^{236}Pa β^- decay   1984Mi02

	Type	Author	History Citation	Literature Cutoff Date
	Full Evaluation	Shaofei Zhu	NDS 182, 2 (2022).	1-Apr-2022

Parent: ^{236}Pa: E=0; J$^\pi$=1$^{(+)}$; T$_{1/2}$=9.1 min *1*; Q(β^-)=2889 *14*; %β^- decay=100.0

^{236}Pa-Q(β^-): From 2021Wa16.

Decay scheme proposed in 1984Mi02. Others: 1968Tr07, 1973Ka10 and 1973Or06.

α: Additional information 1.

^{236}U Levels

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$[‡]	E(level)[†]	J$^{\pi}$[‡]
0	0$^+$	2.342×10^7 y *4*	1604.80 *7*	(1$^-$,2$^+$)
45.2431 *20*	2$^+$		1662.36 *8*	(1,2$^+$)
149.480 *5*	4$^+$		1807.88 *7*	(1,2$^+$)
687.56 *4*	1$^-$	3.78 ns *9*	1865.39 *15*	(1,2$^+$)
744.17 *7*	3$^-$		1972.62 *9*	(1,2$^+$)
919.225 *20*	0$^+$		1979.15 *8*	(1$^-$,2)
957.99 *18*	2$^+$		1981.06 *16*	(1,2$^+$)
966.58 *9*	(1$^-$)		2086.54 *9*	1$^{(-)}$
987.65 *8*	2$^-$		2155.40 *12*	(0,1,2)
1110.66 *8*	(2$^-$)		2226.9 *3*	(0,1,2)
1271.09 *7*	(1$^-$,2,3)			

[†] Deduced by the evaluator from a least-squares fit to γ-ray energies.

[‡] From Adopted Levels.

β^- radiations

E(decay)	E(level)	Iβ^-[†‡]	Log ft	Comments
(662 *14*)	2226.9	0.18 *5*	7.21 *13*	av Eβ=200.8 *49*
(734 *14*)	2155.40	1.08 *6*	6.58 *4*	av Eβ=225.6 *49*
(802 *14*)	2086.54	2.60 *12*	6.33 *4*	av Eβ=249.9 *50*
(908 *14*)	1981.06	1.78 *10*	6.68 *4*	av Eβ=287.8 *51*
(910 *14*)	1979.15	3.25 *13*	6.42 *3*	av Eβ=288.5 *51*
(916 *14*)	1972.62	2.04 *12*	6.64 *4*	av Eβ=290.8 *51*
(1024 *14*)	1865.39	0.60 *6*	7.33 *5*	av Eβ=330.2 *52*
(1081 *14*)	1807.88	8.2 *4*	6.28 *3*	av Eβ=351.5 *53*
(1227 *14*)	1662.36	1.91 *14*	7.11 *4*	av Eβ=406.4 *54*
(1284 *14*)	1604.80	4.7 *3*	6.79 *4*	av Eβ=428.4 *54*
(1618 *14*)	1271.09	0.35 *10*	8.28 *13*	av Eβ=558.5 *56*
(1778 *14*)	1110.66	2.18 *18*	7.64 *4*	av Eβ=622.2 *56*
(1901 *14*)	987.65	1.11 *15*	8.04 *6*	av Eβ=671.5 *57*
(1922 *14*)	966.58	1.85 *14*	7.83 *4*	av Eβ=680.0 *57*
(1931 *14*)	957.99	0.26 *11*	8.69 *19*	av Eβ=683.4 *57*
(1970 *14*)	919.225	0.52 *5*	8.42 *5*	av Eβ=699.1 *57*
(2201 *14*)	687.56	48 *3*	6.64 *3*	av Eβ=793.0 *57*
(2844 *14*)	45.2431	≈10	≈7.7	av Eβ=1057.0 *58*
				Iβ^-: Iβ(2$^+$)≈10 from Iβ(0$^+$)≈10 (1968Tr07) and Iβ(0$^+$)+Iβ(2$^+$)=20.7 *8*.
(2889 *14*)	0	≈10	≈7.8	av Eβ=1075.7 *58*
				Iβ^-: intensity balance results in Iβ(0$^+$)+Iβ(2$^+$)=20.7 *8*. Iβ≈10 from 1968Tr07.

