## $^{238}$Pu α decay 1984Bo41,1970Ba72

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | E. Browne, J. K. Tuli | NDS 108, 681 (2007) | 1-Jun-2006 |

Parent: $^{238}$Pu: E=0.0; $J^\pi=0^+$; $T_{1/2}$=87.7 y *1*; Q(α)=5593.20 *19*; %α decay=100.0

Additional information 1.

Q(α): From 2003Au03. Q(α)=5593.03 *20* from Eα(to g.s.)=5499.03 *20* (1991Ry01).

For systematics of α decay to rotational states see 2006De05.

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γγ: (100γ)(K x ray, 151γ), (151γ)(203γ)          (1955Pe57)
Ag(θ):  (α)(43γ)(θ)                              (1954Mi53)
Ag(θ,H): deduced hyperfine field for U in Fe      (1971An01)
Ag(t):   (α)(ce 43γ)(t)  T1/2=0.266 Ns 20        (1960Be25)
                         T1/2=0.252 Ns 7        (1970To08)
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### $^{234}$U Levels

| E(level)†‡ | Jπ‡ | $T_{1/2}$ | E(level)†‡ | Jπ‡ |
|---|---|---|---|---|
| 0.0 | $0^+$ | | 851.74 *3* | $2^+$ |
| 43.4981 *10* | $2^+$ | 0.252 ns *7* | 926.720 *15* | $2^+$ |
| 143.352 *4* | $4^+$ | | 947.64 *6* | $4^+$ |
| 296.072 *4* | $6^+$ | | 989.430 *13* | $2^-$ |
| 497.04 *3* | $8^+$ | | 1023.9 *3* | $3^-$ & $4^+$ |
| 786.288 *16* | $1^-$ | | 1044.536 *23* | $0^+$ |
| 809.907 *18* | $0^+$ | | 1085.26 *4* | $2^+$ |
| 849.266 *18* | $3^-$ | | | |

† Deduced by the evaluators from a least-squares fit to γ-ray energies.

‡ Adopted values.

### α radiations

| Eα† | E(level) | Iα‡& | HF@ | Comments |
|---|---|---|---|---|
| ≈4579[a] | | $2\times10^{-5}$ | | |
| (4430.7# *4*) | 1085.26 | $\approx1.1\times10^{-6}$ | ≈3.8 | Iα: Iα=$8.5\times10^{-7}$% *7*, deduced by the evaluators from γ-ray transition intensity balance. |
| (4470.8# *3*) | 1044.536 | $1.2\times10^{-6}$ *2* | 7.3 | Iα: Iα=$1.09\times10^{-6}$% *8*, deduced by the evaluators from γ-ray transition intensity balance. |
| (4491.1# *3*) | 1023.9 | | | Iα: Iα=$1.6\times10^{-7}$% *4*, deduced by the evaluators from γ-ray transition intensity balance. |
| (4524.9# *4*) | 989.430 | $\leq1.3\times10^{-7}$ | ≥179 | Additional information 2. |
| (4565.8# *3*) | 947.64 | $2.5\times10^{-7}$ *8* | 192 | Iα: Deduced by the evaluators from γ-ray transition intensity balance. |
| ≈4590 | 926.720 | $1.2\times10^{-5}$ | 5.7 | Eα=4587.88 *25* from E(level)=926.72 *15* and Q(α)=5593.03 *20*.<br>Iα: From 1970Ba72.<br>Iα: Iα=$1.39\times10^{-6}$% *7*, deduced by the evaluators from γ-ray transition intensity balance. |
| 4661 | 851.74 | $5.93\times10^{-6}$ *23* | 42 | Eα=4661.64 *23* from E(level)=851.70 *10* and Q(α)=5590.03 *20*.<br>Iα: Deduced by the evaluators from γ-ray transition intensity balance. |
| (4662.6# *4*) | 849.266 | $0.9\times10^{-7}$ *4* | 2850 | Iα: Iα=$1.1\times10^{-7}$% *4*, deduced by the evaluators from γ-ray transition intensity balance. |
| 4704 | 809.907 | $5\times10^{-5}$ | 10 | Eα=4702.75 *21* from E(level)=809.89 *3* and Q(α)=5590.03 *20*. |

Continued on next page (footnotes at end of table)

