0.114 for absolute γ-ray intensities by assuming no β feeding to the ground state, and balancing the intensity of transitions populating and depoluating the first excited state. The sum of photon intensities of unplaced transitions is 203 *43* (relative to I(129.1γ)=100) using this normalization, which amounts to 22 *5* percent of β^- decay. Due to this large unplaced γ-ray intensity, the unknown spin-parities of many levels, and unknown multipolarities of many γ rays, the current evaluator has opted not to provide a normalization for this dataset.

If J(^{230}Fr)=3, as suggested by 1987Ku04 (from apparent β feedings to the 2$^+$, 4$^+$ states in ^{230}Ra), γ-ray intensity imbalances at 6$^+$, 5$^+$ (or 5$^-$), and 1$^-$ levels suggest that these levels must be populated by additional γ rays from higher-energy levels. Besides the unplaced γ rays, some additional (not yet observed) low-energy and highly converted γ-ray transitions between rotational band states could also affect the β feedings that the present decay scheme yields.

No β^- delayed fission from ^{230}Fr decay (<3×10^{-4}%) (1990Me13).

^{230}Ra Levels

E(level)	J$^\pi$[†]	E(level)	J$^\pi$[†]	E(level)	J$^\pi$[†]	E(level)
0.0[‡]	0$^+$	768.48[#] *8*	(3$^-$)	1033.92 *12*	(2$^+$)	1341.21 *22*
57.48[‡] *7*	(2$^+$)	785.88[@] *10*	(3$^+$)	1144.53 *13*	(4$^+$)	1466.93 *23*
186.61[‡] *8*	(4$^+$)	849.85[@] *12*	(4$^+$)	1158.55 *16*		1522.39 *19*
379.11[‡] *12*	(6$^+$)	879.93[#] *12*	(5$^-$)	1189.05 *19*		1897.26 *12*
710.96[#] *7*	(1$^-$)	893.08 *12*		1211.86 *19*		2005.04 *13*
734.85[@] *7*	(2$^+$)	932.22[@] *20*	(5$^+$)	1281.15 *22*		2043.47 *17*

[†] From Adopted Levels, similar to those in 1987Ku04 from analogy to levels in neighboring nuclei, and from γ-ray transition decay pattern.

[‡] Band(A): g.s. band.

[#] Band(B): K=0 octupole-vibrational band.

[@] Band(C): K=2 γ-vibrational band.

γ(^{230}Ra)

E$_\gamma$[†]	I$_\gamma$[‡]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.[#]	α[&]	Comments
57.4[a] *1*	5.9[a] *6*	57.48	(2$^+$)	0.0	0$^+$	[E2]	133.9 *22*	α(L)=98.5 *16*; α(M)=26.7 *4*; α(N)=7.05 *12*; α(O)=1.494 *24*; α(P)=0.2145 *35*; α(Q)=0.000480 *8* Although not reported in the experimental papers, this transition is assumed to be a doublet placed also between 3$^-$ and 1$^-$ members of the K=0 octupole-vibrational band. Relative transition intensity of 25 *8* for the 57.4γ deexciting the 3$^-$ state is obtained by assuming no β transition feeding the 1$^-$ level at 710.9 keV. I(γ+ce)(57.4γ)=850 is given in 1987Ku04, and Iγ=6.1 *6* in 1986KuZL.
57.4[ab] *1*	0.18[a] *6*	768.48	(3$^-$)	710.96	(1$^-$)	[E2]	133.9 *22*	α(L)=98.5 *16*; α(M)=26.7 *4*; α(N)=7.05 *12*; α(O)=1.494 *24*; α(P)=0.2145 *35*; α(Q)=0.000480 *8*

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^{230}Fr β^- decay 1986KuZL,1987Ku04 (continued)

$\gamma(^{230}Ra)$ (continued)

