^{167}Tm ε decay (9.25 d) 1968Fu09

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 191,1 (2023)	22-Aug-2023

Parent: ^{167}Tm: E=0.0; J^π=1/2$^+$; $T_{1/2}$=9.25 d *2*; Q(ε)=746.1 *13*; %ε decay=100

^{167}Tm-J^π,$T_{1/2}$: From Adopted Levels of ^{167}Tm.

^{167}Tm-Q(ε): From 2021Wa16.

1968Fu09 (also 1965Fu04): ^{167}Tm from ^{165}Ho(α,2n). Measured Eγ, Iγ, delayed (x ray)(ce)-coin using Ge(Li) and Si(Li) detectors at Rossendorf cyclotron facility.

2016Ch04: ^{167}Tm produced in ^{165}Ho(α,2n),Eα=29 MeV reaction at the 88-Inch Cyclotron at LBNL. Measured x rays and γ rays using coaxial and planer HPGe detectors; Measured absolute γ-ray branching ratios for 207.8- and 531.5-keV γ rays.

1979ArZU: measured subshell ce data for 57.1, 207.8 and 264.9 γ rays, and Auger electron intensities using a magnetic spectrometer.

Others:

1996BeZY: measured K-shell capture probability P_K for 265 and 532 levels.

1991Mu15: measured α(K)exp for 207.8γ and α(L)exp for 57.1γ.

1991Be15: measured K-shell capture probability P_K by γ(x ray)-coin.

1990Mu05: measured K-shell capture probability P_K using sum-coin method for γ and x rays.

1987BaZB: measured L-subshell ratios for 57.1 and 207.8 γ rays.

1982BeYN: measured (x ray)γ-coin; deduced K- and L-shell capture probabilities.

1982Ar22 (also 1979ArZU): measured L-Series Auger electron spectra.

1966Ja16: measured half-life of the 265-keV level by $\gamma\gamma$(t).

1963Al32: measured Eγ for 50 and 208 γ rays, half-life of the 208-keV isomer, K-conversion coefficient for 208γ.

1962Ko09: measured multipolarity of 208 and 532 γ rays.

1962Dz03: data for 532 level.

1960Na14: measured Eγ, Iγ for four γ rays.

1959Ha09: measured ce for 57, 208 and 532 γ rays.

1958Be72: measured half-life of 264-keV level by (x ray)(ce)-coin.

1957Mi01: measured half-life and K/L ratio for the 208-keV isomer in ^{167}Er.

1957Gr74: measured ce spectrum.

1957Go78: measured Eγ, Iγ for three γ rays.

1955Ne01: measured Eγ, Iγ for five γ rays, half-life of ^{167}Tm decay.

Additional information 1.

Theory references for decay of ^{167}Tm: 2023Ke01, 1975Fe13.

^{167}Er Levels

E(level)†	J^π‡	$T_{1/2}$‡	Comments
0.0	7/2$^+$	stable	
207.801 *5*	1/2$^-$	2.269 s *6*	$T_{1/2}$: values from this study: 2.27 s *5* (1963Al32), 2.5 s (1957Mi01).
264.874 *5*	3/2$^-$	1.47 ns *5*	$T_{1/2}$: adopted value from (x ray)(ce)(t) (1968Fu09) in this study. Others: 1.46 ns *8* (1966Ja16, $\gamma\gamma$(t)); 2.0 ns *5* (1958Be72, (x ray)(57γ ce)(t)).
281.3 *5*	5/2$^-$		
346.5 *3*	5/2$^-$		
531.54 *4*	3/2$^+$		

† From a least-squares fit to Eγ data.

‡ From the Adopted Levels. Values from this dataset are given under comments.

^{167}Tm ε decay (9.25 d) 1968Fu09 (continued)

ε radiations

ε feedings are from intensity imbalance at each level; no feeding to g.s. is expected, because ΔJ=3.