## $^{238}$Pu α decay 1984Bo41,1970Ba72 (continued)

α radiations (continued)

| Eα[†] | E(level) | Iα[‡&] | HF[@] | Comments |
|---|---|---|---|---|
| | | | | Iα: from 1970Ba72. 1963Bj03 obtained Iα=12×10$^{-4}$% *4* by αγ, (α)(ce) coincidence and attributed it to total alpha-particle population to β band.<br>Iα: Iα=2.24×10$^{-5}$% *21*, deduced by the evaluators from γ-ray transition intensity balance. |
| 4724 | 786.288 | 2.2×10$^{-5}$ | 33 | Eα=4725.96 *21* from E(level)=786.28 *3* and Q(α)=5590.03 *20*.<br>Iα: From 1970Ba72.<br>Iα: Iα=8.4×10$^{-6}$% *4*, deduced by the evaluators from γ-ray transition intensity balance. |
| ≈5015 | 497.04 | 6.8×10$^{-6}$ *4* | 1.01×10$^{4}$ | Eα=5010.34 *21* from E(level)=497.04 *4* and Q(α)=5593.03 *20*.<br>Iα: Deduced by the evaluators from γ-ray transition intensity balance. Iα≈4×10$^{-6}$ was measured by 1970Ba72. |
| 5205.6 | 296.072 | 0.0030 *1* | 427 | Eα=5207.93 *21* from E(level)=296.071 *4* and Q(α)=5593.03 *20*.<br>Iα: Iα=0.00294% 7, deduced by the evaluators from γ-ray transition intensity balance.<br>Iα: other measured intensities: 0.005 *1* (1957Ko33), 0.0018 (1970Ba72), 0.0036 *5* (1984Ah06). |
| 5357.7 | 143.352 | 0.105 *5* | 101 | Eα=5358.09 *21* from E(level)=143.351 *4* and Q(α)=5593.03 *20*.<br>Iα: Iα=0.103% 4, deduced by the evaluators from γ-ray transition intensity balance.<br>Iα: other measured intensities are 0.13 *1* (1957Ko33), 0.068 (1970Ba72), 0.1 (1971So15), 0.106 *3* (1984Ah06). |
| 5456.3 *3* | 43.4981 | 28.98 *10* | 1.4 | Eα: recommended in 1991Ry01 from measured energies of Eα=5456.1 (1970Ba72) and Eα=5456.3 *4* (1971Gr17).<br>Iα: Iα=28.1% 11, deduced by the evaluators from γ-ray transition intensity balance.<br>Iα: other measured intensities are: 28 (1954As07), 28.7 *12* (1957Ko33), 27.8 (1970Ba72), 29.3 *2* (1971So15), 29.0 *1* (1984Ah06), 28.6 *4* (1987Bo25). |
| 5499.03 *20* | 0.0 | 70.91 *10* | 1.0 | Eα: recommended in 1991Ry01 from measured energies of Eα=5499.2 (1970Ba72) and Eα=5599.0 *2* (1971Gr17).<br>Iα: Iα=71.8% 11, deduced by the evaluators from γ-ray transition intensity balance.<br>Iα: other measured intensities are: 72 (1954As07); 71.1 *12* (1957Ko33); 72.2 (1970Ba72); 70.7 *2* (1971So15); 70.9 *1* (1984Ah06), 71.3 *6* (1987Bo25). |

[†] From 1970Ba72 (s), except where noted. Energies listed by 1970Ba72 have been increased by 0.4 keV, and Eα′s of 1971Gr17 are decreased by 0.2 keV, as recommended by 1991Ry01, because of changes in calibration energies. Other measurements: 1954As07 (s), 1957Ko33 (s), 1962Le11 (s), 1968Ba25 (s), 1990Ah01 (semi), 1991Jo02.

[‡] α intensity per 100 α decays. Intensities of α′s to E<300−keV levels are from 1984Bo41; all other Iα′s are deduced from γ-ray intensities, except where indicated. Others: 1994Sa63.

[#] α particle was not observed. Energy is from Q(α) and level energy.

[@] Hf(5499α)=1.0 yields $r_0(^{234}U)$=1.5075.

[&] Absolute intensity per 100 decays.

[a] Existence of this branch is questionable.

## γ($^{234}$U)

Uranium L-subshell Auger, fluorescence, and Coster-Kronig yields were deduced from (α)(L x ray) coincidences by 1968By01, 1971Mc24, 1972Gi02, 1972NiZQ.
M-subshell fluorescence yields and Coster-Kronig transition probabilities were deduced from (M x ray)(L x ray) coincidences by 1974Ba53, 1974Ba54.
(α)(L x ray): electron shakeoff abundances deduced (1975Ra10). See also 1982Im01.
Iγ(L x ray)=10.3% 4, deduced by the evaluators from the γ-ray data given here, is in fair agreement with measured values of 13.9% 1 (1976Va23) and 11.5% 1 (1984Bo41). An average emitted radiation energy per decay of 5588.7 keV *2*, also deduced by the evaluators from all the radiation data given in this evaluation, agrees within 0.1% with 5593.2 keV *2*, reported in the latest adjustment of nuclear masses (2003Au03). These results confirm the consistency and completeness of the decay scheme.

