^{225}Fr β^- decay

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	A. K. Jain (a), R. Raut (b), J. K. Tuli	NDS 110, 1409 (2009)	1-Dec-2008

Parent: ^{225}Fr: E=0.0; J^π=3/2$^-$; $T_{1/2}$=4.0 min *2*; Q(β^-)=1850 *90*; %β^- decay=100.0

1983Ny01: Decay scheme from the $\gamma\gamma$-coincidence data, supplemented with information from ^{229}Th α decay. Absolute photon intensities and β feedings could not be calculated with the available data.

1989An02: Measured ce, $\gamma\gamma$, Eγ. Deduced levels, α, M, J^π. Online mass separation, Ge and Si(Li) detectors, mini-orange spectrometer.

F-K analysis of singles β spectrum by 1975We23 gave a value of 1.64±0.01 MeV for the end-point β energy which would correspond to β^- feedings to levels around 210 *91* keV, since Q(β^-)=1850 *90* (1985Wa02). However, intensity imbalances at lower energy levels suggest that they are directly populated by β branches. β feedings to the 1/2[631] g.s. and the low energy 1/2[501] band members are expected.

^{225}Ra Levels

E(level)	J^π	$T_{1/2}$
0.0	1/2$^+$	14.9 d *2*
25.41 *2*	5/2$^+$	
31.56 *3*	3/2$^-$	
42.77 *3*	3/2$^+$	
55.16 *6*	(1/2$^-$)	
69.36 *6*	(7/2$^-$)	
100.50 *6*	9/2$^+$	
111.60 *5*	7/2$^+$	
120.36 *6*	5/2$^-$	
149.96 *6*	3/2$^+$	
179.75 *2*	5/2$^+$	
225.2 *1*	3/2$^-$	
236.25 *2*	5/2$^+$	
260.2 *1*	5/2$^-$	
394.2 *1*	3/2$^-$,5/2	
478.4 *1*	3/2$^+$	
724.1 *1*	(1/2,3/2,5/2)$^-$	

^{225}Fr β^- decay (continued)

$\gamma(^{225}$Ra)

