^{225}Ac α decay 2000Ar23,2003Ku44

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Ashok Jain, Sukhjeet Singh, Suresh Kumar, Jagdish Tuli	NDS 108,883 (2007)	15-Jan-2007

Parent: ^{225}Ac: E=0.0; J^π=(3/2$^-$); $T_{1/2}$=10.0 d *1*; Q(α)=5935.1 *14*; %α decay=100

2003Ku44: Measured α, γ, α-γ coin, semi.

2000Ar23: Measured γ. Deduced α feeding.

1972Dz14: Measured γ, x Rays, semi.

1967Dz02, 1967Ba51: Measured α, s.

Others: 1972Dz14, 1967Dz02, 1967Ba51.

αγ(θ): 1969LeZW, 1975PeZO, 1977LiYX.

^{221}Fr Levels

1988Sh12 intrepret levels as quadrupole-octupole deformed 1/2±, 3/2±, 5/2± and 3/2± parity doublets. Alternately, 1992Kv03 interpret the levels in terms of octupole phonon admixtures.

E(level)	J^π†	$T_{1/2}$‡	Comments
0.0	5/2$^-$	4.9 min *2*	
26.01 *6*	(1/2)$^-$		
36.66 *6*	(3/2)$^-$	1.5 ns *2*	$T_{1/2}$: From 1978LiZN ce(t).
38.53 *6*	(9/2)$^-$		
99.62 *7*	(3/2)$^-$	80 ps *30*	
99.85 *7*	(3/2)$^+$	160 ps *30*	
100.93 *6*	(5/2)$^-$		
108.40 *6*	(7/2)$^-$	≈280 ps	
145.93 *10*	(1/2)$^+$		
150.05 *7*	(7/2)$^+$	80 ps *20*	
195.82 *7*	(7/2)$^-$	20 ps *5*	
224.68 *6*	(3/2)$^+$	35 ps *10*	
234.52 *9*	(5/2)$^+$		
253.56 *6*	(5/2)$^+$	35 ps *15*	
272.7 *6*	(7/2$^-$,9/2$^-$)		
279.21 *11*	(7/2)$^+$		
288.14 *17*	(9/2)$^-$		
294.7 *6*	(9/2)$^+$		
393.28 *15*	(7/2,5/2)$^+$		
400.62 *24*	(7/2$^-$)		
410.3 *12*			Observed by 2003Ku44.
497.3 *4*			Observed by 2003Ku44.
517.81 *12*	(5/2$^+$)		
552.05 *9*	(3/2)$^-$		
570.83 *16*	(7/2$^+$,5/2$^+$)		
602.3 *7*	(5/2$^-$)		
630.72 *13*	(5/2$^+$)		
637.72 *11*			
712 *5*			
714.2 *6*			E(level): From 2003Ku44.
749.16 *20*			
780.2 *4*			
824.2 *7*			

† From 2003Ku44. J^π for some of the negative parity excited states were deduced by 1977LiYX from their αγ(θ) correlations (data were not given), and Coriolis-coupled band calculations.

‡ From 1978AgZX using the Doppler-shift method, except where given otherwise.

^{225}Ac α decay 2000Ar23,2003Ku44 (continued)

α radiations

Eα[†]	E(level)	Iα[‡&]	HF[#]	Comments
5021	824.2	≤0.001	≥18	
5067 *5*	780.2	0.003 *1*	11 *4*	
5092 *4*	749.16	0.006 *1*	8.7 *15*	
5131 *5*	714.2	0.0020 *8*	42 *17*	
5131 *5*	712	0.0020 *8*	44 *18*	
5202 *5*	637.72	0.0020 *5*	118 *30*	
5211 *3*	630.72	0.030 *3*	8.7 *9*	Iα of 0.003 *3* listed by 1976Dz02 is assumed to be a misprint. Iα=0.025 was given by 1967Ba51.
5239 *4*	602.3	0.0030 *8*	128 *35*	Iα: 1967Ba51 set an upper limit of 0.003 for this α group.
5270 *4*	570.83	0.014 *5*	41 *15*	Iα=0.018 was measured by 1967Ba51, 0.009 *2* by 1967Dz02.
5286 *3*	552.05	0.23 *1*	3.18 *15*	
5321 *3*	517.81	0.07 *1*	16.3 *24*	
5829.9 *14*	497.3			
5829.9 *14*	410.3			
5436 *4*	400.62	0.07 *2*	71 *21*	
5443 *3*	393.28	0.14 *1*	39 *3*	
5540 *4*	294.7	0.015	1225	
5545 *4*	288.14	0.03 *1*	6.6×10^2 *23*	
5554[@] *4*	279.21	0.1	222	
5563 *4*	272.7	0.034	698	
5580 *3*	253.56	1.2 *1*	25.1 *22*	
5598[@] *4*	234.52	0.04	946	
5609 *3*	224.68	1.1 *1*	39 *4*	
5637 *2*	195.82	4.4 *3*	13.6 *10*	
5682 *2*	150.05	1.3 *2*	79 *13*	
5829.9 *14*	145.93	0.023	4661	Observed by 2003Ku44.
5724 *3*	108.40	3.1 *5*	53 *9*	
(5731 *2*)	100.93	0.87 *23*	207 *55*	Eα: from Q(α)=5935.3 *20* and E(level)=100.93; this α was not observed. Recent observation in 2003Ku44 and 2000Ar23. Iα: from intensity balance at the 100.93-keV level.
5732 *2*	99.85	1.32 *10*	138 *11*	Iα: from intensity balance at the 99.85-keV level.
5732 *2*	99.62	8.0 *5*	22.8 *15*	Iα: from intensity balance at the 99.62-keV level. Iα=10.0 *1* was measured which is assumed to include expected α′s to the 99.85 and 100.93-keV levels.
5790.6 *22*	38.53	8.6 *9*	43 *5*	Eα: from 1972Go29. Iα: from 1972Go29.
5792.5 *22*	36.66	18.1 *20*	20.6 *23*	Eα,Iα: from 1972Go29.
5805[@] *2*	26.01	0.3	1404	
5830 *2*	0.0	50.7 *15*	11.1 *4*	

† From 1967Ba51 and 1967Dz02, except where otherwise noted. Original energies of 1967Ba51 are increased by 1 keV and energies of 1967Dz02 decreased by 0.3 keV, as recommended by 1979Ry03, due to changes in calibration energies. Other measurements: 1956Hu96, 1962Wa28, 1964Va20.

‡ From 1967Dz02 and 1967Ba51, except where noted otherwise. Other measurements: 1964Va20, 2003Ku44, 2000Ar23.

\# $r_0(^{221}Fr)$=1.5501 is used in calculations.

@ This α was not observed by 1967Dz02.

& Absolute intensity per 100 decays.

