# $^{188}$Tl ε decay 1984Co17,1976Bo04

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | F. G. Kondev, S. Juutinen, D. J. Hartley | NDS 150, 1 (2018) | 1-Feb-2018 |

Parent: $^{188}$Tl: E=0; $J^\pi=(2^-)$; $T_{1/2}$=71 s *2*; Q(ε)=7866 *32*; %ε+%$β^+$ decay=100.0

Parent: $^{188}$Tl: E=35 *31*; $J^\pi=7^+$; $T_{1/2}$=71.5 s *15*; Q(ε)=7866 *32*; %ε+%$β^+$ decay=100.0

1984Co17 (also 1978CoYZ,1976Ha25,1975Ha27,1975BoYT,1974Ha10 from the same group) produced $^{188}$Tl source by $^{181}$Ta($^{16}$O,9n) reaction. Measured: γ, γγ, ce, γce.

1976Bo04 produced $^{188}$Tl by $^{197}$Au($^3$He,12n) E=207 MeV. Measured: γ, γγ, ce, γce, γγ(θ).

Others: 1970Va27, 1974Pr13, 1976KeZO, 1976Ha25, 1994Jo13.

## $^{188}$Hg Levels

| E(level)† | $J^\pi$‡ | $T_{1/2}$ | Comments |
|---|---|---|---|
| 0.0 | $0^+$ | | |
| 412.91 *8* | $2^+$ | | |
| 824.50 *20* | $0^+$ | 204 ps *45* | $T_{1/2}$: from βγγ(t) in 1994Jo13. |
| 881.10 *8* | $2^+$ | 141 ps *31* | $T_{1/2}$: from βγγ(t) in 1994Jo13. |
| 1004.89 *10* | $4^+$ | | |
| 1207.92 *9* | $4^+$ | | |
| 1239.64 *10* | $(4)^+$ | | |
| 1455.19 *9* | $3^+$ | | |
| 1509.18 *10* | $6^+$ | | |
| 1718.90?# *13* | $(1,2,3)^-$ | | |
| 1774.67?# *12* | $(3,4,5)^+$ | | |
| 1777.23 *11* | $6^+$ | | |
| 1890.43?# *12* | $4^+$ | | |
| 1907.82 *12* | $4^+,5^+$ | | |
| 1909.66 *12* | $5^-$ | | |
| 1969.88 *14* | $8^+$ | | |
| 2077.00?# *19* | $(3,4)^-$ | | |
| 2136.40 *12* | $(5,6)^+$ | | |
| 2201.37 *12* | $7^-$ | | $J^\pi$: 1984Co17 suggest $J^\pi=(4\text{-}6)^+$, based on E1 assignment to 292γ. But the ce data of 1976Bo04 and γ(θ), γ(lin pol) data in (HI,xnγ) support mult=E2 for 292γ, thus giving $J^\pi=7^-$. |
| 2249.9?# *5* | $(6^+)$ | | |
| 2274.2?# *5* | | | |
| 2295.41 *14* | $(6)^-$ | | |
| 2350.89?# *15* | $(4,5,6)^+$ | | |
| 2422.48 *13* | $8^+$ | | |
| 2448.99?# *15* | $8^-$ | | |
| 2470.77?# *16* | $9^-$ | | |
| 2489.7?# *5* | $10^+$ | | |
| 2566.99?# *14* | | | |
| 2680.9?# *5* | $(6^+,7,8^+)$ | | |

† From least-squares fit to Eγ.

‡ From Adopted Levels.