E(decay)	E(level)	Iε[†]	Log *ft*	Comments
(214.6 *13*)	531.54	1.6 *4*	7.28 *11*	εK=0.7504 *11*; εL=0.1864 *6*; εM+=0.06317 *32* K-capture probability measurement: 0.755 *28* (1991Be15). εL(exp)/εK(exp)=0.243 *17* (1991Be15), implying Q(ε)=750 *+30−20* (1991Be15 is presumed to supersede 1982BeYN).
(399.6 *13*)	346.5	0.025 *5*	9.43[1u] *9*	εK=0.7288 *9*; εL=0.2022 *5*; εM+=0.06899 *29*
(481.2 *13*)	264.874	28 *6*	6.87 *9*	εK=0.80614 *38*; εL=0.14632 *17*; εM+=0.04755 *14* K-capture probability measurements: 0.813 *30* (1996BeZY), 0.835 *29* (1990Mu05). εL(exp)/εK(exp)=0.180 *16* (1996BeZY).
(538.3 *13*)	207.801	70 *17*	6.58 *11*	εK=0.80998 *35*; εL=0.14354 *16*; εM+=0.04648 *13*

† Absolute intensity per 100 decays.

γ(^{167}Er)

Iγ normalization: From total I(γ+ce) to g.s.=100%; no feeding to g.s. is expected because ΔJ=3.

Measured L-shell Auger electron intensities (1979ArZU): 0.45% *5* for KL1L1, 0.67% *7* for KL1L2, 0.09% *4* for KL2L2, 0.57% *6* for KL1L3, 1.13% *11* for KL2L3, 0.50% *5* for KL3L3, 3.4% *2* for summed KLL, and 150% *30* for summed LXY. See also 1982Ar22 (from the same group as 1979ArZU) for L-Auger spectrum.

I(Er Kα x ray)=310, relative to Iγ=10.0 for 531.5γ (1960Na14) (after correction for absorption and assuming ω_K=0.949), compared with I(Er Kα x ray)=466 from decay scheme.

E_γ	I_γ[b]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	δ[&]	α[c]	Comments
(16.7[#])	[@]	281.3	5/2⁻	264.874	3/2⁻				
57.0723[‡] *12*	29[†] *5*	264.874	3/2⁻	207.801	1/2⁻	M1+E2	0.352 *16*	5.02 *23*	%Iγ=4.6 *10* α(L)=3.88 *18*; α(M)=0.91 *5* α(N)=0.208 *10*; α(O)=0.0264 *11*; α(P)=0.000684 *11* I_γ: deduced from Iγ(207.8γ) and Ice(L)(57.1γ)/Ice(K)(207.8γ)=18.7 *9*/19.76 *24* (1979ArZU). L1:L2:L3:M1:M2:M3=7.3 *6*:5.6 *4*:5.8 *5*:1.5 *2*:1.4 *2*:1.5 *2*, and L1:M45:N:O=7.3 *6*:0.04 *2*:1.1 *1*:0.14 *3* (1979ArZU); L1/L2=1.43 *4*, L1/L3=1.17 *3* (1987BaZB); L1:L2:L3:M1:M2=280:235:245:180:50 (1959Ha09). δ: deduced by evaluators using BrIccMixing code. α(L)exp=18.3 *7* in 1991Mu15 implying δ=2.7 *+6−4* seems discrepant in view of much lower δ(E2/M1) value from subshell ratios.
(73.8[#])	[@]	281.3	5/2⁻	207.801	1/2⁻	E2		9.64	α(K)=1.90 *3*; α(L)=5.93 *9*; α(M)=1.446 *21* α(N)=0.327 *5*; α(O)=0.0379 *6*; α(P)=8.80×10^{-5} *13* Mult.: from the Adopted Gammas.
207.801[‡] *5*	258[†] *35*	207.801	1/2⁻	0.0	7/2⁺	E3		1.380	%Iγ=41.3 *4* α(K)exp=0.50 *5* (1963Al32); α(K)exp=0.47 *2* (1991Mu15) α(K)=0.476 *7*; α(L)=0.689 *10*; α(M)=0.1718 *24* α(N)=0.0392 *6*; α(O)=0.00466 *7*; α(P)=2.75×10^{-5} *4* Measured absolute intensity=41.9% *16* (2016Ch04). Other Eγ=207.8 (1968Fu09). K:L1:L2:L3:M:N:O=19.76 *24*:2.0 *2*:16.7 *17*:10.0 *10*, and K:M:N:O:=19.76 *24*:7.5 *8*:2.0 *3*:0.3 *1* (1979ArZU). K:L2:L3:M:N=1000:820:430:370:100 (1959Ha09); L1/L2=0.16 *1* and L1/L3=0.25 *1* (1987BaZB); K/L=0.72 *7* (1957Mi01).
250.2[†] *5*	0.014[†] *3*	531.54	3/2⁺	281.3	5/2⁻	[E1]		0.0292 *5*	α(K)=0.0246 *4*; α(L)=0.00359 *6*; α(M)=0.000793 *12* α(N)=0.000183 *3*; α(O)=2.56×10^{-5} *4*; α(P)=1.249×10^{-6} *19* %Iγ=0.0022 *6*
264.9[†]	≤0.46	264.874	3/2⁻	0.0	7/2⁺	[M2]		0.833	α(K)=0.664 *10*; α(L)=0.1306 *19*; α(M)=0.0300 *5*

