^{238}Np β^- decay

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 127, 191 (2015)	1-Jun-2014

Parent: ^{238}Np: E=0.0; $J^\pi=2^+$; $T_{1/2}$=2.099 d *2*; $Q(\beta^-)$=1292.0 *7*; $\%\beta^-$ decay=100.0
^{238}Np-$T_{1/2}$: From Adopted Levels; weighted average of 2.1023 d 7, 2.1024 d 9, 2.1026 d 9 (2006Re09), and 2.0980 d 3 (1990Ch35).
Other values: 2.117 d 2 (1966Qa01), 2.10 d *1* (1950Fr53).
Additional information 1.

^{238}Pu Levels

E(level)	J^π †	$T_{1/2}$	Comments
0.0	0^+ ‡	87.74 y *4*	
44.051 *16*	2^+ ‡		
145.934 *21*	4^+ ‡		
303.36 *6*	6^+		
605.16 *4*	1^- #		
661.43 *4*	3^- #		
763.21 *15*	5^- #		
941.54 *13*	0^+ &		
962.765 *18*	1^- @		
968.2 *3*	(2^-)	<8.5 ns	$T_{1/2}$: from delayed ceγ coincidence.
983.02 *6*	2^+ &		
985.47 *4*	2^- @		
1028.542 *18*	2^+ [a]		
1069.924 *22*	3^+ [a]		
1082.53 *4*	$(4)^-$ [b]	8.5 ns *5*	$T_{1/2}$: from $\beta\gamma$(t) (50-300β)(936.6γ)(t) (1970Be57).
1202.62 *4*	$(3)^-$ [c]		

† From Adopted Levels.
‡ K=0 g.s. band.
# K=0 octupole-vibrational band.
@ K=1 band.
& K=0 β-vibrational band.
[a] K=2 band.
[b] K=4 ν 7/2[743]+ν 1/2[631] proposed by 1972Wi22.
[c] K=3 ν 7/2[743]-ν 1/2[631] proposed by 1972Wi22.

β^- radiations

β measurements: β feeding to each level has been deduced from γ-transition intensities. The measured β energies and intensities are compared below with the values deduced from level scheme.

1950Fr53		1955Ra28	1956Ba95		1962Bo03		from level scheme	
Eβ	Iβ	Iβ	Eβ	Iβ	Eβ	Iβ	Eβ	Iβ
			≈ 200?	8%			222 *2*	11.3% *6*
			250 *10*	31%				
258	*53%*	55%			≈ 260	*58%* 4	263 *2*	45.% *4*
			280 *10*	20%				
							329 *2*	1.3% *1*
			1133	2.8%				
1272	*47%*	45%	1236 *5*	38%	≈ 1240	*42%* 4	*1248* 2	40.5% *10*

E(decay)	E(level)	$I\beta^{-}$ †	Log *ft*	Comments
(89.4 *7*)	1202.62	0.54 *5*	6.6 *1*	av $E\beta$=23.11 *19*
222 *2*	1069.924	11.51 *11*	6.5 *1*	av $E\beta$=60.07 *21*
263 *2*	1028.542	44.8 *5*	6.1 *1*	av $E\beta$=72.20 *21* $\delta(\Delta L=1/\Delta L=2)=10\ +\infty-3$ (1990Si11), so the transition is mainly gamov-Teller.
(306.5 *7*)	985.47	0.521 *7*	8.2 *1*	av $E\beta$=85.08 *22*
(309.0 *7*)	983.02	0.26 *3*	8.6 *1*	av $E\beta$=85.83 *22*
(329.2 *7*)	962.765	1.254 *13*	7.9 *1*	av $E\beta$=91.97 *22*
(630.6 *7*)	661.43	0.0384 *21*	10.4 *1*	av $E\beta$=189.34 *24*
(686.8 *7*)	605.16	0.102 *3*	10.1 *1*	av $E\beta$=208.56 *25*
1248 *2*	44.051	41.1 *6*	8.4 *1*	av $E\beta$=412.4 *3* $I\beta^{-}$: see comment on $I(\gamma+ce)(44.08\gamma)$.

† Absolute intensity per 100 decays.