E_γ [†]	I_γ [‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	α [&]	Comments
129.1 *1*	100 *7*	186.61	(4⁺)	57.48	(2⁺)	[E2]	3.24 *5*	α(K)=0.304 *4*; α(L)=2.154 *31*; α(M)=0.586 *8*; α(N)=0.1547 *22*; α(O)=0.0330 *5* α(P)=0.00480 *7*; α(Q)=2.453×10^{-5} *35*
192.5 *1*	17.0 *17*	379.11	(6⁺)	186.61	(4⁺)	[E2]	0.672 *9*	α(K)=0.1739 *24*; α(L)=0.367 *5*; α(M)=0.0991 *14*; α(N)=0.0262 *4*; α(O)=0.00560 *8* α(P)=0.000829 *12*; α(Q)=8.21×10^{-6} *12*
264.5 *2*	3.6 *4*	1144.53	(4⁺)	879.93	(5⁻)	[E1]	0.0469 *7*	α(K)=0.0376 *5*; α(L)=0.00699 *10*; α(M)=0.001668 *24*; α(N)=0.000436 *6*; α(O)=9.73×10^{-5} *14* α(P)=1.615×10^{-5} *23*; α(Q)=1.020×10^{-6} *14*
265.5 *2*	2.3 *3*	1033.92	(2⁺)	768.48	(3⁻)	[E1]	0.0464 *7*	α(K)=0.0373 *5*; α(L)=0.00693 *10*; α(M)=0.001653 *23*; α(N)=0.000432 *6*; α(O)=9.64×10^{-5} *14* α(P)=1.600×10^{-5} *23*; α(Q)=1.012×10^{-6} *14*
323.1 *2*	3.5 *3*	1033.92	(2⁺)	710.96	(1⁻)	[E1]	0.0298 *4*	α(K)=0.02407 *34*; α(L)=0.00435 *6*; α(M)=0.001036 *15*; α(N)=0.000271 *4*; α(O)=6.07×10^{-5} *9* α(P)=1.016×10^{-5} *14*; α(Q)=6.67×10^{-7} *9*
333.1 *2*	2.7 *3*	1522.39		1189.05		[D,E2]	0.29 *26*	
ˣ336.2 *2*	2.1 *2*							
338.9 *3*	1.0 *2*	1189.05		849.85	(4⁺)	[D,E2]		
375.8 *2*	5.8 *6*	1144.53	(4⁺)	768.48	(3⁻)	[E1]	0.02141 *30*	α(K)=0.01735 *24*; α(L)=0.00308 *4*; α(M)=0.000732 *10*; α(N)=0.0001917 *27* α(O)=4.30×10^{-5} *6*; α(P)=7.24×10^{-6} *10*; α(Q)=4.88×10^{-7} *7*
ˣ385.5 *3*	1.6 *2*							
500.8	<1.2	879.93	(5⁻)	379.11	(6⁺)	[E1]	0.01176 *16*	α(K)=0.00959 *13*; α(L)=0.001648 *23*; α(M)=0.000390 *5*; α(N)=0.0001022 *14* α(O)=2.303×10^{-5} *32*; α(P)=3.91×10^{-6} *5*; α(Q)=2.76×10^{-7} *4*
548.0 *3*	3.0 *3*	734.85	(2⁺)	186.61	(4⁺)	[E2]	0.0312 *4*	α(K)=0.02112 *30*; α(L)=0.00756 *11*; α(M)=0.001927 *27*; α(N)=0.000509 *7* α(O)=0.0001121 *16*; α(P)=1.799×10^{-5} *25*; α(Q)=7.65×10^{-7} *11*
553.2 *2*	4.4 *4*	932.22	(5⁺)	379.11	(6⁺)	[E2][@]	0.0306 *4*	α(K)=0.02074 *29*; α(L)=0.00735 *10*; α(M)=0.001872 *26*; α(N)=0.000494 *7* α(O)=0.0001089 *15*; α(P)=1.749×10^{-5} *25*; α(Q)=7.50×10^{-7} *11* I_γ: from coincidence measurements (1986KuZL).
581.9 *1*	16.6 *12*	768.48	(3⁻)	186.61	(4⁺)	[E1]	0.00872 *12*	α(K)=0.007134 *99*; α(L)=0.001207 *17*; α(M)=0.000285 *4*; α(N)=7.47×10^{-5} *10* α(O)=1.688×10^{-5} *24*; α(P)=2.88×10^{-6} *4*; α(Q)=2.073×10^{-7} *29*
587.0 *2*	7.8 *8*	1466.93		879.93	(5⁻)			
599.3 *1*	17.3 *12*	785.88	(3⁺)	186.61	(4⁺)	[E2][@]	0.0256 *4*	α(K)=0.01781 *25*; α(L)=0.00580 *8*; α(M)=0.001469 *21*; α(N)=0.000388 *5*; α(O)=8.57×10^{-5} *12* α(P)=1.387×10^{-5} *19*; α(Q)=6.38×10^{-7} *9*
ˣ619.8 *3*	3.7 *4*							