x-rays:

| E | I(per 1×10$^6$ α) (1976GuZN) | (1976Va23) | (1984Bo41) | (1995Jo23) | |
|---|---|---|---|---|---|
| 11.6 | - | - | 26.0×10$^2$ 7 | | $L_l$ x ray |
| 13.5 | - | 505×10$^2$ 6 | 406×10$^2$ 6 | | $L_\alpha$ x ray |
| 17.4 | - | 741×10$^2$ 9 | 585×10$^2$ 9 | 530×10$^2$ 4 | $L_\beta$ x ray |
| 20.4 | - | 148×10$^2$ 2 | 138×10$^2$ 2 | 129×10$^2$ 3 | $L_\gamma$ x ray |
| 94.655 5 | 1.05 3 | - | - | | $K\alpha_2$ x ray |
| 98.442 5 | 1.69 3 | - | - | | $K\alpha_1$ x ray |
| 110.42 | 0.21 | - | - | | $K\beta_3$ x ray |
| 111.30 | 0.39 | - | - | | $K\beta_1$ x ray |
| 114.33 | | - | - | | $K\beta_4$ x ray |
| 114.54 | 0.158 | - | - | | $K\beta_2$ x ray |
| 115.40 | | - | - | | K x ray(x) |

E(K x ray)'s are from 1976GuZN (semi). Other K x ray measurements: 1969LeZX.
E(L x ray)'s are from 1984Bo41. See 1984DrZX for energies and intensities of finer L x ray lines. See also 1984BaYT.
Other L x ray measurements: 1954As07, 1982GeZP, 1990Po14, 1992Ba08.
I(M x-rays)/I(L x-rays)=39 4/201 13, measured by 1990Po14.

| $E_\gamma$[†] | $I_\gamma$[‡b] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult.[#] | α[c] | Comments |
|---|---|---|---|---|---|---|---|---|
| 43.498[@] *1* | 392[&] *8* | 43.4981 | 2$^+$ | 0.0 | 0$^+$ | E2 | 713 | α(L)=520 *8*; α(M)=143.5 *20*; α(N+..)=49.3 *7*<br>α(N)=38.9 *6*; α(O)=8.91 *13*; α(P)=1.441 *21*; α(Q)=0.00339 *5*<br>$E_\gamma$: other measured energies are 43.477 *5* (1976GuZN), 43.491 *9* (1972Sc01), 43.492 *10* (1971GuZY).<br>$I_\gamma$: from measured values of Iγ=396 *10* (1984Bo41), 382 *8* (1984He19), 385 *5* (1976GuZN), 411 *8* (1976Um01).<br>Mult.: α=734 *15* from adopted Iγ and Iα. Measured Ice's: L1/L2=0.0345 *19*; L1/L3=0.0399 *22*; L2/L3=1.147 *20* (1969Am02); M1:M2:M3:M45=4.2:104:100:2.0 (1969Am02); α=780 *55* by αγ coincidence (1968Du06); α=790 *65* by αγ coincidence (1968Sc21). |




