^{220}Fr α decay 1996Sh05,1968Ba73

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	S. -c. Wu	NDS 108,1057 (2007)	1-Mar-2007

Parent: ^{220}Fr: E=0; J$^{\pi}$=1^{+}; $T_{1/2}$=27.4 s *3*; Q(α)=6800.7 *19*; %α decay=99.65 *5*

1996Sh05: Radioactivity of ^{220}Fr (from 224Ac(α-decay), produced by Th(p,X), E=200 MeV); ISOCLEL separator; Ge detectors; measured Eα, Iα, Eγ, Iγ, $\alpha\gamma$, α(ce).

1974Ho27, 1968Ba73: measured Eα, Iα.

1970Br29: measured γ, $\gamma\gamma$.

Others: 1964Br16, 1964Mc21.

^{216}At Levels

The level scheme is that proposed by 1996Sh05 and based on their measurements of Eγ, Iγ and $\alpha\gamma$; on Eα and Iα of 1968Ba73; and on $\gamma\gamma$ of 1970Br29. The level configurations are from 1996Sh05.

E(level)[†]	J$^{\pi}$[‡]	Comments
0[@]	1^{-}	
44.59[@] *4*	(2)$^{-}$	
57.11[@] *15*	(4)$^{-}$	Possible isomeric level which undergoes direct α decay to ^{212}Bi (1996Sh05).
105.89[@] *5*	(0)$^{-}$	
122.0[@] *2*	(5)$^{-}$	
153.4[&] *1*	(2)$^{-}$	
160.73[&] *5*	(1)$^{-}$	
169.3[@] *1*	(3^{-})	
199.2[&] *2*	(3)$^{-}$	
208.0 *1*	(1,2)$^{-}$	
234.6 *2*	(1,2^{-})	
254.8 *4*		
278.2[&] *2*	(4)$^{-}$	
302.8 *2*	(1,2^{-})	
317[#] *3*		
381.1 *2*	(2^{-},3^{-})	
421.5 *4*		
479.3?		

[†] From least squares fit to Eγ.
[‡] From Adopted Levels.
[#] From Eα.
[@] Band(A): Configuration=((π $h_{9/2}$)$^{+3}$(ν $g_{9/2}$)$^{+5}$).
[&] Band(B): Configuration=((π $h_{9/2}$)$^{+3}$(ν $g_{9/2}$)$^{+4}$(ν $i_{11/2}$)) + ((π $h_{9/2}$)$^{+2}$(π $f_{7/2}$)(ν $g_{9/2}$)$^{+5}$).

α radiations

Eα[†]	E(level)	Iα[‡&]	HF[@]
6260	421.5	<0.005	>2560
6303.1 *30*	381.1	0.015	1278
6363.9 *25*	317	0.01	3536
6378.2 *20*	302.8	0.35	116

Continued on next page (footnotes at end of table)

^{220}Fr α decay 1996Sh05,1968Ba73 (continued)

α radiations (continued)

Eα†	E(level)	Iα‡&	HF@	Eα†	E(level)	Iα‡&	HF@	Eα†	E(level)	Iα‡&	HF@
6402.1 20	278.2	1.25	41	6508.6 25	169.3	0.6	233	6620# 3	57.11	1.6	240
6427.6 20	254.8	0.24	264	6516.5 25	160.73	3.0	50	6633# 4	44.59	12.2	35
6444.8 25	234.6	≈0.01	≈7658	6524.2 25	153.4	2.5	65	6677# 4	0	66	9.6
6471.5 25	208.0	1.3	75	6555	122.0	<0.6	>353				
6480.1 25	199.2	0.6	177	6573# 4	105.89	9.0	28				

† From 1968Ba73, except where noted otherwise. Authors′ values have been increased by 1.5 keV to correct for more recent values of calibration energies (1991Ry01). Others: 1964Br16, 1964Mc21, 1974Ho27.
‡ From 1996Sh05 (corrected values of 1968Ba73, priv. comm. from C.F. Liang).
# From 1991Ry01, based on measurements of 1968Ba73 and 1974Ho27.
@ $r_0(^{216}At)$=1.553 3, unweighted average of $r_0(^{214}Po)$=1.559 8, $r_0(^{216}Po)$=1.5555 2, $r_0(^{216}Rn)$=1.554 6 and $r_0(^{218}Rn)$=1.5446 19.
& For absolute intensity per 100 decays, multiply by 0.9965 5.