[†] From γ-ray intensity balance.

[‡] Absolute intensity per 100 decays.

$\gamma(^{236}$U$)$

Iγ normalization: From measurement of absolute β-ray (4π gas counter) and absolute γ-ray (a calibrated Ge(Li) detector) rates (1984Mi02).

E$_\gamma$[†]	I$_\gamma$[†@]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.[#]	δ[#]	α	Comments
45.243 2	≈0.117	45.2431	2$^+$	0	0$^+$	E2		589 8	α(L)=429 6; α(M)=118.6 17; α(N)=32.1 5; α(O)=7.36 10; α(P)=1.191 17; α(Q)=0.00285 4 E$_\gamma$: from Adopted Gammas. I$_\gamma$: estimated from Iβ(0$^+$)+Iβ(2$^+$)=20.7 8 and Iβ(0$^+$)≈10.
(56.6 8)	0.017 1	744.17	3$^-$	687.56	1$^-$	(E2)		199 14	α(L)=145 11; α(M)=40.1 29; α(N)=10.9 8; α(O)=2.50 18; α(P)=0.405 29; α(Q)=0.00107 7 E$_\gamma$: from Adopted Gammas. Not observed in ^{236}Pa β^- decay. I$_\gamma$: deduced by the evaluator by assuming negligible β^- decay to the 744-keV level (J^π=1$^-$ to J^π=3$^-$) and using α(E2)=199 for this γ ray.
^{x}68.8[‡]	≤0.3								
104.237 4	≤0.15	149.480	4$^+$	45.2431	2$^+$	E2		10.99 15	α(L)=8.00 11; α(M)=2.220 31; α(N)=0.603 8; α(O)=0.1385 19; α(P)=0.02268 32 α(Q)=9.41×10^{-5} 13 E$_\gamma$: from Adopted Gammas.
222.4[‡&] 1	<0.21	966.58	(1$^-$)	744.17	3$^-$				
243.6 2	0.23 3	987.65	2$^-$	744.17	3$^-$	M1+E2	1.5 4	0.81 21	α(K)=0.51 19; α(L)=0.216 13; α(M)=0.0564 23; α(N)=0.0153 6; α(O)=0.00360 17 α(P)=0.00064 4; α(Q)=2.6×10^{-5} 9
279.0 1	0.53 3	966.58	(1$^-$)	687.56	1$^-$				
300.0 1	0.15 3	987.65	2$^-$	687.56	1$^-$	[M1+E2]		0.6 4	α(K)=0.4 4; α(L)=0.12 4; α(M)=0.030 7; α(N)=0.0081 20; α(O)=0.0019 5; α(P)=3.6×10^{-4} 11 α(Q)=2.1×10^{-5} 16
333.7 1	0.82 4	1604.80	(1$^-$,2$^+$)	1271.09	(1$^-$,2,3)			0.054 23	
^{x}349.7 2	0.23 4								
366.6 1	0.78 9	1110.66	(2$^-$)	744.17	3$^-$			0.577 8	
423.1 1	0.95 5	1110.66	(2$^-$)	687.56	1$^-$			0.391 5	
^{x}453.4[‡] 5	<0.5								
526.7 2	0.31 3	1271.09	(1$^-$,2,3)	744.17	3$^-$				
538.09 7	0.58 9	687.56	1$^-$	149.480	4$^+$	E3		0.20 8	α(K)exp=0.11 5 E$_\gamma$,α,α(K)exp: from the Adopted Gammas.
550.6 1	1.08 6	2155.40	(0,1,2)	1604.80	(1$^-$,2$^+$)				
(583.5[‡] 2)	<0.2	1271.09	(1$^-$,2,3)	687.56	1$^-$				
^{x}587.0[‡] 2	<0.2								
594.5 3	0.32 5	744.17	3$^-$	149.480	4$^+$	[E1]		0.00964 14	α(K)=0.00781 11; α(L)=0.001381 19; α(M)=0.000330 5;

