^{216}Ac α decay (440 μs) 2004Ku24

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	K. Auranen and E. A. Mccutchan	NDS 168, 117 (2020)	1-Aug-2020

Parent: ^{216}Ac: E=0.0; J$^{\pi}$=(1$^-$); T$_{1/2}$=440 μs *16*; Q(α)=9235 *6*; %α decay=100.0
^{216}Ac-T$_{1/2}$: from 2000He17. Other: 390 μs *60* (2005Li17).
^{216}Ac-J$^{\pi}$: analogy with ^{212}At and ^{214}Fr.
2004Ku24: the nuclei of interest were produced in the fusion-evaporation reaction ^{209}Bi(^{12}C,5n). The 240−μg/cm^2 thick targets had a 40−μg/cm^2 thick carbon backing. The ^{12}C beam was provided by the UNILAC accelerator at the energy of 7.1 MeV/nucleon and at the intensity of ≈200 pnA. Residues were selected with the velocity filter SHIP, and those were implanted into 16-strip PIPS Si detector with a HPGe detector mounted immediately behind. Eγ, Eα, Iγ, Iα, $\gamma\alpha$ coincidences were measured.
Others: 1968Va18, 1970To18, 2000He17, 2005Li17, 2018Hu13.
The ^{212}Fr level scheme and ^{216}Ac α-decay data adopted here follows that presented in 2004Ku24.
In the previous A=212 evaluation (2005Br03) four excited states were adopted for ^{212}Fr based on α feeding from a low-lying (47 keV *11*), high-spin (9$^-$) isomeric state of ^{216m}Ac with a half-life nearly identical to that of the ^{216}Ac ground state, see, i.e. 1968Va18, 1970To18, 2000He17. Later, in 2004Ku24, based on $\alpha\gamma$ coincidence measurement it was obseved that all Q$_{\alpha}$+E$_{\gamma}$ sums are equal to the Q$_{\alpha}$ of the g.s. to g.s. α decay, and that a change in beam energy did not have an impact on the relative population of the ^{216}Ac ground state and assumed isomer. Furthermore, in 2004Ku24 it was pointed out that the obtained α-decay hindrance factors do not support high-spin origin, but instead all observed α decays can be explained by the (1$^-$) ground state of ^{216}Ac. Consequently, the assignment of a high-spin isomer in ^{216}Ac is considered erroneous, and the respective ^{212}Fr levels, as well as the corresponding ^{216m}Ac α-decay data set were removed in the present evaluation.
α: Additional information 1.

^{212}Fr Levels

E(level)†	J$^{\pi}$‡	T$_{1/2}$‡	E(level)†	J$^{\pi}$‡	E(level)†
0.0	5$^+$	20.0 min *6*	606.23 *8*		1129.9 *5*
82.48 *6*	(4$^+$)		610.60 *20*		1209.5 *5*
500.72 *7*			777.29 *10*		1239.9 *4*
536.34 *8*			853.73 *8*	(4$^+$,5$^+$,6$^+$)	1287.1 *8*
542.00 *10*	7$^+$		938.21 *10*	(4$^+$,5$^+$,6$^+$)	1356.0 *20*
574.89 *11*			1008.7 *4*		1375.35 *23*

† From a least-square fit to the Eγ data by the evaluator.
‡ From the Adopted Levels.

α radiations

Eα†	E(level)	Iα‡@	HF#	Comments
7758 *6*	1375.35	0.011 *3*	177 *50*	Iα: from the singles α-spectrum.
7776 *15*	1356.0	>0.0010	<2372	Iα: ΔIα=0.0004.
7846 *15*	1287.1	0.016 *3*	229 *45*	Iα: from the singles α-spectrum.
7892 *10*	1239.9	0.021 *2*	242 *27*	Iα: from the singles α-spectrum.
7924 *15*	1209.5	>0.0013	<5116	Iα: ΔIα=0.0002.
8001 *15*	1129.9	>0.0024	<4792	Iα: ΔIα=0.0016.
8114 *9*	1008.7	>0.0020	<13023	Iα: ΔIα=0.0003.
8187 *5*	938.21	0.74 *2*	53 *4*	Iα: from the singles α-spectrum.
8270 *5*	853.73	1.40 *7*	49 *4*	Iα: from the singles α-spectrum.
8346 *7*	777.29	<0.1	>1050	
8509 *7*	610.60	>0.017	<19684	Iα: ΔIα=0.001.
8514 *6*	606.23	>0.11	<3125	Iα: ΔIα=0.02.
8536 *15*	574.89	>0.12	<3474	Iα: ΔIα=0.02.
8576 *6*	542.00	>0.46	<1108	Iα: ΔIα=0.05.