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^{230}Fr β^- decay 1986KuZL,1987Ku04 (continued)

$\gamma(^{230}Ra)$ (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[&]	Comments
[x]633.3 *2*	5.2 *5*							
653.4 *1*	23.0 *16*	710.96	(1⁻)	57.48	(2⁺)	[E1]	0.00697 *10*	α(K)=0.00571 *8*; α(L)=0.000956 *13*; α(M)=0.0002255 *32*; α(N)=5.91×10⁻⁵ *8* α(O)=1.337×10⁻⁵ *19*; α(P)=2.288×10⁻⁶ *32*; α(Q)=1.672×10⁻⁷ *23*
663.2 *1*	29.7 *21*	849.85	(4⁺)	186.61	(4⁺)	[E2][@]	0.02054 *29*	α(K)=0.01472 *21*; α(L)=0.00435 *6*; α(M)=0.001095 *15*; α(N)=0.000289 *4*; α(O)=6.40×10⁻⁵ *9* α(P)=1.046×10⁻⁵ *15*; α(Q)=5.21×10⁻⁷ *7*
677.4 *1*	61 *4*	734.85	(2⁺)	57.48	(2⁺)	[E2][@]	0.01963 *27*	α(K)=0.01415 *20*; α(L)=0.00411 *6*; α(M)=0.001031 *14*; α(N)=0.000272 *4*; α(O)=6.04×10⁻⁵ *8* α(P)=9.87×10⁻⁶ *14*; α(Q)=5.00×10⁻⁷ *7*
693.3 *1*	23.2 *16*	879.93	(5⁻)	186.61	(4⁺)	[E1]	0.00623 *9*	α(K)=0.00511 *7*; α(L)=0.000851 *12*; α(M)=0.0002005 *28*; α(N)=5.26×10⁻⁵ *7* α(O)=1.189×10⁻⁵ *17*; α(P)=2.039×10⁻⁶ *29*; α(Q)=1.500×10⁻⁷ *21*
[x]699.1 *2*	6.5 *5*							
706.5 *1*	16.3 *11*	893.08		186.61	(4⁺)			
711.0[a] *1*	24[a] *6*	710.96	(1⁻)	0.0	0⁺	[E1]	0.00594 *8*	α(K)=0.00488 *7*; α(L)=0.000810 *11*; α(M)=0.0001908 *27*; α(N)=5.00×10⁻⁵ *7* α(O)=1.132×10⁻⁵ *16*; α(P)=1.942×10⁻⁶ *27*; α(Q)=1.433×10⁻⁷ *20* I_γ: from coincidence measurements (1986KuZL).
711.0[a] *1*	124[a] *12*	768.48	(3⁻)	57.48	(2⁺)	[E1]	0.00594 *8*	α(K)=0.00488 *7*; α(L)=0.000810 *11*; α(M)=0.0001908 *27*; α(N)=5.00×10⁻⁵ *7* α(O)=1.132×10⁻⁵ *16*; α(P)=1.942×10⁻⁶ *27*; α(Q)=1.433×10⁻⁷ *20* I_γ: from coincidence measurements (1986KuZL).
728.4 *1*	66 *4*	785.88	(3⁺)	57.48	(2⁺)	[E2][@]	0.01687 *24*	α(K)=0.01237 *17*; α(L)=0.00338 *5*; α(M)=0.000844 *12*; α(N)=0.0002224 *31* α(O)=4.95×10⁻⁵ *7*; α(P)=8.14×10⁻⁶ *11*; α(Q)=4.33×10⁻⁷ *6*
734.9 *1*	54 *4*	734.85	(2⁺)	0.0	0⁺	[E2]	0.01657 *23*	α(K)=0.01217 *17*; α(L)=0.00330 *5*; α(M)=0.000823 *12*; α(N)=0.0002171 *30* α(O)=4.83×10⁻⁵ *7*; α(P)=7.96×10⁻⁶ *11*; α(Q)=4.26×10⁻⁷ *6*
745.4 *3*	14.8 *22*	932.22	(5⁺)	186.61	(4⁺)	[E2][@]	0.01609 *23*	α(K)=0.01186 *17*; α(L)=0.00318 *4*; α(M)=0.000793 *11*; α(N)=0.0002090 *29* α(O)=4.65×10⁻⁵ *7*; α(P)=7.67×10⁻⁶ *11*; α(Q)=4.14×10⁻⁷ *6*
754.0 *5*	4.4 *11*	1522.39		768.48	(3⁻)			
765.5 *3*	4.1 *5*	1144.53	(4⁺)	379.11	(6⁺)	[E2]	0.01524 *21*	α(K)=0.01129 *16*; α(L)=0.00297 *4*; α(M)=0.000738 *10*; α(N)=0.0001946 *27* α(O)=4.34×10⁻⁵ *6*; α(P)=7.16×10⁻⁶ *10*; α(Q)=3.93×10⁻⁷ *6*
792.4 *2*	18.4 *13*	849.85	(4⁺)	57.48	(2⁺)	[E2]	0.01421 *20*	α(K)=0.01060 *15*; α(L)=0.00272 *4*; α(M)=0.000674 *9*; α(N)=0.0001776 *25*; α(O)=3.96×10⁻⁵ *6* α(P)=6.56×10⁻⁶ *9*; α(Q)=3.68×10⁻⁷ *5*