$^{234}_{92}U_{142}$-3

## $^{238}$Pu α decay 1984Bo41,1970Ba72 (continued)

### γ($^{234}$U) (continued)

| $E_\gamma$ † | $I_\gamma$ ‡ b | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult. # | δ | α c | Comments |
|---|---|---|---|---|---|---|---|---|---|
| (62.70 a 1) | ≤0.0001 | 989.430 | 2⁻ | 926.720 | 2⁺ | E1 | | 0.426 | α(L)=0.320 5; α(M)=0.0791 11; α(N+..)=0.0266 4<br>α(N)=0.0209 3; α(O)=0.00481 7; α(P)=0.000795 12;<br>α(Q)=3.22×10$^{-5}$ 5<br>$I_\gamma$: from I(62.70γ)/I(946γ)=0.12 4, measured in 6.75-h $^{234}$Pa β$^-$ decay. |
| 99.853 @ 3 | 72.9 & 8 | 143.352 | 4⁺ | 43.4981 | 2⁺ | E2 | | 13.42 | α(L)=9.77 14; α(M)=2.71 4; α(N+..)=0.933 13<br>α(N)=0.736 11; α(O)=0.1691 24; α(P)=0.0277 4; α(Q)=0.0001099 16<br>$E_\gamma$: other measured energies are 99.864 5 (1976GuZN), 99.85 1 (1972Sc01), 99.84 4 (1969LeZX).<br>$I_\gamma$: from measured intensities of Iγ=74.3 8 (1984He19), 73.0 11 (1984Bo41) and 72.4 14 (1976GuZN).<br>Mult.: L2/L3≈1.0 by (α)(ce) (1959Tr37); α=13.3 7 from Iα and Iγ. See also $^{234}$Pa β$^-$ decay. |
| (140.15 a 2) | ≤0.00002 | 989.430 | 2⁻ | 849.266 | 3⁻ | M1+E2 | 1.3 5 | 5.1 13 | α(K)=2.6 16; α(L)=1.79 18; α(M)=0.48 6; α(N+..)=0.165 21<br>α(N)=0.129 17; α(O)=0.030 4; α(P)=0.0052 5; α(Q)=0.00014 7<br>$I_\gamma$: from I(140.91γ)/I(946γ)=0.023 3, measured in 6.75-h $^{234}$Pa β$^-$ decay. |
| 152.720 @ 2 | 9.29 & 7 | 296.072 | 6⁺ | 143.352 | 4⁺ | E2 | | 2.14 | α(K)=0.217 3; α(L)=1.404 20; α(M)=0.388 6; α(N+..)=0.1338 19<br>α(N)=0.1055 15; α(O)=0.0243 4; α(P)=0.00402 6; α(Q)=2.69×10$^{-5}$ 4<br>$E_\gamma$: other measured energies are 152.68 2 (1976GuZN), 152.719 19 (1972Sc01), 152.71 5 (1969LeZX).<br>$I_\gamma$: Weighted average of 9.36 10 (1984He19), 9.28 14 (1984Bo41), 9.56 20 (1976GuZN), and 9.230 68 (1994Ba91).<br>Mult.: from experimental α deduced from Ice/Iγ [I(ce 99γ)/I(ce 152γ)=40 (1959Tr37)] and also from intensity balance at the 296-keV level. See also $^{234}$Pa β$^-$ decay. |
| (192.91 a 7) | ≈6.4×10$^{-6}$ | 1044.536 | 0⁺ | 851.74 | 2⁺ | [E2] | | 0.856 | α(K)=0.1635 23; α(L)=0.505 8; α(M)=0.1391 20; α(N+..)=0.0480 7<br>α(N)=0.0378 6; α(O)=0.00872 13; α(P)=0.001455 21;<br>α(Q)=1.381×10$^{-5}$ 20<br>$I_\gamma$: from Iγ(192.91γ)/Iγ(1001γ)≈0.55/837 10, measured in 1.17-min $^{234}$Pa β$^-$ decay. |
| 200.97 3 | 0.039 2 | 497.04 | 8⁺ | 296.072 | 6⁺ | E2 | | 0.734 | α(K)=0.1534 22; α(L)=0.424 6; α(M)=0.1166 17; α(N+..)=0.0402 6<br>α(N)=0.0317 5; α(O)=0.00731 11; α(P)=0.001223 18;<br>α(Q)=1.237×10$^{-5}$ 18<br>$E_\gamma$: from 6.75-h $^{234}$Pa β$^-$ decay. Energies measured in $^{238}$Pu α decay are 201.017 30 (1972Sc01), 200.98 (1976GuZN), 200.9 2 (1969LeZX).<br>$I_\gamma$: from measured intensities of 0.036 8 (1969LeZX), 0.0399 9 (1976GuZN). Iγ=0.0374 10 is listed in 1979Ce04. |
| (203.12 a 3) | ≤0.00008 | 989.430 | 2⁻ | 786.288 | 1⁻ | M1+E2 | 1.4 4 | 1.5 4 | α(K)=0.9 4; α(L)=0.423 11; α(M)=0.1113 16; α(N+..)=0.0385 6 |