E$_\gamma$[†]	I$_\gamma$[‡]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.[&]	δ	α[c]	Comments
(11.1[@] *1*)		111.60	7/2$^+$	100.50	9/2$^+$				
(11.21[#])		42.77	3/2$^+$	31.56	3/2$^-$				
(17.36[@] *3*)	5.3 *29*	42.77	3/2$^+$	25.41	5/2$^+$	(M1)		140.6	α(L)=2.99; α(M)=103.5 I$_\gamma$: calculated from Iγ(17.36γ)/Iγ(42.8γ)=18 *9*/16 *1*, as measured in ^{229}Th α decay, and Iγ(42.8γ)=4.7 *9*.
(23.6[#])	1.1 *4*	55.16	(1/2$^-$)	31.56	3/2$^-$	(M1+E2)		241 *33*	α(L)=182 *9*; α(M)=43.9 *24* I$_\gamma$: calculated from Iγ(23.6γ)/Iγ(55.1γ)=12 *1*/26 *4* as measured in ^{229}Th α decay. α: deduced in ^{229}Th α decay.
(25.39[@] *2*)		25.41	5/2$^+$	0.0	1/2$^+$	(E2)		7377	α(L)=5442; α(M)=1455 Mult.: (α(L1)exp+α(L2)exp)=8 *3*, α(L3)exp=6.1 *23*,
(30.3[@] *1*)	<0.28	179.75	5/2$^+$	149.96	3/2$^+$	(M1+E2)		≈223	α(L)≈167; α(M)≈42 I$_\gamma$: calculate from Iγ(30γ)/Iγ(137γ)<4/115, as measured in ^{229}Th α decay.
31.10[@] *5*		100.50	9/2$^+$	69.36	(7/2$^-$)	[E1]		2.52	
31.7 *2*	91 *16*	31.56	3/2$^-$	0.0	1/2$^+$	E1		2.44	α(L)=1.83; α(M)=0.456 Mult.: (α(M)exp)<0.6.
37.8 *2*	0.13 *7*	69.36	(7/2$^-$)	31.56	3/2$^-$	E2		1040	α(L)=766; α(M)=206 Mult.: (α(L3)exp)=58 *22*, α(M)exp=34 *24*, I$_\gamma$: from Iγ(37.8γ)/Iγ(44.0γ)=0.32 *16*/64 *3*, as measured in ^{229}Th α decay, and Iγ(44.0γ)=26 *5*. Iγ(37.8γ)=0.9 *4* was given by 1983Ny01 which would imply large β feeding from 3/2$^-$ ^{225}Fr to the (7/2$^-$) state at 69.36 keV in ^{225}Ra.
(42.3[@] *1*)		111.60	7/2$^+$	69.36	(7/2$^-$)				
42.8 *2*	4.7 *9*	42.77	3/2$^+$	0.0	1/2$^+$	M1	0.28 *7*	77 *20*	α(L)=58 *14*; α(M)=15 *4* Mult.: (α(L)exp)=13.3 *31*.
44.0 *2*	26 *5*	69.36	(7/2$^-$)	25.41	5/2$^+$	E1[a]		1.002	α(L)=0.756; α(M)=0.185 Mult.: (α(L)exp)=0.60 *12*.
45.2 *2*	5.6 *10*	225.2	3/2$^-$	179.75	5/2$^+$	E1		0.932	α(L)=0.703; α(M)=0.172 Mult.: (α(L)exp)=2.0 *5*.
50.8 *2*	3.4 *3*	120.36	5/2$^-$	69.36	(7/2$^-$)	M1		23.5	α(L)=17.7; α(M)=4.25; α(N+..)=1.52 Mult.: α(L)exp=7.3 *18*,
55.1 *2*	2.3 *6*	55.16	(1/2$^-$)	0.0	1/2$^+$	E1		0.549	α(L)=0.414; α(M)=0.1008; α(N+..)=0.0339 Mult.: α(L)exp<1.9,
56.3 *5*	0.4[b] *2*	236.25	5/2$^+$	179.75	5/2$^+$	M1(+E2)	0.11 *11*	18.9 *16*	α(L)=14.3 *12*; α(M)=3.5 *4*; α(N+..)=1.23 *12* Mult.: α(L)exp=9.6 *27*, Iγ(56γ)/Iγ(211γ)=0.28 *2*/2.7 *3*, measured in ^{229}Th α decay, and Iγ(211γ)=8.5 *7* from ^{225}Fr β^- decay yield Iγ(56γ)=0.88 *14*.
(68.09[@] *4*)	0.47 *8*	179.75	5/2$^+$	111.60	7/2$^+$	M1+E2	0.32 *16*	15 *5*	α(L)=11 *4*; α(M)=2.8 *10*; α(N+..)=1.0 *4*

