^{234}Th β^- decay

History

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

Parent: ^{234}Th: E=0.0; $J^\pi=0^+$; $T_{1/2}$=24.10 d *3*; Q(β^-)=273 *3*; %β^- decay=100.0

Additional information 1.

2004Ab03: Measured %Iγ(63.29γ) relative to %Iγ(59.41γ) in ^{241}Am decay. Source ^{238}U α decay.

Measured $\beta\gamma$: 1963Bj02, 1956On07, 1955De40, 1954Jo19.

Measured $\gamma\gamma$: 1973Go40, 1962Ad01, 1954Jo19.

^{234}Pa Levels

E(level)	J^π	$T_{1/2}$	Comments
0.0	4^+	6.70 h *5*	
73.92 *2*	(3^+)		
73.92+x	(0^-)	1.159 min *16*	
103.42+x	(2^-)	<0.5 ns	$T_{1/2}$: (63γ)(L x-rays)(t) (1958Va34).
166.30+x	(1^-)	≤0.1 ns	$T_{1/2}$: (100β)(93γ)(t) (1964Ab04).
166.72+x	(1^+)	0.55 ns *10*	$T_{1/2}$: (100β)(63γ)(t) (1964Ab04). Other measurement: 1958Va34.
177.27+x?	(1^-)		
186.73+x	(1^+)		

β^- radiations

Measured β's:

1953St36 (s)		1955De40 ($\beta\gamma$)		1963Bj02 (s)		1973Go40 (s)	
Eβ	Iβ(%)	Eβ	Iβ(%)	Eβ	Iβ(%)	Eβ	Iβ(%)
						22 3	1.3 7
						60 3	5.4 10
103	33	100 2	35	100	33	104 2	20.7 10
193	67	191	65 3	194	67	198.5 15	72.5 20

other β^- measurements: 1946Jn01, 1947Br01, 1954Jo19, 1956On07.

E(decay)	E(level)	Iβ^-[†][‡]	Log *ft*	Comments
(4×10^1[@] *4*)	186.73+x	1.5 *7*	7.0	av Eβ=22.3 *8*
(5×10^1[#@] *5*)	177.27+x?	0.015 *5*	9.2	av Eβ=24.8 *8*
(5×10^1[@] *5*)	166.72+x	6.4 *9*	6.7	av Eβ=27.7 *9*
(5×10^1[@] *5*)	166.30+x	14 *2*	6.4	av Eβ=27.8 *9*
198.5 *15*	73.92+x	78 *2*	6.4	av Eβ=53.6 *9*

[†] All β branchings have been deduced from intensity balance at each level.

[‡] Absolute intensity per 100 decays.

[#] Existence of this branch is questionable.

[@] Estimated for a range of levels.

^{234}Th β^- decay (continued)

$\gamma(^{234}Pa)$

Iγ normalization: From %Iγ(63.29γ + 62.86γ)=3.72 *7*, weighted average of 3.743 *71* (2004Ab03) and 3.65 *11*. The latter has been calculated from Iγ(63.29γ + 62.86γ)/Iγ(1001γ in ^{234m}Pa β- Decay)=4.33 *12* [weighted average of 4.33 *9* (1982Mo30) and 4.29 *12* (1990Sc09)], and %Iγ(1001γ)=0.843 *8* [value recommended by the evaluators (See ^{234m}Pa β- Decay)].

Iγ normalization: %Iγ(92.38γ + 92.80γ)=5.57 *28* reported in 1992Li05 disagrees with 4.2% 3, deduced by the evaluators from Iγ(rel)(92.38γ + 92.80γ)=846 *32* and Iγ normalization=0.0050 *4*. Although the cause for this disagreement has not been determined, it is plausible that a 93.3-keV line from Th Kα_1 x ray may have affected the results in 1992Li05.

Ice′s given here are from 1973Go40. The original intensities have been renormalized by the evaluators such that α(L1)(92.38γ)=3.53 *5*, theoretical value (BRICC).