## $^{238}$Pu α decay 1984Bo41,1970Ba72 (continued)

### γ($^{234}$U) (continued)

| $E_\gamma$[†] | $I_\gamma$[‡b] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult.[#] | α[c] | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | α(N)=0.0301 *5*; α(O)=0.00708 *11*; α(P)=0.00125 *5*; α(Q)=4.6×10$^{-5}$ *17*<br>$I_\gamma$: from I(203γ)/I(946γ)=0.092 *10*, measured in 6.75-h $^{234}$Pa β$^-$ decay. |
| (233.6 *2*) | | 1085.26 | 2$^+$ | 851.74 | 2$^+$ | | | Total Ice≈5×10$^{-7}$% from Ice(233.6γ)/Iγ(1085γ)≈5.3, measured in $^{234}$Np ε decay. |
| (234.6[a] *2*) | | 1044.536 | 0$^+$ | 809.907 | 0$^+$ | E0 | | Total Ice=1.0×10$^{-7}$% from Ice/Iγ(1001γ)=0.10, deduced in 1.17-min $^{234}$Pa β$^-$ decay. |
| 235.9 *3* | 0.00010 *5* | 1085.26 | 2$^+$ | 849.266 | 3$^-$ | [E1] | 0.0673 | α(K)=0.0532 *8*; α(L)=0.01067 *16*; α(M)=0.00258 *4*; α(N+..)=0.000885 *13*<br>α(N)=0.000689 *10*; α(O)=0.0001639 *24*; α(P)=2.99×10$^{-5}$ *5*; α(Q)=1.82×10$^{-6}$ *3*<br>$E_\gamma$: 235.62 *10* from $^{234}$Np ε decay.<br>$I_\gamma$: measured by 1969LeZX. |
| 258.3 *2* | 0.00084 *13* | 1044.536 | 0$^+$ | 786.288 | 1$^-$ | (E1) | 0.0548 | α(K)=0.0434 *7*; α(L)=0.00858 *13*; α(M)=0.00207 *3*; α(N+..)=0.000712 *10*<br>α(N)=0.000554 *8*; α(O)=0.0001320 *19*; α(P)=2.42×10$^{-5}$ *4*; α(Q)=1.498×10$^{-6}$ *22*<br>$I_\gamma$: measured by 1969LeZX. |
| 299.2 *2* | 0.00048 *13* | 1085.26 | 2$^+$ | 786.288 | 1$^-$ | [E1] | 0.0395 | α(K)=0.0314 *5*; α(L)=0.00608 *9*; α(M)=0.001465 *21*; α(N+..)=0.000504 *7*<br>α(N)=0.000392 *6*; α(O)=9.35×10$^{-5}$ *14*; α(P)=1.724×10$^{-5}$ *25*; α(Q)=1.103×10$^{-6}$ *16*<br>$I_\gamma$: measured by 1969LeZX. |
| 705.9 *3* | 0.00053 *20* | 849.266 | 3$^-$ | 143.352 | 4$^+$ | [E1] | 0.00698 | α(K)=0.00568 *8*; α(L)=0.000987 *14*; α(M)=0.000235 *4*; α(N+..)=8.12×10$^{-5}$ *12*<br>α(N)=6.30×10$^{-5}$ *9*; α(O)=1.519×10$^{-5}$ *22*; α(P)=2.88×10$^{-6}$ *4*; α(Q)=2.13×10$^{-7}$ *3*<br>$I_\gamma$: there is a disagreement for the intensity of 705.6γ deexciting the 849.1-keV level: Iγ(705.9γ)=0.00102 *15* (1969LeZX), 0.00049 *20* (1976GuZN), 0.00056 *23* (1984Ov01). Average of the more recent and consistent values has been adopted. |
| 708.42 *20* | 0.0041 *7* | 851.74 | 2$^+$ | 143.352 | 4$^+$ | [E2] | 0.0219 | α(K)=0.01536 *22*; α(L)=0.00489 *7*; α(M)=0.001246 *18*; α(N+..)=0.000432 *6*<br>α(N)=0.000336 *5*; α(O)=7.99×10$^{-5}$ *12*; α(P)=1.457×10$^{-5}$ *21*; α(Q)=7.28×10$^{-7}$ *11*<br>$I_\gamma$: from Iγ(708γ)/Iγ(808γ)=0.51 *8*, as measured in $^{234}$Np ε decay. The intensities measured in $^{238}$Pu α decay are Iγ=0.00279 *22* (1969LeZX), 0.0049 *5* (1976GuZN), 0.0038 *7* (1984Ov01). |
| 742.81 *10* | 0.052 *2* | 786.288 | 1$^-$ | 43.4981 | 2$^+$ | E1 | 0.00636 | α(K)=0.00518 *8*; α(L)=0.000895 *13*; α(M)=0.000213 *3*; α(N+..)=7.37×10$^{-5}$ *11*<br>α(N)=5.71×10$^{-5}$ *8*; α(O)=1.378×10$^{-5}$ *20*; α(P)=2.61×10$^{-6}$ *4*; α(Q)=1.95×10$^{-7}$ *3*<br>$I_\gamma$: from Iγ=0.0562 *10* (1969LeZX), 0.0507 *8* (1976GuZN), 0.0504 *27*(1984Ov01). Iγ=0.0522 *9* is listed in 1979Ce04. |
| 766.39 *10* | 0.22 *2* | 809.907 | 0$^+$ | 43.4981 | 2$^+$ | E2 | 0.0187 | α(K)=0.01336 *19*; α(L)=0.00396 *6*; α(M)=0.001003 *14*; α(N+..)=0.000348 *5*<br>α(N)=0.000271 *4*; α(O)=6.45×10$^{-5}$ *9*; α(P)=1.182×10$^{-5}$ *17*; α(Q)=6.25×10$^{-7}$ *9*<br>$I_\gamma$: from Iγ=0.24 *3* (1969LeZX), 0.215 *3* (1976GuZN), 0.223 *16* (1984Ov01). |
| (783.4[a] *1*) | 0.00024 *4* | 926.720 | 2$^+$ | 143.352 | 4$^+$ | [E2] | 0.0179 | α(K)=0.01285 *18*; α(L)=0.00374 *6*; α(M)=0.000946 *14*; α(N+..)=0.000328 *5*<br>α(N)=0.000255 *4*; α(O)=6.08×10$^{-5}$ *9*; α(P)=1.116×10$^{-5}$ *16*; α(Q)=5.99×10$^{-7}$ *9*<br>$I_\gamma$: from adopted γ-ray branching from the 926-keV level. |
| 786.30 *10* | 0.0322 *25* | 786.288 | 1$^-$ | 0.0 | 0$^+$ | E1 | 0.00573 | α(K)=0.00467 *7*; α(L)=0.000804 *12*; α(M)=0.000191 *3*; α(N+..)=6.61×10$^{-5}$ *10*<br>α(N)=5.12×10$^{-5}$ *8*; α(O)=1.237×10$^{-5}$ *18*; α(P)=2.35×10$^{-6}$ *4*; α(Q)=1.766×10$^{-7}$ *25*<br>$I_\gamma$: from Iγ=0.0352 *8* (1969LeZY), 0.0321 *5* (1976GuZN), 0.0306 *12* (1984Ov01). Iγ=0.0316 *10* is listed in 1979Ce04. |
| (804.4[a] *3*) | 0.0012 *5* | 947.64 | 4$^+$ | 143.352 | 4$^+$ | E0+E2 | ≈0.57 | $I_\gamma$: from Iγ(804γ)/Iγ(904γ)=1.8 *7*, measured in 6.75-h $^{234}$Pa β$^-$ decay.<br>α: deduced in 6.70-h $^{234}$Pa β$^-$ decay. |