$^{225}_{88}$Ra$_{137}$-2

γ(^{225}Ra) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	δ	α[c]	Comments
									I_γ: calculated from Iγ(68γ)/Iγ(137γ)=0.067 *10*/1.15 *3*, as measured in ^{229}Th α decay.
(68.83[@] *3*)		111.60	7/2$^+$	42.77	3/2$^+$				
75.09[@] *7*		100.50	9/2$^+$	25.41	5/2$^+$	E2		37.6	
75.1 *1*	45 *4*	225.2	3/2$^-$	149.96	3/2$^+$	E1		0.240	α(L)=0.181; α(M)=0.0438; α(N+..)=0.0149 Mult.: α(L)exp=0.12 *3*, α(M)exp=0.02 *1*,
77.5 *1*	10.6 *11*	120.36	5/2$^-$	42.77	3/2$^+$	E1		0.220	α(L)=0.1659; α(M)=0.0401; α(N+..)=0.01362 Mult.: α(L)exp<0.3.
80.3 *1*	2.6[b] *5*	260.2	5/2$^-$	179.75	5/2$^+$	E1		0.201	α(L)=0.152; α(M)=0.0366; α(N+..)=0.0125 Mult.: α(L)exp<0.9.
(86.25[@] *4*)		111.60	7/2$^+$	25.41	5/2$^+$				
86.7 *3*	6[b] *2*	236.25	5/2$^+$	149.96	3/2$^+$	M1		5.03	α(L)=3.80; α(M)=0.908; α(N+..)=0.324 Mult.: α(L)exp=5.0 *19*, α(M)exp=1.2 *2*. Iγ(87γ)/Iγ(211γ)=2.5 *1*/2.7 *3*, measured in ^{229}Th α decay, and Iγ(211γ)=8.5 *7* from ^{225}Fr β^- decay yield Iγ(87γ)=7.9 *2*.
95.0 *3*	2.2[b] *17*	120.36	5/2$^-$	25.41	5/2$^+$	E1		0.1286	α(L)=0.0971; α(M)=0.0234; α(N+..)=0.00803 Mult.: α(L)exp<0.12. E_γ: 94.92 *8* from ^{229}Th α decay. Iγ(94.9γ)/Iγ(77.5γ)=3.4 *10* was measured in ^{229}Th α decay; this ratio yields Iγ(94.9γ)=3.1 *9*.
95.0 *3*	2.8[b] *18*	149.96	3/2$^+$	55.16	(1/2$^-$)	E1		0.1292	α(L)=0.0977; α(M)=0.0235; α(N+..)=0.00807 Mult.: α(L)<0.04.
107.1 *1*	11 *2*	149.96	3/2$^+$	42.77	3/2$^+$	M1(+E2)	0.3 *3*	13.1 *6*	α(K)=10.1 *9*; α(L)=2.3 *3*; α(M)=0.56 *7*; α(N+..)=0.20 *3* Mult.: (α(L)exp=0.71 *20*, α(M)exp=0.37 *7*.
110.3[d] *1*	0.85 *11*	179.75	5/2$^+$	69.36	(7/2$^-$)	[E1]		0.385	α(K)=0.299; α(L)=0.0653; α(M)=0.01567; α(N+..)=0.00541 I_γ: calculated from Iγ(110γ)/Iγ(137γ)=0.12112/1.15 *3*, as measured in ^{229}Th α decay.
110.3 *1*	20 *3*	260.2	5/2$^-$	149.96	3/2$^+$	(E1)[a]		0.385	α(K)=0.299; α(L)=0.0653; α(M)=0.0157; α(N+..)=0.00541 Mult.: α(L)exp=0.07 *4*.
(115.98[@] *10*)	0.054 *13*	236.25	5/2$^+$	120.36	5/2$^-$	[E1]		0.341	α(K)=0.265; α(L)=0.0572; α(M)=0.01373; α(N+..)=0.00474 I_γ: calculated from Iγ(115γ)/Iγ(211γ)=0.017 *3*/2.7 *3*, as measured in ^{229}Th α decay.
124.5[d] *1*	9.2 *10*	149.96	3/2$^+$	25.41	5/2$^+$	M1		8.84	α(K)=7.09; α(L)=1.322; α(M)=0.316; α(N+..)=0.1131 Mult.: α(K)exp=7.3 *15*,α(L)exp=1.3 *4*. Iγ=11.5 *9* was measured for the doublet.
124.5[d]	2.3 *4*	236.25	5/2$^+$	111.60	7/2$^+$	(M1)		8.82	α(K)=7.07; α(L)=1.32; α(M)=0.315; α(N+..)=0.113 I_γ: calculated from Iγ(124.65γ)/Iγ(211γ)=0.72 *6*/2.7 *3*, as measured in ^{229}Th α decay, and Iγ(211γ)=8.5 *7*.
134.0 *1*	0.9 *3*	394.2	3/2$^-$,5/2	260.2	5/2$^-$			3.7 *35*	
137.0 *1*	8.1 *6*	179.75	5/2$^+$	42.77	3/2$^+$	M1		6.91	α(K)=5.40; α(L)=1.01; α(M)=0.241; α(N+..)=0.086 Mult.: α(K)exp=1.6 *3*,α(L)exp=1.0 *1*.

