

^{214}Ac α decay 2004Ku24,2000He17,1968Va04

Type	Author	History	Citation	Literature Cutoff Date
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Parent: ^{214}Ac : $E=0.0$; $J^\pi=(5^-)$; $T_{1/2}=8.2$ s 2; $Q(\alpha)=7352.1$ 25; $\% \alpha$ decay ≥ 89.0

^{214}Ac - $J^\pi=(5^-)$ proposed in 1979Sc09 from analogy with ^{212}Fr , ^{210}At , and ^{208}Bi .

Others: 1961Gr42, 1979Sc09.

2004Ku24: ^{214}Ac isotope was produced from $^{209}\text{Bi}(^{12}\text{C},7n)$ reaction, $E=9.1$ MeV/nucleon. Evaporation residues separated from ^{12}C beam by the velocity filter SHIP at GSI. After separation the residues were implanted into a position-sensitive 16-strip PIPS Si detector (FWHM=22 keV at 8 MeV for each strip). In one experiment an HPGe, and in another experiment a Ge clover detector were mounted behind the Si detector. Measured E_γ , E_α , I_γ , I_α , α - γ /X-ray coin. Deduced level scheme, γ -ray multipolarity, and J^π .

2000He17: Same research group of 2004Ku24. ^{214}Ac was produced from ^{218}Pa α decay, $^{170}\text{Er}(^{51}\text{V},\alpha 3n)$ and $^{209}\text{Bi}(^{12}\text{C},7n)$ reactions. 16-strip PIPS Si detector, two planar Ge-detectors or an HPGe detector. Measured E_γ , E_α , I_γ , I_α , α - γ /X-ray coin. Deduced level scheme.

1968Va04: ^{214}Ac isotope was produced from $^{209}\text{Bi}(^{12}\text{C},7n)$ reaction. Recoiling reaction products were slowed down in a helium atmosphere and collected onto a catcher foil in an adjacent vacuum chamber. Si(Au) surface-barrier detector. Measured E_α , I_α , E_γ . Deduced level scheme.

 ^{210}Fr Levels

E(level) [†]	J^π [#]	$T_{1/2}$ [#]	Comments
0.0	6 ⁺	3.18 min 6	
62.68 6			
138.96 7	(5,6,7) ⁺		
195.55 8			
209.06 7			
225.14? 10			E(level): Uncertain level – not adopted.
244.20 7	(5,6,7) ⁺		
333.00 [‡] 10			
339.50 [‡] 10			
346.40 [‡] 10			
363.69 9	(4 to 8) ⁺		
444.20 [‡] 20			
525.71 7	(4 to 8) ⁺		
601.40 [‡] 20			
622.50 [‡] 20			
713.4 [‡] 7			
753.7 [‡] 7			

[†] From least-squares fit to γ -ray energies.

[‡] Possible (unobserved) transition from this to a low-lying level.

[#] From Adopted Levels.

 α radiations

E_α [†]	E(level)	I_α ^{†&}	HF [@]	Comments
6478 15	753.7	>0.0023	<230	I_α : >0.0023 8 (2004Ku24).
6515 15	713.4	>0.0022	<351	I_α : >0.0022 8 (2004Ku24).
6606 7	622.50	>0.0066	<273	I_α : >0.0066 13 (2004Ku24).
6626 7	601.40	>0.0047	<465	I_α : >0.0047 12 (2004Ku24).