γ(^{221}Fr)

Iγ normalization: The Normalization factor is revised in view of the comments of 2000Ar23. The earlier value obtained by 1990Ak05 was 1.09.
αγ: 2003Ku44, 1964Va20; 1967Le23 and 1969LeZW also discuss αγ coinc. results, but the specific data and spectra are not given.
Multipolarities in brackets are from the level scheme. These are not measured.
The following γ rays were reported by 2000Ar23 but not by 2003Ku44:

Eγ	Iγ	Eγ	Iγ
53.01 *5*	< 0.004	442.16 *8*	0.0045 *7*
62.6 *3*	<0.03	443.43 *10*	0.0014 *5*
63.5 *3*	0.021 *3*	446.31 *10*	0.0006 *3*
69.87 *5*	0.0047 *12*	527.29 *5*	0.0019 *3*
119.09 *6*	0.018 *3*	532.11 *9*	0.00073 *19*
121.06 *7*	0.017 *5*	656.18 *11*	0.00049 *23*
161.35 *7*	0.0036 *9*	657.88 *5*	0.0014 *3*
220.43 *8*	0.0060 *18*	702.00 *14*	0.00016 *7*
238.64 *8*	0.0010 *3*	752.46 *12*	0.00026 *7*
388.07 *7*	0.00121 *23*	808.48 *10*	0.0021 *3*
429.80 *18*	0.00038 *19*		

E_γ [†]	I_γ [†‡f]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	α [g]	$I_{(\gamma+ce)}$ [f]	Comments
10.642 *5*		36.66	(3/2)$^-$	26.01	(1/2)$^-$			8.5 *15*	ce(M1)=2.20 *13*; ce(M2)=0.28 *6*; ce(M3)<0.15; ce(N1)=0.78 *6* (2003Ku44) 2003Ku44, 2002Ya04 confirm this transition which was proposed by 1972Go29 and 1972Dz14 to account for intensity imbalances at the 26- and 37-keV levels.
26.0	0.0015 *5*	26.01	(1/2)$^-$	0.0	5/2$^-$	(E2) [@]	5.94×10^3		ce(L2)=2.72 *16*; ce(L3)=2.68 *7*; ce(M2)=1.00 *25*; ce(M3)=1.22 *26* (2003Ku44) α(L)=4.39×10^3 *7*; α(M)=1176 *17*; α(N+..)=378 *6* α(N)=307 *5*; α(O)=63.3 *9*; α(P)=8.01 *12*; α(Q)=0.00946 *14* M3:N1:N2:N3=0.9 *1*:<0.025:0.25 *5*:0.25 *5*. Mult.: M1+E2 from ce,M1 admixture is <60% (2003Ku44).
36.7 *1*	0.0155 *14*	36.66	(3/2)$^-$	0.0	5/2$^-$	E2+M1 [@]	6.×10^2 *6*		ce(L2)=5.69 *23*; ce(L3)=6.20 *29*(2003Ku44) α(L)=4.E2 4; α(M)=1.1×10^2 *11*; α(N+..)=4.E1 4 α(N)=3.E1 3; α(O)=6 *6*; α(P)=0.8 *7*; α(Q)=0.0035 *16* L1:L2:L3:M2:M3:N2:N3=0.2 *1*:6.1 *7*:6.2 *8*:1.7 *2*:1.7 *2*:0.5 *1*:0.5 *1*. M1 admixture is <20% (2003Ku44).
38.5 *1*	0.0094 *8*	38.53	(9/2)$^-$	0.0	5/2$^-$	E2 [@]	863 *17*		ce(L2)=3.07 *17*; ce(L3)=3.66 *32* (2003Ku44) α(L)=637 *12*; α(M)=171 *4*; α(N+..)=55.1 *11*

$^{221}_{87}Fr_{134}$-3

γ(^{221}Fr) (continued)

E_γ [†]	I_γ [†‡f]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	δ [#]	α [g]	Comments
									α(N)=44.7 *9*; α(O)=9.23 *18*; α(P)=1.173 *23*; α(Q)=0.00158 *3* L1:L2:L3:M2:M3:N2:N3=0.11 *7*:3.1 *3*: 3.1 *4*:0.8 *1*:0.8 *1*:0.25 *5*:0.25 *5*. Mult.: M1 admixture <10% (2003Ku44).
46.2 *2*	0.0039 *6*	145.93	(1/2)$^+$	99.62	(3/2)$^-$	[E1]		0.843 *16*	α(L)=0.638 *12*; α(M)=0.156 *3*; α(N+..)=0.0492 *9* α(N)=0.0398 *8*; α(O)=0.00821 *15*; α(P)=0.001068 *19*; α(Q)=3.01×10^{-5} *5*
49.1 *2*	0.0066 *7*	150.05	(7/2)$^+$	100.93	(5/2)$^-$	(E1)		0.716 *13*	α(L)=0.542 *10*; α(M)=0.1322 *24*; α(N+..)=0.0418 *8* α(N)=0.0338 *6*; α(O)=0.00699 *13*; α(P)=0.000918 *16*; α(Q)=2.65×10^{-5} *5* B(E1)(W.u.)=0.00012 *4*
57.8 *2*	0.0039 *8*	253.56	(5/2)$^+$	195.82	(7/2)$^-$	[E1]		0.463 *8*	α(L)=0.350 *6*; α(M)=0.0851 *15*; α(N+..)=0.0270 *5* α(N)=0.0218 *4*; α(O)=0.00455 *8*; α(P)=0.000611 *10*; α(Q)=1.87×10^{-5} *3* B(E1)(W.u.)=0.00013 *7*
62.9 *1*	0.43 *2*	99.62	(3/2)$^-$	36.66	(3/2)$^-$	M1[@]		10.87	α(L)=8.25 *13*; α(M)=1.97 *3*; α(N+..)=0.651 *10* α(N)=0.516 *8*; α(O)=0.1154 *17*; α(P)=0.0185 *3*; α(Q)=0.001035 *16* B(M1)(W.u.)=0.056 *22* E2 admixture is <1%.
64.3 *1*	0.041 *4*	100.93	(5/2)$^-$	36.66	(3/2)$^-$	M1+E2[@]	0.45 *13*	20 *6*	α(L)=15 *4*; α(M)=3.9 *11*; α(N+..)=1.3 *4* α(N)=1.0 *3*; α(O)=0.22 *6*; α(P)=0.031 *7*; α(Q)=0.00084 *7* E2 admixture is (17±5)%.
69.87 *5*	0.0047 *12*	108.40	(7/2)$^-$	38.53	(9/2)$^-$	E2+M1		28 *20*	α(L)=21 *15*; α(M)=5 *4*; α(N+..)=1.8 *13* α(N)=1.4 *11*; α(O)=0.30 *22*; α(P)=0.04 *3*; α(Q)=0.0004 *4* E_γ,I_γ: From 2000Ar23; seen also in β^- decay.
71.4 *3*	0.0126 *25*	108.40	(7/2)$^-$	36.66	(3/2)$^-$	E2+M1[@]		25 *18*	α(L)=19 *13*; α(M)=5 *4*; α(N+..)=1.6 *12* α(N)=1.3 *10*; α(O)=0.27 *20*; α(P)=0.036 *24*; α(Q)=0.0004 *3* M1 admixture is >25%.
73.5	0.025 *7*	99.62	(3/2)$^-$	26.01	(1/2)$^-$	E2+M1[@]		22 *16*	α(L)=16 *12*; α(M)=4 *4*; α(N+..)=1.4 *10* α(N)=1.1 *9*; α(O)=0.24 *17*; α(P)=0.032 *21*; α(Q)=0.0004 *3* M1 admixture is >30% Iγ; 2003Ku44 calculated Iγ using ce data from 1972Dz14. ce(L3)=0.21 *5*; L1:L2:L3:M2:M3=<0.05:0.25 *3*:0.21 *5*: 0.08 *3*:0.06 *2*. These conversion data suggest that possible M1 admixture is less than 40%.
73.9 *1*	0.264 *17*	99.85	(3/2)$^+$	26.01	(1/2)$^-$	E1[@]		0.240	α(L)=0.182 *3*; α(M)=0.0439 *7*; α(N+..)=0.01401 *21* α(N)=0.01129 *17*; α(O)=0.00238 *4*; α(P)=0.000329 *5*; α(Q)=1.091×10^{-5} *16* B(E1)(W.u.)=0.00053 *12* M2 admixture is >0.5% (2003Ku44). I_γ: 2003Ku44 calculated Iγ using ce data from 1972Dz14.

