

²⁰²At ε+β⁺ decay 1998Bi06

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	F. G. Kondev	NDS 196,342 (2024)	1-Sep-2023

Parent: ²⁰²At: E=0; J^π=3⁺; T_{1/2}=184 s 1; Q(ε)=7346 29; %ε+%β⁺ decay=88 7

Parent: ²⁰²At: E=190 40; J^π=7⁺; T_{1/2}=182 s 2; Q(ε)=7346 29; %ε+%β⁺ decay=91.4 11

²⁰²At(0)-E,J^π,T_{1/2}: From Adopted Levels for ²⁰²At.

²⁰²At(0)-Q(ε): From 2021Wa16.

²⁰²At(190)-E,J^π,T_{1/2}: From Adopted Levels for ²⁰²At.

²⁰²At(190)-Q(ε): From 2021Wa16.

1998Bi06: ²⁰²At produced by on-line separation following bombardment of natural rhenium target with ²⁰Ne beam; E(²⁰Ne)=200 MeV. Detectors: Two HPGe for γ rays, one LEPS for x rays; one cooled Si(Li) (4mm thick) for conversion electrons. Measured: γ(t), X(t), ce(t), γγ(t), γX(t), γce(t) and Xce(t).

Others: 1992Hu04, 1970DaZM, 1969MoZW.

ε+β⁺ from 10⁻ state in ²⁰²At was proposed in 1990LhZX because of the observation of the 912.5 keV 6 transition depopulating the 11⁻ state in ²⁰²Po. It is not clear to the evaluator whether the population of the 11⁻ state in ²⁰²Po is a result of direct production in spallation of ²³⁸U or in ²⁰²At ε decay. No ε+β⁺ branch from the 10⁻ state in ²⁰²At was observed in 1998Bi06 and 1992Hu04.

According to 1992Hu04 at least 73% of the total ε decay comes from the 7⁺ isomer, the rest is due to the 3⁺ g.s. decay (184 s).

²⁰²Po Levels

E(level) [†]	J ^π [‡]	T _{1/2} [‡]	Comments
0	0 ⁺	44.5 min 4	
677.20 20	2 ⁺		
1248.6 3	4 ⁺		
1302.5 3	(2) ⁺		
1585.2 6			
1667.4 3	4 ⁺		
1689.5 6			
1691.5 4	6 ⁺		
1691.5+x	8 ⁺	110 ns 15	Additional information 1. E(level): From ¹⁹⁷ Au(¹¹ B,4nγ) x <40 keV. X=22 keV was suggested in 1992Hu04 based on wrong placements of 625.3γ and 603.2γ transitions. T _{1/2} : ≈100 ns was determined from the time difference spectra between 502.8γ, 526.3γ and 603.2γ (above the isomer) and 677.2γ, 571.3γ and 433.0γ keV (below the isomer) (1998Bi06).
1758.0 20	0 ⁺		
1774.4 6			
1775.3 3			
1866.2 4	5 ⁻		
2102.9 4			
2127.7 4	(6 ⁺)		
2194.30+x 20	7 ⁻ ,8 ⁻ ,9 ⁻		
2218.10+x 20	9 ⁻	≈1.5 ns	
2230.9 4	(7 ⁻)		
2254.1 4	2 ⁺ ,6 ⁺		
2282.6 4	(5 ⁻)		
2294.70+x 20	7 ⁺ ,8 ⁺ ,9 ⁺		
2345.9 6	3 ⁻ ,7 ⁻		
2485.2 5	4 ⁻ ,5 ⁻ ,6 ⁻		
2577.6 4	4 ⁺ ,8 ⁺		
2830.7+x 4			
2839.6 4			

Continued on next page (footnotes at end of table)

$^{202}\text{At } \varepsilon + \beta^+ \text{ decay } \mathbf{1998\text{Bi06}}$ (continued)

^{202}Po Levels (continued)

† From a least-square fit to $E\gamma$.

‡ From Adopted Levels.