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^{230}Fr β^- decay 1986KuZL,1987Ku04 (continued)

$\gamma(^{230}Ra)$ (continued)

E_γ [†]	I_γ [‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	α [&]	Comments
^{x}801.9 *3*	1.7 *3*							
811.9 *3*	6.8 *7*	1522.39		710.96	(1$^-$)			
832.4 *3*	3.7 *4*	1211.86		379.11	(6$^+$)			
835.5 *3*	11.8 *12*	893.08		57.48	(2$^+$)			
^{x}840.4 *5*	2.8 *4*							
847.2 *3*	5.9 *7*	1033.92	(2$^+$)	186.61	(4$^+$)	[E2]	0.01243 *17*	α(K)=0.00938 *13*; α(L)=0.002295 *32*; α(M)=0.000567 *8*; α(N)=0.0001494 *21* α(O)=3.34×10^{-5} *5*; α(P)=5.56×10^{-6} *8*; α(Q)=3.24×10^{-7} *5*
863.5 *3*	2.7 *3*	1897.26		1033.92	(2$^+$)			
^{x}886.0 *2*	4.8 *5*							
898.7 *2*	8.1 *8*	2043.47		1144.53	(4$^+$)			
958.0 *2*	6.5 *7*	1144.53	(4$^+$)	186.61	(4$^+$)	[M1,E2]	0.021 *11*	α(K)=0.017 *9*; α(L)=0.0031 *14*; α(M)=7.5×10^{-4} *34*; α(N)=2.0×10^{-4} *9*; α(O)=4.5×10^{-5} *21* α(P)=8.E−6 *4*; α(Q)=5.8×10^{-7} *32*
^{x}965.8 *2*	4.9 *5*							
971.8 *2*	15.0 *15*	1158.55		186.61	(4$^+$)			
976.3 *3*	8.2 *8*	1033.92	(2$^+$)	57.48	(2$^+$)	[M1,E2]	0.020 *10*	α(K)=0.016 *9*; α(L)=0.0030 *14*; α(M)=7.2×10^{-4} *32*; α(N)=1.9×10^{-4} *8*; α(O)=4.3×10^{-5} *19* α(P)=7.4×10^{-6} *35*; α(Q)=5.5×10^{-7} *31*
^{x}986.5 *3*	1.6 *2*							
1002.2 *3*	13.5 *14*	1189.05		186.61	(4$^+$)			
1004.3 *3*	11.2 *11*	1897.26		893.08				
^{x}1018.8 *3*	4.5 *5*							
1025.4 *2*	7.3 *7*	1211.86		186.61	(4$^+$)			
1033.8 *5*	3.0 *5*	1033.92	(2$^+$)	0.0	0$^+$	[E2]	0.00845 *12*	α(K)=0.00656 *9*; α(L)=0.001428 *20*; α(M)=0.000348 *5*; α(N)=9.18×10^{-5} *13* α(O)=2.063×10^{-5} *29*; α(P)=3.48×10^{-6} *5*; α(Q)=2.221×10^{-7} *31*
^{x}1049.2 *3*	10.0 *7*							
1086.9 *5*	3.0 *5*	1144.53	(4$^+$)	57.48	(2$^+$)	[E2]	0.00768 *11*	α(K)=0.00599 *8*; α(L)=0.001274 *18*; α(M)=0.000310 *4*; α(N)=8.17×10^{-5} *11* α(O)=1.837×10^{-5} *26*; α(P)=3.11×10^{-6} *4*; α(Q)=2.022×10^{-7} *28*