From ENSDF

$^{225}_{88}$Ra$_{137}$-3

γ(^{225}Ra) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	δ	α[c]	$I_{(\gamma+ce)}$	Comments
139.8 *1*	11.1 *8*	260.2	5/2⁻	120.36	5/2⁻	M1[a]		4.6 *21*		α(K)=2.8 *26*; α(L)=1.3 *3*; α(M)=0.34 *11*; α(N+..)=0.12 *4* Mult.: α(K)exp=3.3 *3*,α(L)exp=1.7 *3*,α(M)exp<0.4.
148.4 *1*	14.5 *11*	179.75	5/2⁺	31.56	3/2⁻	E1		0.1877		α(K)=0.1478; α(L)=0.0302; α(M)=0.00722; α(N+..)=0.00250 Mult.: α(K)exp<0.2,α(L)exp<1.0.
149.9 *1*	0.8 *2*	149.96	3/2⁺	0.0	1/2⁺	M1(+E2)	0.4 *4*	4.7 *5*		α(K)=3.6 *6*; α(L)=0.82 *5*; α(M)=0.201 *16*; α(N+..)=0.072 *6* Mult.: α(K)exp=9.6 *14*.
154.4 *1*	4.8 *4*	179.75	5/2⁺	25.41	5/2⁺	M1(+E2)	0.4 *4*	4.4 *4*		α(K)=3.4 *5*; α(L)=0.75 *4*; α(M)=0.184 *13*; α(N+..)=0.066 *5* Mult.: α(K)exp=7.6 *15*.
157.9 *1*	1.3 *3*	394.2	3/2⁻,5/2	236.25	5/2⁺	E1		2.3 *21*		Mult.: α(K)exp=4.3 *21*.
(166.976[@] *7*)	0.63 *10*	236.25	5/2⁺	69.36	(7/2⁻)	[E1]		0.141		α(K)=0.1115; α(L)=0.222; α(M)=0.00530; α(N+..)=0.00183 I_γ: calculated from Iγ(167γ)/Iγ(211γ)=0.200 *10*/2.7 *3*, as measured in ^{229}Th α decay, and Iγ(211γ)=8.5 *7*.
169.0 *3*	2[b] *1*	394.2	3/2⁻,5/2	225.2	3/2⁻	M1		1.9	18	Mult.: α(K)exp=2.8 *7*,α(L)exp=0.4 *1*.
169.9 *1*	20 *2*	225.2	3/2⁻	55.16	(1/2⁻)	M1[a]		2.4 *13*		α(K)=1.6 *14*; α(L)=0.59 *5*; α(M)=0.15 *2*; α(N+..)=0.054 *8* Mult.: α(K)exp=2.3 *8*,α(L)exp=0.46*5*,α(M)exp=0.16*2*.
179.9 *1*	1.4 *3*	179.75	5/2⁺	0.0	1/2⁺	E2		0.884		α(K)=0.2000; α(L)=0.500; α(M)=0.1353; α(N+..)=0.0487 Mult.: α(K)exp=0.32*11*.
182.3 *1*	100	225.2	3/2⁻	42.77	3/2⁺	E1		0.1138		α(K)=0.0903; α(L)=0.0177; α(M)=0.00424; α(N+..)=0.00147 Mult.: α(K)exp=0.062 *8*,α(L)exp=0.0089 *11*.
190.8 *1*	24 *2*	260.2	5/2⁻	69.36	(7/2⁻)	M1[a]		2.63		α(K)=2.12; α(L)=0.392; α(M)=0.0937; α(N+..)=0.0332 Mult.: α(K)exp=3.1 *3*,α(L)exp=0.56 *10*, α(M)exp <0.096.
193.5 *3*	15[b] *3*	225.2	3/2⁻	31.56	3/2⁻	M1		1.6 *9*		α(K)=1.1 *9*; α(L)=0.370 *7*; α(M)=0.094 *4*; α(N+..)=0.0336 *17* Mult.: α(K)exp=1.6 *2*,α(L)exp=0.36 *2*, α(M)exp=0.08 *1*.
193.5 *3*	14[b] *3*	236.25	5/2⁺	42.77	3/2⁺	M1		2.53		α(K)=2.03; α(L)=0.377; α(M)=0.0900; α(N+..)=0.0319 Mult.: α(K)exp=2.9 *10*.
199.7 *1*	35 *3*	225.2	3/2⁻	25.41	5/2⁺	E1		0.0914		α(K)=0.0728; α(L)=0.0141; α(M)=0.00336; α(N+..)=0.00116 Mult.: α(K)exp=0.041 *5*,α(L)exp=0.016 *2*, α(M)exp<0.06.
204.9 *1*	4.1 *4*	236.25	5/2⁺	31.56	3/2⁻	E1		0.0861		α(K)=0.0687; α(L)=0.0132; α(M)=0.00316; α(N+..)=0.00109 Mult.: α(K)exp=0.10 *6*.
210.9 *1*	8.5 *7*	236.25	5/2⁺	25.41	5/2⁺	M1		1.98		α(K)=1.60; α(L)=0.296; α(M)=0.0706; α(N+..)=0.0250 Mult.: α(K)exp=1.0 *3*,α(L)exp=0.25 *5*.
217.5 *1*	8.8 *9*	260.2	5/2⁻	42.77	3/2⁺	E1		0.0746		α(K)=0.0595; α(L)=0.0114; α(M)=0.00271; α(N+..)=0.00094 Mult.: α(K)exp < 0.3,α(L)exp < 0.03.
225.1 *1*	55 *4*	225.2	3/2⁻	0.0	1/2⁺	E1		0.0688		α(K)=0.0550; α(L)=0.01044; α(M)=0.00249;