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^{214}Ac α decay [2004Ku24](#), [2000He17](#), [1968Va04](#) (continued) α radiations (continued)

$E\alpha^\dagger$	E(level)	$I\alpha^\ddagger\&$	HF [@]	Comments
6701 5	525.71	0.14 [‡] 2	29	
6783 7	444.20	>0.015	<599	$I\alpha$: >0.015 4 (2004Ku24).
6861 6	363.69	>0.09	<202	$I\alpha$: >0.09 2 (2004Ku24).
6878 5	346.40	>0.13	<163	$E\alpha$: Other: 6881 keV 15 (2000He17). $I\alpha$: 0.13 2 (2004Ku24).
6879 6	339.50	>0.031	<724	$I\alpha$: >0.031 8 (2004Ku24).
6889 6	333.00	>0.054	<439	$I\alpha$: >0.054 10 (2004Ku24).
6978 5	244.20	1.1 [‡] 3	43	
6998 ^a 7	225.14?	>0.04	<1485	$E\alpha$: Other: $E\alpha$ =7002 keV 15 (1968Va04). $I\alpha$: >0.04 2 (2004Ku24).
7011 5	209.06	>0.44 [#]	<155	$E\alpha$: Other: 7016 keV 15 (2000He17).
7023 5	195.55	>0.35 [#]	<217	$E\alpha$: Other: 7021 keV 15 (2000He17).
7081 4	138.96	42 [‡] 2	2.7	$E\alpha$: Others: $E\alpha$ =7080 keV 15 (2000He17), 7082 keV 5 (1968Va04).
7153 6	62.68			
7215 3	0.0	54 [‡] 2	6.6	$E\alpha$: Others: $E\alpha$ =7210 keV 10 (2000He17), 7214 keV 5 (1968Va04).

[†] From [2004Ku24](#), except otherwise noted. $E\alpha$ values of [1968Va04](#) (in comment section) have been increased by 2 keV, as recommended in [1991Ry01](#) because of changes in calibration energies. $I\alpha$: deduced indirectly from α - γ coin events in [2004Ku24](#), unless otherwise stated.

[‡] α -intensity extracted from singles α -spectrum ([2004Ku24](#)).

[#] >0.35 5; 7011 α and 7023 α form a doublet ([2004Ku24](#)) with % I_α =2.1 2 from the singles α -spectrum.

[@] Using $r_0(^{210}\text{Fr})=1.4701$, average of $r_0(^{208}\text{Rn})=1.467$ 10, $r_0(^{210}\text{Rn})=1.4552$ 21, $r_0(^{210}\text{Ra})=1.492$ 16, and $r_0(^{212}\text{Ra})=1.466$ 6 ([1998Ak04](#)).

[&] For absolute intensity per 100 decays, multiply by ≥ 0.89 .

^a Existence of this branch is questionable.

 $\gamma(^{210}\text{Fr})$

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\#$	E_f	J_f^π	Mult.	$\alpha^\&$	Comments
62.68		62.6 [@] 1	100	0.0	6 ⁺			
138.96	(5,6,7) ⁺	76.3 [@] 1 138.9 1	6 2 100 3	62.68 0.0	6 ⁺	M1	5.62	$\alpha(\text{K})=4.53$ 7; $\alpha(\text{L})=0.832$ 12; $\alpha(\text{M})=0.198$ 3 $\alpha(\text{N})=0.0520$ 8; $\alpha(\text{O})=0.01162$ 17; $\alpha(\text{P})=0.00186$ 3; $\alpha(\text{Q})=0.0001040$ 15 E_γ : Weighted average of 139.0 keV 1 (2004Ku24) and 138.6 keV 2 (2000He17). Mult.: From $\alpha(\text{K})_{\text{exp}}=4.6$ 4 (2004Ku24). E_γ : Tentative assignment to ^{210}Fr in 2004Ku24 . E_γ : Other: 193.0 keV 2 (2000He17).
195.55		133.1 ^a 1	37 12	62.68				
209.06		195.5 1 146.4 1 209.0 [@] 1	100 4 59 3 100 3	0.0 6 ⁺ 62.68 0.0 6 ⁺				
225.14?		162.5 ^a 1 225.1 ^a 2	100 20 <15	62.68 0.0 6 ⁺				Mult.: (M1+E2) from $\alpha(\text{K})_{\text{exp}}=0.4$ 3. Pure E2 not excluded (2004Ku24). E_γ : Uncertain placement from uncertain level – not adopted. E_γ : Doublet with 224.7 γ ; γ -ray and level energy were calculated from the sum 62.6 γ and 162.5 γ in cascade to the g.s. Uncertain placement from uncertain level – not adopted.