# Level proposed by 1976Bo04 only, not confirmed by 1984Co17.

## $^{188}$Tl ε decay 1984Co17,1976Bo04 (continued)

### γ($^{188}$Hg)

The data represent a mixture between decays of the (2$^-$) ground state and the 7$^+$ isomer in $^{188}$Tl. The decay scheme is incomplete (pandemonium), and hence no log *ft* values and gamma-ray normalization per 100 decays of the parent nuclide were carried out.

| $E_\gamma$[†] | $I_\gamma$[‡] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult.[#] | Comments |
|---|---|---|---|---|---|---|---|
| [x]146.8[@] *4* | 0.6 *1* | | | | | | |
| 153.9[@] *4* | 1.1 *1* | 2448.99? | 8$^-$ | 2295.41 | (6)$^-$ | | |
| 167.3[@] *4* | 0.5 *1* | 2077.00? | (3,4)$^-$ | 1909.66 | 5$^-$ | | |
| 203.2 *2* | 1.3 *1* | 1207.92 | 4$^+$ | 1004.89 | 4$^+$ | M1(+E2) | Mult.: α(K)exp=0.99 *5* (1976Ha25), 0.99 *11* (1984Co17). |
| 215.7 *1* | 0.60 *10* | 1455.19 | 3$^+$ | 1239.64 | (4)$^+$ | | |
| 247.6[a] *1* | 1.9[a] *1* | 1455.19 | 3$^+$ | 1207.92 | 4$^+$ | E2+M1 | Mult.: From α(K)exp=0.13 *2* (1984Co17); other δ=0.9 *4* using α(K)exp=0.33 *8* (1976Bo04). |
| 247.6[a] *1* | 1.9[a] *1* | 2448.99? | 8$^-$ | 2201.37 | 7$^-$ | | |
| 269.4[a] *1* | 1.4[a] *1* | 1509.18 | 6$^+$ | 1239.64 | (4)$^+$ | | |
| 269.4[a] *1* | 1.4[a] *1* | 2470.77? | 9$^-$ | 2201.37 | 7$^-$ | | |
| 280.0[@] *4* | 0.6 *1* | 2249.9? | (6$^+$) | 1969.88 | 8$^+$ | | |
| [x]281.5[&] *1* | 0.80 *8* | | | | | | $E_\gamma$: May be the same as 280.0 from 1976Bo04. |
| 291.7 *1* | 4.0 *3* | 2201.37 | 7$^-$ | 1909.66 | 5$^-$ | E2 | Mult.: E2 from α(K)exp=0.066 *16* (1976Bo04). α(K)exp=0.021 *5* (1984Co17) suggests E1. |
| 301.2 *1* | 5.5 *3* | 1509.18 | 6$^+$ | 1207.92 | 4$^+$ | E2 | Mult.: α(K)exp=0.071 *18* (1976Bo04), 0.083 *15* (1984Co17). |
| 326.9 *1* | 10.7 *5* | 1207.92 | 4$^+$ | 881.10 | 2$^+$ | E2 | Mult.: α(K)exp=0.049 *7* (1976Bo04), 0.040 *4* (1984Co17). |
| 381.5[@] *4* | 0.5 *1* | 1890.43? | 4$^+$ | 1509.18 | 6$^+$ | | |
| 385.8 *1* | 3.7 *3* | 2295.41 | (6)$^-$ | 1909.66 | 5$^-$ | E2+M1 | Mult.: α(K)exp=0.038 *10* (1976Bo04), 0.036 *9* (1984Co17). |