γ(^{238}Pu)

Iγ normalization, I(γ+ce) normalization: From weighted average of the following absolute γ-ray intensities: 24.99% *34* (2012Le03), 25.6% *4* (2010Le01), 25.17% *13* (2006Re09), 25.19% *21* (1990Ch35), and 23.8% *6* (1967Sc34) for the 984.5-keV gamma ray.

$\gamma\gamma$: 1971Wi03.

Additional information 2.

1981Le15 normalized experimental α to α(K)(1028.54γ)=0.0088 (E2 theory).

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x-rays: measurements of 1981Le15 for Kα   x ray and of 1972Wi22 for K|   x ray
   Eγ       Iγ
  ----     ----
 99.6     0.769 8      Kα2      x ray
 average RI from 2006Re09 and 1981Le15.
103.7     1.16 8       Kα1      x ray
 average RI from 2006Re09 and 1981Le15.
117.3     0.295        Kβ1'      x ray
 from 2006Re09.
120.5     0.119        Kβ2'      x ray
 From RI(120.5) + RI(121.7)= 0.119 (2006Re09).
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E_γ [†]	I_γ [‡b]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [@]	δ [&]	α [c]	$I_{(\gamma+ce)}$ [b]	Comments
44.06 *2*	0.395 *6*	44.051	2$^+$	0.0	0$^+$	E2		775	320.6 *10*	Mult.: from α(M)exp=175 *20* (1981Le15). $I_{(\gamma+ce)}$: from ΣI(γ+ce)[(γ+ce) to g.s. excluding the 44.08γ]=76.4 *7*, the normalization factor 0.2519 *21*, and the requirement of 100% feeding of the g.s. by γ+ce, one gets I(γ+ce)(44γ)=320.6 *10* and Iβ(to 44 level)=41.0% *5*. From α, one then gets Iγ=0.413 *5*, including a 1% uncertainty assigned to the theoretical α value. 1990Ch35 report Iγ=0.35 *4*, and 1981Le15, based on ce data, report 0.32 *4*. I_γ: From I(ce) and theoretical α value. α: value given is the E2 theory value lowered by 3% (see 1987Ra01).
101.88 *3*	0.97 *4*	145.934	4$^+$	44.051	2$^+$	E2		14.8		Mult.: α(L)exp=11.2 *6*; (L1+L2):L3=1.61 *5* (1981Le15).
114.4 *4*	0.020 *4*	1082.53	(4)$^-$	968.2	(2$^-$)	(E2)		8.67		E_γ,I_γ: from 1972Wi22. Mult.: from an intensity balance at the 968 level, $\alpha\leq$16; therefore, mult could be E1, M1 or E2. An intensity balance at the 1083 level gives α=11 *6* which rules out E1 and pure M1. The proposed level structure requires ΔJ=2.
120.09 *3*	0.42[#] *3*	1202.62	(3)$^-$	1082.53	(4)$^-$	M1(+E2)	<0.38	3.81 *21*		Mult.: from α(L)exp=2.8 *6*, α(M)exp=0.69 *6*, α(N)exp=0.23 *3* (1981Le15).

^{238}Np β^- decay (continued)

$\gamma(^{238}$Pu) (continued)