$^{234}_{92}U_{142}$-5

## $^{238}$Pu α decay 1984Bo41,1970Ba72 (continued)

### γ($^{234}$U) (continued)

| $E_\gamma$ [†] | $I_\gamma$ [‡ b] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult. [#] | α [c] | Comments |
|---|---|---|---|---|---|---|---|---|
| 805.6 *3* | 0.0006 *3* | 849.266 | 3⁻ | 43.4981 | 2⁺ | [E1] | 0.00549 | α(K)=0.00447 *7*; α(L)=0.000768 *11*; α(M)=0.000183 *3*; α(N+..)=6.32×10$^{-5}$ *9*<br>α(N)=4.89×10$^{-5}$ *7*; α(O)=1.182×10$^{-5}$ *17*; α(P)=2.25×10$^{-6}$ *4*; α(Q)=1.693×10$^{-7}$ *24*<br>$I_\gamma$: measured intensities of Iγ=0.00136 *15* (1969LeZX), 0.00126 *19* (1976GuZN), 0.0016 *5* (1984Ov01) might possibly include Iγ of 804.1γ deexciting the 947-keV level. The ratio of Iγ(705.9γ)/Iγ(805.6γ)=0.90 *7*, adopted from the 6.75-h and 1.159-min $^{234}$Pa $\beta^-$ decay, and from the $^{234}$Np ε decay, yields Iγ(805.6γ)=0.00059 *23*.<br>Iγ(804.1γ)+Iγ(805.6γ)=0.0012 *5*+0.0006 *3*=0.0018 *6*. |
| 808.25 *15* | 0.0079 *2* | 851.74 | 2⁺ | 43.4981 | 2⁺ | E0+E2 | 4.3 | α(K)=3.31; α(L)+=0.94<br>$I_\gamma$: from 0.00824 *20* (1969LeZX), 0.00784 *24* (1976GuZN), 0.0089 *9* (1984Ov01).<br>α: deduced in $^{234}$Np ε decay. |
| 810 | | 809.907 | 0⁺ | 0.0 | 0⁺ | E0 | | Ice(K)=6×10$^{-5}$%; K/LMN=3.5, α(K)exp>60 (1963Le17, 1964Le22). I(γ+ce)=7.7×10$^{-5}$%.<br>$E_\gamma$: 809.8 was measured in $^{234}$Np ε decay. |
| 851.70 *10* | 0.0124 *15* | 851.74 | 2⁺ | 0.0 | 0⁺ | [E2] | 0.01513 | α(K)=0.01109 *16*; α(L)=0.00302 *5*; α(M)=0.000759 *11*; α(N+..)=0.000263 *4*<br>α(N)=0.000205 *3*; α(O)=4.89×10$^{-5}$ *7*; α(P)=9.03×10$^{-6}$ *13*; α(Q)=5.10×10$^{-7}$ *8*<br>$I_\gamma$: from 0.0140 *5* (1969LeZX), 0.0126 *3* (1976GuZN), 0.0109 *12* (1984Ov01). |
| 880.5 *3* | 0.0016 *4* | 1023.9 | 3⁻ & 4⁺ | 143.352 | 4⁺ | | | $I_\gamma$: from Iγ=0.0017 *5* (1969LeZX), 0.0015 *4* (1984Ov01). |
| 883.23 *10* | 0.0076 *6* | 926.720 | 2⁺ | 43.4981 | 2⁺ | E2 | 0.01409 | α(K)=0.01040 *15*; α(L)=0.00276 *4*; α(M)=0.000692 *10*; α(N+..)=0.000240 *4*<br>α(N)=0.000187 *3*; α(O)=4.46×10$^{-5}$ *7*; α(P)=8.25×10$^{-6}$ *12*; α(Q)=4.76×10$^{-7}$ *7*<br>$I_\gamma$: from Iγ=0.0083 *4* (1969LeZX), 0.0071 *14* (1984Ov01). Iγ=0.00775 *55* is listed in 1979Ce04. |
| 904.3 *2* | 0.00064 *10* | 947.64 | 4⁺ | 43.4981 | 2⁺ | [E2] | 0.01346 | α(K)=0.00998 *14*; α(L)=0.00260 *4*; α(M)=0.000652 *10*; α(N+..)=0.000226 *4*<br>α(N)=0.0001758 *25*; α(O)=4.20×10$^{-5}$ *6*; α(P)=7.78×10$^{-6}$ *11*; α(Q)=4.55×10$^{-7}$ *7*<br>$I_\gamma$: from Iγ=0.00073 *10* (1969LeZX), 0.00056 *23* (1984Ov01). |
| 926.72 *15* | 0.0058 *3* | 926.720 | 2⁺ | 0.0 | 0⁺ | (E2) | 0.01284 | α(K)=0.00956 *14*; α(L)=0.00245 *4*; α(M)=0.000613 *9*; α(N+..)=0.000213 *3*<br>α(N)=0.0001653 *24*; α(O)=3.95×10$^{-5}$ *6*; α(P)=7.34×10$^{-6}$ *11*; α(Q)=4.34×10$^{-7}$ *6*<br>$I_\gamma$: from Iγ=0.0061 *3* (1969LeZX), 0.0054 *7* (1984Ov01). Iγ=0.00565 *29* is listed in 1979Ce04. |
| 941.9 *2* | 0.0047 *5* | 1085.26 | 2⁺ | 143.352 | 4⁺ | [E2] | 0.0126 | α(K)=0.0094; α(L)=0.00241<br>$I_\gamma$: from Iγ=0.0050 *3* (1969LeZX), 0.0042 *9* (1984Ov01). Iγ=0.0049 *6* is listed in 1979Ce04. |





