

^{198}At α decay (4.46 s) 2019Gh11,1992Hu04,1996En01

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh		NDS 177, 1 (2021)	3-Sep-2021

Parent: ^{198}At : $E=0$; $J^\pi=(3^+)$; $T_{1/2}=4.46$ s 10; $Q(\alpha)=6889.4$ 19; $\% \alpha$ decay=97 3

^{198}At - J^π : From ^{198}At Adopted Levels in the ENSDF database (Dec 2015 update).

^{198}At - $T_{1/2}$: From α decay curves; quoted values is weighted average of 4.47 s 10 (2019Gh11), 4.2 s 20 (2012Fo09), 3.8 s 4 (2005Uu02), 4.6 s +18-10 (1996En01), 4.2 s 3 (1992Hu04), and 4.9 s 5 (1967Tr06). Other: 3.0 s 1 (2014Ka23) is considered discrepant. Half-life of 4.2 s 2 in ^{198}At Adopted Levels in the ENSDF database (Dec 2015 update) is revised here with the inclusion of 2019Gh11 measurement.

^{198}At - $Q(\alpha)$: From 2021Wa16.

^{198}At - $\% \alpha$ decay: From $\% \alpha \geq 94$ (1995BiZZ). Others: $\% \alpha = 76$ 21 (1998Bo14), >80 (1992Hu04), >90 (1980Ew03).

2019Gh11: ^{198}At from α decay of ^{202}Fr , which was produced in $\text{U}(p,X)$, $E=1.4$ GeV at ISOLDE-CERN facility using UC_x target and pulsed proton beam. Francium atoms were ionized and accelerated to 30 keV, followed by mass separation using High-Resolution separator (HRS). Measured E_α , I_α , $\alpha\gamma$ -coin using Si surface barrier detectors for α particles and two single-crystal HPGe detectors for γ detection. FWHM ≈ 33 keV for $E_\alpha=5$ -8 MeV range. The two activities of ^{202}Fr could not be separated in this work.

1992Hu04: online mass-separated source from ^{202}Fr α decay produced in $\text{Ir}(^{20}\text{Ne},xn)^{202}\text{Fr}$ and $^{181}\text{Ta}(^{32}\text{S},2p9n)^{202}\text{Fr}$, and directly in $\text{Re}(^{20}\text{Ne},xn)^{198}\text{At}$. Measured E_α , I_α , γ rays, conversion electrons, $\alpha\gamma(t)$ coin using Ge and Si(Li) detectors.

1996En01: online mass separated (gas-filled recoil separator) source from ^{202}Fr α decay produced in $^{170}\text{Yb}(^{35}\text{Cl},3n)$, $E=171$ -186 MeV. Measured α particles using semiconductor detector.

2005Uu02, 2005Uu03: ^{198}At produced in α decay of ^{202}Fr produced in $^{141}\text{Pr}(^{63}\text{Cu},pn)$, $E=278$ -288 MeV and in $^{170}\text{Yb}(^{36}\text{Ar},p3n)$, $E=180$ -185 MeV.

2014Ka23: ^{198}At source from ^{202}Fr α decay, which was produced in $^{149}\text{Sm}(^{56}\text{Fe},p2n)$, $E(^{56}\text{Fe})=244$ -275 MeV reaction, with beam from GSI accelerator facility. Target= $370 \mu\text{g}/\text{cm}^2$ thick enriched to 96.9% in ^{149}Sm , and backed with $40 \mu\text{g}/\text{cm}^2$ thick carbon backing and covered with a $10 \mu\text{g}/\text{cm}^2$ layer of carbon. It was mounted on a rotating wheel. Evaporation residues were separated using SHIP facility at GSI, and implanted into the detection system consisting of 16-strip position sensitive Si detectors (PSSD), a pack of six Si strip detectors (BOX) at the back to detect escaping α particles, and three time-of-flight detectors in front of PSSDs. Measured position and time correlations between evaporation residues (ER) and α events, E_α , half-lives of ground states and isomers of ^{202}Fr and ^{198}At , $\text{Er}-\alpha-\alpha$ correlations. Comparison with previous experimental results. (ER) $\alpha\alpha$ correlated events were assigned to $^{202}\text{Fr} \rightarrow ^{198}\text{At} \rightarrow ^{194}\text{Bi}$ decay chain.

Others:

2012Fo09: measured E_α , $T_{1/2}$.

1999Ta03: measured E_α , $T_{1/2}$.

1998Bo14: measured α -decay branching ratios.

1995BiZZ: measured E_α , $T_{1/2}$.

1987Wo04, 1987Wo11: measured E_α , I_α , α -anisotropy,

1980Ew03: measured E_α , α -branchings, α -reduced widths.

1975BaYJ: measured E_α , I_α , $T_{1/2}$.

1967Tr06: measured E_α , $T_{1/2}$.

 ^{194}Bi Levels

<u>E(level)[†]</u>	<u>J^π[‡]</u>
0.0	(3 ⁺)
218.2 1	(2 ⁺ , 3 ⁺ , 4 ⁺)
382.4 1	(1 to 5) ⁽⁺⁾
399.6 1	(1 to 5) ⁽⁺⁾
485.5 2	(1 to 5) ⁽⁺⁾

[†] From E_γ values.

[‡] From the Adopted Levels.