| [x]387.5 *2* | 0.30 *5* | | | | | | |
| 387.5[&] *2* | 0.30 *5* | 2295.41 | (6)$^-$ | 1907.82 | 4$^+$,5$^+$ | | |
| 398.2[&] *2* | 0.60 *6* | 1907.82 | 4$^+$,5$^+$ | 1509.18 | 6$^+$ | | |
| 412.9 *1* | 100 *5* | 412.91 | 2$^+$ | 0.0 | 0$^+$ | E2 | Mult.: α(K)exp=0.030 *7* (1976Bo04), 0.031 *3* (1984Co17); α(L)exp=0.009 *2* (1984Co17). |
| [x]417.9[&] *1* | 1.1 *1* | | | | | E2+M1 | Mult.: α(K)exp=0.03 *1* (1984Co17). |
| 424.1 *1* | 3.9 *3* | 2201.37 | 7$^-$ | 1777.23 | 6$^+$ | E1 | Mult.: a(K)exp=0.013 *3* (1976Bo04), 0.020 *10* (1984Co17). |
| 443.1 *1* | 1.9 *2* | 2350.89? | (4,5,6)$^+$ | 1907.82 | 4$^+$,5$^+$ | E2+M1 | Mult.: α(K)exp=0.032 *7* (1984Co17). |
| [x]445.9[&] *1* | 1.0 *1* | | | | | | |
| 450.3 *1* | 0.50 *5* | 1455.19 | 3$^+$ | 1004.89 | 4$^+$ | M1+E2 | Mult.: α(K)exp=0.068 *14* (1984Co17). |
| 452.7 *1* | 2.8 *2* | 1907.82 | 4$^+$,5$^+$ | 1455.19 | 3$^+$ | E2(+M1) | Mult.: α(K)exp=0.029 *5* (1984Co17). |
| 460.7 *1* | 8.2 *5* | 1969.88 | 8$^+$ | 1509.18 | 6$^+$ | E2 | Mult.: α(K)exp=0.014 *4* (1984Co17). |
| 468.2 *1* | 5.7 *3* | 881.10 | 2$^+$ | 412.91 | 2$^+$ | M1+E2 | Mult.: α(K)exp=0.085 *21* (1976Bo04), 0.087 *5* (1984Co17); α(L)exp=0.013 *4* (1984Co17). |
| 478.9[@b] *4* | 0.8 *1* | 2448.99? | 8$^-$ | 1969.88 | 8$^+$ | | $E_\gamma$: 1984Co17 assign this line to $^{188}$Au ε decay. |
| 499.5[@b] *4* | 1.1 *1* | 2274.2? | | 1774.67? | (3,4,5)$^+$ | | $E_\gamma$: 1984Co17 assign this line to $^{188}$Au ε decay. |
| 504.3 *1* | 26.5 *16* | 1509.18 | 6$^+$ | 1004.89 | 4$^+$ | E2 | Mult.: α(K)exp=0.017 *3* (1976Bo04), 0.019 *2* (1984Co17), α(L)exp=0.0048 *8* (1984Co17). |
| 519.8[@] *4* | 0.45 *5* | 2489.7? | 10$^+$ | 1969.88 | 8$^+$ | | |
| 535.0 *1* | 1.3 *1* | 1774.67? | (3,4,5)$^+$ | 1239.64 | (4)$^+$ | M1 | Mult.: α(K)exp=0.013 *4* (1984Co17). |
| 569.3 *1* | 3.9 *3* | 1777.23 | 6$^+$ | 1207.92 | 4$^+$ | E2 | Mult.: α(K)exp=0.017 *4* (1984Co17), α(L)exp=0.0036 *9* (1976Bo04). |
| 574.0 *1* | 4.5 *3* | 1455.19 | 3$^+$ | 881.10 | 2$^+$ | E2+M1 | Mult.: α(K)exp=0.024 *4* (1984Co17), 0.022 *5* (1976Bo04). |