$^{236}\text{Pa}\ \beta^-$ **decay**   **1984Mi02 (continued)**

$\gamma(^{236}\text{U})$ (continued)

E_γ[†]	I_γ[†@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α	Comments
								$\alpha(\text{N})=8.83\times10^{-5}$ *12*
								$\alpha(\text{O})=2.128\times10^{-5}$ *30*; $\alpha(\text{P})=4.01\times10^{-6}$ *6*; $\alpha(\text{Q})=2.91\times10^{-7}$ *4*
617.1 *2*	0.21 *4*	1604.80	$(1^-,2^+)$	987.65	2^-			
^{x}626.9 *2*	0.23 *5*							
642.23 *7*	37.0 *20*	687.56	1^-	45.2431	2^+	E1(+M2+E3)	0.15 *2*	$\alpha(\text{K})\text{exp}=0.111$ *10*; $\alpha(\text{L})\text{exp}=0.031$ *9*
								$E_\gamma,\alpha,\alpha(\text{K})\text{exp},\alpha(\text{L})\text{exp}$: from the Adopted Gammas.
674.5 *2*	0.21 *7*	1662.36	$(1,2^+)$	987.65	2^-			
687.59 *6*	9.9 *5*	687.56	1^-	0	0^+	E1	0.31 *2*	$\alpha(\text{K})\text{exp}=0.219$ *14*; $\alpha(\text{L})\text{exp}=0.069$ *9*
								$E_\gamma,\alpha,\alpha(\text{K})\text{exp},\alpha(\text{L})\text{exp}$: from the Adopted Gammas.
^{x}696.3 *2*	0.19 *4*							
^{x}740.8 *2*	0.33 *5*							
860.6 *1*	0.76 *2*	1604.80	$(1^-,2^+)$	744.17	3^-			
870.4 *2*	0.69 *6*	1981.06	$(1,2^+)$	1110.66	(2^-)			
873.98 *2*	0.51 *5*	919.225	0^+	45.2431	2^+	[E2]	0.01439 *20*	$\alpha(\text{K})=0.01060$ *15*; $\alpha(\text{L})=0.00283$ *4*; $\alpha(\text{M})=0.000711$ *10*; $\alpha(\text{N})=0.0001917$ *27*
								$\alpha(\text{O})=4.58\times10^{-5}$ *6*; $\alpha(\text{P})=8.47\times10^{-6}$ *12*; $\alpha(\text{Q})=4.85\times10^{-7}$ *7*
884.0[&] *2*	<0.15	2155.40	(0,1,2)	1271.09	$(1^-,2,3)$			
917.0 *3*	1.37 *8*	1604.80	$(1^-,2^+)$	687.56	1^-			
921.2 *2*	0.4 *1*	966.58	(1^-)	45.2431	2^+	(E1)	0.00432 *6*	$\alpha(\text{K})=0.00353$ *5*; $\alpha(\text{L})=0.000599$ *8*; $\alpha(\text{M})=0.0001423$ *20*; $\alpha(\text{N})=3.81\times10^{-5}$ *5*; $\alpha(\text{O})=9.22\times10^{-6}$ *13*
								$\alpha(\text{P})=1.757\times10^{-6}$ *25*; $\alpha(\text{Q})=1.345\times10^{-7}$ *19*
942.4 *2*	0.87 *6*	987.65	2^-	45.2431	2^+	(E1)	0.00415 *6*	$\alpha(\text{K})=0.00339$ *5*; $\alpha(\text{L})=0.000575$ *8*; $\alpha(\text{M})=0.0001365$ *19*; $\alpha(\text{N})=3.66\times10^{-5}$ *5*; $\alpha(\text{O})=8.85\times10^{-6}$ *12*
								$\alpha(\text{P})=1.686\times10^{-6}$ *24*; $\alpha(\text{Q})=1.294\times10^{-7}$ *18*
958.0 *2*	0.84 *9*	957.99	2^+	0	0^+			
966.8 *2*	0.91 *8*	966.58	(1^-)	0	0^+	(E1)	0.00397 *6*	$\alpha(\text{K})=0.00325$ *5*; $\alpha(\text{L})=0.000549$ *8*; $\alpha(\text{M})=0.0001302$ *18*; $\alpha(\text{N})=3.49\times10^{-5}$ *5*; $\alpha(\text{O})=8.44\times10^{-6}$ *12*
								$\alpha(\text{P})=1.610\times10^{-6}$ *23*; $\alpha(\text{Q})=1.239\times10^{-7}$ *17*
975.0 *2*	0.19 *5*	1662.36	$(1,2^+)$	687.56	1^-			
^{x}990.9 *2*	0.55 *6*							
1006.3[‡&] *5*	<0.15	1972.62	$(1,2^+)$	966.58	(1^-)			
1023.1 *3*	0.58 *5*	1981.06	$(1,2^+)$	957.99	2^+			
1065.0 *2*	0.32 *4*	1110.66	(2^-)	45.2431	2^+			
^{x}1155.9 *1*	0.40 *5*							
1177.7 *2*	0.36 *5*	1865.39	$(1,2^+)$	687.56	1^-			
1225.9 *1*	0.80 *6*	1271.09	$(1^-,2,3)$	45.2431	2^+			
1234.9 *1*	1.09 *7*	1979.15	$(1^-,2)$	744.17	3^-			
^{x}1283.7 *1*	1.14 *7*							
1291.6 *1*	1.09 *7*	1979.15	$(1^-,2)$	687.56	1^-			
^{x}1517.8 *1*	1.25 *7*							
1559.6 *1*	2.2 *2*	1604.80	$(1^-,2^+)$	45.2431	2^+			
^{x}1587.0 *2*	0.66 *6*							

