^{224}Pa α decay 1996Li05

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 112,1115 (2011)	31-Oct-2010

Parent: ^{224}Pa: E=0; J^π=(5^-); $T_{1/2}$=0.79 s *6*; Q(α)=7694 *5*; %α decay=100
Additional information 1.

^{220}Ac Levels

1996Li05: measured α, γ, ce, αγ, (α)(ce), (α)(γ)(ce).
1990An19: measured α.
1987FuZT: measured α, time correlated αα.
The decay scheme is that proposed by 1996Li05, and is based on γ, α, αγ and (α)(ce) measurements.
1987FuZT also measured Eα and Iα and the results, although in general agreement with those from 1996Li05, show some discrepancies. In particular, 1987FuZT reported an α group with Eα=7528 keV which feeds a 28-keV level. This α group was not seen in 1996Li05.
Evaluators have significantly modified the decay scheme by introducing a 28-keV level, as suggested in 1987FuZT. Thus, the 28-keV γ ray reported in 1996Li05 is probably a doublet. The individual intensities have been adjusted to produce a more consistent transition-intensity balance in the decay scheme, and to reproduce the experimental alpha-particle intensities. The multipolarity of the 40.7-keV γ ray has been reported as M1 in 1996Li05. Evaluators, however, have assigned an M1+3%E2 multipolarity to the γ ray for consistency in the decay-scheme transition intensity balance, since its conversion coefficient is very sensitive to an E2 admixture. Using this interpretation, the sum of the γ-ray transition intensities to the g.s. and 13-keV is 116 (13)%.
1990An19 observed two α groups with Eα=7460 (25%) and 7555 (75%) which they were interpreted to belong to a parent of ^{220}Ac. These results are in disagreement with those reported in 1996Li05.

E(level)[†]	J^π[‡]	Comments
0.0	(3^-)	
13.79 *13*	(2^-)	
28?		E(level): level suggested by α group reported in 1987FuZT.
40.69 *10*	(4^-)	
68.71 *14*	(5^-)	
71.56 *20*	(1^-)	
108.51 *18*	(3^-)	
113.30 *20*	(1^-)	
145.6? *3*		Iα=2.6% *9*, from γ-ray transition intensity balance.
150.18 *14*	(4^-)	
153.00 *10*	(2^-)	
184.21 *16*	(3^-)	
233.81 *17*	(5^+)	
263.22 *15*	(4^+)	
312.0 *8*		
335.18 *20*		
356.1 *3*		
411.9 *7*		

† From least squares fit to γ-ray energies.
‡ Proposed by 1996Li05, based on γ-ray multipolarities, α hindrance factors, and shell model expectations.

^{224}Pa α decay 1996Li05 (continued)

α radiations

Eα[†]	E(level)	Iα[†@]	HF[‡]	Comments
7151	411.9	<0.05	>340	Iα=0.04%, from γ-ray transition intensity balance.
7205	356.1	0.2	1.8×10^2 *8*	Eα=7191, Iα=0.7% *2* reported in 1987FuZT. Iα=0.43% *7*, from γ-ray transition intensity balance.
7226	335.18	0.1	3.2×10^2 *18*	Eα=7221, Iα=1.3% *4* from 1987FuZT. Iα=0.39% *5*, from γ-ray transition intensity balance.
7249	312.0	0.1	3.9×10^2 *22*	Iα=0.03%, from γ-ray transition intensity balance.
7297	263.22	2.0	29 *16*	Eα=7.292, Iα=3.6% *5* reported in 1987FuZT. Iα=2.7% *2*, from γ-ray transition intensity balance.
7326	233.81	1.5	49 *27*	Two α groups with Eα=7337, Iα=1.4% *3* and Eα=7316, Iα=1.9% *3* reported in 1987FuZT. Iα=1.0% *2*, from γ-ray transition intensity balance.
7375	184.21	2.5	43 *24*	Iα=3.3% *3*, from γ-ray transition intensity balance.
7405	153.00	12[#]	12 *6*	Iα=11.2% *8*, from γ-ray transition intensity balance.
7408	150.18	4.0[#]	35 *20*	Iα=3.5% *5*, from γ-ray transition intensity balance.
7444	113.30	2.5	75 *40*	Iα=1.1% *2*, from γ-ray transition intensity balance.
7449	108.51	4.0	49 *27*	Iα=3.9% *12*, from γ-ray transition intensity balance.
7484	71.56	<0.7	>370	Iα<3.4%, from γ-ray transition intensity balance.
7488	68.71	70	3.8 *21*	Iα: 66 *3* from 1987FuZT. Iα=71% *8*, from γ-ray transition intensity balance.
7515	40.69	<0.5	>660	Iα≈13% from γ-ray transition intensity balance.
7528	28?	2.9 *6*	125	Iα=1.3% *2*, from γ-ray transition intensity balance. Eα,Iα: From 1987FuZT, α group not seen in 1996Li05.
7542	13.79	<0.5	>810	
7556	0.0	<0.5	>900	

† From 1996Li05, unless otherwise noted.
‡ $r_0(^{220}Ac)$=1.530 *20*.
# 1987FuZT reported one α group with Eα=7408 and Iα=17% *2*.
@ Absolute intensity per 100 decays.