γ(^{221}Fr) (continued)

Eγ[†]	Iγ[†‡f]	Ei(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[#]	α[g]	Comments
74.6 *4*	0.022 *7*	100.93	(5/2)⁻	26.01	(1/2)⁻	M1+E2[@]	≈0.5	≈12.3	α(L)≈9.17; α(M)≈2.35; α(N+..)≈0.767 α(N)≈0.617; α(O)≈0.132; α(P)≈0.0187; α(Q)≈0.000521 E2 admixture is 20%.
78.8	0.0107 *15*	224.68	(3/2)⁺	145.93	(1/2)⁺	M1[@]		5.63	α(exp)=5.1 *11* (2003Ku44) α(L)=4.27 *6*; α(M)=1.019 *15*; α(N+..)=0.337 *5* α(N)=0.267 *4*; α(O)=0.0597 *9*; α(P)=0.00958 *14*; α(Q)=0.000536 *8* B(M1)(W.u.)=0.014 *5*
87.4 *1*	0.226 *13*	195.82	(7/2)⁻	108.40	(7/2)⁻	M1		4.17	α(exp)=2.8 *6* (2003Ku44) α(N)=0.198 *3*; α(O)=0.0442 *7*; α(P)=0.00709 *11*; α(Q)=0.000396 *6* B(M1)(W.u.)=0.11 *4* Admixture of E2 is <1%.
94.9 *1*	0.084 *8*	195.82	(7/2)⁻	100.93	(5/2)⁻	M1(+E2)[@]		7 *4*	α(L)=5 *3*; α(M)=1.4 *9*; α(N+..)=0.5 *3* α(N)=0.37 *22*; α(O)=0.08 *5*; α(P)=0.011 *5*; α(Q)=0.00017 *14* E2 admixture is <5%.
96.7 *5*	0.028 *5*	195.82	(7/2)⁻	99.62	(3/2)⁻	M1+E2[@]	0.69 *27*	5.4 *13*	ce(L1)=0.045 *10*; L1:L2:L3=0.045 *10*:0.045 *10*:0.06 *2* α(L)=4.0 *9*; α(M)=1.0 *3*; α(N+..)=0.34 *9* α(N)=0.27 *7*; α(O)=0.058 *14*; α(P)=0.0082 *16*; α(Q)=0.00021 *5* B(M1)(W.u.)=0.007 *4*; B(E2)(W.u.)=1.1×10^2 *8* E2 admixture is (32±12)%.
99.6	0.70 *6*	99.62	(3/2)⁻	0.0	5/2⁻	M1+E2[@]	0.18 *5*	3.04 *13*	α(L)=2.30 *9*; α(M)=0.56 *3*; α(N+..)=0.183 *8* α(N)=0.146 *7*; α(O)=0.0323 *14*; α(P)=0.00509 *16*; α(Q)=0.000264 *6* B(M1)(W.u.)=0.022 *9*; B(E2)(W.u.)=23 *16* E2 admixture is (3±1)%. Iγ: 2003Ku44 calculated Iγ using ce data from 1972Dz14. ce(L1)=1.30 *15*; L1:L2:L3:M1:M3=1.30 *15*:0.20 *3*:0.070 *15*:0.39 *5*:0.07 *2*.
99.8 *1*	1.00 *11*	99.85	(3/2)⁺	0.0	5/2⁻	E1(+M2)[@]		0.1076	α(L)=0.0816 *12*; α(M)=0.0196 *3*; α(N+..)=0.00631 *9* α(N)=0.00507 *8*; α(O)=0.001080 *16*; α(P)=0.0001538 *22*; α(Q)=5.58×10^{-6} *8* B(E1)(W.u.)=0.00081 *19* M2 admixture is >0.3% (2003Ku44). Iγ: 2003Ku44 calculated Iγ using ce data from 1972Dz14.
100.8 *2*	0.075 *6*	100.93	(5/2)⁻	0.0	5/2⁻	M1+E2[@]		6 *3*	α(L)=4.2 *21*; α(M)=1.1 *6*; α(N+..)=0.36 *19* α(N)=0.29 *16*; α(O)=0.06 *4*; α(P)=0.008 *4*; α(Q)=0.00015 *12*
103.6 *2*	0.0023 *5*	253.56	(5/2)⁺	150.05	(7/2)⁺	[M1+E2]		10 *3*	α(N)=0.25 *14*; α(O)=0.05 *3*; α(P)=0.007 *3*; α(Q)=0.00014 *11*
108.4 *1*	0.216 *11*	108.40	(7/2)⁻	0.0	5/2⁻	M1+E2[@]	0.53 *13*	10.3 *5*	ce(K)=1.19 *10* (2003Ku44) α(K)=7.2 *8*; α(L)=2.30 *24*; α(M)=0.58 *7*; α(N+..)=0.190 *22*

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γ(^{221}Fr) (continued)