1094.8 *3*	18.0 *18*	1281.15		186.61	(4$^+$)			
1101.2 *2*	14.1 *11*	1158.55		57.48	(2$^+$)			
^{x}1106.5 *3*	4.3 *5*							
1111.8 *3*	6.6 *7*	1897.26		785.88	(3$^+$)			
1128.8 *2*	21.5 *15*	1897.26		768.48	(3$^-$)			
1154.6 *2*	15.4 *11*	1341.21		186.61	(4$^+$)			
1162.6 *2*	24.6 *17*	1897.26		734.85	(2$^+$)			
^{x}1191.6 *5*	4.1 *5*							
1219.0 *5*	4.7 *5*	2005.04		785.88	(3$^+$)			
1223.4 *3*	14.1 *14*	1281.15		57.48	(2$^+$)			
^{x}1230.8 *5*	2.8 *3*							
1236.6 *3*	10.7 *11*	2005.04		768.48	(3$^-$)			
^{x}1259.1 *5*	1.6 *3*							
1270.2 *2*	10.8 *11*	2005.04		734.85	(2$^+$)			
1274.6 *3*	4.8 *7*	2043.47		768.48	(3$^-$)			
1294.0 *2*	12.5 *13*	2005.04		710.96	(1$^-$)			
^{x}1326.1 *3*	2.3 *4*							
^{x}1330.2 *5*	1.8 *5*							

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^{230}Fr β^- decay 1986KuZL,1987Ku04 (continued)

γ(^{230}Ra) (continued)

E_γ †	I_γ ‡	E_i(level)	E_f	J^π_f	E_γ †	I_γ ‡	E_i(level)	E_f	J^π_f
^{x}1349.6 *5*	2.0 *4*				^{x}1750.5 *5*	2.4 *4*			
^{x}1365.1 *5*	2.4 *5*				^{x}1793.7 *5*	2.6 *4*			
1465.0 *5*	1.2 *3*	1522.39	57.48	(2$^+$)	1839.3 *5*	3.2 *5*	1897.26	57.48	(2$^+$)
^{x}1473.7 *5*	1.8 *6*				1857.8 *3*	8.1 *8*	2043.47	186.61	(4$^+$)
^{x}1495.3 *5*	4.6 *7*				^{x}1869.4 *3*	23.7 *24*			
^{x}1519.9 *5*	2.1 *4*				^{x}1880.1 *3*	9.6 *10*			
^{x}1545.4 *5*	6.9 *7*				^{x}1883.9 *5*	2.3 *5*			
^{x}1562.4 *5*	4.8 *7*				^{x}1887.9 *5*	3.8 *6*			
^{x}1601.3 *5*	2.3 *4*				^{x}1908.3 *5*	1.9 *3*			
^{x}1605.1 *5*	3.4 *5*				^{x}1927.4 *5*	4.6 *5*			
^{x}1610.0 *5*	3.5 *5*				1947.7 *3*	14.5 *15*	2005.04	57.48	(2$^+$)
^{x}1615.8 *5*	4.0 *6*				^{x}1987.4 *5*	7.1 *7*			
^{x}1662.6 *5*	4.2 *6*				^{x}2013.7 *5*	6.8 *7*			
^{x}1702.0 *3*	8.2 *8*				^{x}2041.5 *5*	3.1 *3*			
1710.2 *2*	15.6 *16*	1897.26	186.61	(4$^+$)	^{x}2093.1 *5*	7.7 *8*			
^{x}1737.5 *5*	4.7 *5*				^{x}2232.6 *5*	3.0 *3*			
^{x}1744.4 *5*	4.2 *4*				^{x}2376.5 *5*	4.1 *4*			