²⁰²At ε+β⁺ decay **1998Bi06 (continued)**

γ(²⁰²Po)

I_γ normalization: Since the half-lives of the two ε decaying parent states are almost the same, it is impossible to attribute specific γ rays to one of them. The normalization factor can not be determined with the available spectroscopic information.

<u>E_γ #</u>	<u>I_γ #</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult. †</u>	<u>δ[‡]</u>	<u>α[@]</u>	<u>Comments</u>
364.7 2	3.6 5	2230.9	(7 ⁻)	1866.2	5 ⁻	E2		0.0720 10	α(K)=0.0433 6; α(L)=0.02143 30; α(M)=0.00550 8 α(N)=0.001413 20; α(O)=0.000278 4; α(P)=2.87×10 ⁻⁵ 4 Mult.: α(K)exp=0.036 5.
387.0 5	1.8 5	1689.5		1302.5	(2) ⁺				
416.5 3	2.9 3	2282.6	(5 ⁻)	1866.2	5 ⁻	M1+E2	1.03 +28-22	0.127 19	α(K)=0.099 16; α(L)=0.0212 19; α(M)=0.0051 4 α(N)=0.00132 11; α(O)=0.000271 24; α(P)=3.29×10 ⁻⁵ 35 Mult.: α(K)exp=0.09 2 and α(L)exp=0.023 3. α(K)=0.12 4; α(L)=0.024 5; α(M)=0.0057 11 α(N)=0.00146 28; α(O)=0.00030 6; α(P)=3.8×10 ⁻⁵ 9 Mult.: α(K)exp=0.12 4.
418.6 3	1.2 3	1667.4	4 ⁺	1248.6	4 ⁺	M1+E2	0.7 6	0.15 5	α(K)=0.119 30; α(L)=0.022 4; α(M)=0.0053 8 α(N)=0.00136 20; α(O)=0.00028 4; α(P)=3.6×10 ⁻⁵ 7 Mult.: α(K)exp=0.13 4.
436.3 2	1.8 6	2127.7	(6 ⁺)	1691.5	6 ⁺	M1(+E2)	≤1.0	0.149 35	α(K)=0.0285 4; α(L)=0.01102 16; α(M)=0.00279 4 α(N)=0.000717 10; α(O)=0.0001423 20; α(P)=1.527×10 ⁻⁵ 21 Mult.: α(K)=0.0288 value was used to calibrate Si(Li) detector.
443.0 2	55 4	1691.5	6 ⁺	1248.6	4 ⁺	E2		0.0432 6	α(K)=0.02414 34; α(L)=0.00852 12; α(M)=0.002148 31 α(N)=0.000552 8; α(O)=0.0001099 16; α(P)=1.197×10 ⁻⁵ 17 Mult.: α(K)exp=0.033 8.
479.7 4	1.4 4	2345.9	3 ⁻ ,7 ⁻	1866.2	5 ⁻	E2		0.0355 5	α(K)=0.00836 12; α(L)=0.001372 19; α(M)=0.000321 4 α(N)=8.20×10 ⁻⁵ 12; α(O)=1.693×10 ⁻⁵ 24; α(P)=2.104×10 ⁻⁶ 30 Mult.: α(K)exp<0.012 4.
502.8 2	2.6 7	2194.30+x	7 ⁻ ,8 ⁻ ,9 ⁻	1691.5+x	8 ⁺	(E1)		0.01015 14	No α(K)exp measured due to 525.8γ contaminant.
525.8 5	1.4 5	1774.4		1248.6	4 ⁺				
526.3 5	2.7 5	2218.10+x	9 ⁻	1691.5+x	8 ⁺				
536.0 3	0.5 3	2830.7+x		2294.70+x	7 ⁺ ,8 ⁺ ,9 ⁺				
571.3 2	87 8	1248.6	4 ⁺	677.20	2 ⁺	E2		0.02355 33	α(K)=0.01690 24; α(L)=0.00500 7; α(M)=0.001246 17 α(N)=0.000320 4; α(O)=6.43×10 ⁻⁵ 9; α(P)=7.23×10 ⁻⁶ 10