E_γ †	I_γ †‡f	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	α g	Comments
								α(N)=0.152 *18*; α(O)=0.033 *4*; α(P)=0.0048 *4*; α(Q)=0.000171 *16* B(M1)(W.u.)≈0.0036; B(E2)(W.u.)≈28 E2 Admixture is (22±4)%.
111.5 *1*	0.264 *14*	150.05	(7/2)$^+$	38.53	(9/2)$^-$	(E1)	0.363	α(K)=0.283 *4*; α(L)=0.0609 *9*; α(M)=0.01462 *21*; α(N+..)=0.00470 *7* α(N)=0.00378 *6*; α(O)=0.000808 *12*; α(P)=0.0001162 *17*; α(Q)=4.35×10^{-6} *7* B(E1)(W.u.)=0.00041 *11*
112.8	0.0018 *2*	400.62	(7/2$^-$)	288.14	(9/2)$^-$	[M1]&	10.16	α(K)=8.17 *12*; α(L)=1.512 *22*; α(M)=0.360 *5*; α(N+..)=0.1192 *17* α(N)=0.0945 *14*; α(O)=0.0211 *3*; α(P)=0.00339 *5*; α(Q)=0.000189 *3*
114	0.00075 *10*	393.28	(7/2,5/2)$^+$	279.21	(7/2)$^+$	M1@	9.86	α(exp)=13.0 *17* (2003Ku44) α(K)=7.93 *12*; α(L)=1.466 *21*; α(M)=0.350 *5*; α(N+..)=0.1156 *17* α(N)=0.0917 *13*; α(O)=0.0205 *3*; α(P)=0.00329 *5*; α(Q)=0.000184 *3*
119.9 *1*	0.066 *3*	145.93	(1/2)$^+$	26.01	(1/2)$^-$	[E1]	0.305	α(K)=0.238 *4*; α(L)=0.0503 *8*; α(M)=0.01206 *17*; α(N+..)=0.00389 *6* α(N)=0.00312 *5*; α(O)=0.000668 *10*; α(P)=9.67×10^{-5} *14*; α(Q)=3.69×10^{-6} *6* Iγ=0.068 *6* was measured. Intensity of the part deexciting the 393.28-keV level was deduced by the evaluator from Iγ(119γ)/Iγ(169γ)=0.28 *4*/0.26 *3*, as measured in ^{221}Rn β^- decay.
123.8 *1*	0.072 *4*	224.68	(3/2)$^+$	100.93	(5/2)$^-$	[E1]	0.282	α(K)=0.221 *4*; α(L)=0.0462 *7*; α(M)=0.01108 *16*; α(N+..)=0.00357 *5* α(N)=0.00287 *4*; α(O)=0.000615 *9*; α(P)=8.92×10^{-5} *13*; α(Q)=3.43×10^{-6} *5* B(E1)(W.u.)=0.00021 *7*
124.8 *1*	0.024 *1*	224.68	(3/2)$^+$	99.85	(3/2)$^+$	M1+E2@	5.6 *21*	α(K)=3 *3*; α(L)=1.7 *6*; α(M)=0.45 *18*; α(N+..)=0.15 *6* α(N)=0.12 *5*; α(O)=0.025 *10*; α(P)=0.0035 *10*; α(Q)=8.E−5 *7*
126.2 *2*	0.0070 *6*	234.52	(5/2)$^+$	108.40	(7/2)$^-$	(E1)	0.269	α(K)=0.211 *3*; α(L)=0.0440 *7*; α(M)=0.01054 *16*; α(N+..)=0.00340 *5* α(N)=0.00273 *4*; α(O)=0.000585 *9*; α(P)=8.49×10^{-5} *13*; α(Q)=3.29×10^{-6} *5*
129.2 *2*	0.0022 *4*	279.21	(7/2)$^+$	150.05	(7/2)$^+$	[M1,E2]	5.0 *20*	α(K)=3 *3*; α(L)=1.5 *5*; α(M)=0.39 *15*; α(N+..)=0.13 *5* α(N)=0.10 *4*; α(O)=0.022 *8*; α(P)=0.0030 *8*; α(Q)=7.E−5 *6*
133.6 *1*	0.017 *1*	234.52	(5/2)$^+$	100.93	(5/2)$^-$	(E1)	0.234	α(K)=0.184 *3*; α(L)=0.0379 *6*; α(M)=0.00907 *13*; α(N+..)=0.00293 *5* α(N)=0.00235 *4*; α(O)=0.000505 *8*; α(P)=7.36×10^{-5} *11*; α(Q)=2.89×10^{-6} *4*
134.9 *1*	0.027 *2*	234.52	(5/2)$^+$	99.62	(3/2)$^-$	E1@	0.229	α(K)=0.180 *3*; α(L)=0.0369 *6*; α(M)=0.00884 *13*; α(N+..)=0.00286 *4* α(N)=0.00229 *4*; α(O)=0.000492 *7*; α(P)=7.18×10^{-5} *11*; α(Q)=2.83×10^{-6} *4*
137.6	0.0019 *2*	410.3		272.7	(7/2$^-$,9/2$^-$)			E,I from 2003Ku44.
139.6	0.0012 *2*	393.28	(7/2,5/2)$^+$	253.56	(5/2)$^+$	M1+E2@	3.9 *17*	α(exp)=3.2 *5* (2003Ku44) α(K)=2.4 *21*; α(L)=1.1 *3*; α(M)=0.29 *9*; α(N+..)=0.09 *3* α(N)=0.075 *24*; α(O)=0.016 *5*; α(P)=0.0023 *5*; α(Q)=6.E−5 *5*

γ(^{221}Fr) (continued)

E_γ[†]	I_γ[†‡f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[g]	Comments
144.7[d]	0.0004[e] *1*	294.7	(9/2)$^+$	150.05	(7/2)$^+$	M1+E2	3.5 *16*	α(K)=2.2 *19*; α(L)=0.96 *23*; α(M)=0.25 *8*; α(N+..)=0.081 *23* α(N)=0.065 *19*; α(O)=0.014 *4*; α(P)=0.0020 *4*; α(Q)=5.E−5 *5* Mult.: from 2003Ku44.
145.2 *1*	0.126 *6*	253.56	(5/2)$^+$	108.40	(7/2)$^-$	E1[@]	0.191	α(exp)≤0.1 (2003Ku44) α(K)=0.1512 *22*; α(L)=0.0305 *5*; α(M)=0.00729 *11*; α(N+..)=0.00236 *4* α(N)=0.00189 *3*; α(O)=0.000407 *6*; α(P)=5.97×10^{-5} *9*; α(Q)=2.39×10^{-6} *4* B(E1)(W.u.)=0.00026 *12* E2 admixture is <1%.
150.1 *1*	0.60 *3*	150.05	(7/2)$^+$	0.0	5/2$^-$	E1[@]	0.1764	α(K)=0.1396 *20*; α(L)=0.0280 *4*; α(M)=0.00669 *10*; α(N+..)=0.00216 *3* α(N)=0.001733 *25*; α(O)=0.000374 *6*; α(P)=5.49×10^{-5} *8*; α(Q)=2.22×10^{-6} *4* B(E1)(W.u.)=0.00038 *10* M2 Admixture is <0.4%.
152.6 *2*	0.019 *1*	253.56	(5/2)$^+$	100.93	(5/2)$^-$	[E1]	0.1695	α(K)=0.1342 *20*; α(L)=0.0268 *4*; α(M)=0.00641 *10*; α(N+..)=0.00207 *3* α(N)=0.001660 *24*; α(O)=0.000358 *6*; α(P)=5.27×10^{-5} *8*; α(Q)=2.14×10^{-6} *3* B(E1)(W.u.)=3.4×10^{-5} *15*
153.9 *1*	0.182 *9*	253.56	(5/2)$^+$	99.62	(3/2)$^-$	E1[@]	0.1660	α(exp)≤0.35 (2003Ku44) α(N)=0.001624 *23*; α(O)=0.000351 *5*; α(P)=5.16×10^{-5} *8*; α(Q)=2.10×10^{-6} *3* B(E1)(W.u.)=0.00032 *14*
157.3 *2*	0.32 *2*	195.82	(7/2)$^-$	38.53	(9/2)$^-$	M1+E2[@]	2.7 *13*	α(K)=1.7 *15*; α(L)=0.70 *12*; α(M)=0.18 *4*; α(N+..)=0.059 *13* α(N)=0.047 *11*; α(O)=0.0101 *20*; α(P)=0.00144 *14*; α(Q)=4.E−5 *4* E2 admixture is <4%.
169.1	0.007 *1*	393.28	(7/2,5/2)$^+$	224.68	(3/2)$^+$	[M1,E2]	2.1 *11*	α(K)=1.4 *12*; α(L)=0.53 *6*; α(M)=0.137 *24*; α(N+..)=0.045 *8* α(N)=0.036 *7*; α(O)=0.0077 *11*; α(P)=0.00111 *5*; α(Q)=3.E−5 *3*
169.9	0.012 *1*	195.82	(7/2)$^-$	26.01	(1/2)$^-$			
170.7 *2*	0.017 *1*	279.21	(7/2)$^+$	108.40	(7/2)$^-$	E1[@]	0.1291	α(K)=0.1027 *15*; α(L)=0.0201 *3*; α(M)=0.00480 *7*; α(N+..)=0.001554 *23* α(N)=0.001244 *18*; α(O)=0.000269 *4*; α(P)=3.99×10^{-5} *6*; α(Q)=1.662×10^{-6} *24*
[x]173.4[bi]	0.010 *1*							
178.3 *2*	0.014 *1*	279.21	(7/2)$^+$	100.93	(5/2)$^-$	E1[@]	0.1162	α(K)=0.0925 *14*; α(L)=0.0180 *3*; α(M)=0.00429 *7*; α(N+..)=0.001391 *20* α(N)=0.001112 *16*; α(O)=0.000241 *4*; α(P)=3.58×10^{-5} *6*; α(Q)=1.507×10^{-6} *22*
179.8 *3*	0.0094 *6*	288.14	(9/2)$^-$	108.40	(7/2)$^-$	[M1,E2][&]	1.8 *10*	α(K)=1.2 *10*; α(L)=0.43 *3*; α(M)=0.109 *14*; α(N+..)=0.036 *5* α(N)=0.028 *4*; α(O)=0.0061 *6*; α(P)=0.000887 *15*; α(Q)=2.8×10^{-5} *22*
[x]183[bi]	0.0073 *11*							
186.1	0.011 *1*	224.68	(3/2)$^+$	38.53	(9/2)$^-$			