^{198}At α decay (4.46 s) 2019Gh11,1992Hu04,1996En01 (continued) α radiations

$E\alpha^\dagger$	$E(\text{level})$	$I\alpha^{\ddagger\#}$	$\text{HF}^\ddagger$	Comments
6152 11				6152 α observed in coin with 218 γ and 382 γ . 2019Gh11 tentatively propose a level in ^{194}Bi at 600 keV deexciting by a cascade of 218 and 382 γ rays. Authors stated that it remained unclear whether one of these γ rays is the same as the 218.2 or 382.4 feeding the g.s. If a level is defined at 600 keV, then 218 and/or 382 must be a doublet.
6275 8	485.5	0.08 1	43 6	Reduced α width $\delta_\alpha^2=1.6$ 3 (2019Gh11).
6359 8	399.6	0.11 1	70 7	$E\alpha$: weighted average of 6358 8 (2019Gh11) and 6360 10 (1992Hu04). $I\alpha$: other: 0.34 5 (1992Hu04). Reduced α width $\delta_\alpha^2=1.0$ 1 (2019Gh11).
6361 9	382.4	0.008 2	1.12×10^3 29	Reduced α width $\delta_\alpha^2=0.06$ 2 (2019Gh11).
6537 8	218.2	0.020 3	1.98×10^3 31	$E\alpha$: weighted average of 6535 8 (2019Gh11) and 6539 10 (1992Hu04). Reduced α width $\delta_\alpha^2=0.034$ 5 (2019Gh11).
6750 4	0.0	100	2.61 11	$E\alpha$: weighted average of 6747 5 (2014Ka23), 6749.0 34 (2012Fo09), 6748 6 (2005Uu02), 6753 4 (1996En01), 6755 4 (1992Hu04), 6747 15 (1980Ew03), 6747 5 (1967Tr06). Others: 6755 (1995BiZZ), 6724 26 (2015We13). Reduced α width $\delta_\alpha^2=26$ keV 1 (2019Gh11), 39 keV 2 (2014Ka23).

[†] From 2019Gh11, unless otherwise stated.[‡] The nuclear radius parameter $r_0(^{194}\text{Bi})=1.5187$ 42 (2020Si16) deduced from interpolation (or unweighted average) of radius parameters of the adjacent even-even nuclides, as given in 2020Si16: ^{192}Pb , ^{194}Pb , ^{194}Po , and ^{196}Po .[#] For absolute intensity per 100 decays, multiply by 0.97 3. $\gamma(^{194}\text{Bi})$

Intensities from $\alpha\gamma$ -coin data are given under comments, and are relative to 100 for I(6358 α -218.2 γ -coin) in the decay of (3^+) g.s. of ^{218}At (2019Gh11).

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [#]	δ	$\alpha^@$	Comments
218.2	($2^+, 3^+, 4^+$)	218.2 1	100	0.0	(3^+)	M1+E2	1.0 6	0.7 3	$\alpha(\text{K})\text{exp}=0.5$ 3 (2019Gh11) E_γ : see comment for unplaced 6152 α , where another 218 γ is possible, suggesting a doublet. Other: 218 1 (1992Hu04). Mult., δ : from $\alpha(\text{K})\text{exp}$ determined from intensity ratio between K x-rays and 218-keV γ rays (2019Gh11), from which evaluators deduce $\delta(\text{E2/M1})=1.0$ 6. I(6535 α -218.2 γ -coin)=21 3. I(6358 α -218.2 γ -coin)=100. I(6275 α -218.2 γ -coin)=39 5. I(6361 α -382.4 γ -coin)=9 2. I(6275 α -382.4 γ -coin)=61 7.
382.4	(1 to 5) ⁽⁺⁾	382.4 1	100	0.0	(3^+)	[M1+E2]		0.15 9	I(6361 α -382.4 γ -coin)=9 2. I(6275 α -382.4 γ -coin)=61 7.
399.6	(1 to 5) ⁽⁺⁾	181.4 1	100 12	218.2	($2^+, 3^+, 4^+$)	(M1)		1.88	Mult.: dominant M1 from intensity balance considerations of 181-218 γ cascade (2019Gh11); with possible E2 admixture. E_γ : other: 181 1 (1992Hu04). I(6358 α -181.4 γ -coin)=52 6.

Continued on next page (footnotes at end of table)

^{198}At α decay (4.46 s) [2019Gh11](#),[1992Hu04](#),[1996En01](#) (continued) $\gamma(^{194}\text{Bi})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [#]	$\alpha^\text{@}$	Comments
399.6	(1 to 5) ⁽⁺⁾	399.7 2	44 8	0.0 (3 ⁺)		[M1+E2]	0.13 8	I(6358 α -399.7 γ -coin)=23 4.
485.5	(1 to 5) ⁽⁺⁾	103.4 2	31 8	382.4 (1 to 5) ⁽⁺⁾		(E2)	7.6 17	Mult.: dominant E2 from intensity balance considerations of 103-382 γ cascade (2019Gh11); with possible M1 admixture.
		267.1 1	100 15	218.2 (2 ⁺ ,3 ⁺ ,4 ⁺)		(M1)	0.638	I(6275 α -103.4 γ -coin)=8 2.
								Mult.: dominant M1 from intensity balance considerations of 267-218 γ cascade (2019Gh11); with possible E2 admixture.
		485.8 7	15 8	0.0 (3 ⁺)		[M1+E2]	0.08 5	I(6275 α -267.1 γ -coin)=26 4. I(6275 α -485.8 γ -coin)=4 2.

[†] From [2019Gh11](#).[‡] Relative branching ratios deduced by evaluators from $\alpha\gamma$ -coin intensities from [2019Gh11](#) listed under comments.[#] Deduced by [2019Gh11](#) from intensity balance arguments.[@] 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.^x γ ray not placed in level scheme.

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Decay Scheme

Intensities: Relative photon branching from each level