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^{225}Fr β^- decay (continued)

$\gamma(^{225}$Ra) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	α[c]	Comments
								α(N+..)=0.00086 Mult.: α(K)exp < 0.06,α(L)exp < 0.02, α(M)exp < 0.004.
228.6 *1*	3.3 *4*	260.2	$5/2^-$	31.56	$3/2^-$	M1	1.0 *6*	α(K)=0.7 *5*; α(L)=0.21 *3*; α(M)=0.052 *4*; α(N+..)=0.0186 *13* Mult.: α(K)exp=0.905,α(L)exp=0.172.
234.8 *11*	14.3 *1*	260.2	$5/2^-$	25.41	$5/2^+$	E1	0.0623	α(K)=0.0498; α(L)=0.00941; α(M)=0.00225; α(N+..)=0.00078 Mult.: α(K)exp < 0.06.
(236.249[@] *8*)	0.54 *8*	236.25	$5/2^+$	0.0	$1/2^+$	E2	0.333	α(K)=0.118; α(L)=0.158; α(M)=0.0423; α(N+..)=0.0151 I_γ: calculated from Iγ(236γ)/Iγ(211γ)=0.170 *9*/2.7 *3*, as measured in ^{229}Th α decay, and Iγ(211γ)=8.5 *7*.
242.1 *1*	1.6 *2*	478.4	$3/2^+$	236.25	$5/2^+$	M1	0.7 *6*	Mult.: α(K)exp=1.3 *2*.
244.2 *1*	0.7 *2*	394.2	$3/2^-,5/2$	149.96	$3/2^+$		0.7 *6*	
253.4 *1*	1.9 *3*	478.4	$3/2^+$	225.2	$3/2^-$		0.62 *57*	
324.7 *2*	0.4 *1*	394.2	$3/2^-,5/2$	69.36	$(7/2^-)$		0.31 *28*	
328.6 *1*	1.3 *3*	478.4	$3/2^+$	149.96	$3/2^+$	M1	0.31 *28*	Mult.: α(K)exp=0.74 *12*.
358.1 *3*	0.5 *2*	478.4	$3/2^+$	120.36	$5/2^-$		0.24 *22*	
368.8 *2*	0.8 *3*	394.2	$3/2^-,5/2$	25.41	$5/2^+$		0.22 *20*	
435.6 *1*	4.7 *5*	478.4	$3/2^+$	42.77	$3/2^+$	M1	0.14 *13*	Mult.: α(K)exp=0.16 *3*,α(L)exp=0.046 *15*.
453.0 *1*	3.3 *4*	478.4	$3/2^+$	25.41	$5/2^+$	M1	0.13 *11*	Mult.: α(K)exp=0.29 *6*.
464.1 *1*	1.6 *3*	724.1	$(1/2,3/2,5/2)^-$	260.2	$5/2^-$	M1	0.12 *10*	Mult.: α(K)exp=0.13 *6*.
478.3 *1*	6.6 *6*	478.4	$3/2^+$	0.0	$1/2^+$	M1	0.11 *10*	Mult.: α(K)exp=0.13 *3*,α(L)exp=0.04 *1*.
499.0 *2*	4.4 *7*	724.1	$(1/2,3/2,5/2)^-$	225.2	$3/2^-$	M1	0.10 *9*	Mult.: α(K)exp=0.11 *1*,α(L)exp=0.03 *1*.
574.1 *2*	1.9 *3*	724.1	$(1/2,3/2,5/2)^-$	149.96	$3/2^+$	E1	0.07 *6*	Mult.: α(K)exp < 0.06.

[†] Measurements of 1983Ny01, unless otherwise noted.
[‡] Relative photon intensity measured by 1983Ny01.
[#] Transition was not observed; energy from level scheme.
[@] From ^{229}Th α decay; transition was not observed in ^{225}Fr β^- decay.
[&] From 1989An02 and ^{229}Th α decay, except those noted.
[a] Determined by 1983Ny01 from K x ray/γ in coincidence data.
[b] Obtained by 1983Ny01 from $\gamma\gamma$-coincidence data.
[c] 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.
[d] Multiply placed.