$^{202}\text{At } \varepsilon+\beta^+$ decay **1998Bi06** (continued)

$\gamma(^{202}\text{Po})$ (continued)

E_γ #	I_γ #	E_i (level)	J_i^π	E_f	J_f^π	Mult. †	δ^\ddagger	$\alpha^@$	Comments
591.0 2	0.8 4	2282.6	(5 ⁻)	1691.5	6 ⁺				Mult.: $\alpha(\text{K})=0.0172$ and $\alpha(\text{L})=0.00514$ values were used to calibrate Si(Li) detector.
603.2 2	17.2 8	2294.70+x	7 ⁺ ,8 ⁺ ,9 ⁺	1691.5+x	8 ⁺	M1+E2	0.39 +14-17	0.070 5	$\alpha(\text{K})=0.057$ 4; $\alpha(\text{L})=0.0100$ 6; $\alpha(\text{M})=0.00236$ 13 $\alpha(\text{N})=0.000607$ 35; $\alpha(\text{O})=0.000127$ 7; $\alpha(\text{P})=1.63\times 10^{-5}$ 10 Mult.: $\alpha(\text{K})_{\text{exp}}=0.057$ 4.
617.6 3	14.8 5	1866.2	5 ⁻	1248.6	4 ⁺	E1		0.00670 9	$\alpha(\text{K})=0.00554$ 8; $\alpha(\text{L})=0.000892$ 13; $\alpha(\text{M})=0.0002081$ 29 $\alpha(\text{N})=5.33\times 10^{-5}$ 7; $\alpha(\text{O})=1.102\times 10^{-5}$ 15; $\alpha(\text{P})=1.383\times 10^{-6}$ 19 Mult.: $\alpha(\text{K})_{\text{exp}}=0.0060$ 6.
619.0 3	1.2 5	2485.2	4 ⁻ ,5 ⁻ ,6 ⁻	1866.2	5 ⁻	M1		0.0725 10	$\alpha(\text{K})=0.0592$ 8; $\alpha(\text{L})=0.01015$ 14; $\alpha(\text{M})=0.002386$ 34 $\alpha(\text{N})=0.000614$ 9; $\alpha(\text{O})=0.0001286$ 18; $\alpha(\text{P})=1.664\times 10^{-5}$ 23 Mult.: $\alpha(\text{K})_{\text{exp}}=0.06$ 2.
625.3 2	3.6 5	1302.5	(2) ⁺	677.20	2 ⁺	M1+E2	1.8 +7-4	0.031 5	$\alpha(\text{K})=0.024$ 4; $\alpha(\text{L})=0.0053$ 6; $\alpha(\text{M})=0.00128$ 14 $\alpha(\text{N})=0.00033$ 4; $\alpha(\text{O})=6.7\times 10^{-5}$ 8; $\alpha(\text{P})=8.1\times 10^{-6}$ 11 Mult.: $\alpha(\text{K})_{\text{exp}}=0.024$ 4.