$\gamma(^{220}Ac)$

All γ-ray data are from 1996Li05.

E_γ	I_γ[‡&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[†]	Comments
(13.8)		13.79	(2$^-$)	0.0	(3$^-$)	[M1,E2]	2.1×10^4 *21*	α(M)=1.6×10^4 *16*; α(N+..)=5.E3 *6* α(N)=4.E3 *5*; α(O)=9.E2 *9*; α(P)=1.4×10^2 *14*; α(Q)=0.30 *9* Mult.: α(M1)=304, α(E2)=43000.
28.0[@] *1*	3.0 *4*	28?		0.0	(3$^-$)	[E1]	3.34 *6*	α(L)=2.50 *5*; α(M)=0.634 *11*; α(N+..)=0.202 *4* α(N)=0.163 *3*; α(O)=0.0340 *6*; α(P)=0.00487 *8*; α(Q)=0.000164 *3* I_γ: Evaluators have interpreted this γ ray as a doublet with Iγ(doublet)=8.1 (6) (1996Li05). Iγ=3.0 *4* and E1 multipolarity was assumed from decay-scheme balance consistency.
28.0[@] *1*	5.1 *5*	68.71	(5$^-$)	40.69	(4$^-$)	M1	143 *3*	α(L)=108.4 *19*; α(M)=26.1 *5*; α(N+..)=8.86 *16* α(N)=6.93 *13*; α(O)=1.61 *3*; α(P)=0.298 *6*; α(Q)=0.0266 *5* I_γ: Evaluators have interpreted this γ ray as a doublet with Iγ(doublet)=8.1 (6) (1996Li05).

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^{224}Pa α decay 1996Li05 (continued)

γ(^{220}Ac) (continued)

$E_γ$	$I_γ$[‡&]	E_i(level)	$J^π_i$	E_f	$J^π_f$	Mult.[#]	δ	α[†]	Comments
									Iγ=5.1 *5* was assumed from decay scheme balance consistency.
39.5[a]		153.00	(2⁻)	113.30	(1⁻)	[M1,E2]		5.×10² *5*	α(L)=3.E2 3; α(M)=9.E1 9; α(N+..)=3.E1 3 α(N)=25 *23*; α(O)=5 *5*; α(P)=0.9 *8*; α(Q)=0.007 *3* Additional information 3.
40.7 *1*	13.4 *8*	40.69	(4⁻)	0.0	(3⁻)	M1+E2	0.18	70.3 *12*	α(L)=52.7 *9*; α(M)=13.21 *22*; α(N+..)=4.45 *8* α(N)=3.50 *6*; α(O)=0.795 *14*; α(P)=0.1388 *23*; α(Q)=0.00860 *14* Mult.: Reported as M1 in 1996Li05. Evaluators adopted M1+E2 for transition-intensity balance purposes.
57.8 *2*	2.6 *9*	71.56	(1⁻)	13.79	(2⁻)	[M1]		17.0 *3*	α(L)=12.83 *23*; α(M)=3.08 *6*; α(N+..)=1.046 *19* α(N)=0.817 *15*; α(O)=0.190 *4*; α(P)=0.0352 *6*; α(Q)=0.00313 *6*
67.8 *2*	3.8 *10*	108.51	(3⁻)	40.69	(4⁻)	M1		10.63 *18*	α(L)=8.05 *14*; α(M)=1.93 *4*; α(N+..)=0.655 *11* α(N)=0.512 *9*; α(O)=0.1191 *20*; α(P)=0.0220 *4*; α(Q)=0.00196 *4*
74.0 *2*	2.7 *9*	145.6?		71.56	(1⁻)	[M1]		8.74 *13*	α(L)=19 *13*; α(M)=5 *4*; α(N+..)=1.7 *12* α(N)=1.3 *10*; α(O)=0.29 *21*; α(P)=0.05 *3*; α(Q)=0.0009 *7* Mult.: Assumed by evaluators from γ-ray transition intensity balance. Additional information 2.
81.5 *3*	≤3.0	153.00	(2⁻)	71.56	(1⁻)	M1		6.22 *11*	α(L)=4.71 *9*; α(M)=1.129 *20*; α(N+..)=0.383 *7* α(N)=0.300 *6*; α(O)=0.0697 *13*; α(P)=0.01288 *23*; α(Q)=0.001145 *21*
109.5 *1*	3.0 *3*	150.18	(4⁻)	40.69	(4⁻)	M1		13.07	α(K)=10.43 *15*; α(L)=2.00 *3*; α(M)=0.480 *7*; α(N+..)=0.1628 *24* α(N)=0.1272 *19*; α(O)=0.0296 *5*; α(P)=0.00547 *8*; α(Q)=0.000486 *7*
113.1 *2*	5.1 *5*	263.22	(4⁺)	150.18	(4⁻)	E1		0.360	α(K)=0.278 *4*; α(L)=0.0623 *10*; α(M)=0.01506 *23*; α(N+..)=0.00498 *8* α(N)=0.00394 *6*; α(O)=0.000880 *13*; α(P)=0.0001488 *22*; α(Q)=8.47×10⁻⁶ *13*
113.3 *2*	1.6 *3*	113.30	(1⁻)	0.0	(3⁻)	(E2)		6.07 *10*	α(K)=0.266 *4*; α(L)=4.25 *7*; α(M)=1.163 *19*; α(N+..)=0.388 *7* α(N)=0.309 *5*; α(O)=0.0675 *11*; α(P)=0.01059 *18*; α(Q)=5.02×10⁻⁵ *8*
139.2 *1*	4.8 *4*	153.00	(2⁻)	13.79	(2⁻)	M1		6.65	α(K)=5.32 *8*; α(L)=1.003 *15*; α(M)=0.241 *4*; α(N+..)=0.0817 *12* α(N)=0.0638 *9*; α(O)=0.01484 *21*; α(P)=0.00275 *4*; α(Q)=0.000243 *4*
151.0 *2*	1.7 *5*	335.18		184.21	(3⁻)				Additional information 5.
153.0 *1*	10.7 *7*	153.00	(2⁻)	0.0	(3⁻)	M1		5.08	α(K)=4.07 *6*; α(L)=0.766 *11*; α(M)=0.184 *3*; α(N+..)=0.0623 *9*