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^{216}Ac α decay (440 μs) 2004Ku24 (continued)

α radiations (continued)

Eα[†]	E(level)	Iα[‡@]	HF[#]	Comments
8581 *6*	536.34	>0.51	<1.03×10^3	Iα: ΔIα=0.06.
8616 *6*	500.72	0.23 *5*	2.69×10^3 *61*	Iα: from the singles α-spectrum.
9029 *7*	82.48	48.8 *10*	145 *9*	Iα: deduced from the singles α-spectrum by assuming the tail in the 9029 α transition towards higher energy is due to summing of 9029 keV α-particles and conversion electrons from the 82 keV transition. Other: 25 *28* (2018Hu13). Eα: others: 8990 keV *20* (1970To18), 8976 *10* (2018Hu13).
9105 *7*	0.0	47.5 *5*	235 *14*	Iα: deduced from the singles α-spectrum by assuming the tail in the 9029 α transition towards higher energy is due to summing of 9029 keV α-particles and conversion electrons from the 82 keV transition. Other: 75 *57* (2018Hu13). Eα: Others: 9052 keV *10* (2000He17), 9070 *50* (2005Li17), 9070 keV *8* (1970To18), 9069 *6* (2018Hu13).

[†] From 2004Ku24.

[‡] Deduced indirectly by 2004Ku24 from αγ coincidences by normalizing the number of γ-ray counts to those of α- and γ-lines observed for the 853 and 938 levels (which yielded identical values), unless stated otherwise. Uncertainties for intensities obtained by this method are statistical only. Plausible effect due to summing of α-particle and conversion electrons were not taken into account, meaning the quoted I_α values are lower or upper limits as indicated.

[#] $r_0(^{212}Fr)$=1.5043 *22*, average of $r_0(^{212}Ra)$=1.4695 *14*, $r_0(^{214}Ra)$=1.5487 *30*, $r_0(^{210}Rn)$=1.4557 *12*, and $r_0(^{212}Rn)$=1.5433 *36* (2020Si16).

[@] Absolute intensity per 100 decays.

γ(^{212}Fr)

E_i(level)	J^π_i	E_γ[†]	I_γ[†]	E_f	J^π_f	Mult.[‡]	α	Comments
82.48	(4$^+$)	82.6 *1*	100	0.0	5$^+$			
500.72		418.3 *1*	100 *6*	82.48	(4$^+$)			
		500.7 *1*	53 *4*	0.0	5$^+$			
536.34		453.9 *1*	9 *1*	82.48	(4$^+$)			
		536.3 *1*	100 *6*	0.0	5$^+$			
542.00	7$^+$	542.0 *1*	100	0.0	5$^+$	E2	0.0305	
574.89		492.4[#] *1*	100 *4*	82.48	(4$^+$)			
		575.0[#] *4*	1.3 *4*	0.0	5$^+$			
606.23		105.8 *2*	11 *3*	500.72				
		523.7 *1*	100 *7*	82.48	(4$^+$)			
		606.2 *1*	60 *7*	0.0	5$^+$			
610.60		610.6 *2*	100	0.0	5$^+$			
777.29		276.6 *2*	1.3 *6*	500.72				
		694.8 *1*	100 *5*	82.48	(4$^+$)			
		777.3 *2*	14 *2*	0.0	5$^+$			
853.73	(4$^+$,5$^+$,6$^+$)	352.9 *2*	1.2 *5*	500.72				
		771.3 *1*	77 *4*	82.48	(4$^+$)			
		853.7 *1*	100 *4*	0.0	5$^+$	(M1)	0.0397	α(K)exp=0.06 *6* α(K)=0.0322 *5*; α(L)=0.00569 *8*; α(M)=0.001348 *19*; α(N)=0.000353 *5*; α(O)=7.90×10^{-5} *11* α(P)=1.269×10^{-5} *18*; α(Q)=7.13×10^{-7} *10* α(K)exp: deduced by gating on α-particles with energies between 8230 and 8320.
938.21	(4$^+$,5$^+$,6$^+$)	855.8 *7*	≤5	82.48	(4$^+$)			
		938.2 *1*	100 *2*	0.0	5$^+$	(M1)	0.0310	α(K)exp=0.027 *17* α(K)=0.0252 *4*; α(L)=0.00443 *7*;

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^{216}Ac α decay (440 μs) 2004Ku24 (continued)

γ(^{212}Fr) (continued)

E_i(level)	E_γ †	I_γ †	E_f	J^π_f	Comments
					α(M)=0.001051 *15*; α(N)=0.000275 *4*; α(O)=6.16×10^{-5} *9* α(P)=9.90×10^{-6} *14*; α(Q)=5.57×10^{-7} *8* α(K)exp: deduced from ratio between $L_{\alpha1}$ x-rays and 938 γ-rays gated by the 8187 α-transition.
1008.7	1008.7 *4*	100	0.0	5^+	
1129.9	1047.5 *9*	85 *50*	82.48	(4^+)	
	1129.9 *5*	100 *40*	0.0	5^+	
1209.5	1209.5 *5*	100	0.0	5^+	
1239.9	1239.9 *4*	100	0.0	5^+	
1287.1	1287.1 *8*	100	0.0	5^+	
1356.0	1356 *2*	100	0.0	5^+	
1375.35	436.8 *6*	17 *6*	938.21	$(4^+,5^+,6^+)$	
	1293.1 *4*	45 *17*	82.48	(4^+)	
	1375.3 *3*	100 *20*	0.0	5^+	

† From 2004Ku24. Intensities are normalized to 100 for the most intense γ-ray from each level.
‡ From the Adopted Levels. For cases where the multipolarity derives from this dataset, supporting evidence is given in the comments.
\# Placement of transition in the level scheme is uncertain.
^{x} γ ray not placed in level scheme.