$^{234}_{92}U_{142}$-6

γ($^{234}$U) (continued)

| $E_\gamma$[†] | $I_\gamma$[‡ b] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Mult.[#] | α[c] | Comments |
|---|---|---|---|---|---|---|---|---|
| 946.0 *3* | ≤0.00086 | 989.430 | 2⁻ | 43.4981 | 2⁺ | (E1) | 0.00412 | α(K)=0.00337 *5*; α(L)=0.000571 *8*; α(M)=0.0001355 *19*; α(N+..)=4.69×10$^{-5}$ *7* α(N)=3.63×10$^{-5}$ *5*; α(O)=8.78×10$^{-6}$ *13*; α(P)=1.675×10$^{-6}$ *24*; α(Q)=1.285×10$^{-7}$ *18* $I_\gamma$: from 1984Ov01. Iγ=0.00097 *15* is listed by 1969LeZX. |
| 1001.03 *15* | 0.0098 *7* | 1044.536 | 0⁺ | 43.4981 | 2⁺ | E2 | 0.01107 | α(K)=0.00835 *12*; α(L)=0.00204 *3*; α(M)=0.000507 *8*; α(N+..)=0.0001760 *25* α(N)=0.0001367 *20*; α(O)=3.28×10$^{-5}$ *5*; α(P)=6.10×10$^{-6}$ *9*; α(Q)=3.76×10$^{-7}$ *6* $I_\gamma$: from Iγ=0.0106 *4* (1969LeZX), 0.0091 *12* (1984Ov01). Iγ=0.0101 *4* is listed in 1979Ce04. |
| 1041.8 *3* | 0.0022 *3* | 1085.26 | 2⁺ | 43.4981 | 2⁺ | | | $I_\gamma$: from Iγ=0.00204 *17* (1969LeZX), 0.0029 *7* (1984Ov01). |
| 1085.4 *3* | 0.00091 *10* | 1085.26 | 2⁺ | 0.0 | 0⁺ | | | $I_\gamma$: from Iγ=0.00082 *10* (1969LeZX), 0.0011 *5* (1984Ov01). |

[†] From 1969LeZX (semi), unless otherwise noted. See also 1984Ov01. Other measurements: 1954As07, 1955Ch02, 1956Ne17, 1971Cl03, 1971Ma68. See also γ rays from $^{234}$Pa $\beta^-$ decay and $^{234}$Np ε decay.

[‡] Photon intensities (given as per 1×10$^6$ α decays) are from 1969LeZX, 1976GuZN and 1984Ov01, except where noted. Authors' Iγ's have been renormalized by the evaluators at Iγ(152γ)=9.29 *7*. Other measurements: 1979Ce04, 1976Um01, 1971GuZY, 1971Cl03, 1971Ma68, 1956Ne17. The authors of 1979Ce04 list only limited number of Iγ's which have not been renormalized by the evaluators here.

[#] Adopted multipolarities. For additional data, see 6.75-h and 1.17-min $^{234}$Pa $\beta^-$ decay and $^{234}$Np ε decay. Multipolarities in square brackets are from the level scheme.

[@] From 1984He19.

[&] Recommended in 1986LoZT.

[a] From Adopted Gammas; γ ray was not observed in $^{238}$Pu decay.

[b] For absolute intensity per 100 decays, multiply by 1.00×10$^{-4}$.

[c] 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.





$^{234}_{92}U_{142}$-7

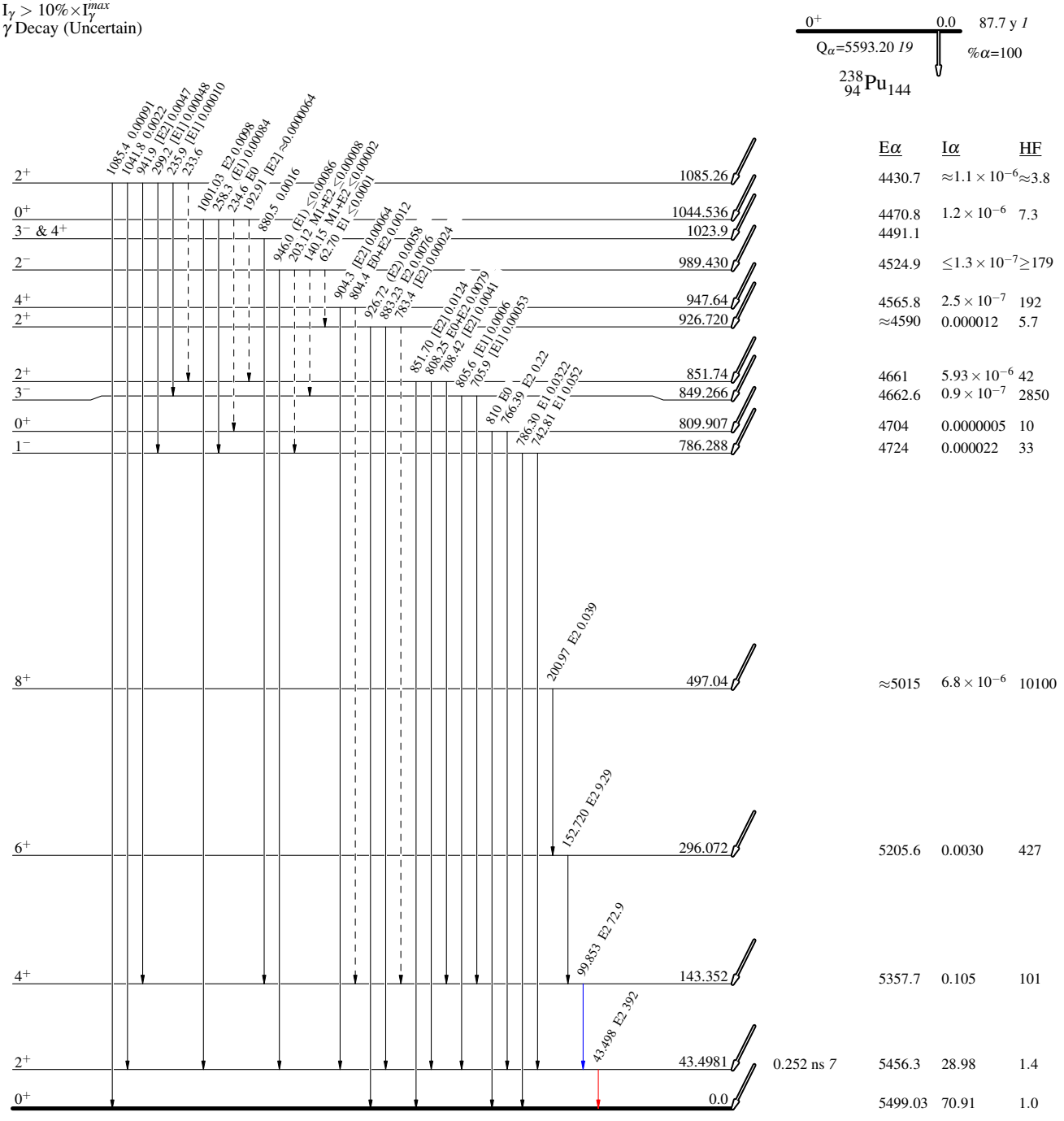
## $^{238}$Pu α decay 1984Bo41,1970Ba72

### Decay Scheme

Intensities: For %Iγ multiply by $1.00\times10^{-4}$

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)




$^{234}_{92}U_{142}$