^{236}Pa β^- decay   **1984Mi02** (continued)

$\gamma(^{236}$U) (continued)

E_γ †	I_γ †@	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	α	Comments
1604.9 2	0.4 1	1604.80	$(1^-,2^+)$	0	0^+			
1617.1 1	0.91 8	1662.36	$(1,2^+)$	45.2431	2^+			
1662.4 2	0.60 6	1662.36	$(1,2^+)$	0	0^+			
x1749.0 2	0.33 4							
1762.7 1	6.0 3	1807.88	$(1,2^+)$	45.2431	2^+			
x1773.5 3	0.30 3							
1807.8 1	2.24 12	1807.88	$(1,2^+)$	0	0^+			
1865.5 2	0.24 3	1865.39	$(1,2^+)$	0	0^+			
x1907.5 1	0.60 8							
x1917.2 2	0.06 2							
1927.0 2	1.02 7	1972.62	$(1,2^+)$	45.2431	2^+			
1934.1 2	1.07 7	1979.15	$(1^-,2)$	45.2431	2^+			
x1948.1 2	0.91 9							
1972.7 1	1.02 9	1972.62	$(1,2^+)$	0	0^+			
1981.0 3	0.51 5	1981.06	$(1,2^+)$	0	0^+			
2041.3 1	1.67 9	2086.54	$1^{(-)}$	45.2431	2^+	(E1)	1.66×10^{-3} 2	α(K)=0.000929 13; α(L)=0.0001512 21; α(M)=3.57×10^{-5} 5; α(N)=9.57×10^{-6} 13 α(O)=2.325×10^{-6} 33; α(P)=4.48×10^{-7} 6; α(Q)=3.64×10^{-8} 5
2078.5& 5	<0.09	2226.9	(0,1,2)	149.480	4^+			
2086.5 2	0.93 8	2086.54	$1^{(-)}$	0	0^+	(E1)	1.65×10^{-3} 2	α(K)=0.000896 13; α(L)=0.0001458 20; α(M)=3.44×10^{-5} 5; α(N)=9.22×10^{-6} 13 α(O)=2.242×10^{-6} 31; α(P)=4.32×10^{-7} 6; α(Q)=3.52×10^{-8} 5
2181.6 3	0.18 5	2226.9	(0,1,2)	45.2431	2^+			