$^{221}_{87}$Fr$_{134}$-7

γ(^{221}Fr) (continued)

E_γ [†]	I_γ [†‡f]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	δ [#]	α [g]	Comments
186.3	0.0036 3	294.7	(9/2)$^+$	108.40	(7/2)$^-$	E1 [@]		0.1045	α(K)=0.0834 12; α(L)=0.01607 23; α(M)=0.00383 6; α(N+..)=0.001244 18 α(N)=0.000995 14; α(O)=0.000216 3; α(P)=3.21×10^{-5} 5; α(Q)=1.365×10^{-6} 20
187.2	0.0089 3	288.14	(9/2)$^-$	100.93	(5/2)$^-$				
188.0 1	0.45 2	224.68	(3/2)$^+$	36.66	(3/2)$^-$	E1 [@]		0.1023	α(K)=0.0816 12; α(L)=0.01570 22; α(M)=0.00375 6; α(N+..)=0.001216 17 α(N)=0.000972 14; α(O)=0.000211 3; α(P)=3.14×10^{-5} 5; α(Q)=1.338×10^{-6} 19 B(E1)(W.u.)=0.00038 12 M2 admixture is <0.5%.
[x]193.2 [bi]	0.0017 3								
195.8 2	0.123 6	195.82	(7/2)$^-$	0.0	5/2$^-$	M1+E2 [@]	0.8 2	1.53 20	α(K)=1.11 20; α(L)=0.314 5; α(M)=0.0785 17; α(N+..)=0.0258 5 α(N)=0.0206 5; α(O)=0.00448 8; α(P)=0.000667 15; α(Q)=2.6×10^{-5} 5 B(M1)(W.u.)=0.0031 12; B(E2)(W.u.)=17 8 E2 admixture is (40±20)%.
197.4	0.023 2	393.28	(7/2,5/2)$^+$	195.82	(7/2)$^-$	E1 [@]		0.0909	α(exp)≤0.04 (2003Ku44) α(K)=0.0727 11; α(L)=0.01388 20; α(M)=0.00331 5; α(N+..)=0.001075 15 α(N)=0.000859 12; α(O)=0.000187 3; α(P)=2.79×10^{-5} 4; α(Q)=1.200×10^{-6} 17
197.9	0.033 3	234.52	(5/2)$^+$	36.66	(3/2)$^-$				
198.4 3	0.017 1	224.68	(3/2)$^+$	26.01	(1/2)$^-$	[E1]		0.0899	α(K)=0.0718 11; α(L)=0.01370 20; α(M)=0.00327 5; α(N+..)=0.001061 16 α(N)=0.000848 13; α(O)=0.000184 3; α(P)=2.75×10^{-5} 4; α(Q)=1.186×10^{-6} 17 B(E1)(W.u.)=1.2×10^{-5} 4
204.7 [a] 3	0.0011 4	400.62	(7/2$^-$)	195.82	(7/2)$^-$				
216.9 2	0.271 14	253.56	(5/2)$^+$	36.66	(3/2)$^-$	(E1)		0.0726	α(K)=0.0582 9; α(L)=0.01096 16; α(M)=0.00261 4; α(N+..)=0.000849 12 α(N)=0.000678 10; α(O)=0.0001475 21; α(P)=2.22×10^{-5} 4; α(Q)=9.73×10^{-7} 14 B(E1)(W.u.)=0.00017 8
224.7 1	0.098 5	224.68	(3/2)$^+$	0.0	5/2$^-$	[E1]		0.0668	α(K)=0.0536 8; α(L)=0.01004 14; α(M)=0.00239 4; α(N+..)=0.000777 11 α(N)=0.000621 9; α(O)=0.0001352 19; α(P)=2.04×10^{-5} 3; α(Q)=9.00×10^{-7} 13 B(E1)(W.u.)=4.8×10^{-5} 15

$^{221}_{87}$Fr$_{134}$-8

γ(^{221}Fr) (continued)

E_γ[†]	I_γ[†‡f]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α[g]	Comments
228.2 4	0.004 1	253.56	(5/2)$^+$	26.01	(1/2)$^-$			
^{x}231.3[bi] 2	0.0066 6							
236.0 6	0.0015 2	272.7	(7/2$^-$,9/2$^-$)	36.66	(3/2)$^-$			
240.7 2	0.010 1	279.21	(7/2)$^+$	38.53	(9/2)$^-$	[E1]	0.0568	α(K)=0.0457 7; α(L)=0.00847 12; α(M)=0.00202 3; α(N+..)=0.000656 10 α(N)=0.000524 8; α(O)=0.0001142 17; α(P)=1.726×10^{-5} 25; α(Q)=7.74×10^{-7} 11
243.2 2	0.0030 3	393.28	(7/2,5/2)$^+$	150.05	(7/2)$^+$	[M1]	1.162	α(K)=0.938 14; α(L)=0.1706 25; α(M)=0.0406 6; α(N+..)=0.01343 19 α(N)=0.01065 16; α(O)=0.00238 4; α(P)=0.000382 6; α(Q)=2.13×10^{-5} 3
249.6 2	0.012 1	288.14	(9/2)$^-$	38.53	(9/2)$^-$	[M1][&]	1.081	α(K)=0.872 13; α(L)=0.1587 23; α(M)=0.0378 6; α(N+..)=0.01249 18 α(N)=0.00990 14; α(O)=0.00221 4; α(P)=0.000355 5; α(Q)=1.98×10^{-5} 3
253.5 1	0.116 6	253.56	(5/2)$^+$	0.0	5/2$^-$	[E1]	0.0503	α(K)=0.0405 6; α(L)=0.00746 11; α(M)=0.001775 25; α(N+..)=0.000578 9 α(N)=0.000461 7; α(O)=0.0001007 15; α(P)=1.526×10^{-5} 22; α(Q)=6.91×10^{-7} 10 B(E1)(W.u.)=4.5×10^{-5} 20
256[d]	0.0006[e] 2	294.7	(9/2)$^+$	38.53	(9/2)$^-$	[E1]	0.0492	α(K)=0.0396 6; α(L)=0.00729 11; α(M)=0.001733 25; α(N+..)=0.000564 8 α(N)=0.000450 7; α(O)=9.84×10^{-5} 14; α(P)=1.491×10^{-5} 21; α(Q)=6.76×10^{-7} 10
279.3 3	0.025 2	279.21	(7/2)$^+$	0.0	5/2$^-$	E1[@]	0.0402	α(K)=0.0325 5; α(L)=0.00591 9; α(M)=0.001404 20; α(N+..)=0.000457 7 α(N)=0.000365 6; α(O)=7.98×10^{-5} 12; α(P)=1.215×10^{-5} 18; α(Q)=5.60×10^{-7} 8
284.8 3	0.0063 5	393.28	(7/2,5/2)$^+$	108.40	(7/2)$^-$	[E1]	0.0385	α(K)=0.0311 5; α(L)=0.00564 8; α(M)=0.001339 19; α(N+..)=0.000437 7 α(N)=0.000348 5; α(O)=7.62×10^{-5} 11; α(P)=1.161×10^{-5} 17; α(Q)=5.37×10^{-7} 8
298.6[a] 3	0.0018 5	552.05	(3/2)$^-$	253.56	(5/2)$^+$			From 2003Ku44.
317.4[h]	>0.00011	552.05	(3/2)$^-$	234.52	(5/2)$^+$			
317.4[h]	0.00011 5	570.83	(7/2$^+$,5/2$^+$)	253.56	(5/2)$^+$			
321.8 4	0.0030 4	517.81	(5/2$^+$)	195.82	(7/2)$^-$			
^{x}348.2[bi] 4	0.0025 3							
354.9 3	0.0023 3	393.28	(7/2,5/2)$^+$	38.53	(9/2)$^-$	[E1]	0.0235	α(N)=0.000208 3; α(O)=4.56×10^{-5} 7; α(P)=7.02×10^{-6} 10; α(Q)=3.37×10^{-7} 5
356.6[a]	0.000229	552.05	(3/2)$^-$	195.82	(7/2)$^-$			