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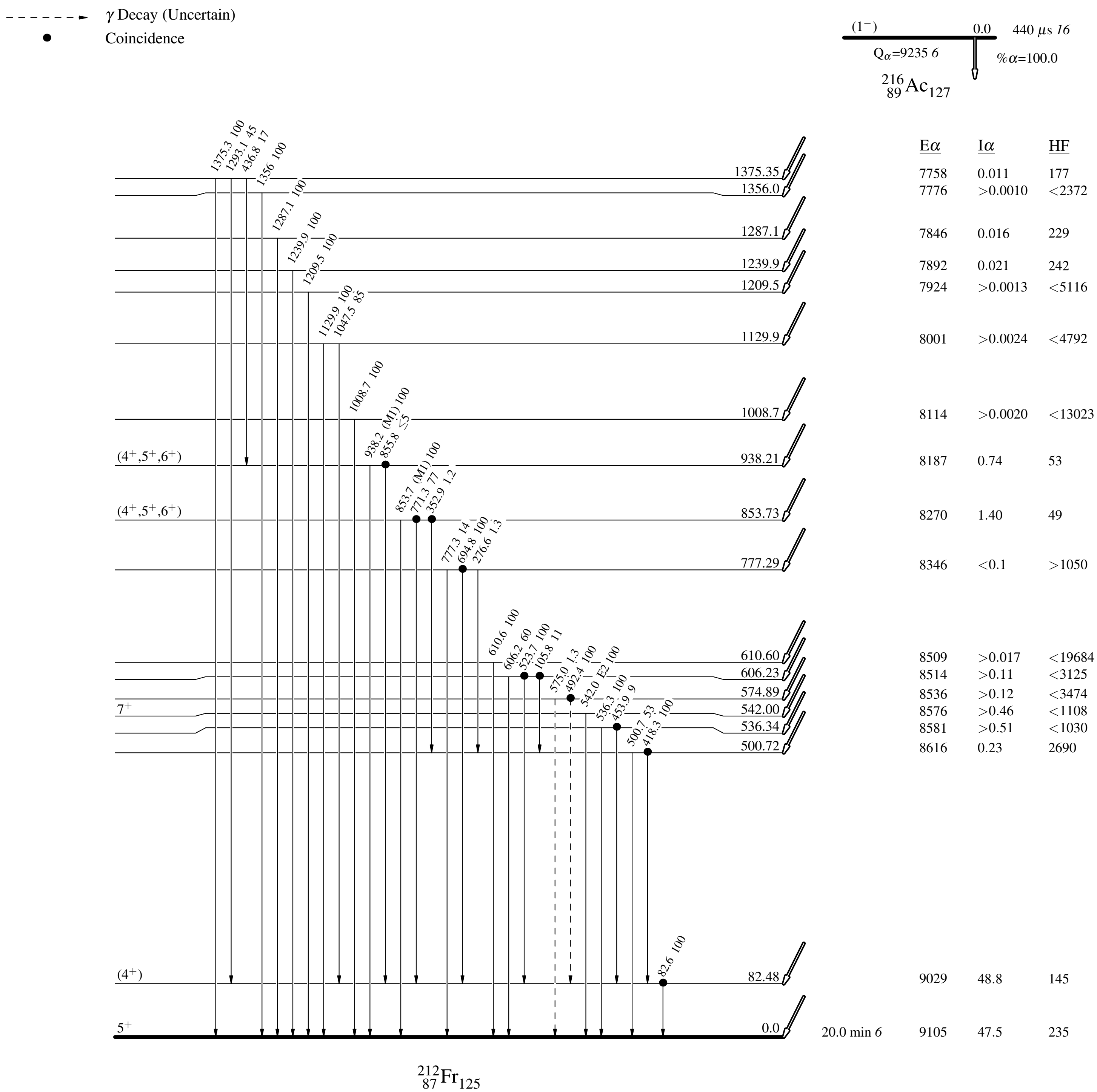
Legend

Decay Scheme

Intensities: % photon branching from each level



Eα	Iα	HF
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7776	>0.0010	<2372
7846	0.016	229
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8001	>0.0024	<4792
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8509	>0.017	<19684
8514	>0.11	<3125
8536	>0.12	<3474
8576	>0.46	<1108
8581	>0.51	<1030
8616	0.23	2690
9029	48.8	145
9105	47.5	235