γ(^{167}Er) (continued)

E_γ	I_γ [b]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [&]	α [c]	Comments
								α(N)=0.00702 *10*; α(O)=0.000999 *14*; α(P)=5.12×10^{-5} *8* %Iγ=0.04 *4* I$_\gamma$: upper limit of 0.46 *6* deduced from Iγ(207.8γ) and Ice(L)(264.9γ)/Ice(K)(207.8γ)≤0.1/19.76 *24* (1979ArZU).
266.5[†] *5*	0.014[†] *3*	531.54	3/2$^+$	264.874	3/2$^-$	E1[a]	0.0249	α(K)exp≤0.02 (1965Fu04) α(K)=0.0210 *4*; α(L)=0.00305 *5*; α(M)=0.000673 *10* α(N)=0.0001556 *23*; α(O)=2.18×10^{-5} *4*; α(P)=1.072×10^{-6} *16* %Iγ=0.0022 *6*
323.7[†] *5*	0.013[†] *3*	531.54	3/2$^+$	207.801	1/2$^-$	E1[a]	0.01538	α(K)exp≤0.01 (1965Fu04) α(K)=0.01299 *19*; α(L)=0.00187 *3*; α(M)=0.000411 *6* α(N)=9.51×10^{-5} *14*; α(O)=1.340×10^{-5} *20*; α(P)=6.75×10^{-7} *10* %Iγ=0.0021 *6*
346.5[†] *3*	0.155[†] *20*	346.5	5/2$^-$	0.0	7/2$^+$	E1	0.01304	α(K)=0.01102 *16*; α(L)=0.001577 *23*; α(M)=0.000347 *5* α(N)=8.04×10^{-5} *12*; α(O)=1.135×10^{-5} *16*; α(P)=5.76×10^{-7} *9* %Iγ=0.025 *5* Mult.: from the Adopted Gammas.
531.54[‡] *4*	10.0[†]	531.54	3/2$^+$	0.0	7/2$^+$	E2[a]	0.01407	%Iγ=1.6 α(K)exp=0.013 (1965Fu04) α(K)=0.01128 *16*; α(L)=0.00217 *3*; α(M)=0.000494 *7* α(N)=0.0001140 *16*; α(O)=1.551×10^{-5} *22*; α(P)=6.27×10^{-7} *9* Measured absolute intensity=1.73% *7* (2016Ch04). K:L1:M=2.2:0.35:0.1 (1959Ha09). Other Eγ=531.5 (1968Fu09).

† From 1968Fu09.

‡ From the Adopted Gammas.

\# Rounded-off value from the Adopted Gammas. Transition is expected, but has not been observed in ^{167}Tm ε decay.

@ Negligible; if it is assumed that there is no ε branch, the only feeding into the 281.6 level is from 250.2γ (Iγ=0.014).

& From ce data as given under comments, unless otherwise noted. The same values are adopted in Adopted Gammas.

a From (x ray)γ- and (ce)γ-coin (1965Fu04).

b For absolute intensity per 100 decays, multiply by 0.160 *22*.

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.

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