E_γ[†]	I_γ[‡b]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	δ[&]	α[c]	Comments
132.77 *50*	0.0095 *8*	1202.62	(3)$^-$	1069.924	3$^+$	[E1]		0.271	
157.42 *5*	≈0.004	303.36	6$^+$	145.934	4$^+$	[E2]		2.243	E_γ,I_γ: from ^{242}Cm α decay (1981Le15).
174.08 *5*	0.091 *2*	1202.62	(3)$^-$	1028.542	2$^+$	[E1]		0.143	
^{x}220.87 *11*	0.0122 *14*					(M2)		11.45	α(K)exp=6.7 *15*, α(L)exp=4.0 *10* (1981Le15). E_γ,I_γ: from 1972Wi22. 1981Le15 report Iγ<0.14. Other: 2006Re09.
301.37 *7*	0.043 *3*	962.765	1$^-$	661.43	3$^-$	E2		0.213	Mult.: from ε decay.
319.26 *20*	0.033 *3*	1082.53	(4)$^-$	763.21	5$^-$	M1+E2	1.0 *5*	0.66 *23*	Mult.,δ: from α(K)exp=0.49 *20* (1981Le15).
321.8 *1*	0.0048 *20*	983.02	2$^+$	661.43	3$^-$				I_γ: From 1981Le15. Other value: Iγ=0.0048 *8* (2006Re09).
324.07 *15*	0.058 *2*	985.47	2$^-$	661.43	3$^-$	M1+E2	2.8 *8*	0.29 *6*	Mult.: from α(K)exp=0.17 *5* (1981Le15).
336.38 *15*	0.0009 *5*	941.54	0$^+$	605.16	1$^-$				E_γ: from ^{242}Cm α decay (1981Le15). I_γ: from the intensity of the 897γ and the branching ratio I(336γ)/I(897γ)=0.031 *15* in ^{242}Cm α decay. (1981Le15).
357.68 *9*	0.200 *4*	962.765	1$^-$	605.16	1$^-$	M1+E2	2.43 *20*	0.224 *15*	Mult.: from α(K)exp=0.13 *2* (1981Le15) and data in ε decay.
378.1 *1*	0.012 *2*	983.02	2$^+$	605.16	1$^-$				I_γ: From 1981Le15. Other value: Iγ=0.008 *8* (2006Re09).
380.33 *10*	0.043 *3*	985.47	2$^-$	605.16	1$^-$	[M1]		0.67	Mult.: see ε decay.
421.05 *10*	0.086 *3*	1082.53	(4)$^-$	661.43	3$^-$	[M1]		0.29	
459.80 *20*	0.012 *1*	763.21	5$^-$	303.36	6$^+$				E_γ: from ^{242}Cm α decay (1981Le15).
515.53 *7*	0.147 *3*	661.43	3$^-$	145.934	4$^+$	E1+M2[a]	0.114 *17*	0.023 *3*	δ: from α(K)exp in ε decay. 1990Si11 report δ=−0.2 +*2*−*5*.
561.17 *5*	0.419 *5*	605.16	1$^-$	44.051	2$^+$	E1[a]		0.0116	δ: 1990Si11 report δ=0.3 +∞−4. δ <0.05 from α(K)exp in ε decay.
605.18 *5*	0.308 *6*	605.16	1$^-$	0.0	0$^+$	E1[a]		0.0101	
617.41[d] *5*	0.269[d#] *6*	661.43	3$^-$	44.051	2$^+$	E1+M2[a]	0.077 *17*	0.0122 *13*	δ: from α(K)exp in ε decay. 1990Si11 report δ=−0.2 +*1*−*2*.
617.41[d]	≈0.03[d#]	763.21	5$^-$	145.934	4$^+$				
836.88 *7*	0.095 *5*	983.02	2$^+$	145.934	4$^+$	[E2]		0.0176	
882.63 *3*	3.19 *2*	1028.542	2$^+$	145.934	4$^+$	E2		0.0159	Mult.: from α(K)exp=0.0115 *8* (1981Le15).
^{x}885.00 *15*	0.16 *2*								E_γ,I_γ: from 2006Re09.
897.55 *30*	0.032 *3*	941.54	0$^+$	44.051	2$^+$	(E2)		0.0154	Mult.: from ε decay.
918.70 *4*	2.10 *2*	962.765	1$^-$	44.051	2$^+$	E1		0.00471	Mult.: from α(K)exp=0.0036 *8* (1981Le15). δ: 1990Si11 report δ=−0.02 +*11*−*3*. δ <0.05 from α(K)exp in ε decay.
923.99 *2*	10.33 *5*	1069.924	3$^+$	145.934	4$^+$	M1+E2	+44 +*72*−*8*	0.0145	Mult.: from α(K)exp=0.0099 *4* (1981Le15) δ; from 1990Si11.
924	0.26	968.2	(2$^-$)	44.051	2$^+$				Eγ and Iγ measured by 1970Be57 in delayed ceγ coincidence.
936.60 *5*	1.43[#] *1*	1082.53	(4)$^-$	145.934	4$^+$	[E1+M2]	−0.24 *4*	0.009 *5*	δ: From 1990Si11.
938.85 *30*	0.117 *7*	983.02	2$^+$	44.051	2$^+$	E0+E2		4.4 *4*	Mult.: from α(K)exp=3.5 *4*, K/L=5.2 *2* (1981Le15); K:L12:M12=72:21:7.5 (1960Al29). I_γ: Other from Iγ/Iγ(837γ)=0.94 *22* in α decay.