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## $^{188}$Tl ε decay 1984Co17,1976Bo04 (continued)

### γ($^{188}$Hg) (continued)

| $E_\gamma$[†] | $I_\gamma$[‡] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult.[#] | Comments |
|---|---|---|---|---|---|---|---|
| ≈574[@ b] | | 2350.89? | $(4,5,6)^+$ | 1777.23 | $6^+$ | | |
| 592.1 *1* | 69 *3* | 1004.89 | $4^+$ | 412.91 | $2^+$ | E2 | Mult.: From adopted gammas. Used for normalization of the ce data. |
| 622.0 *2* | 0.70 *7* | 2077.00? | $(3,4)^-$ | 1455.19 | $3^+$ | E1 | Mult.: α(K)exp<0.006 (1976Bo04). |
| 627.2 *1* | 1.7 *1* | 2136.40 | $(5,6)^+$ | 1509.18 | $6^+$ | E2+M1 | Mult.: α(K)exp=0.029 *7* (1976Bo04), 0.019 *7* (1984Co17). |
| 645.6 *2* | 2.4 *2* | 2422.48 | $8^+$ | 1777.23 | $6^+$ | E2 | Mult.: α(K)exp=0.015 *4* (1976Bo04), 0.023 *9* (1984Co17). |
| 682.8[@ b] *4* | 0.2 *1* | 1890.43? | $4^+$ | 1207.92 | $4^+$ | | |
| 692.3 *2* | 2.5 *2* | 2201.37 | $7^-$ | 1509.18 | $6^+$ | E1 | Mult.: α(K)exp≤0.005 (1976Bo04) gives E1, whereas α(K)exp=0.0093 *35* (1984Co17) gives E2. |
| 700.1 *2* | 3.3 *3* | 1907.82 | $4^+,5^+$ | 1207.92 | $4^+$ | E2+M1 | Mult.: α(K)exp=0.015 *5* (1976Bo04), 0.019 *3* (1984Co17). |
| 701.7 *2* | 0.9 *2* | 1909.66 | $5^-$ | 1207.92 | $4^+$ | | |
| 711.0[@] *4* | 0.2 *1* | 2680.9? | $(6^+,7,8^+)$ | 1969.88 | $8^+$ | | |
| [x]714.1 *2* | 0.40 *5* | | | | | (E0+M1+E2) | Mult.: α(K)exp=0.17 *3* (1984Co17). Other: >0.3 (1976Bo04). |
| [x]745.7[&] *2* | 0.50 *6* | | | | | | |
| [x]764.6 *1* | 0.80 *8* | | | | | (E0+M1+E2) | Mult.: α(K)exp=0.052 *13* (1976Bo04). |
| 769.8 *1* | 2.0 *2* | 1774.67? | $(3,4,5)^+$ | 1004.89 | $4^+$ | M1(+E2) | Mult.: α(K)exp=0.029 *7* (1976Bo04). |
| 772.4 *1* | 13.5 *6* | 1777.23 | $6^+$ | 1004.89 | $4^+$ | E2 | Mult.: α(K)exp=0.0085 *13* (1976Bo04), 0.0065 *11* (1984Co17), α(L)exp=0.0021 *3* and K/L=4.1 *8* (1976Bo04). |
| 789.8[@] *4* | 0.5 *1* | 2566.99? | | 1777.23 | $6^+$ | | |
| 795.2 *1* | 11.3 *6* | 1207.92 | $4^+$ | 412.91 | $2^+$ | E2 | Mult.: α(K)exp=0.0073 *8* (1984Co17), 0.0078 *12*, α(L)exp=0.0020 *3*, and K/L=3.9 *8* (1976Bo04). |
| [x]804.6[@] *4* | 0.6 *1* | | | | | | |
| 824.5 *2* | | 824.50 | $0^+$ | 0.0 | $0^+$ | E0 | $\rho^2$=0.0077 *+22−32* (1994Jo13).<br>$E_\gamma$: from ce data (1984Co17).<br>I(γ+ce)=0.31 *3*, deduced from ce(K)(824)/ce(K)(413γ)=0.080 *9*, ce(L)(824)/ce(K)(413γ)= 0.017 *2* (1984Co17). Other: ≥58% (1994Jo13).<br>Mult.: from α(K)exp>1.3 *1* (1984Co17), >1.3 and α(L)exp>0.22 (1976Bo04). |
| 826.7 *1* | 2.7 *2* | 1239.64 | $(4)^+$ | 412.91 | $2^+$ | (E2) | Mult.: α(K)exp=0.018 *5* (1984Co17) consistent with both M1 and E2, but the latter agrees with the decay scheme. |
| [x]835.1[@] *4* | 0.8 *1* | | | | | M1(+E2) | Mult.: α(K)exp=0.0075 *19* (1976Bo04). |
| 837.8 *1* | 1.3 *1* | 1718.90? | $(1,2,3)^-$ | 881.10 | $2^+$ | E1 | Mult.: α(K)exp=0.0035 *20* (1976Bo04). |
| 841.2[@] *4* | 1.8 *2* | 2350.89? | $(4,5,6)^+$ | 1509.18 | $6^+$ | | |
| [x]873.9[&] *1* | 0.6 *1* | | | | | | |
| 881.1 *1* | 8.6 *11* | 881.10 | $2^+$ | 0.0 | $0^+$ | E2 | Mult.: α(K)exp=0.0061 *15* (1976Bo04), 0.0065 *7* (1984Co17). |
| 885.1[@] *4* | 0.85 *9* | 1890.43? | $4^+$ | 1004.89 | $4^+$ | (M1) | Mult.: α(K)exp≈0.04 (1976Bo04). |
| 904.8 *1* | 12.3 *7* | 1909.66 | $5^-$ | 1004.89 | $4^+$ | E1 | Mult.: α(K)exp=0.0027 *4* (1976Bo04), 0.0020 *3* (1984Co17). |
| 913.2 *1* | 0.3 *1* | 2422.48 | $8^+$ | 1509.18 | $6^+$ | | |
| 928.5 *1* | 1.6 *1* | 2136.40 | $(5,6)^+$ | 1207.92 | $4^+$ | | |
| [x]948.0[&] *1* | 0.5 *1* | | | | | E1,E2 | Mult.: α(K)exp=0.0047 *24* (1984Co17). |
| 1009.8[@] *4* | 0.2 *1* | 1890.43? | $4^+$ | 881.10 | $2^+$ | | |
| 1042.0 *1* | 3.5 *2* | 1455.19 | $3^+$ | 412.91 | $2^+$ | E2+M1 | Mult.: α(K)exp=0.0047 *24* (1984Co17). |