† From 1986KuZL and 1987Ku04.

‡ Relative photon intensities are from 1986KuZL. Transition intensities are shown in 1987Ku04 on their decay scheme.

\# Assumed from the level scheme; they were not determined experimentally.

@ Branching ratios of γ rays to the K=0 g.s. band imply that any possible M1 admixture is small (M1 transitions from a K=2 band to the K=0 band would be K forbidden). See 1987Ku04 for comparison of experimental and theoretical branching ratios.

& Additional information 1.

^{a} Multiply placed with intensity suitably divided.

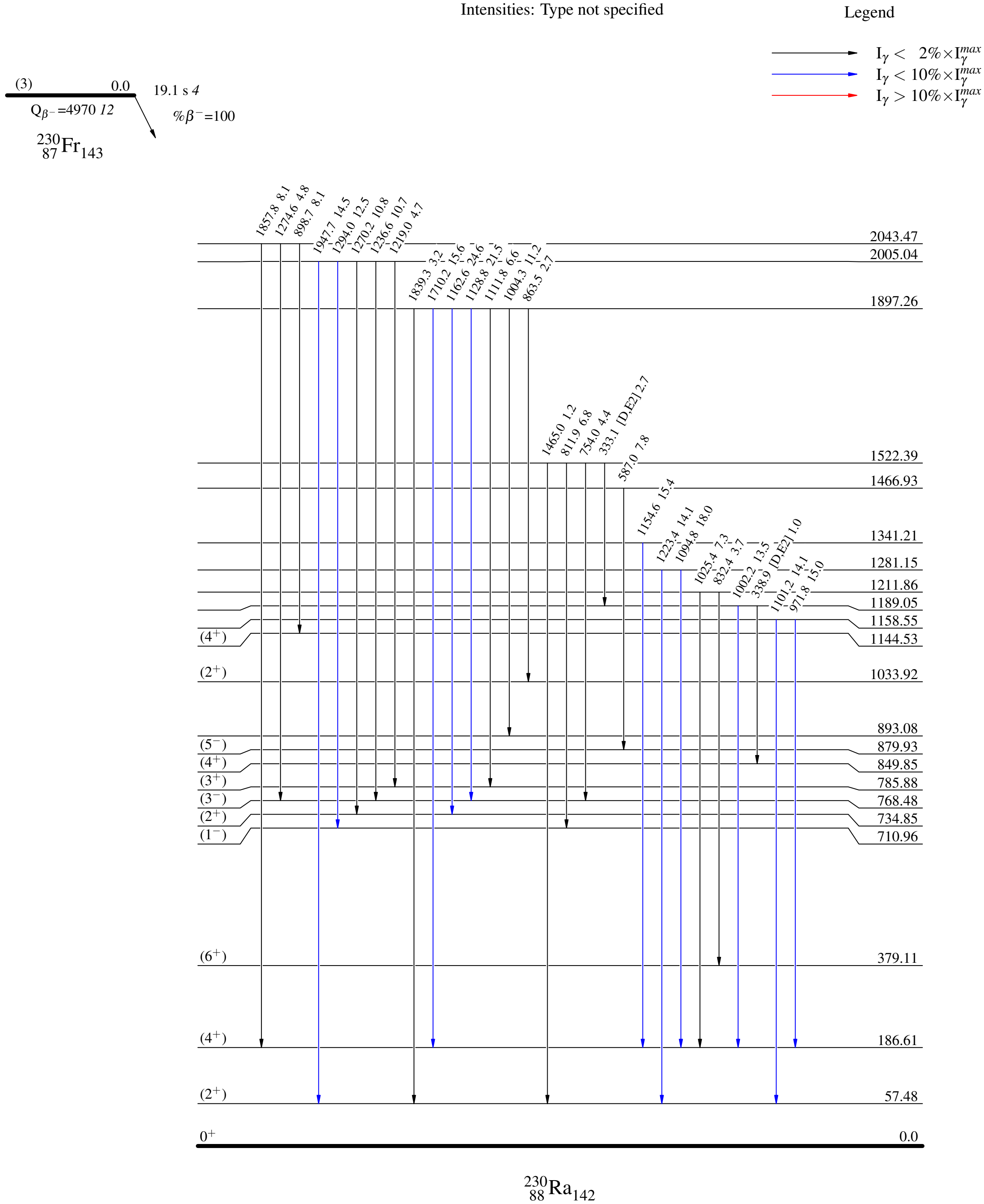
^{b} Placement of transition in the level scheme is uncertain.