$\gamma(^{216}At)$

All γ data are from 1996Sh05.
Iγ(K x ray At)=82 5 per 1000 α (1996Sh05). If all the observed γ′s above the K-shell binding energy are M1, yielding the largest possible number of K x ray, the evaluator obtained total I(K x ray)=68 2 per 1000 α′s.

E_γ	I_γ†‡	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α#	Comments
ˣ34.6 2	0.07 2							
44.60 5	5.6 2	44.59	(2)⁻	0	1⁻	M1	24.6	α(L)=18.7 3; α(M)=4.44 7; α(N+..)=1.430 21 α(N)=1.150 17; α(O)=0.246 4; α(P)=0.0340 5 Mult.: α(L)exp=20 4.
(45.8)		199.2	(3)⁻	153.4	(2)⁻			
(47.3)		208.0	(1,2)⁻	160.73	(1)⁻			
54.8 1	0.15 5	160.73	(1)⁻	105.89	(0)⁻	[M1]	13.43	α(L)=10.22 16; α(M)=2.42 4; α(N+..)=0.781 12 α(N)=0.628 10; α(O)=0.1344 21; α(P)=0.0186 3
61.3 1	0.7 1	105.89	(0)⁻	44.59	(2)⁻	E2	76.3	α(L)=56.4 9; α(M)=15.10 25; α(N+..)=4.73 8 α(N)=3.89 7; α(O)=0.761 13; α(P)=0.0757 13 Mult.: α(L23)exp=54 15.
64.9 1	0.5 1	122.0	(5)⁻	57.11	(4)⁻	M1	8.18	α(L)=6.23 10; α(M)=1.476 22; α(N+..)=0.476 7 α(N)=0.382 6; α(O)=0.0819 12; α(P)=0.01131 17 Mult.: α(L)exp=11 4.
ˣ75.7 1	0.3 1							
96.4@	<0.4	153.4	(2)⁻	57.11	(4)⁻	(E2)	9.00	α(L)=6.62; α(M)=1.77; α(N+..)=0.608 Mult.: α(L)exp>3.0.
105.88 5	3.0 2	105.89	(0)⁻	0	1⁻	M1	10.27	α(K)=8.30 12; α(L)=1.502 22; α(M)=0.356 5; α(N+..)=0.1146 17 α(N)=0.0921 13; α(O)=0.0197 3; α(P)=0.00272 4 Mult.: α(L)exp=1.8 3.
108.8 1	0.45 6	153.4	(2)⁻	44.59	(2)⁻	M1	9.51	α(K)=7.69 11; α(L)=1.388 20; α(M)=0.329 5; α(N+..)=0.1059 15 α(N)=0.0852 13; α(O)=0.0182 3; α(P)=0.00252 4 Mult.: α(L)exp=1.5 5.
112.1 2	0.05 2	169.3	(3⁻)	57.11	(4)⁻	[M1+E2]	6.8 20	α(K)=4 4; α(L)=2.3 10; α(M)=0.6 3; α(N+..)=0.18 9 α(N)=0.15 8; α(O)=0.030 14; α(P)=0.0034 11

Continued on next page (footnotes at end of table)

^{220}Fr α decay 1996Sh05,1968Ba73 (continued)

γ(^{216}At) (continued)