γ(^{221}Fr) (continued)

E_γ[†]	I_γ[†‡f]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[g]	Comments
362.2 *4*	0.0042 *4*	400.62	(7/2$^-$)	38.53	(9/2)$^-$	[M1][&]	0.389	α(K)=0.314 *5*; α(L)=0.0567 *9*; α(M)=0.01349 *20*; α(N+..)=0.00446 *7* α(N)=0.00354 *5*; α(O)=0.000790 *12*; α(P)=0.0001268 *19*; α(Q)=7.08×10^{-6} *11*
368.3[a] *6*	0.0006 *2*	517.81	(5/2$^+$)	150.05	(7/2)$^+$			
375.0 *7*	0.0017 *4*	570.83	(7/2$^+$,5/2$^+$)	195.82	(7/2)$^-$			
403.4[a] *3*	0.00016 *14*	637.72		234.52	(5/2)$^+$			
406.2 *3*	0.0067 *4*	552.05	(3/2)$^-$	145.93	(1/2)$^+$	[E1]	0.01756	α(K)=0.01430 *21*; α(L)=0.00249 *4*; α(M)=0.000588 *9*; α(N+..)=0.000192 *3* α(N)=0.0001531 *22*; α(O)=3.37×10^{-5} *5*; α(P)=5.21×10^{-6} *8*; α(Q)=2.56×10^{-7} *4*
417.9 *3*	0.0048 *4*	517.81	(5/2$^+$)	99.62	(3/2)$^-$			
435.0 *3*	0.0024 *3*	630.72	(5/2$^+$)	195.82	(7/2)$^-$			
450.1[a] *7*	0.0032 *8*	552.05	(3/2)$^-$	100.93	(5/2)$^-$			
452.4 *2*	0.089 *5*	552.05	(3/2)$^-$	99.62	(3/2)$^-$	[M1]	0.213	α(K)=0.1725 *25*; α(L)=0.0310 *5*; α(M)=0.00736 *11*; α(N+..)=0.00243 *4* α(N)=0.00193 *3*; α(O)=0.000431 *6*; α(P)=6.92×10^{-5} *10*; α(Q)=3.87×10^{-6} *6*
458.8[a] *4*	0.00058 *22*	497.3		38.53	(9/2)$^-$			
462.4 *6*	0.0008 *3*	570.83	(7/2$^+$,5/2$^+$)	108.40	(7/2)$^-$			
469.5 *3*	0.0028 *3*	570.83	(7/2$^+$,5/2$^+$)	100.93	(5/2)$^-$			
481.1 *2*	0.029 *2*	517.81	(5/2$^+$)	36.66	(3/2)$^-$			
492.6[a] *6*	0.00022 *14*	517.81	(5/2$^+$)	26.01	(1/2)$^-$			
512.5[a] *7*	0.0005 *2*	552.05	(3/2)$^-$	38.53	(9/2)$^-$			
515.3 *2*	0.019 *1*	552.05	(3/2)$^-$	36.66	(3/2)$^-$	[M1]	0.1505	α(K)=0.1218 *18*; α(L)=0.0218 *3*; α(M)=0.00518 *8*; α(N+..)=0.001712 *24* α(N)=0.001357 *19*; α(O)=0.000303 *5*; α(P)=4.87×10^{-5} *7*; α(Q)=2.72×10^{-6} *4*
517.9 *2*	0.015 *1*	517.81	(5/2$^+$)	0.0	5/2$^-$			
522.1 *2*	0.0018 *3*	630.72	(5/2$^+$)	108.40	(7/2)$^-$			
526.1 *1*	0.033 *2*	552.05	(3/2)$^-$	26.01	(1/2)$^-$	[M1]	0.1424	α(K)=0.1153 *17*; α(L)=0.0206 *3*; α(M)=0.00490 *7*; α(N+..)=0.001619 *23* α(N)=0.001283 *18*; α(O)=0.000287 *4*; α(P)=4.61×10^{-5} *7*; α(Q)=2.58×10^{-6} *4*
529.7 *3*	0.0071 *7*	630.72	(5/2$^+$)	100.93	(5/2)$^-$			
531.2 *3*	0.0040 *5*	630.72	(5/2$^+$)	99.62	(3/2)$^-$			
[x]538.1[ci] *1*	≈0.001							
545.8 *6*	0.00046 *12*	780.2		234.52	(5/2)$^+$			
552.0 *2*	0.0056 *4*	552.05	(3/2)$^-$	0.0	5/2$^-$	[M1]	0.1253	α(K)=0.1015 *15*; α(L)=0.0181 *3*; α(M)=0.00430 *6*; α(N+..)=0.001423 *20* α(N)=0.001128 *16*; α(O)=0.000252 *4*; α(P)=4.05×10^{-5} *6*; α(Q)=2.27×10^{-6} *4*

γ(^{221}Fr) (continued)

E_γ[†]	I_γ[†‡f]	E_i(level)	J^π_i	E_f	J^π_f
565.6[a] 7	0.00019 8	602.3	(5/2⁻)	36.66	(3/2)⁻
568.3[a] 6	0.0013 3	714.2		145.93	(1/2)⁺
571.0 2	0.0032 5	570.83	(7/2⁺,5/2⁺)	0.0	5/2⁻
591.4[a] 7	0.0007 2	630.72	(5/2⁺)	38.53	(9/2)⁻
594.6 3	0.0028 6	630.72	(5/2⁺)	36.66	(3/2)⁻
601.0 3	0.0037 9	637.72		36.66	(3/2)⁻
603.5 5	0.0016 4	749.16		145.93	(1/2)⁺
629.9[a] 7	0.00026 8	780.2		150.05	(7/2)⁺
637.1[a] 7	≈0.0001	637.72		0.0	5/2⁻
[x]646.3 3	0.00010 4				
649.5 2	0.0012 3	749.16		99.62	(3/2)⁻
[x]653.5 4	0.00015 4				
[x]668.1 4	0.00024 7				
[x]674.3 4	0.00007 4				
680.4 6	0.00061 15	780.2		99.85	(3/2)⁺
[x]698.4 4	0.00017 5				
[x]747	<0.0001				
[x]753.7	<0.0001				
[x]768.4 5	0.00024 7				
780.6[a] 6	0.00005 1	780.2		0.0	5/2⁻
824.2[a] 7	≈0.00004	824.2		0.0	5/2⁻

† From 2003Ku44, except where otherwise noted.Other measurements:2000Ar23, 1955St04, 1956Hu96, 1964Va20, 1967Le23, 1967LoZZ, 1972Dz14.