† From 1984Mi02, unless otherwise noted.
‡ Assignment to ^{236}Pa β^- decay is uncertain.
# From Adopted Gammas.
@ Absolute intensity per 100 decays.
& Placement of transition in the level scheme is uncertain.
x γ ray not placed in level scheme.

^{236}Pa β^- decay   1984Mi02

Decay Scheme

Intensities: I_γ per 100 parent decays

Legend

→ (black)	$I_\gamma < 2\% \times I_\gamma^{max}$
→ (blue)	$I_\gamma < 10\% \times I_\gamma^{max}$
→ (red)	$I_\gamma > 10\% \times I_\gamma^{max}$
⇢ (dashed)	γ Decay (Uncertain)

$1^{(+)}$ 0 9.1 min 1

$Q_{\beta^-}=2889\ 14$ %β^-=100

$^{236}_{91}\text{Pa}_{145}$

From ENSDF

$I\beta^-$	Log ft		
0.18	7.21	(0,1,2)	2226.9
1.08	6.58	(0,1,2)	2155.40
2.60	6.33	$1^{(-)}$	2086.54
1.78	6.68	$(1,2^+)$	1981.06
3.25	6.42	$(1^-,2)$	1979.15
2.04	6.64	$(1,2^+)$	1972.62
0.60	7.33	$(1,2^+)$	1865.39
8.2	6.28	$(1,2^+)$	1807.88
1.91	7.11	$(1,2^+)$	1662.36
4.7	6.79	$(1^-,2^+)$	1604.80
0.35	8.28	$(1^-,2,3)$	1271.09
2.18	7.64	(2^-)	1110.66
1.11	8.04	2^-	987.65
1.85	7.83	(1^-)	966.58
0.26	8.69	2^+	957.99
0.52	8.42	0^+	919.225
		3^-	744.17
48	6.64	1^-	687.56 3.78 ns 9
		4^+	149.480
≈10	≈7.7	2^+	45.2431
≈10	≈7.8	0^+	0 2.342×10^7 y 4

Gamma transition labels:
2181.6 0.18; 2078.5 <0.09; 884.0 <0.15; 550.6 1.08; 2086.5 (E1) 0.93; 2041.3 (E1) 1.67; 1981.0 0.51; 1023.1 0.58; 870.4 0.69; 1934.1 1.07; 1291.6 1.09; 1234.9 1.09; 1972.7 1.02; 1927.0 1.02; 1006.3 <0.15; 1865.5 0.24; 1177.1 0.36; 1807.8 2.24; 1762.7 6.0; 1662.4 0.60; 1617.1 0.91; 975.0 0.19; 674.5 0.21; 1604.9 0.6; 1559.6 2.4; 917.0 1.37; 860.6 0.78; 617.1 0.21; 333.7 0.82; 1225.9 0.80; 583.5 <0.2; 526.7 0.31; 1065.0 0.32; 423.1 0.95; 366.6 0.78; 942.4 (E1) 0.87; 300.0 [M1+E2] 0.15; 243.6 M1+E2 0.23; 966.8 (E1) 0.91; 921.2 (E1) 0.6; 279.0 0.33; 222.4 <0.21; 958.0 0.84; 873.98 [E2] 0.51; 594.5 (E1) 0.32; 56.6 (E2) 0.019; 687.59 E1 9.9; 642.23 E1(+M2+E3) 37.0; 538.09 E3 0.58; 104.237 E2 <0.15; 45.243 E2 ≈0.117

$^{236}_{92}\text{U}_{144}$