Eγ	Iγ†‡	Ei(level)	J^{π}_{i}	E_f	J^{π}_{f}	Mult.	α#	Comments
116.2 *1*	0.35 *5*	160.73	(1)⁻	44.59	(2)⁻	M1	7.88	α(K)=6.38 *9*; α(L)=1.148 *17*; α(M)=0.272 *4*; α(N+..)=0.0876 *13* α(N)=0.0705 *10*; α(O)=0.01509 *22*; α(P)=0.00208 *3* Mult.: α(K)exp=14 *5*.
124.7 *1*	0.70 *6*	169.3	(3⁻)	44.59	(2)⁻	[M1+E2]	4.7 *17*	α(K)=2.8 *25*; α(L)=1.5 *6*; α(M)=0.38 *16*; α(N+..)=0.12 *5* α(N)=0.10 *4*; α(O)=0.020 *8*; α(P)=0.0022 *6*
128.7 *2*	0.12 *4*	234.6	(1,2⁻)	105.89	(0)⁻			
132.8 *3*	0.07 *3*	254.8		122.0	(5)⁻			
ˣ138.3 *2*	0.23 *5*							
ˣ139.7 *1*	0.31 *5*							
142.1 *1*	0.8 *1*	199.2	(3)⁻	57.11	(4)⁻	M1	4.45	α(K)=3.60 *5*; α(L)=0.645 *10*; α(M)=0.1527 *22*; α(N+..)=0.0492 *7* α(N)=0.0396 *6*; α(O)=0.00847 *12*; α(P)=0.001170 *17* Mult.: α(K)exp=7.0 *23*.
153.4 *1*	2.6 *2*	153.4	(2)⁻	0	1⁻	M1	3.58	α(K)=2.90 *4*; α(L)=0.518 *8*; α(M)=0.1227 *18*; α(N+..)=0.0395 *6* α(N)=0.0318 *5*; α(O)=0.00681 *10*; α(P)=0.000940 *14* Mult.: α(K)exp=4.2 *8*.
154.5 *3*	0.4 *1*	199.2	(3)⁻	44.59	(2)⁻	M1	3.51	α(K)=2.84 *5*; α(L)=0.508 *8*; α(M)=0.1203 *19*; α(N+..)=0.0387 *6* α(N)=0.0312 *5*; α(O)=0.00667 *10*; α(P)=0.000921 *14* Mult.: α(K)exp=4.5 *12*.
156.1 *1*	1.1 *2*	278.2	(4)⁻	122.0	(5)⁻	M1	3.41	α(K)=2.76 *4*; α(L)=0.493 *7*; α(M)=0.1168 *17*; α(N+..)=0.0376 *6* α(N)=0.0303 *5*; α(O)=0.00648 *10*; α(P)=0.000895 *13* Mult.: α(K)exp=4.4 *10*.
160.73 *5*	3.8 *2*	160.73	(1)⁻	0	1⁻	M1	3.14	α(K)=2.54 *4*; α(L)=0.454 *7*; α(M)=0.1075 *15*; α(N+..)=0.0346 *5* α(N)=0.0278 *4*; α(O)=0.00596 *9*; α(P)=0.000823 *12* Mult.: α(K)exp=3.8 *7*.
163.4 *1*	1.8 *2*	208.0	(1,2)⁻	44.59	(2)⁻	M1	2.99	α(K)=2.42 *4*; α(L)=0.433 *7*; α(M)=0.1025 *15*; α(N+..)=0.0330 *5* α(N)=0.0266 *4*; α(O)=0.00569 *8*; α(P)=0.000786 *11* Mult.: α(K)exp=2.7 *5*.
173.0 *3*	0.06 *3*	381.1	(2⁻,3⁻)	208.0	(1,2)⁻			
182.1 *4*	0.05 *2*	381.1	(2⁻,3⁻)	199.2	(3)⁻			
196.9 *2*	0.20 *5*	302.8	(1,2⁻)	105.89	(0)⁻			
208.0 *4*	0.07 *3*	208.0	(1,2)⁻	0	1⁻	[M1+E2]	1.0 *6*	α(K)=0.7 *6*; α(L)=0.213 *7*; α(M)=0.0535 *19*; α(N+..)=0.0170 *5* α(N)=0.0138 *5*; α(O)=0.00285 *6*; α(P)=0.00035 *5*
ˣ218.6 *4*	0.10 *3*							
221.1 *3*	0.20 *5*	278.2	(4)⁻	57.11	(4)⁻	[M1+E2]	0.8 *5*	α(K)=0.6 *5*; α(L)=0.173 *13*; α(M)=0.0431 *9*; α(N+..)=0.0137 *4* α(N)=0.01116 *23*; α(O)=0.00230 *13*; α(P)=0.00028 *6*
ˣ222.2 *5*	0.08 *3*							
233.6 *2*	0.35 *6*	278.2	(4)⁻	44.59	(2)⁻	[E2]	0.291	α(K)=0.1183 *17*; α(L)=0.1281 *19*; α(M)=0.0339