‡ Relative photon intensities measured by 2003Ku44, unless otherwise noted. Other measurements: 1972Dz14, 1967Le23, 1981Di14, 2000Ar23. See 1966Wa23 for a comparison of earlier measurements.

\# Multipolarities and δ from ce data of 1969Dz04, 1970Dz12, and 1971DzZP as summarized by 1972Dz14, and from ^{221}Rn β^- decay, unless stated otherwise. See also 1966Wa23 and 1969Le09.

@ Multipolarities from 2003Ku44.

& Assumed by the evaluator by considering intensity balances, if there are no more appreciable gammas deexciting or feeding the levels involved.

a placements are not in conflict with the αγ coin (2003Ku44) The Ice′s given by 1972Dz14 were normalized such that the conversion coefficient for the 218.0γ in ^{217}At agrees with E2 theory (1972Dz14): α(K)=0.14, α(L1)=0.022, α(L2)=0.096, α(L3)=0.050 were used for 218γ (1969Dz06).

b From 2003Ku44; Possibility that they belong to 213Bi decay should not be excluded.

c Reported by 1990ArZZ but not by 2000ArZZ and 2003Ku44.

d From ^{221}Rn β^- decay; transition was seen in ^{225}Ac α decay.

e From relative photon branching measured in ^{221}Rn β^- decay.

f Absolute intensity per 100 decays.

g Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned

$\gamma(^{221}Fr)$ (continued)

multipolarities, and mixing ratios, unless otherwise specified.
[h] Multiply placed.
[i] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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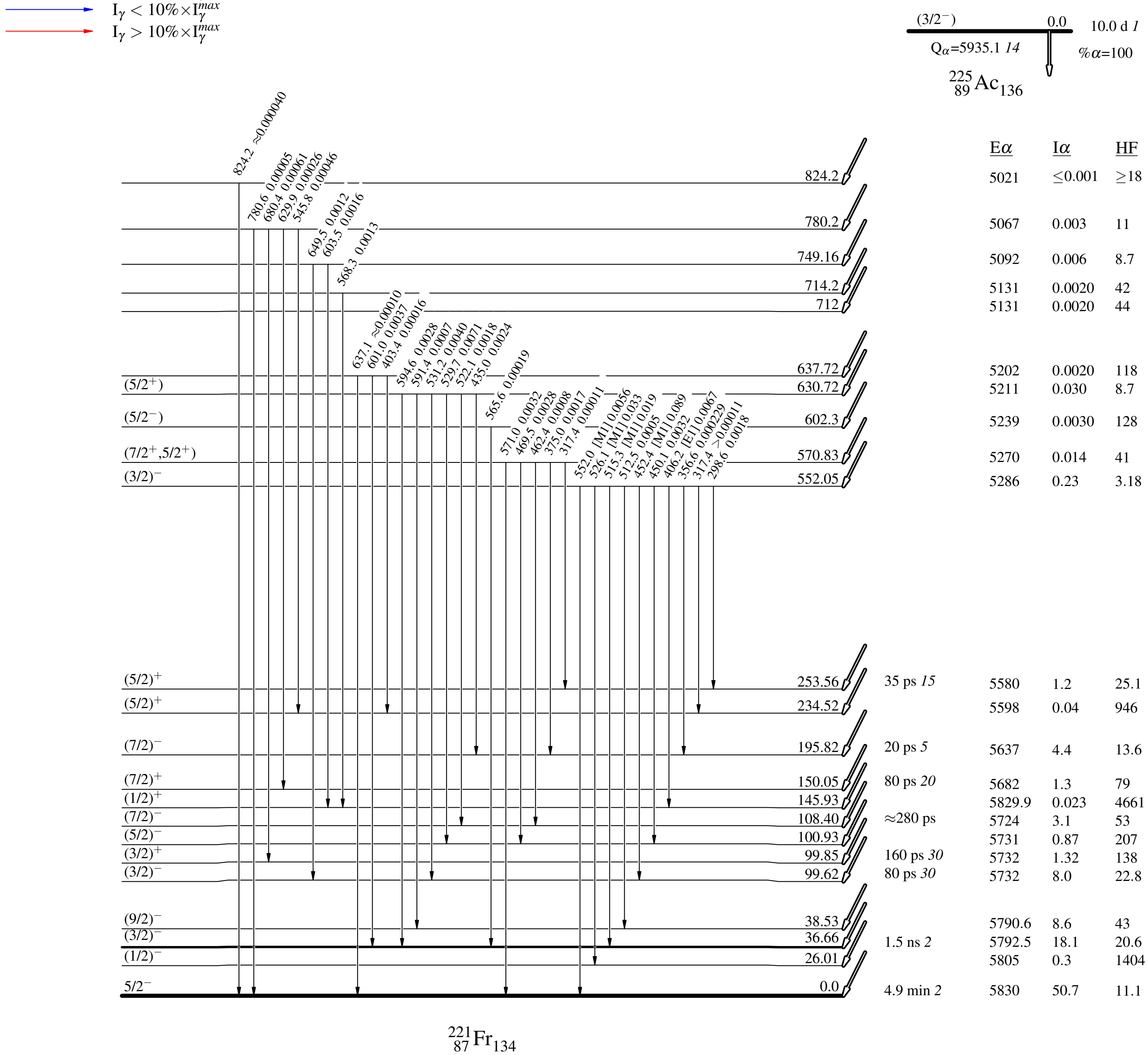
^{225}Ac α decay 2000Ar23,2003Ku44