677.2 2	100	677.20	2 ⁺	0	0 ⁺	E2		0.01620 23	$\alpha(\text{K})=0.01210$ 17; $\alpha(\text{L})=0.00310$ 4; $\alpha(\text{M})=0.000763$ 11 $\alpha(\text{N})=0.0001960$ 27; $\alpha(\text{O})=3.97\times 10^{-5}$ 6; $\alpha(\text{P})=4.59\times 10^{-6}$ 6 Mult.: $\alpha(\text{K})=0.0122$ and $\alpha(\text{L})=0.00314$ values were used to calibrate Si(Li) detector.
854.3 3	0.7 4	2102.9		1248.6	4 ⁺				
878.8 3	2.1 5	2127.7	(6) ⁺	1248.6	4 ⁺	E2		0.00948 13	$\alpha(\text{K})=0.00737$ 10; $\alpha(\text{L})=0.001596$ 22; $\alpha(\text{M})=0.000386$ 5 $\alpha(\text{N})=9.92\times 10^{-5}$ 14; $\alpha(\text{O})=2.028\times 10^{-5}$ 28; $\alpha(\text{P})=2.435\times 10^{-6}$ 34 Mult.: $\alpha(\text{K})_{\text{exp}}=0.006$ 2.
886.1 2	0.8 2	2577.6	4 ⁺ ,8 ⁺	1691.5	6 ⁺	E2		0.00932 13	$\alpha(\text{K})=0.00726$ 10; $\alpha(\text{L})=0.001564$ 22; $\alpha(\text{M})=0.000378$ 5 $\alpha(\text{N})=9.72\times 10^{-5}$ 14; $\alpha(\text{O})=1.988\times 10^{-5}$ 28; $\alpha(\text{P})=2.389\times 10^{-6}$ 33 Mult.: $\alpha(\text{K})_{\text{exp}}=0.009$ 3.
908.0 5	0.7 2	1585.2		677.20	2 ⁺				
990.4 3	1.3 3	1667.4	4 ⁺	677.20	2 ⁺	E2		0.00749 11	$\alpha(\text{K})=0.00591$ 8; $\alpha(\text{L})=0.001204$ 17; $\alpha(\text{M})=0.000289$ 4 $\alpha(\text{N})=7.43\times 10^{-5}$ 10; $\alpha(\text{O})=1.526\times 10^{-5}$ 21; $\alpha(\text{P})=1.858\times 10^{-6}$ 26 Mult.: $\alpha(\text{K})_{\text{exp}}=0.006$ 2.
1005.5 2	1.1 3	2254.1	2 ⁺ ,6 ⁺	1248.6	4 ⁺	E2		0.00728 10	$\alpha(\text{K})=0.00575$ 8; $\alpha(\text{L})=0.001163$ 16; $\alpha(\text{M})=0.000279$ 4 $\alpha(\text{N})=7.17\times 10^{-5}$ 10; $\alpha(\text{O})=1.474\times 10^{-5}$ 21; $\alpha(\text{P})=1.797\times 10^{-6}$ 25 Mult.: $\alpha(\text{K})_{\text{exp}}=0.005$ 2.
1034.2 3	0.6 3	2282.6	(5 ⁻)	1248.6	4 ⁺				
1098.1 2	1.1 3	1775.3		677.20	2 ⁺				
1148.1 2	0.7 2	2839.6		1691.5	6 ⁺				