Continued on next page (footnotes at end of table)

^{220}Fr α decay 1996Sh05,1968Ba73 (continued)

γ(^{216}At) (continued)

E_γ	I_γ [†‡]	E_i(level)	J^π_i	E_f	J^π_f	Comments
						5; α(N+..)=0.01068 *16* α(N)=0.00875 *13*; α(O)=0.00174 *3*; α(P)=0.000186 *3*
[x]242.0 *3*	0.09 *3*					
258.2 *2*	0.48 *10*	302.8	(1,2⁻)	44.59	(2)⁻	
260.5 *5*	0.07 *3*	421.5		160.73	(1)⁻	
268.3 *4*	0.09 *3*	421.5		153.4	(2)⁻	
302.7 *4*	0.30 *5*	302.8	(1,2⁻)	0	1⁻	
318.6[@] *4*	0.25 *5*	479.3?		160.73	(1)⁻	
323.9 *7*	0.10 *3*	381.1	(2⁻,3⁻)	57.11	(4)⁻	
[x]336.0 *10*	0.05 *2*					
381.0 *5*	0.32 *5*	381.1	(2⁻,3⁻)	0	1⁻	
[x]410.0 *10*	0.05 *2*					

† Iγ per 1000 α′s.

‡ For absolute intensity per 100 decays, multiply by 9.965×10^{-2} *5*.

\# 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.

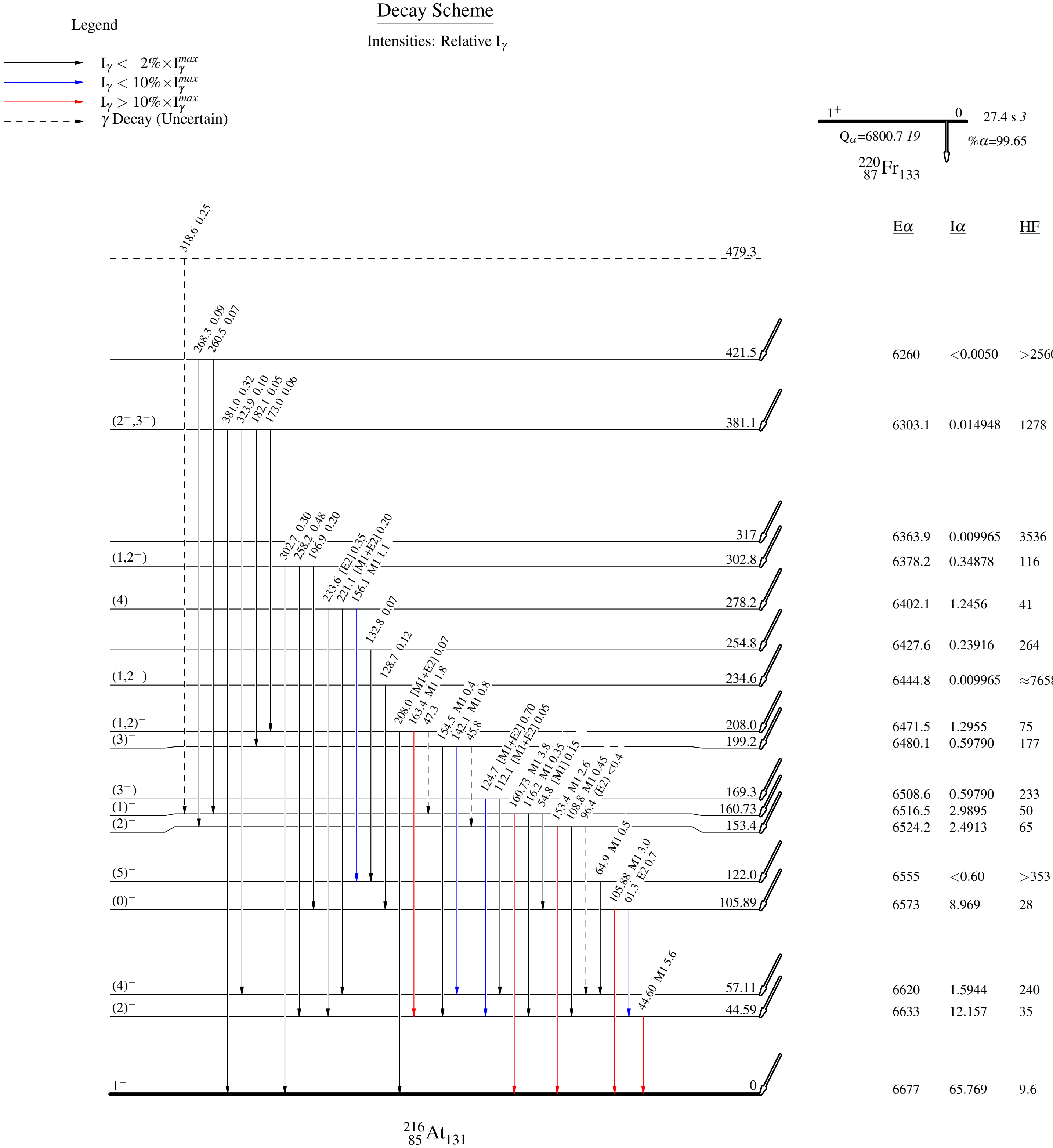
@ Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