E_γ [†]	I_γ [‡@]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	δ	α [&]	Comments
(<10)		73.92+x	(0$^-$)	73.92	(3$^+$)				E_γ: transition was not observed. Energy of this expected transition was deduced by 1973Go40 from nonobservation of its conversion electrons. Their detection limit was 6 keV, and if there were conversion lines belonging to this transition in the 6 keV<E<10 keV energy range, they would have been obscured by intense Auger and Coster-Kronig electrons. Ti(<10γ)=Ti(73.92γ deexciting the 73.92 level). If there is no other transition deexciting the 1.159-min isomeric level, then Ti(<10−keV γ)= Ti(1.159-min isomeric-decay branch)=0.16% 4.
20.02 *2*	1.0 *4*	186.73+x	(1$^+$)	166.72+x	(1$^+$)	M1+E2	0.08 *2*	2.4×10^2 *7*	α(L)=7.E1 4; α(M)=124 *21*; α(N+..)=43 *7* α(N)=33 *6*; α(O)=7.8 *13*; α(P)=1.42 *20*; α(Q)=0.0885 *13* I_γ: calculated by the evaluators from measured Ice(M)′s and M-subshell conversion coefficients. Ice(M1)=107 *4*; M1:M2:M3:N1:N2:N3:O1= 107 *4*:47 *2*:26 *5*:32 *5*:13 *3*:12 *3*:10 *3*.
29.49 *2*	0.24 *2*	103.42+x	(2$^-$)	73.92+x	(0$^-$)	E2		4.40×10^3	α(L)=3.22×10^3 *5*; α(M)=882 *13*; α(N+..)=299 *5* α(N)=237 *4*; α(O)=53.4 *8*; α(P)=8.54 *13*; α(Q)=0.01691 *25* I_γ: calculated by the evaluator from Ice(L3) and theoretical conversion coefficient (BRICC) of lc3=1565 *23*. Ice(L3)=353 *35*; L2:L3:M1:M2:M3:(N2+N3):O= 341 *35*:353 *35*:3.8 *20*:97.5 *70*:97.5 *70*:59 *10*:24 *7*.
[x]57.75 *10*	1.0 *6*								I_γ: from 1973Go40.
62.86 *2*	3.2 *5*	166.30+x	(1$^-$)	103.42+x	(2$^-$)	M1+E2	0.33 *8*	25 *5*	α(L)=19 *4*; α(M)=4.8 *9*; α(N+..)=1.7 *3* α(N)=1.30 *24*; α(O)=0.30 *6*; α(P)=0.054 *9*; α(Q)=0.00277 *12* E_γ: 62.97 *9* was measured by 1973Ta25. I_γ: Iγ(62.86γ+63.29γ)=736; Iγ(62.86γ)=3.2 *5* from Ice(L)′s and L-subshell conversion coefficients. Ice(L3)=10.6 *9*; L1:L2:L3:M1:M2:M3:N1:N2= 28 *3*:20 *1*:10.6 *9*:6.4 *5*:4.0 *9*:4.0 *3*:2.1 *6*:1.9 *6*.
63.29 *2*	733 *51*	166.72+x	(1$^+$)	103.42+x	(2$^-$)	E1		0.405	α(L)=0.305 *5*; α(M)=0.0750 *11*; α(N+..)=0.0250 *4* α(N)=0.0197 *3*; α(O)=0.00447 *7*; α(P)=0.000737 *11*;

^{234}Th β^- decay (continued)

$\gamma(^{234}Pa)$ (continued)