Decay Scheme

Legend

Intensities: I_γ per 100 parent decays

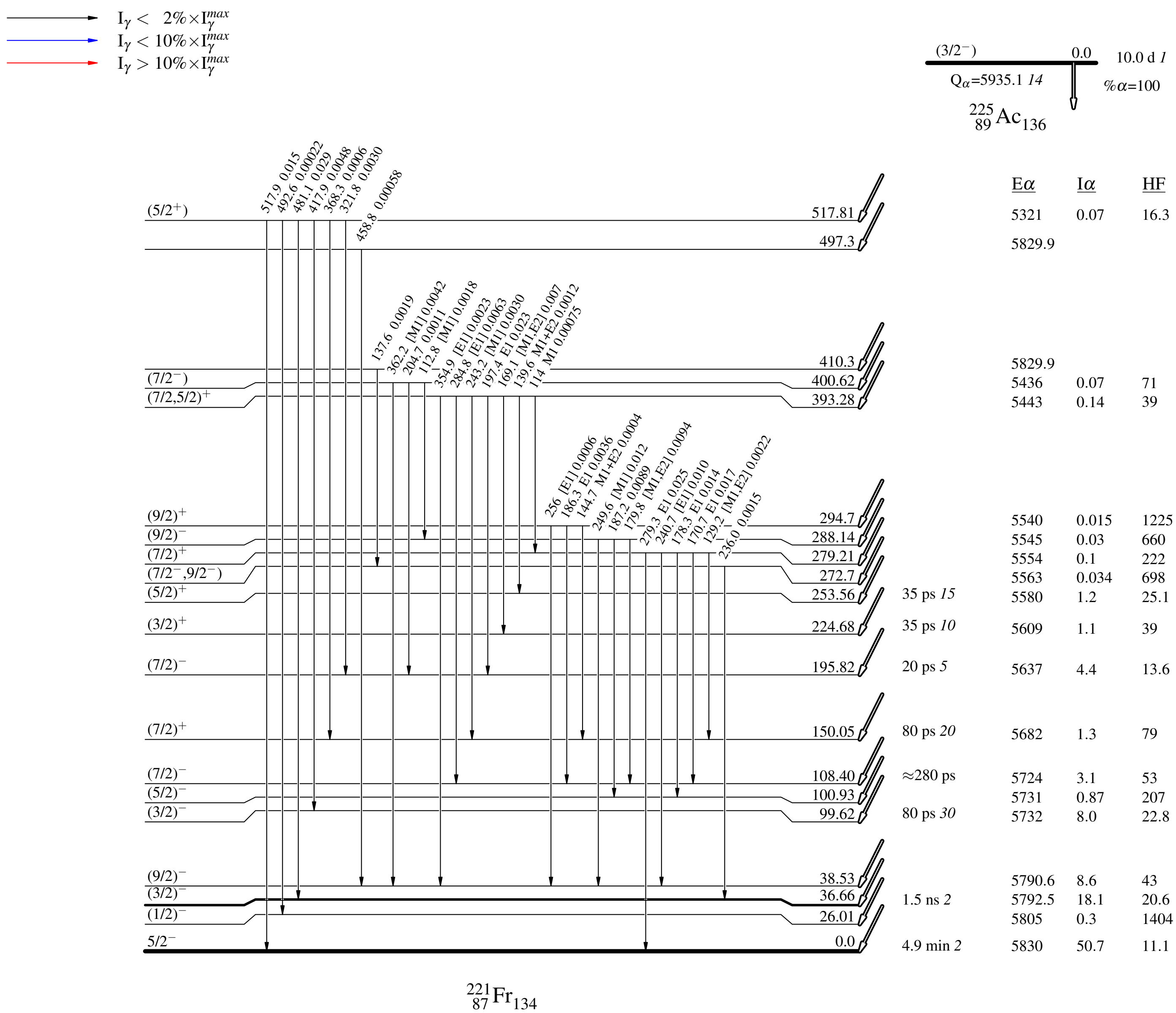
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$



^{225}Ac α decay 2000Ar23,2003Ku44

Decay Scheme (continued)

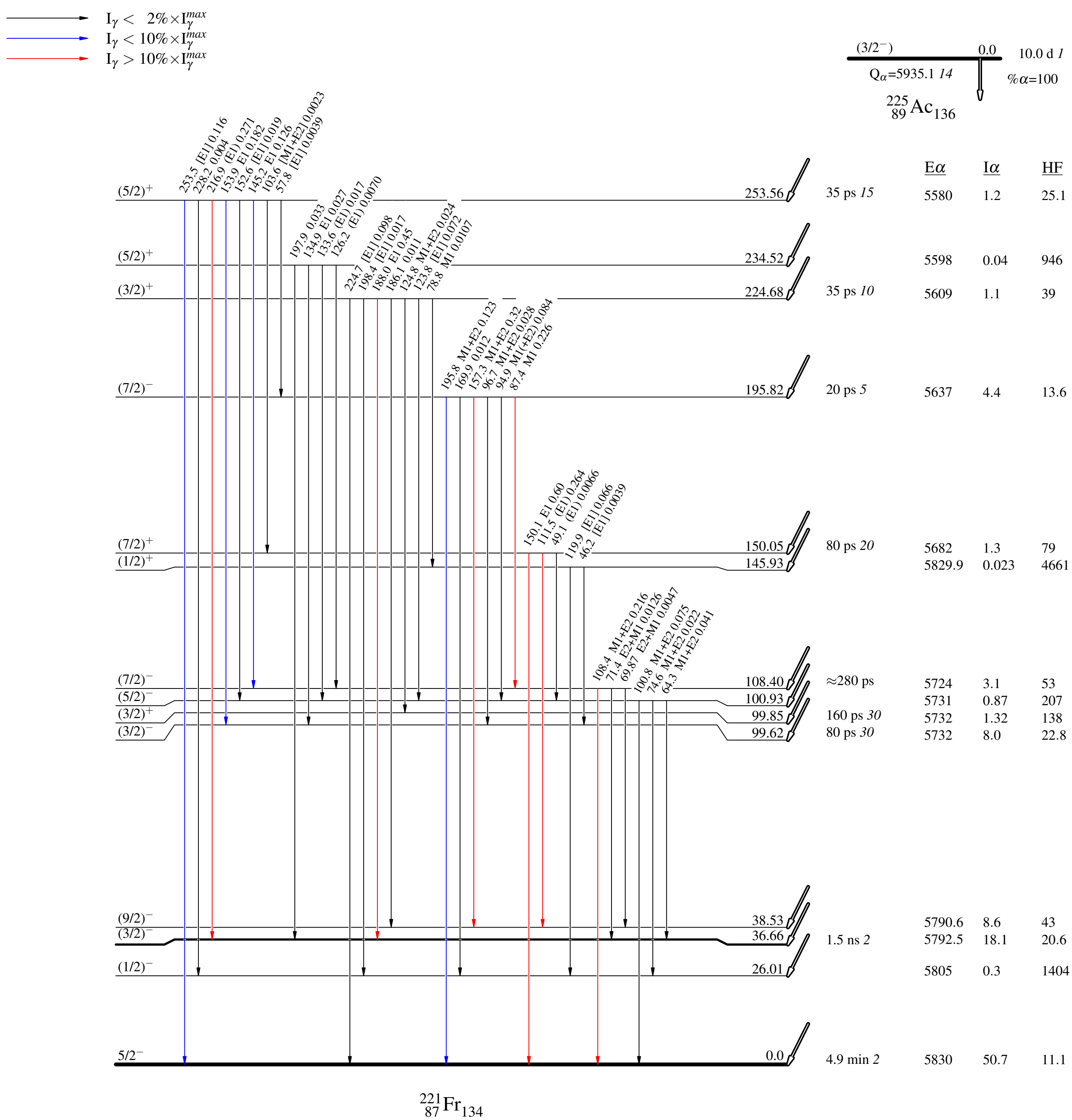
Intensities: I_γ per 100 parent decays



^{225}Ac α decay 2000Ar23,2003Ku44

Decay Scheme (continued)

Intensities: I_γ per 100 parent decays



^{225}Ac α decay 2000Ar23,2003Ku44

Decay Scheme (continued)

Intensities: I_γ per 100 parent decays