^{233}Np ε decay (36.2 min) 1973We08

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	B. Singh, J. K. Tuli, E. Browne	NDS 170, 499 (2020)	8-Oct-2020

Parent: ^{233}Np: E=0.0; J$^\pi$=(5/2$^+$); T$_{1/2}$=36.2 min *1*; Q(ε)=1030 *50*; %ε+%β^+ decay≈100.0
^{233}Np-J$^\pi$,T$_{1/2}$: From ^{233}Np Adopted Levels.
^{233}Np-Q(ε): From 2017Wa10.
^{233}Np-%ε+%β^+ decay: %ε≈100, %α≤0.001.
1973We08: ^{233}Np source was prepared in ^{233}U(d,2n),E=18 MeV reaction using Karlsruhe Isochronous cyclotron. Measured Eγ, Iγ, half-life of decay of ^{233}Np using Ge(Li) detectors.
^{233}Np ε decay scheme is basically from 1973We08. Transitions that were not observed by 1973We08, but were seen in ^{233}Pa β^- and ^{237}Pu α decays were added by evaluators for the sake of completeness. The 205.3-keV γ was placed by 1973We08 to deexcite the 298.4-keV level. This γ was not seen in ^{233}Pa β^- decay studies by 1973Va33 in coincidence spectrum with 42-keV γ.

^{233}U Levels

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$[‡]
0.0[#]	5/2$^+$	1.592×10^5 y *2*
40.351[#] *10*	7/2$^+$	
92.11[#] *4*	9/2$^+$	
298.815[&] *13*	(5/2$^-$)	
311.911[@] *12*	3/2$^+$	
320.69[&] *7*	7/2$^-$	
340.476[@] *12*	5/2$^+$	
546.53[a] *18*	(5/2$^+$)	
597.23[a] *23*	(7/2$^+$)	

[†] From least-squares fit to Eγ data.
[‡] From the Adopted Levels.
[#] Member of 5/2[633] band.
[@] Member of 3/2[631] band.
[&] Member of 5/2[752] band.
[a] Member of 5/2[622] band.

ε,β^+ radiations

E(decay)	E(level)	Iε[†]	Log *ft*	Comments
(4.3×10^2 *5*)	597.23	≈0.2	≈7.1	εK= 0.7039; εL= 0.2166; εM+= 0.07949
(4.8×10^2 *5*)	546.53	≈1.1	≈6.5	εK= 0.7141; εL= 0.2095; εM+= 0.07639
(6.9×10^2 *5*)	340.476	≈0.4	≈7.3	εK= 0.7390; εL= 0.1921; εM+= 0.06888
(7.1×10^2 *5*)	320.69	≈0.2	≈7.6	εK= 0.7406; εL= 0.1910; εM+= 0.06841
(7.2×10^2 *5*)	311.911	≈0.6	≈7.1	εK= 0.7412; εL= 0.1906; εM+= 0.06821
(7.3×10^2 *5*)	298.815	≈0.6	≈7.1	εK= 0.7422; εL= 0.1899; εM+= 0.06792
(9.9×10^2 *5*)	40.351			
(1.03×10^3 *5*)	0.0	≈97	≈5.2	εK= 0.7571; εL= 0.1795; εM+= 0.06346 I(ε+β^+): the ε branching to ground-state band was estimated by 1973We08 as 97% from K x-ray intensity, but the x-ray intensity is not given by the authors.

[†] For absolute intensity per 100 decays, multiply by ≈1.0.

γ(^{233}U)

Iγ normalization: Assumption of ε branching of ≈97% to the 5/2[633] g.s. band, as estimated by 1973We08 based on K x-ray intensity, yields ≈0.007 as the normalization factor to convert relative photon intensities to absolute intensities.