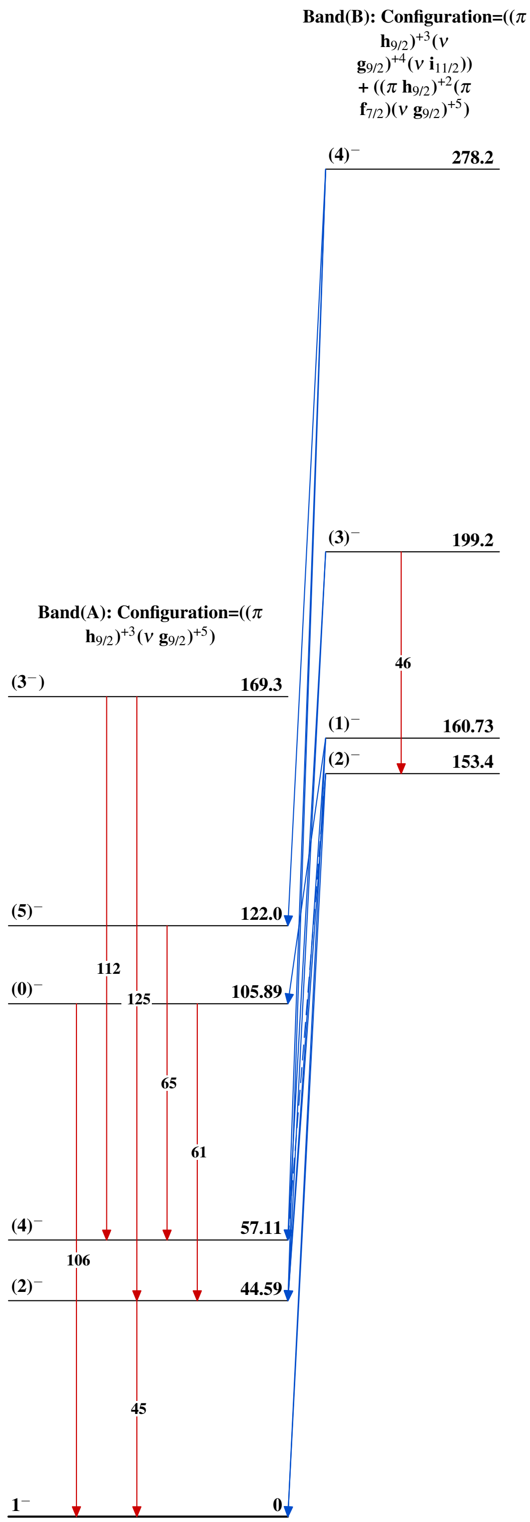
^{220}Fr α decay 1996Sh05,1968Ba73

Decay Scheme

Intensities: Relative I_γ



^{220}Fr α decay 1996Sh05,1968Ba73



$^{216}_{85}At_{131}$