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^{224}Pa α decay 1996Li05 (continued)

γ(^{220}Ac) (continued)

E_γ	I_γ[‡&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[†]	Comments
								α(N)=0.0487 *7*; α(O)=0.01133 *16*; α(P)=0.00209 *3*; α(Q)=0.000186 *3*
154.7 *2*	2.8 *6*	263.22	(4^+)	108.51	(3^-)	[E1]	0.1705	α(K)=0.1340 *20*; α(L)=0.0276 *4*; α(M)=0.00665 *10*; α(N+..)=0.00221 *4* α(N)=0.00174 *3*; α(O)=0.000393 *6*; α(P)=6.77×10^{-5} *10*; α(Q)=4.21×10^{-6} *6*
165.1 *1*	8.4 *15*	233.81	(5^+)	68.71	(5^-)	E1	0.1458	α(K)=0.1150 *17*; α(L)=0.0234 *4*; α(M)=0.00563 *8*; α(N+..)=0.00187 *3* α(N)=0.001476 *21*; α(O)=0.000333 *5*; α(P)=5.76×10^{-5} *9*; α(Q)=3.64×10^{-6} *6*
170.5 *3*	1.9 *3*	184.21	(3^-)	13.79	(2^-)	M1	3.74	α(K)=3.00 *5*; α(L)=0.563 *9*; α(M)=0.1349 *20*; α(N+..)=0.0458 *7* α(N)=0.0358 *6*; α(O)=0.00832 *13*; α(P)=0.001539 *23*; α(Q)=0.0001364 *21*
182.0 *4*	≈1.0	335.18		153.00	(2^-)			Additional information 6.
184.2 *2*	6.3 *5*	184.21	(3^-)	0.0	(3^-)	M1	3.01	α(K)=2.41 *4*; α(L)=0.452 *7*; α(M)=0.1083 *16*; α(N+..)=0.0368 *6* α(N)=0.0287 *5*; α(O)=0.00668 *10*; α(P)=0.001236 *18*; α(Q)=0.0001095 *16*
194.5 *1*	15.7 *10*	263.22	(4^+)	68.71	(5^-)	E1	0.0986	α(K)=0.0782 *11*; α(L)=0.01544 *22*; α(M)=0.00371 *6*; α(N+..)=0.001235 *18* α(N)=0.000974 *14*; α(O)=0.000220 *3*; α(P)=3.84×10^{-5} *6*; α(Q)=2.53×10^{-6} *4*
247.6 *3*	1.8 *5*	356.1		108.51	(3^-)			Additional information 9.
287.4 *3*	2.1 *5*	356.1		68.71	(5^-)			Additional information 10.
294.7 *5*	≈0.8	335.18		40.69	(4^-)			Additional information 7.
298.2 *7*	≈0.3	312.0		13.79	(2^-)			Additional information 4.
315.8 *7*	≈0.4	356.1		40.69	(4^-)			Additional information 11.
335.0 *7*	≈0.4	335.18		0.0	(3^-)			Additional information 8.
398.0 *10*	≈0.2	411.9		13.79	(2^-)			Additional information 12.
412.0 *10*	≈0.2	411.9		0.0	(3^-)			Additional information 13.

† Additional information 14.
‡ Iγ per 1000α.
# Based on α(K)exp and α(L)exp and K/L ratios, values not given.
@ Possible doublet.
& For absolute intensity per 100 decays, multiply by 0.10.
a Placement of transition in the level scheme is uncertain.

^{224}Pa α decay 1996Li05

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 decays through this branch