Eγ[†]	Iγ[†&]	Ei(level)	J^{π}_i	E_f	J^{π}_f	Mult.[#]	δ[#]	α[a]	Comments
(28.562[‡] *11*)	0.130[‡] *10*	340.476	5/2+	311.911	3/2+	M1+E2	0.16 *2*	3.2×10^2 *4*	α(L)=2.4×10^2 *3*; α(M)=60 *7* α(N)=16.3 *19*; α(O)=3.9 *5*; α(P)=0.69 *7*; α(Q)=0.0336 *5*
(40.351[‡] *10*)		40.351	7/2+	0.0	5/2+	M1+E2	0.93 *11*	5.1×10^2 *6*	α(L)=3.7×10^2 *5*; α(M)=102 *13* α(N)=28 *4*; α(O)=6.4 *8*; α(P)=1.04 *12*; α(Q)=0.0087 *5*
(41.660[‡] *10*)	0.023[‡] *3*	340.476	5/2+	298.815	(5/2−)	[E1]		1.255	α(L)=0.940 *14*; α(M)=0.236 *4* α(N)=0.0621 *9*; α(O)=0.01399 *20*; α(P)=0.00219 *3*; α(Q)=7.52×10^{-5} *11*
(51.5[‡] *5*)		92.11	9/2+	40.351	7/2+				
(92.1[‡] *5*)		92.11	9/2+	0.0	5/2+				
[x]205.3 *4*	3.3 *3*								
226.0 *5*	5.1 *4*	546.53	(5/2+)	320.69	7/2−	[E1]		0.0742	α(K)=0.0586 *9*; α(L)=0.01183 *18*; α(M)=0.00286 *5* α(N)=0.000765 *12*; α(O)=0.000182 *3*; α(P)=3.31×10^{-5} *5*; α(Q)=1.99×10^{-6} *3*
(228.57[‡] *5*)	5.9[‡] *10*	320.69	7/2−	92.11	9/2+	[E1]		0.0723	α(K)=0.0571 *8*; α(L)=0.01151 *17*; α(M)=0.00279 *4* α(N)=0.000744 *11*; α(O)=0.000177 *3*; α(P)=3.22×10^{-5} *5*; α(Q)=1.94×10^{-6} *3*
234.3 *3*	22 *1*	546.53	(5/2+)	311.911	3/2+	[M1]		1.99	α(K)=1.583 *23*; α(L)=0.307 *5*; α(M)=0.0742 *11* α(N)=0.0200 *3*; α(O)=0.00486 *7*; α(P)=0.000938 *14*; α(Q)=7.48×10^{-5} *11*
[x]242.5 *4*	12 *1*								
247.6 *4*	5.7 *7*	546.53	(5/2+)	298.815	(5/2−)	[E1]		0.0603	α(K)=0.0477 *7*; α(L)=0.00949 *14*; α(M)=0.00229 *4* α(N)=0.000613 *9*; α(O)=0.0001460 *22*; α(P)=2.67×10^{-5} *4*; α(Q)=1.638×10^{-6} *24*
(248.37[‡] *4*)	0.107[‡] *6*	340.476	5/2+	92.11	9/2+	[E2]		0.346 *6*	α(K)=0.1064 *16*; α(L)=0.175 *3*; α(M)=0.0479 *8* α(N)=0.01298 *22*; α(O)=0.00301 *5*; α(P)=0.000508 *9*; α(Q)=7.16×10^{-6} *11*
256.0 *5*	6.0 *4*	597.23	(7/2+)	340.476	5/2+	[M1]		1.555	α(K)=1.237 *19*; α(L)=0.240 *4*; α(M)=0.0579 *9* α(N)=0.01560 *24*; α(O)=0.00379 *6*; α(P)=0.000732 *11*; α(Q)=5.83×10^{-5} *9*
258.5 *5*	14 *1*	298.815	(5/2−)	40.351	7/2+	[E1]		0.0547	α(K)=0.0433 *7*; α(L)=0.00857 *13*; α(M)=0.00207 *3* α(N)=0.000553 *9*; α(O)=0.0001317 *20*; α(P)=2.41×10^{-5} *4*; α(Q)=1.496×10^{-6} *22* Eγ: 258.45 *2* in the Adopted dataset.
(271.556[‡] *10*)	0.84[‡] *1*	311.911	3/2+	40.351	7/2+	E2		0.258	α(K)=0.0904 *13*; α(L)=0.1227 *18*; α(M)=0.0334 *5* α(N)=0.00906 *13*; α(O)=0.00210 *3*; α(P)=0.000357 *5*; α(Q)=5.77×10^{-6} *8*

$^{233}_{92}U_{141}$-2

γ(^{233}U) (continued)