$^{202}\text{At } \varepsilon+\beta^+$ decay [1998Bi06](#) (continued)

$\gamma(^{202}\text{Po})$ (continued)

<u>E_γ</u> [#]	<u>E_i</u> (level)	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u> [†]	Comments
1758 2	1758.0	0 ⁺	0	0 ⁺	E0	Ice=0.00013 3 relative to $I_\gamma(677.2)$. No 1758 γ ray observed.

[†] From $\alpha(\text{K})\text{exp}$ and $\alpha(\text{L})\text{exp}$ data of [1998Bi06](#), except for the 443 γ , 571 γ and 677 γ transitions that were used for calibration.

[‡] From $\alpha(\text{K})\text{exp}$ and $\alpha(\text{L})\text{exp}$ using the briccmixing program.

[#] From [1998Bi06](#).

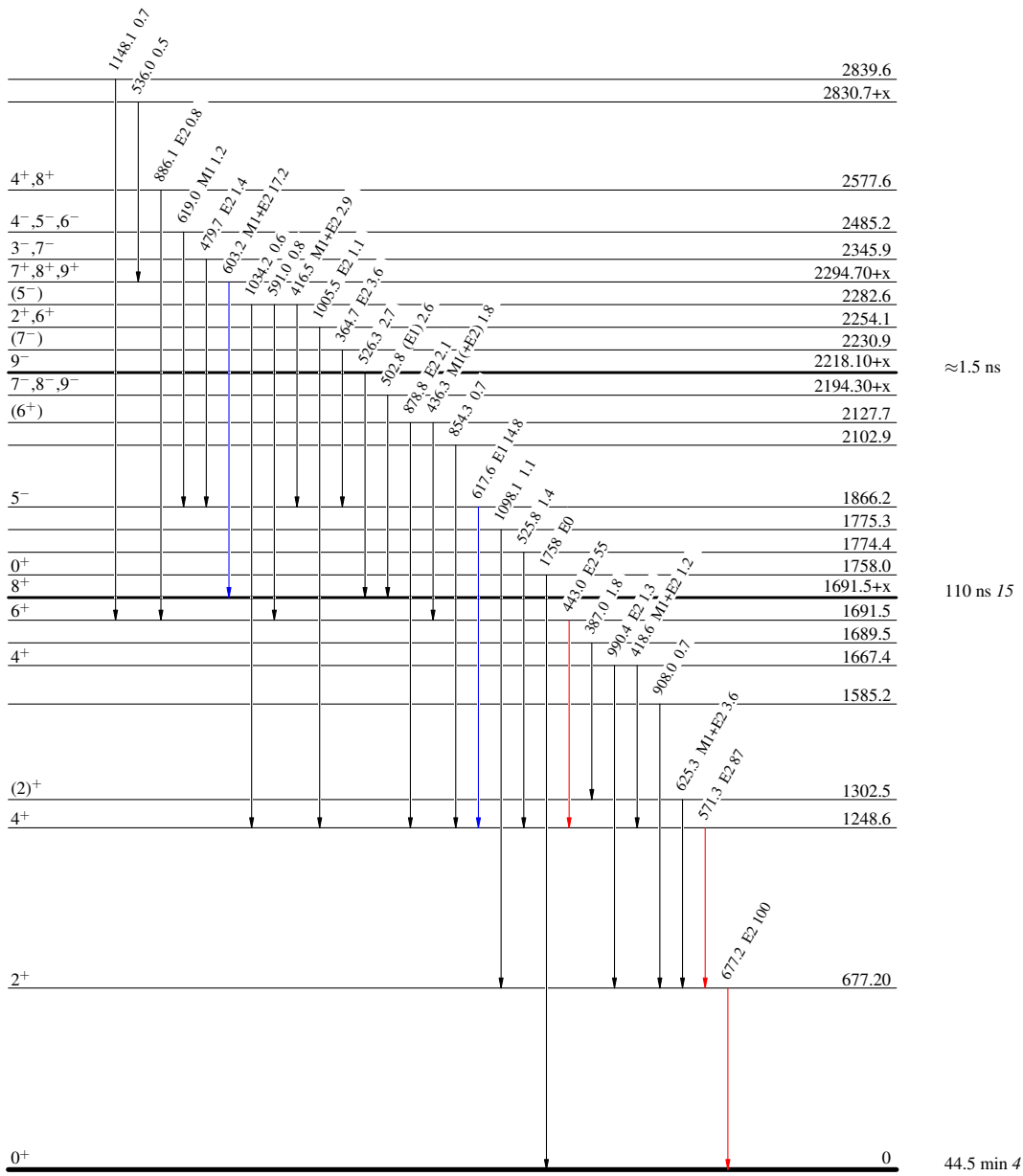
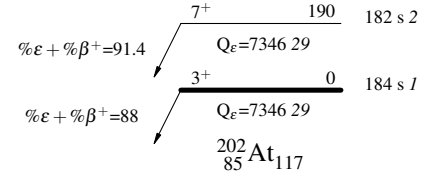
[@] [Additional information 2](#).

^{202}At ϵ decay 1998Bi06

Decay Scheme

- Legend
- \longrightarrow $I_\gamma < 2\% \times I_\gamma^{\text{max}}$
 - \longrightarrow (blue) $I_\gamma < 10\% \times I_\gamma^{\text{max}}$
 - \longrightarrow (red) $I_\gamma > 10\% \times I_\gamma^{\text{max}}$

Intensities: Relative I_γ



$^{202}_{84}\text{Po}_{118}$