

^{216}Fr α decay (71 ns) [1996Li37](#)

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

Parent: ^{216}Fr : $E=133.3$ I; $J^\pi=(3^-)$; $T_{1/2}=71$ ns 5; $Q(\alpha)=9174$ 3; $\% \alpha$ decay <10.0

^{216}Fr - $\% \alpha$ decay: the α decay branch is evaluated in [2007Wu02](#) as $\% \alpha > 50$ based on an intensity balance from the α decay of ^{220}Ac . The decay proceeds by a single allowed unhindered 8933α transition. Such a large α decay branch for this short lived isomer leads to $\text{HF} < 0.24$ which is unphysical. The evaluators adopt a conservative $\% \alpha < 10$ %, from the requirement that HF be not smaller than one. If one considers that HF for the g.s. to g.s. allowed, unhindered transition is $\text{HF}=1.7$ based on systematics, this would imply $\% \alpha \approx 6\%$.

[1996Li37](#): ^{216}Fr activity was measured in secular equilibrium with ^{224}Pa ($T_{1/2}=0.8$ s) and ^{220}Ac ($T_{1/2}=26$ ms). ^{224}Pa was produced by $^{209}\text{Bi}(^{18}\text{O},3n)$, $E=96$ MeV. Measured alpha particles, γ rays, $\alpha\gamma$ coin, conversion electrons, α -ce and α - γ -ce coin. Detectors not given. However, α - and γ -ray spectra suggest that Si(Au) surface barrier and germanium detectors, respectively, were used.

α : [Additional information 1](#).

 ^{212}At Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [‡]	Comments
0.0	(1 ⁻)	0.314 s 3	
55.0 2	(1 ⁻ , 2 ⁻)		E(level): a weak transition at 55 keV is observed in coincidence with the 8933-keV α peak, however feeding of the 55-keV level could not be identified. 1996Li37 suggest a possible 105-keV transition between the 160-keV level and the 55-keV level to account for the imbalance, however, this transition is not discernable in $\alpha\gamma$ coincidence spectra.
160.3 I	(2 ⁻)		
205.3 2	(3 ⁻)		

[†] From E_γ .

[‡] From the Adopted Levels.

 α radiations

E_α	E(level)	I_α [‡]	HF [†]	Comments
8933 8	205.3	100	>1	Observed in coincidence with 45.0 γ .

[†] Using $r_0(^{212}\text{At})=1.5522$ 36, average of $r_0(^{214}\text{Rn})=1.5655$ 13, $r_0(^{212}\text{Rn})=1.5433$ 36, $r_0(^{212}\text{Po})=1.5658$ 59, and $r_0(^{210}\text{Po})=1.5340$ 25 ([2020Si16](#)).

[‡] For absolute intensity per 100 decays, multiply by <0.1.

 $\gamma(^{212}\text{At})$

I_γ normalization: intensities are given in [1996Li37](#) as normalized to 100 total decays from both the 1⁻, 0.70 μs g.s and the 133-keV, 71 ns isomer measured in equilibrium with the ^{220}Ac parent. Gamma-ray intensities given here are deduced by evaluators from measured absolute α intensities and γ feedings; original values from [1996Li37](#) given in the comments.

E_γ	I_γ [‡]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	α	Comments
45.0 I	0.40 I	205.3	(3 ⁻)	160.3	(2 ⁻)	M1	24.0	$\alpha(\text{L})=18.2$ 3; $\alpha(\text{M})=4.32$ 7; $\alpha(\text{N})=1.120$ 18; $\alpha(\text{O})=0.240$ 4; $\alpha(\text{P})=0.0331$ 6 Mult.: transition-intensity balance at 160-keV level requires

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^{216}Fr α decay (71 ns) [1996Li37](#) (continued) $\gamma(^{212}\text{At})$ (continued)

E_γ	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [†]	α	Comments
55.0 2		55.0	(1 ⁻ , 2 ⁻)	0.0	(1 ⁻)	(M1)	13.28	$\alpha \approx 25$, thus the 45-keV γ ray is predominately M1. I_γ: 0.15 5 normalized to 100 total decays from both the 0.70 μs g.s and the 133-keV, 71 ns isomer measured in secular equilibrium with the ^{220}Ac parent (1996Li37). $\alpha(\text{L})=10.12$ 18; $\alpha(\text{M})=2.40$ 5; $\alpha(\text{N})=0.621$ 11; $\alpha(\text{O})=0.1330$ 24; $\alpha(\text{P})=0.0184$ 4 E_γ: a weak transition at 55 keV is observed in coincidence with the 8933-keV α peak, however feeding of the 55-keV level could not be identified. I_γ: ≈ 0.03 normalized to 100 total decays from both the 0.70 μs g.s and the 133-keV, 71 ns isomer measured in secular equilibrium with the ^{220}Ac parent (1996Li37).
160.3 1	2.4 5	160.3	(2 ⁻)	0.0	(1 ⁻)	M1	3.16	$\alpha(\text{K})=2.56$ 4; $\alpha(\text{L})=0.457$ 7; $\alpha(\text{M})=0.1083$ 16; $\alpha(\text{N})=0.0281$ 4; $\alpha(\text{O})=0.00601$ 9 $\alpha(\text{P})=0.000830$ 12 Mult.: $I(\text{K x ray})=3.0$ 5 in α-K x ray coin is consistent with M1 multipolarity. Also K x ray/$I_\gamma(160.3\gamma)=3$ 1 suggests M1. I_γ: 1.0 2 normalized to 100 total decays from both the 0.70 μs g.s and the 133-keV, 71 ns isomer measured in secular equilibrium with the ^{220}Ac parent (1996Li37).

[†] From the Adopted Gammas. For cases where values are derived from this dataset, additional support is given in the comments.

[‡] Absolute intensity per 100 decays.

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Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

Legend

→

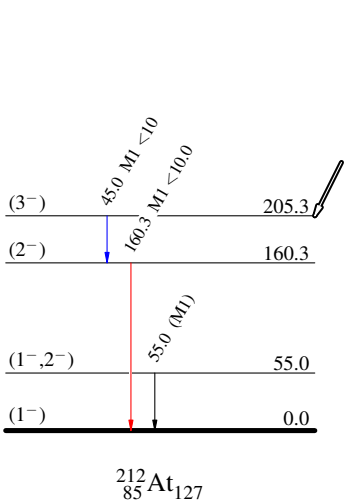
$I_{\gamma} < 2\% \times I_{\gamma}^{max}$

→

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

→

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



(3 ⁻)	133.3	71 ns 5
$Q_{\alpha}=9174.3$		$\% \alpha < 10.0$
$^{216}\text{Fr}_{129}$		
<u>Eα</u>	<u>Iα</u>	<u>HF</u>
8933	10.0	>1

0.314 s 3

$^{212}_{85}\text{At}_{127}$