E_γ[†]	I_γ[†&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[#]	α[a]	Comments
280.5 *5*	19 *1*	320.69	7/2⁻	40.351	7/2⁺	[E1]		0.0455	α(K)=0.0362 *6*; α(L)=0.00706 *11*; α(M)=0.001704 *25* α(N)=0.000456 *7*; α(O)=0.0001087 *16*; α(P)=2.00×10^{-5} *3*; α(Q)=1.261×10^{-6} *19* E_γ: 280.57 *5* in the Adopted dataset.
298.81[‡] *2*	72 *4*	298.815	(5/2⁻)	0.0	5/2⁺	[E1]		0.0395	α(K)=0.0314 *5*; α(L)=0.00608 *9*; α(M)=0.001466 *21* α(N)=0.000392 *6*; α(O)=9.36×10^{-5} *14*; α(P)=1.725×10^{-5} *25*; α(Q)=1.104×10^{-6} *16* E_γ: 299.1 *3* for the unresolved doublet in ε decay. I_γ: 84 *4* was observed for the doublet at 299 keV. The two components are placed from 299 and 340 levels. Intensity divided by evaluators based on the following branching ratios in the Adopted dataset: 340 level: Iγ(300)/Iγ(340)=1.474 *21*, which give Iγ=11.6 *6* for placement from 340 level. Remaining intensity (84 *4*−11.6 *6*) of 72 *4* should belong to 299γ from 299 level, which is consistent with 63 *7* obtained from Iγ(299)/Iγ(258)=4.48 *36*, but somewhat more precise.
300.128[‡] *10*	11.6 *6*	340.476	5/2⁺	40.351	7/2⁺	M1+E2	−0.08 *2*	0.87[@] *3*	I_γ: see comment for 299.1γ from the 299 level for division of the intensity of the 299γ doublet. E_γ: 299.1 *3* for the unresolved doublet in ε decay.
312.1 *3*	100	311.911	3/2⁺	0.0	5/2⁺	M1+E2	−0.10 *1*	0.80[@] *3*	E_γ: 311.901 *10* in the Adopted dataset.
321.0 *3*	9.9 *7*	320.69	7/2⁻	0.0	5/2⁺	[E1]		0.0338	α(K)=0.0270 *4*; α(L)=0.00517 *8*; α(M)=0.001245 *18* α(N)=0.000333 *5*; α(O)=7.96×10^{-5} *12*; α(P)=1.471×10^{-5} *21*; α(Q)=9.55×10^{-7} *14* E_γ: 320.73 *10* in the Adopted dataset.
340.7 *4*	7.9 *4*	340.476	5/2⁺	0.0	5/2⁺	M1+E2	−0.23 *5*	0.62[@] *3*	E_γ: 340.477 *10* in the Adopted dataset.
^{x}393.0 *4*	2.5 *2*								
^{x}425.6 *4*	8.3 *5*								
504.8 *5*	5.9 *9*	597.23	(7/2⁺)	92.11	9/2⁺	[M1]		0.242	α(K)=0.194 *3*; α(L)=0.0370 *6*; α(M)=0.00892 *13* α(N)=0.00240 *4*; α(O)=0.000584 *9*; α(P)=0.0001126 *16*; α(Q)=8.98×10^{-6} *13*
506.5 *5*	22 *3*	546.53	(5/2⁺)	40.351	7/2⁺	[M1]		0.240	α(K)=0.192 *3*; α(L)=0.0366 *6*; α(M)=0.00884 *13* α(N)=0.00238 *4*; α(O)=0.000579 *9*; α(P)=0.0001116 *16*; α(Q)=8.90×10^{-6} *13*
546.9 *4*	40 *2*	546.53	(5/2⁺)	0.0	5/2⁺	[M1]		0.196	α(K)=0.1561 *22*; α(L)=0.0298 *5*; α(M)=0.00718 *11* α(N)=0.00193 *3*; α(O)=0.000470 *7*; α(P)=9.06×10^{-5} *13*; α(Q)=7.23×10^{-6} *11*
557.1 *4*	4.0 *4*	597.23	(7/2⁺)	40.351	7/2⁺	[M1]		0.186	α(K)=0.1486 *21*; α(L)=0.0283 *4*; α(M)=0.00683 *10* α(N)=0.00184 *3*; α(O)=0.000447 *7*; α(P)=8.62×10^{-5} *13*; α(Q)=6.88×10^{-6} *10*
597.7 *4*	3.8 *3*	597.23	(7/2⁺)	0.0	5/2⁺	[M1]		0.1541	α(K)=0.1231 *18*; α(L)=0.0234 *4*; α(M)=0.00564 *8* α(N)=0.001520 *22*; α(O)=0.000370 *6*; α(P)=7.13×10^{-5} *10*; α(Q)=5.69×10^{-6} *8*

$\gamma(^{233}U)$ (continued)

E_γ [†]	I_γ [†&]	E_i(level)
[x]644.4 *5*	1.1 *1*	
[x]665.9 *4*	2.4 *2*	

[†] From 1973We08.
[‡] From the Adopted Levels, Gammas dataset. This γ is not observed in ^{233}Np ε decay.
[#] From the Adopted dataset. Multipolarities in square brackets are assumed from ΔJ^π values. The ΔJ=1 transitions from the 5/2[622] band members to the 5/2[633] band members are assumed as M1, as opposed to M1+E2, in analogy to those transitions in ^{233}Th and ^{235}U.
[@] From ^{233}U β^- decay, where measured conversion coefficients are from 1989Br24, who found this transition to have penetration effects.
[&] For absolute intensity per 100 decays, multiply by ≈0.007.
[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.

$^{233}_{92}U_{141}$-4

^{233}Np ε decay (36.2 min) 1973We08