E_γ[†]	I_γ[‡@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ	α[&]	Comments
									α(Q)=3.14×10^{-5} *5* Iγ: from Iγ(62.86γ+63.29γ)=736 and Iγ(62.86γ)=3.2 *5*. Eγ: 63.282 *2* (1973Sa33), 63.35 *9* (1973Ta25). Ice(L1)=70 *6*; L1:L2:L3:M1:M2:M3:M4:M5:N1:N2:N3:O= 70 *6*:57 *1*:62 *2*:19 *4*:19 *4*:15 *4*:1.3 *7*:1.3 *7*:5.1 *11*:3.8 *10*:4.0 *10*:3.8 *10*. ΔIγ=51, estimated by evaluators.
73.92[ab]		177.27+x?	(1$^-$)	103.42+x	(2$^-$)				
73.92[a] *2*	2.6 *2*	73.92	(3$^+$)	0.0	4$^+$	(M1+E2)	0.11 *3*	10.6 *4*	α(L)=7.96 *25*; α(M)=1.94 *7*; α(N+..)=0.669 *23* α(N)=0.520 *18*; α(O)=0.124 *4*; α(P)=0.0235 *7*; α(Q)=0.00185 *3* Ice(L1)=13.2 *3*; L1:L2:M1=132 *3*:21 *2*:42 *2*.
83.30 *5*	12.0 *6*	186.73+x	(1$^+$)	103.42+x	(2$^-$)	[E1]		0.196	α(L)=0.1475 *21*; α(M)=0.0361 *5*; α(N+..)=0.01208 *17* α(N)=0.00952 *14*; α(O)=0.00218 *3*; α(P)=0.000369 *6*; α(Q)=1.735×10^{-5} *25*
[x]87.02 *6*	2.9 *5*					(M1+E2)		15 *9*	α(L)=11 *7*; α(M)=2.9 *18*; α(N+..)=1.0 *6* α(N)=0.8 *5*; α(O)=0.18 *11*; α(P)=0.030 *17*; α(Q)=0.0007 *5* Iγ: 1.4 *2* was measured by 1973Go40.
[x]92.00 *5*									Ice(L1)=5.7 *4*; L1/M1=57 *4*/23 *4*=2.4 *4*. Ice(L1)=5.1 *14*; L1/M1=3.0 *17*. No photon was observed.
92.38 *1*	426 *22*	166.30+x	(1$^-$)	73.92+x	(0$^-$)	M1		5.27	α(L)=3.98 *6*; α(M)=0.960 *14*; α(N+..)=0.332 *5* α(N)=0.257 *4*; α(O)=0.0618 *9*; α(P)=0.01180 *17*; α(Q)=0.000977 *14* Eγ=92.367 *5* (1973Sa33), 92.47 *8* (1973Ta25). Iγ: Iγ(92.38γ+92.80γ)=846 *43*; Iγ(92.38γ)=426 *22* from Iγ(92.38γ)/Iγ(92.80γ)=50.3 *7*/49.7 *7*, as measured by 1973Sa33 (contribution from Kα_1 x ray of thorium was removed). Ice(L1)=1504 *2*; L1:L2:L3:M1:M2:N1:O1:P1= 1504 *2*:≤184 *2*:10 *3*:386 *5*:48 *2*:115 *1*:24 *5*:7 *2*.
92.80 *2*	420 *22*	166.72+x	(1$^+$)	73.92+x	(0$^-$)	E1		0.1472	α(L)=0.1110 *16*; α(M)=0.0271 *4*; α(N+..)=0.00910 *13* α(N)=0.00716 *10*; α(O)=0.001643 *23*; α(P)=0.000281 *4*; α(Q)=1.370×10^{-5} *20* Iγ: see comment for Iγ(92.38γ). Eγ: 92.792 *5* (1973Sa33), 92.82 *8* (1973Ta25). Ice(L1)=34 *4*; L1:L2:L3=34 *4*:17 *3*:13 *10*.
103.35 *10*	0.63 *19*	177.27+x?	(1$^-$)	73.92+x	(0$^-$)	[M1]		3.81	α(L)=2.87 *5*; α(M)=0.693 *10*; α(N+..)=0.240 *4* α(N)=0.186 *3*; α(O)=0.0446 *7*; α(P)=0.00853 *13*; α(Q)=0.000706 *10* The photon peak was assumed by 1973Go40 to be a doublet from observed ce lines assigned as L1 lines. Iγ: calculated from Ice(L1) and α(L1)(M1 theory)=2.55 *4* (BRICC). Iγ(103.35γ+103.71γ)=1.31 *10* was measured by 1973Go40 and Iγ(103.5γ)=0.8 *1* was given by 1978Ch06. Ice(L1 103.35γ)=1.6 *5*. Ice(L1 103.71γ)=2.9 *8*.
[x]103.71 *6*									
[x]108.00 *5*	1.6 *2*								

^{234}Th β^- decay (continued)

$\gamma(^{234}Pa)$ (continued)

E_γ [†]	I_γ [‡@]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	α [&]	Comments
112.81 *5*	42 *3*	186.73+x	(1^+)	73.92+x	(0^-)	[E1]	0.23 *14*	α(K)≤0.29; α(L)=0.0674; α(M)=0.01636; α(N+..)=0.00581 α: limit on α(K) has been obtained by the evaluators from extrapolation of α(K)′s for Eγ≥113.6 keV. The K-binding energy for protactinium is 112.6 keV; therefore, a large uncertainty on the total conversion coefficient is given to reflect the uncertainty of the α(K) value.
[x]132.9								1973Go40 propose that the 132.9γ deexcites a 2^+ state at 206.8+x keV to the 0^- level at 73.92+x keV. Ice(K)=5.9 *20*. The ce line observed at 111.78 keV with Ice=3.4 *14* was assigned by 1973Go40 to L1(132.9γ); however, the ce line observed at 112 keV was assigned by 1963Bj02 to ^{234}Pa g.s. decay (ce(K) 227.25γ). Iγ(132.9γ)=0.19 *6*, if it is an M2 transition, as suggested by 1973Go40.
[x]184.8	2 *1*							I_γ: from 1965Fo09. No intensity is given by 1973Go40, and this transition was not observed by 1978Ch06.

[†] Measurements by 1973Go40 (s ce, semi γ). These measurements are in agreement with the measurements by 1978Ch06 (semi γ), 1963Bj02 (s ce), 1962Fo11 (s ce), 1961Ge13 (s ce). The authors of 1973Sa33 (Ge(Li) x-ray) and 1973Ta25 (Si(Li)) measured Eγ′s for the doublets in 63- and 92-keV peaks. Their measured energies are given for comparison.

[‡] Relative photon intensities are from 1978Ch06, unless otherwise noted.

[#] From ce data of 1973Go40. See also 1962Fo11 and 1963Bj02. Multipolarities in square brackets are from level scheme.

[@] For absolute intensity per 100 decays, multiply by 0.0050 *4*.

[&] 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.

[a] Multiply placed.

[b] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

$^{234}_{91}Pa_{143}$-4

^{234}Th β^- decay

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays