^{241}Pu α decay 1976GuZN,1968Ah01,1965Ba26

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	M. S. Basunia	NDS 107, 2323 (2006)	15-Mar-2006

Parent: ^{241}Pu: E=0.0; $J^\pi=5/2^+$; $T_{1/2}$=14.290 y *6*; Q(α)=5140.0 *5*; %α decay=2.45×10^{-3} *1*

Other measurements: 1953As40, 1964Dz03.

1976GuZN: High isotopic purity ^{241}Pu source (preparation not described) was counted using variety of Ge detectors and alpha counter; Measured: Eγ, Iγ, α-γ coin, α branching.

1968Ah01: 99.9% chemically pure ^{241}Pu was measured; Detectors: silicon surface barrier detector, NAI, and Ge(Li); Measured: Eα, Iα, Eγ, Iγ, γγ coin, α-γ γ-α coin, α branching.

1965Ba26: Enriched ^{241}Pu source was prepared from vacuum evaporation of plutonium solution; spectra were taken with magnetic spectrograph; Measured: Eα, Iα.

%α=2.45×10^{-3} *2*.

^{237}U Levels

E(level)[†]	J^π[‡]	$T_{1/2}$	Comments
0.0[@]	1/2$^+$	6.75 d *1*	$T_{1/2}$: From Adopted Levels.
11.5[@] *6*	3/2$^+$		
56.3[@] *6*	5/2$^+$		
83.0[@] *8*	7/2$^+$		
160.0[&] *6*	5/2$^+$	3.1 ns *1*	$T_{1/2}$: From (α)(148.5γ, K x-rays)(t) in 1968Ah01.
204.3[&] *9*	7/2$^+$		
261.0[&] *10*	9/2$^+$		
274.0[a] *12*	(7/2)$^-$	155 ns *6*	$T_{1/2}$: From (4600-4850 α)(114γ)(t) in 1968Ah01.
318.3[#a] *5*	(9/2$^-$)		
≈328.5[#&]	11/2$^+$		
368.8[#a] *6*	(11/2$^-$)		

[†] From a least-squares fit to the γ-ray energies, except otherwise noted, assuming ΔE=1 keV for γ-rays with no uncertainty.
[‡] From Adopted Levels.
[#] Deduced from the Eα and Q(α)=5140.0 *5* values by the evaluator.
[@] 1/2[631] band.
[&] 5/2[622] band.
[a] 7/2[743] band.

α radiations

Eα[†]	E(level)	Iα[‡@]	HF[#]	Comments
4692 *6*	368.8	≈0.03	≈127	
≈4732	≈328.5	≈0.03	≈247	Eα: Reported only in 1965Ba26.
4742 *5*	318.3	≈0.07	≈125	
4783 *5*	274.0	0.2 *1*	90 *45*	
4797 *3*	261.0	1.4 *1*	15.8 *12*	Iα: 1.18 in 1965Ba26.
4852.9 *11*	204.3	12.1 *2*	4.51 *9*	Eα: Weighted average of 4853 *3* (1968Ah01) and 4852.9 1.2 (1968Ba25).
4895.9 *11*	160.0	83.2 *5*	1.311 *13*	Eα: Weighted average of 4896 *3* (1968Ah01) and 4895.9 1.2 (1968Ba25).
4972 *3*	83.0	1.3 *1*	274 *22*	
4999 *4*	56.3	0.41 *5*	1.30×10^3 *16*	
5042 *3*	11.5	1.02	1022	Iα: From 1965Ba26. Iα=1.5 *1* together for 5055α and 5042α in 1968Ah01.
5055 *5*	0.0	0.35	3533	Iα: From 1965Ba26. Iα=1.5 *1* together for 5055α and 5042α in 1968Ah01.

Continued on next page (footnotes at end of table)

^{241}Pu α decay 1976GuZN,1968Ah01,1965Ba26 (continued)

α radiations (continued)

† From 1968Ah01, except otherwise noted. Eα reported both in 1968Ah01 and 1965Ba26. In 1991Ry01 the original Eα energies of 1965Ba26, 1968Ba25 have been increased by 0.4 keV, and energies of 1968Ah01 have been increased by 0.6 keV because of changes in calibration energies.

‡ From 1968Ah01, except otherwise noted. α intensity per 100 α decays.

$r_0(^{237}U)$=1.5156 *9*, average of $r_0(^{238}U)$=1.5143 *9* and $r_0(^{236}U)$ =1.5168 *3* (1998Ak04), is used in calculations. See 1969Po05 and 1976Du03 for theoretical calculations of hindrance factors.

@ For absolute intensity per 100 decays, multiply by 2.45×10^{-5} *1*.