^{238}Np β^- decay (continued)

γ(^{238}Pu) (continued)

E_γ[†]	I_γ[‡b]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	δ[&]	α[c]	$I_{(\gamma+ce)}$[b]	Comments
941.41 *4*	1.98 *2*	985.47	2^-	44.051	2^+	[E1+M2]	−0.17 *+1−2*	0.0079 *6*		δ: from 1990Si11.
941.5 *3*		941.54	0^+	0.0	0^+	E0			0.042 *3*	Mult.: no photons were observed, Ice(K)=0.0338 *25* (1981Le15).
962.76 *2*	2.56 *2*	962.765	1^-	0.0	0^+	E1		0.0043		Mult.: from α(K)exp=0.0021 *10* (1981Le15).
968.2 *4*	0.032 *14*	968.2	(2^-)	0.0	0^+	[M2]		0.122		
983.0 *3*	0.27 *8*	983.02	2^+	0.0	0^+	[E2]		0.0129		E_γ,I_γ: from α decay. $I\gamma/I\gamma(837\gamma)$=2.7 *8*.
984.45	100 *1*	1028.542	2^+	44.051	2^+	M1+E2	>+23	0.0129		Mult.: from α(K)exp=0.0096 *3*; K/L=4.4 *2*; (L1+L2)/L3=19 *2*; L/M=3.4 *2* (1981Le15) α(K)exp=0.0100 from absolute Ice measurements of 1962Bo03, and absolute I(γ)=23.8 *6* measurements of 1967Sc34. δ: From 1990Si11.
1025.87 *2*	34.8 *2*	1069.924	3^+	44.051	2^+	M1+E2	>+31	0.0119		Mult.: from α(K)exp=0.0091 *4*, K/L=4.3 *3* (1981Le15). δ: from 1990Si11.
1028.53 *2*	72.5 *3*	1028.542	2^+	0.0	0^+	E2		0.0119		Mult.: from K/L=4.2 *2* (1981Le15).

[†] From 2006Re09, unless otherwise noted. Others: 1981Le15, 1972Wi22. include their Eγ values from α decay in these weighted averages See also 1970Be57 (semi), 1970Pa22 (semi), 1962Bo03 (s ce), 1960Al29 (s ce), 1956Ba95 (s ce), 1967Sc34 and 1969GuZW (semi) see also γ and ce′s observed in ^{238}Am ε decay, ^{242}Am α decay. Other measurements: 1950Fr53 (s ce), 1955Ra27 (s ce), 1959Ga13 (s ce).

[‡] Weighted average from 2006Re09, 2010Le01, 1990Ch35, 1981Le15, and 1971We22, unless otherwise noted. The Iγ are normalized to Iγ(984γ)=100 others: 2009So02, 1970Pa22, 1970Be57, 1969GuZW, 1967Sc34.

[#] Iγ=0.269 *6* for the doubly placed 617 transition. 1981Le15 divide the intensity based on band structure considerations whereby one expects Iγ/Iγ(459.8γ) from the 763 *5*- level to be ≈3. The evaluators assign an uncertainty of 50% to this estimate in order to deduce Iγ for placement from the 661 *3*- level.

[@] From ce data of 1956Ba95, 1960Al29, 1962Bo03, 1981Le15. See also ε decay.

[&] Values of 1990Si11 are from low temperature nuclear orientation of ^{238}Np(Gd).

[a] From ce data in ^{242}Cm α decay.

[b] For absolute intensity per 100 decays, multiply by 0.2515 *13*.

[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.

[d] Multiply placed with intensity suitably divided.

[x] γ ray not placed in level scheme.

$^{238}_{94}\mathrm{Pu}_{144}$-5

^{238}Np β^- decay

Decay Scheme

Intensities: I_γ per 100 parent decays
@ Multiply placed: intensity suitably divided

Legend