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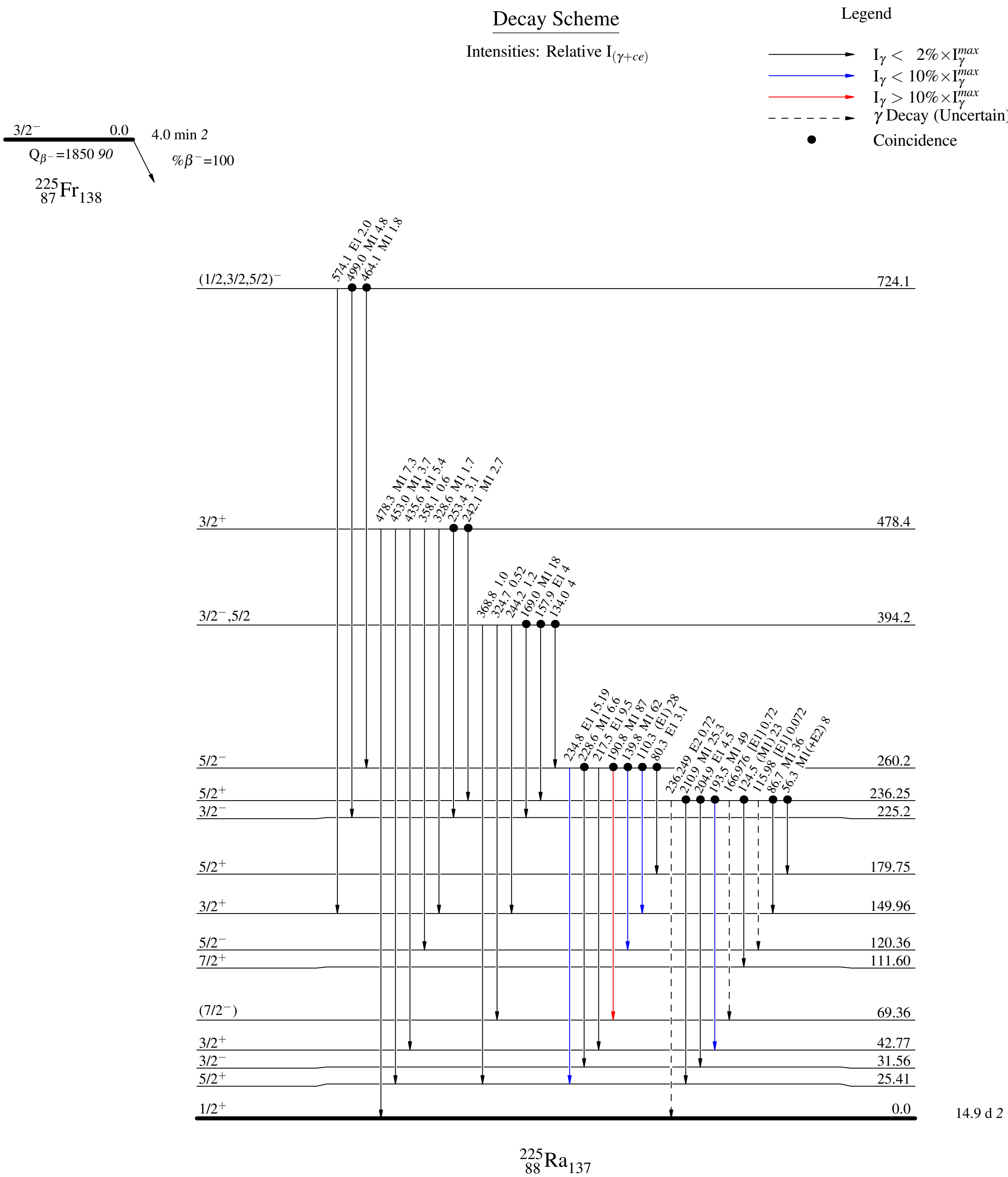
^{225}Fr β^- decay

Decay Scheme

Intensities: Relative $I_{(\gamma+ce)}$



^{225}Fr β^- decay

Decay Scheme (continued)

Intensities: Relative $I_{(\gamma+ce)}$

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