^{x} γ ray not placed in level scheme.

^{230}Fr β^- decay 1986KuZL,1987Ku04

Decay Scheme

Intensities: Type not specified

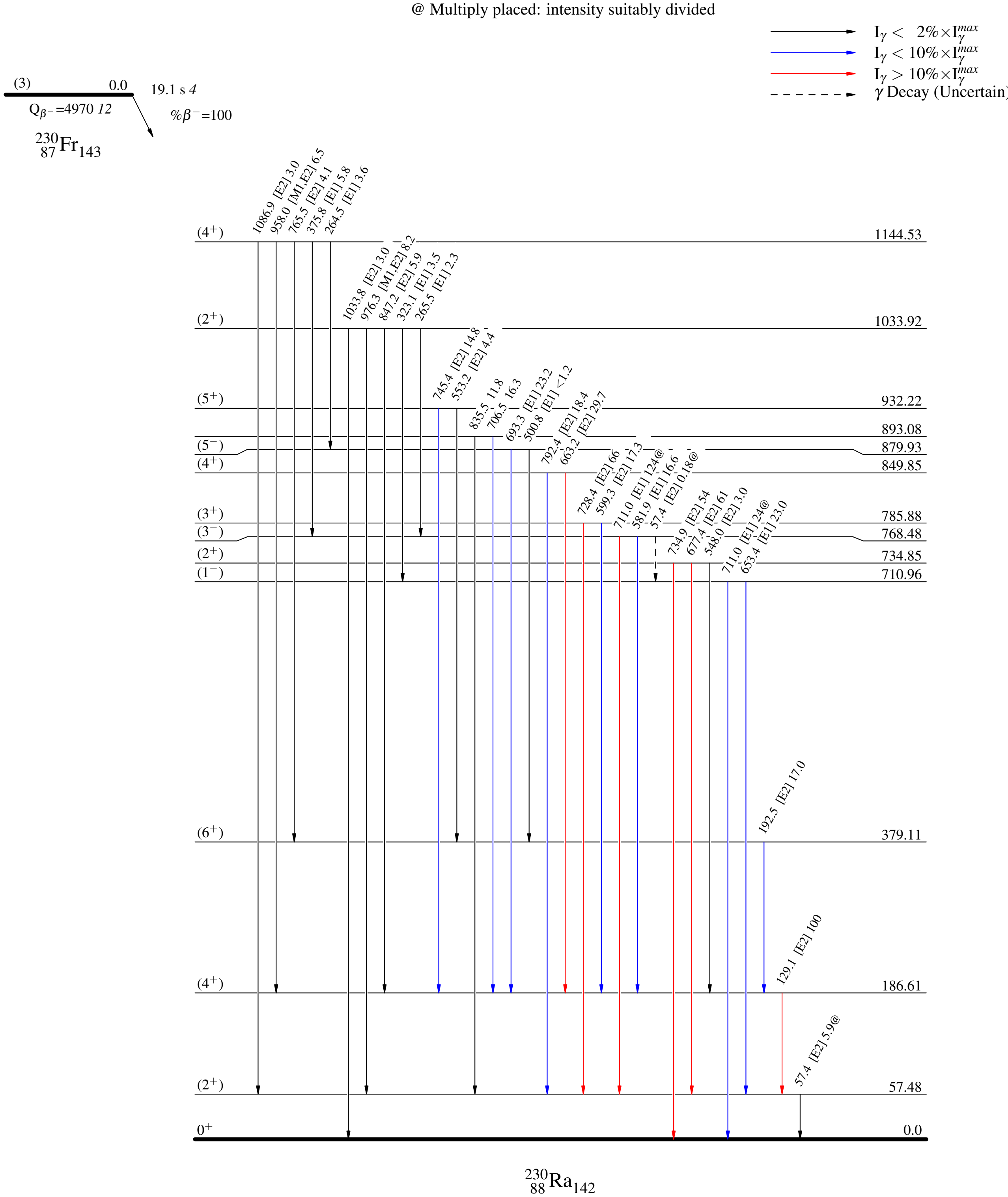


^{230}Fr β^- decay 1986KuZL,1987Ku04