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## $^{188}$Tl ε decay 1984Co17,1976Bo04 (continued)

### γ($^{188}$Hg) (continued)

| $E_\gamma$ [†] | $I_\gamma$ [‡] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Comments |
|---|---|---|---|---|---|---|
| 1057.8 *1* | 1.1 *1* | 2566.99? | | 1509.18 | $6^+$ | |
| 1071.4[@] *4* | 0.3 *1* | 2077.00? | $(3,4)^-$ | 1004.89 | $4^+$ | |
| 1170.5[@b] *4* | 2.4 *3* | 2680.9? | $(6^+,7,8^+)$ | 1509.18 | $6^+$ | $E_\gamma$: 1984Co17 assign this line to $^{188}$Au ε decay. |
| [x]1239.2[@b] *4* | 0.4 *1* | | | | | $E_\gamma$: Placement with the 1239-keV level in 1976Bo04 seems incorrect. |
| [x]1272.6 *1* | 0.9 *1* | | | | | |
| 1306.1[@b] *4* | 1.0 *1* | 1718.90? | $(1,2,3)^-$ | 412.91 | $2^+$ | $E_\gamma$: 1984Co17 assign this line to $^{188}$Au ε decay. |
| [x]1445.6[&] *1* | 1.1 *1* | | | | | |
| 1477.5 *1* | 1.0 *1* | 1890.43? | $4^+$ | 412.91 | $2^+$ | |

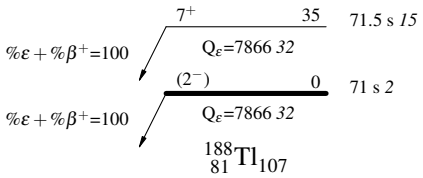
[†] From 1984Co17, unless otherwise stated.
[‡] For combined activity from 1984Co17, unless otherwise stated.
[#] From ce data of 1984Co17 and 1976Bo04. 592γ is assumed to be a pure E2 and used for normalization of the data.
[@] Reported by 1976Bo04 only.
[&] Reported by 1984Co17 only.
[a] Multiply placed with undivided intensity.
[b] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