γ(^{237}U)

1976GuZN

X rays(uranium):

Eγ	Iγ/100α	
94.658 5	12.3	Kα$_2$ x ray
98.442 5	19.7	Kα$_1$ x ray
110.421	2.40	Kβ$_3$ x ray
111.300	4.44	Kβ$_1$ x ray
111.89	0.13	Kβ$_5$ x ray
114.34	0.65	Kβ$_2$ x ray
114.56	1.48	Kβ$_4$ x ray
115.40	0.54	KO$_{23}$ x ray

E$_\gamma$ †	I$_\gamma$ #&	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.	δ	α a	I$_{(\gamma+ce)}$ &	Comments
11.39		11.5	3/2$^+$	0.0	1/2$^+$					E$_\gamma$: From 1971GuZY.
(26.7)		83.0	7/2$^+$	56.3	5/2$^+$				3.9 *14*	I$_{(\gamma+ce)}$: transition not observed. Highly converted M1+E2 transition with total transition intensity of 3.9% 14 of α decay is expected from intensity balance at the 82.89-keV level.
44.20	0.17	204.3	7/2$^+$	160.0	5/2$^+$	(M1+E2)	0.194 *13*	75.2 *28*		α(L)=56.3 *22*; α(M)=14.2 *6* Mult.,δ: from total conversion coefficient of α=75.2 *28*. α: obtained from intensity balance at the 204.15-keV level. For the 40.748-keV 7/2$^+$ to 5/2$^+$, 5/2[622] intraband transition in ^{237}Pu, δ=0.194 *30* was deduced in ^{237}Am ε decay.
44.86	0.034	56.3	5/2$^+$	11.5	3/2$^+$	[M1+E2]	0.50 *20*	166 *65*		α(L)=122 *54*; α(M)=33 *15* The intensity balance at the 56.28-keV level yields δ=0.50 *14*. An δ=0.62 was obtained by evaluator from calculation using the Alaga rule on 44.86γ and 56.32γ. Alaga rule yields Iγ(44.86γ; E2 part)/Iγ(56.32γ)=0.0916, from which E2/M1(44.86γ)=0.27 (δ=0.62) is obtained. The 45.724γ in ^{237}Pu which connects the 5/2$^+$ and 3/2$^+$ states of the 1/2[631] band, the mixing ratio was determined to be δ=0.47 *13*.
56.32	0.102	56.3	5/2$^+$	0.0	1/2$^+$	[E2]		208.4		α(L)=151.2; α(M)=41.7; α(N+..)=15.5
56.76	0.04	261.0	9/2$^+$	204.3	7/2$^+$	[M1+E2]	0.11 *+8−11*	28 *4*		α(L)=21 *5*; α(M)=5.0 *17*; α(N+..)=1.87 *17* α: from intensity balance at the 261.0-keV level. δ: from the total conversion coefficient of α=28 *4*.
71.6	0.117 *4*	83.0	7/2$^+$	11.5	3/2$^+$	[E2]		65.9		α(L)=47.7; α(M)=13.2; α(N+..)=4.91
77.10	0.84@ *2*	160.0	5/2$^+$	83.0	7/2$^+$	[M1]				α(L)=7.90; α(M)=1.92; α(N+..)=0.698 B(M1)(W.u.)=0.000147 *9* I$_\gamma$: Weighted average of 0.90 *3* (1976GuZN), 0.861 *22*

$^{237}_{92}U_{145}$-3

γ(^{237}U) (continued)