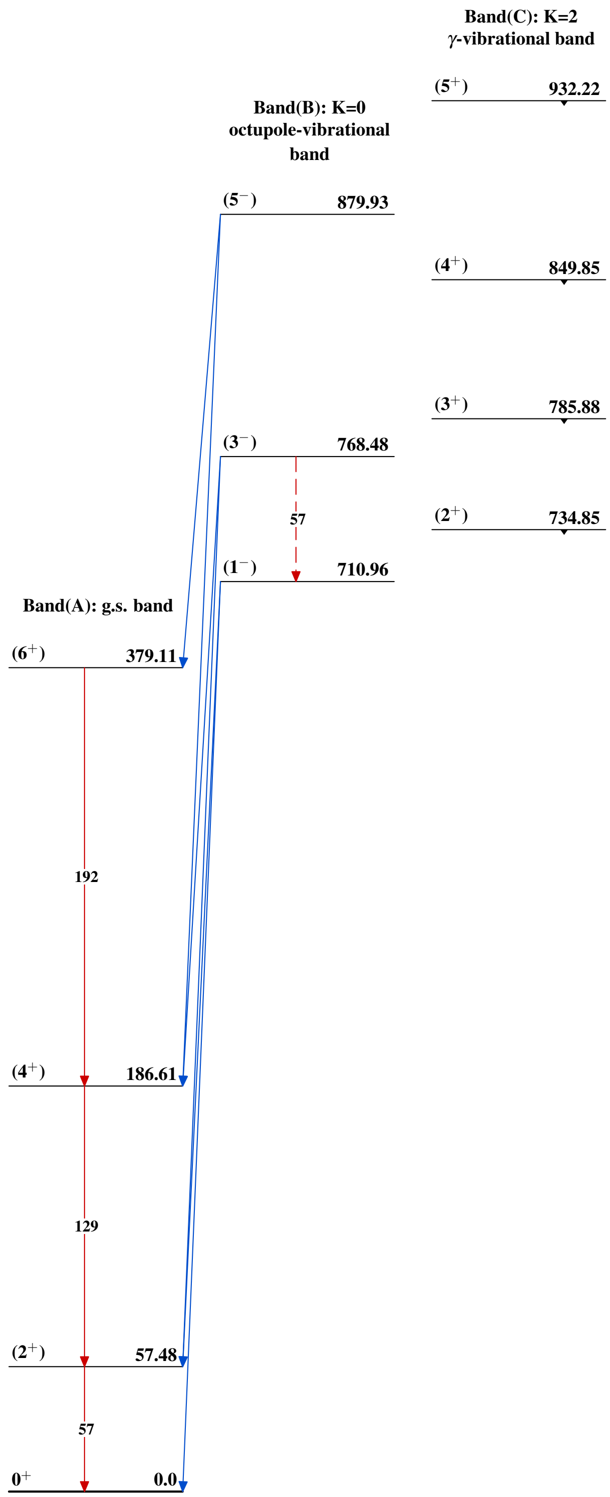
Decay Scheme (continued)

Intensities: Type not specified

@ Multiply placed: intensity suitably divided



^{230}Fr β^- decay 1986KuZL,1987Ku04



$^{230}_{88}Ra_{142}$