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^{214}Ac α decay [2004Ku24,2000He17,1968Va04](#) (continued) $\gamma(^{210}\text{Fr})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\#$	E_f	J_f^π	Mult.	$\alpha^\&$	Comments
244.20	(5,6,7) ⁺	181.4 1	13 11	62.68				
		244.2 1	100 6	0.0	6 ⁺	M1	1.149	$\alpha(\text{K})=0.927$ 13; $\alpha(\text{L})=0.1687$ 24; $\alpha(\text{M})=0.0402$ 6 $\alpha(\text{N})=0.01053$ 15; $\alpha(\text{O})=0.00235$ 4; $\alpha(\text{P})=0.000378$ 6; $\alpha(\text{Q})=2.11\times 10^{-5}$ 3 Mult.: From $\alpha(\text{K})\text{exp}=1.9$ 14 (2004Ku24).
333.00		333.0 1	100	0.0	6 ⁺			
339.50		339.5 1	100	0.0	6 ⁺			
346.40		346.4 1	100	0.0	6 ⁺			E_γ : Other: 348.6 keV 16 (2000He17).
363.69	(4 to 8) ⁺	154.6 1	78 12	209.06				
		224.7 1	100 9	138.96	(5,6,7) ⁺	M1	1.449	$\alpha(\text{K})=1.168$ 17; $\alpha(\text{L})=0.213$ 3; $\alpha(\text{M})=0.0507$ 8 $\alpha(\text{N})=0.01329$ 19; $\alpha(\text{O})=0.00297$ 5; $\alpha(\text{P})=0.000477$ 7; $\alpha(\text{Q})=2.66\times 10^{-5}$ 4 Mult.: From $\alpha(\text{K})\text{exp}=1.5$ 9 (2004Ku24).
444.20		363.9 2	24 4	0.0	6 ⁺			
525.71	(4 to 8) ⁺	444.2 2	100	0.0	6 ⁺			
		281.4 1	74 7	244.20	(5,6,7) ⁺	M1	0.776	$\alpha(\text{K})=0.627$ 9; $\alpha(\text{L})=0.1137$ 16; $\alpha(\text{M})=0.0271$ 4 $\alpha(\text{N})=0.00709$ 10; $\alpha(\text{O})=0.001586$ 23; $\alpha(\text{P})=0.000254$ 4; $\alpha(\text{Q})=1.420\times 10^{-5}$ 20 Mult.: From $\alpha(\text{K})\text{exp}=1.1$ 9 (2004Ku24).
		316.6 2	33 5	209.06				
		330.1 1	57 8	195.55				
		386.7 2	31 4	138.96	(5,6,7) ⁺			
		463.0 2	23 4	62.68				
		525.9 1	100 6	0.0	6 ⁺			
601.40		601.4 2	100	0.0	6 ⁺			
622.50		622.5 2	100	0.0	6 ⁺			
713.4		713.4 7	100	0.0	6 ⁺			
753.7		753.7 7	100	0.0	6 ⁺			

[†] Detected in coincidence with alpha particles ([2004Ku24](#)).

[‡] Based upon α - γ coin data – [2004Ku24](#) identify the γ -ray as a transition between excited states, and not feeding the g.s.. The sum of 41.5 and 121.0 keV is equal to 162.5 keV, which is a tentative transition from 225 level to 62 level. It is speculated in [2004Ku24](#) that in a cascade 41.5 γ and 121.0 γ could feed the level at 62 keV via a level at 104.1- or 183.6-keV from 225-keV level.

[#] From [2004Ku24](#).

[@] Also reported in [2000He17](#).

[&] [Additional information 1](#).

^a Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

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Legend

Decay Scheme

Intensities: Relative photon branching from each level

----- γ Decay (Uncertain)
 • Coincidence