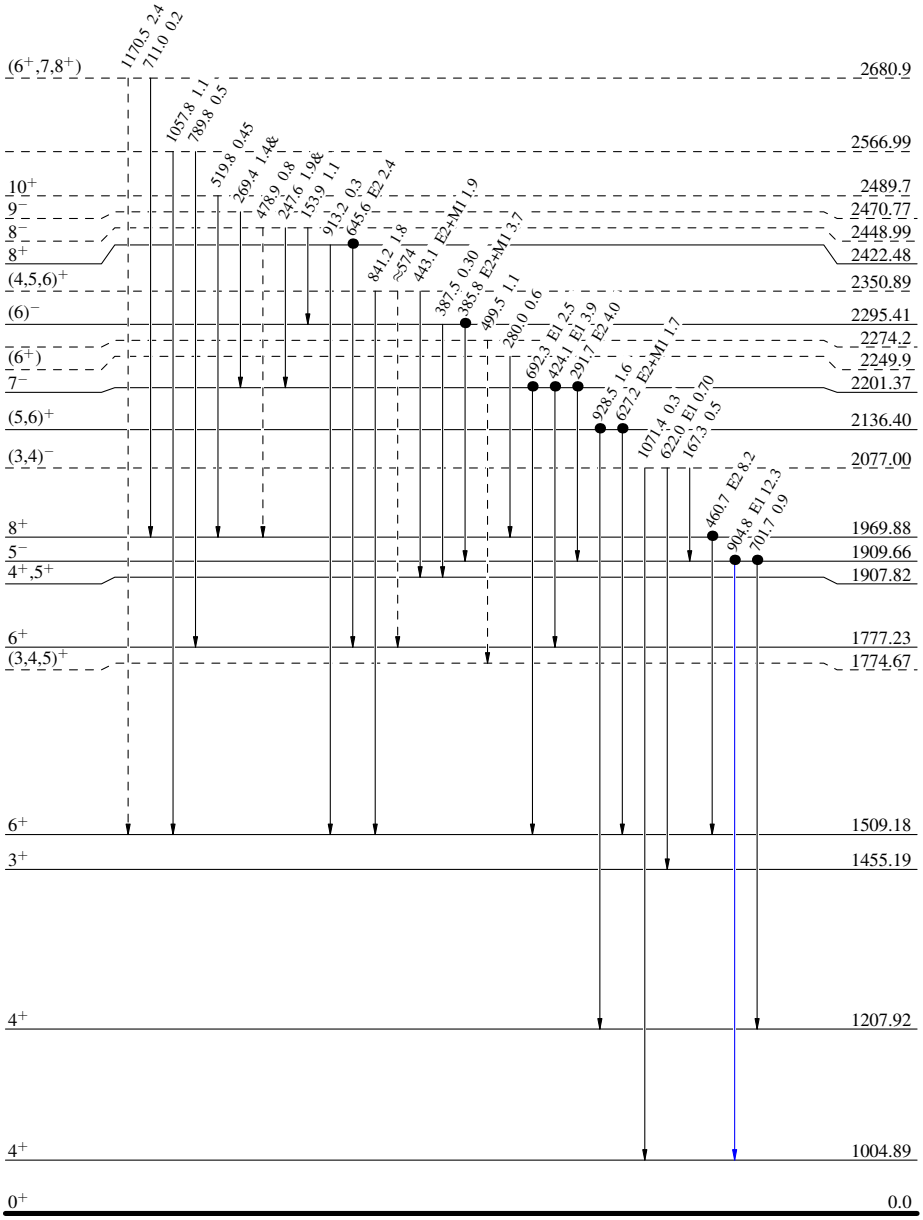
## $^{188}$Tl ε decay 1984Co17,1976Bo04

### Decay Scheme

Intensities: Relative $I_\gamma$
& Multiply placed: undivided intensity given

Legend
- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)
- Coincidence




$^{188}_{80}Hg_{108}$

## $^{188}$Tl ε decay 1984Co17,1976Bo04

### Decay Scheme (continued)

Intensities: Relative $I_\gamma$
& Multiply placed: undivided intensity given