E_γ †	I_γ #&	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α a	Comments
									(1985He02), 0.829 *18* (1985Wi04). Iγ=0.207×10^{-6} *4*/^{237}U decay which corresponds to 0.845 *18* per 100 α decays is recommended in 1986LoZT from Iγ's of 1985He02 and 1985Wi04. α: E2 admixture is calculated to be small, E2/M1=0.00159, using Alaga rule on 77.1γ and 159.9γ and their corresponding Iγ. E2/M1 value yields δ=0.04 and α=10.7.
(101.0)	≈0.0029	261.0	9/2$^+$	160.0	5/2$^+$	[E2]		13.0	α(L)=9.44; α(M)=2.62; α(N+..)=0.986 E_γ: from level scheme. Transition was not observed; it would be obscured by the K x-rays. I_γ: Estimated using Alaga rule on (101γ) and 56.76γ by the evaluator, using Iγ(56.76γ)=0.040 *4* and δ(56.76γ)=0.11 *+8−11*.
103.680 *5*	4.13 *2*	160.0	5/2$^+$	56.3	5/2$^+$	[M1+E2]	0.069	4.49 *4*	α(L)=3.37 *4*; α(M)=0.816 *7*; α(N+..)= 0.300 *3* B(M1)(W.u.)=0.000295 *16*; B(E2)(W.u.)=0.0386 *21* I_γ: Weighted average of: 4.12 *2* (1976GuZN), 4.16 *12* (1985He02), and 4.21 *5* (1985Wi04). 1986LoZT recommend Iγ=1.02×10^{-6} *2* per ^{237}U decay which is equal to 4.16 *9* per 100 α decays. Other values: 4.5 *5* (1968Ah01), 4.24 *20* (1978DiZU). Mult.: E2/M1=0.00479 is obtained from Iγ(103.68γ; E2 part)/Iγ(159.955γ)=0.0735, calculated by the evaluator using the Alaga rule, Iγ(103γ)=4.15 *5*, and Iγ(159γ)=0.267 *6*. α: for pure M1, α=4.45.
114.0	3.3 *3*	274.0	(7/2)$^-$	160.0	5/2$^+$	E1		0.090	α(L)=0.0676; α(M)=0.0164; α(N+..)=0.00582 B(E1)(W.u.)=7.1×10^{-7} *4* E_γ,I_γ: From γγ coincidence in 1968Ah01. Mult.: from intensity balance at the 274.0-keV level: α(E2)=7.42, α(M1)=3.38.
121.2	0.028	204.3	7/2$^+$	83.0	7/2$^+$	[M1]		13.7	α(K)=10.8; α(L)=2.13; α(M)=0.515; α(N+..)=0.189
148.567 *10*	7.59 *5*	160.0	5/2$^+$	11.5	3/2$^+$	[M1+E2]	0.169 *+3−2*	7.50 *14*	α(K)=5.90 *16*; α(L)=1.20 *2*; α(M)=0.292 *5*; α(N+..)=0.107 *2* B(M1)(W.u.)=0.000180 *11*; B(E2)(W.u.)=0.069 *5* I_γ: Weighted average of 7.63 *12* (1976GuZN), 7.60 *7* (1985He02), 7.57 *7* (1985Wi04). Iγ=1.859×10^{-6} *16* per ^{237}U decay, corresponding to 7.59 *9* per 100 α decays, is recommended in 1986LoZT. Other values: 7.56 *28* (1978DiZU), 9.0 *9* (1968Ah01). Mult.: E2/M1=0.0281 *8* (δ=0.170) is obtained from Iγ(148γ; E2 part)/Iγ(159γ)=0.790, calculated by the evaluator using the Alaga rule, Iγ(148γ)=7.59, and Iγ(159γ)=0.270. α: for pure M1, α=7.64.
159.955	0.267@ *3*	160.0	5/2$^+$	0.0	1/2$^+$	[E2]		1.82	α(K)=0.212; α(L)=1.16; α(M)=0.322; α(N+..)=0.120 B(E2)(W.u.)=0.060 *4* I_γ: Iγ=0.0658×10^{-6} *9* per ^{237}U decay, corresponding to 0.269 *5* per 100 α decays, is recommended in 1986LoZT.

$^{237}_{92}U_{145}$-4

^{241}Pu α decay 1976GuZN,1968Ah01,1965Ba26 (continued)

$\gamma(^{237}U)$ (continued)

E_γ [†]	E_i(level)
[x]641 [‡] *2*	
[x]687 [‡] *2*	

[†] From 1976GuZn, except noted otherwise. Measurements of 1968Ah01, 1976GuZN, 1985He02, and 1985Wi04 are in good agreement. Other measurements: 1952Fr25, 1965Ba35, 1976Um01, 1979Ce04, 1993Dr05.

[‡] Measurement of 1968Ah01. Assignment to ^{241}Pu α decay has not been established. If they belong to ^{241}Pu α decay, they could be identical to the 641.34- and 686.29-keV γ's seen in (n,γ), deexciting the $5/2^+$,3/2[631] state. Since Iγ's were not given, a positive assignment could not be made. Note also that the γ's deexciting the $3/2^+$ state of this band have not been reported in ^{241}Pu α decay either.

[#] From 1976GuZN, except otherwise noted. Absolute photon intensity per 100 α decays. Iγ values are in γ/dis (1976GuZn) converted to absolute photon intensity per 100 α decays by evaluator using $\%\alpha$=0.00245 *1*.

[@] Weighted average of 1985He02 and 1985Wi04. The intensities in 1985He02 and 1985Wi04 are listed as absolute photon intensities per 1×10^6 ^{241}Pu decays. These intensities are converted to Iγ's per 100 α decays by using $\%\alpha$=0.00245 *1*. For γ's not listed in 1985He02 and 1985Wi04, the measured intensities in 1968Ah01 and 1976GuZN are in fair agreement.

[&] For absolute intensity per 100 decays, multiply by 2.45×10^{-5} *1*.

[a] 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.

$^{237}_{92}U_{145}$-5

^{241}Pu α decay 1976GuZN,1968Ah01,1965Ba26

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 decays through this branch

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)