^{164}Tm ε decay (5.1 min) 1992Ch03,1987Ad06,1971De22

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen[#]	NDS 147, 1 (2018)	30-Nov-2017

Parent: ^{164}Tm: E=0+x; $J^\pi=6^-$; $T_{1/2}$=5.1 min *1*; Q(ε)=4039 *24*; %ε+%β^+ decay≈20.0
^{164}Tm-E: x=10 keV *6* (2017Au03), <40 keV (1987Dr07).
^{164}Tm-J^π,$T_{1/2}$: From ^{164}Tm Adopted Levels. Configuration=π[404]+ν[523].
^{164}Tm-Q(ε): from 2017Wa10.
1992Ch03: measured Eγ, Iγ, $\gamma\gamma$.
1987Ad06: measured Eγ, Iγ, $\gamma\gamma$.
1971De22: measured Eγ, Iγ, $\gamma\gamma$, ce, Xγ(t).
1973Ch28: measured $\gamma\gamma$(t).

^{164}Er Levels

A 2370 level proposed by 1987Ad06 is omitted. The deexciting 386γ is placed from 1744 level as proposed by 1992Ch03 and 1971De22.

E(level)[†]	J^π[‡]	$T_{1/2}$[#]	Comments
0.0	0^+		
91.40 *3*	2^+		
299.50 *5*	4^+		
614.44 *6*	6^+		
946.44 *6*	3^+		
1024.71 *10*	8^+		
1058.72 *11*	4^+		
1197.49 *7*	5^+		
1358.76 *12*	6^+		
1545.01 *18*	7^+		
1610.36 *17*	$(4^-,5^-)$		a 413γ (1987Ad06) from this level is not confirmed by 1992Ch03 or 1971De22.
1664.25 *7*	$(5)^-$	<0.08 ns	
1683.45[@] *9*	(5^+)		
1744.54 *7*	$(6)^-$	0.22 ns *3*	
1764.0[@] *4*	$(7)^-$		
1798.5[@] *4*	$(5)^-$		
1845.58 *8*	7^-		
1985.04 *7*	7^-	23.0 ns *16*	$T_{1/2}$: average of 22.7 ns *17* (1971De22) and 23.3 ns *16* (1973Ch28). Configuration=π7/2[404]⊗π7/2[523].
2163.63[@] *21*	(8^-)		
3303.1[@] *4*	$(6^-,7^-)$		

[†] From least-squares fit to Eγ data.
[‡] From Adopted Levels.
[#] From $\gamma\gamma$(t) (1973Ch28), unless otherwise stated.
[@] Level proposed by 1992Ch03 only.

^{164}Tm ε decay (5.1 min) 1992Ch03,1987Ad06,1971De22 (continued)

ε,β^+ radiations

The decay scheme seems fairly complete from total energy absorbed=801 keV *26* (from RADLST code) as compared to Q(ε)×%ε branching ratio=807 keV *5*.

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I($\varepsilon+\beta^+$)†	Comments
(736 *24*)	3303.1		0.23 *4*	5.9 *1*	0.23 *4*	εK=0.8186 *10*; εL=0.1394 *7*; εM+=0.04204 *25*
(2054 *24*)	1985.04	0.49 *5*	14.9 *6*	5.01 *3*	15.4 *6*	av Eβ=483 *14*; εK=0.805 *3*; εL=0.1258 *5*; εM+=0.03745 *16*
(2193 *24*)	1845.58	0.02 *1*	0.5 *3*	6.6 *3*	0.5 *3*	av Eβ=544 *14*; εK=0.792 *4*; εL=0.1234 *6*; εM+=0.03672 *19*
(2241 *24*)	1798.5	0.021 *4*	0.36 *6*	6.7 *1*	0.38 *6*	av Eβ=565 *14*; εK=0.786 *4*; εL=0.1224 *7*; εM+=0.03644 *20*
(2275 *24*)	1764.0	0.0090 *14*	0.14 *2*	7.1 *1*	0.15 *2*	av Eβ=580 *14*; εK=0.782 *4*; εL=0.1217 *7*; εM+=0.03622 *21*
(2294 *24*)	1744.54	0.08 *4*	1.2 *7*	6.2 *3*	1.3 *7*	av Eβ=589 *14*; εK=0.780 *4*; εL=0.1213 *7*; εM+=0.03610 *21*
(2356 *24*)	1683.45	0.062 *8*	0.80 *8*	6.40 *5*	0.86 *9*	av Eβ=616 *14*; εK=0.772 *5*; εL=0.1200 *8*; εM+=0.03569 *22*
(2375‡ *24*)	1664.25	<0.05	<0.6	>6.5	<0.7	av Eβ=624 *14*; εK=0.769 *5*; εL=0.1195 *8*; εM+=0.03555 *23*
(2429‡ *24*)	1610.36	<0.008	<0.08	>7.4	<0.09	av Eβ=648 *14*; εK=0.762 *5*; εL=0.1182 *8*; εM+=0.03516 *24*
(2494 *24*)	1545.01	0.013 *7*	0.12 *6*	7.3 *3*	0.13 *7*	av Eβ=677 *14*; εK=0.752 *5*; εL=0.1166 *9*; εM+=0.03466 *25*
(2680‡ *24*)	1358.76	<0.015	<0.095	>7.4	<0.11	av Eβ=760 *14*; εK=0.720 *6*; εL=0.1113 *10*; εM+=0.0331 *3*
(2842‡ *24*)	1197.49	<0.09	<0.4	>6.9	<0.5	av Eβ=832 *14*; εK=0.688 *7*; εL=0.1062 *11*; εM+=0.0316 *3*
(2980‡ *24*)	1058.72	<0.014	<0.17	>8.8^{1u}	<0.18	av Eβ=899 *14*; εK=0.765 *4*; εL=0.1220 *6*; εM+=0.03644 *19*
(3425‡ *24*)	614.44	<0.2	<0.5	>7.0	<0.7	av Eβ=1094 *15*; εK=0.558 *8*; εL=0.0856 *12*; εM+=0.0254 *4* I($\varepsilon+\beta^+$): from ΔK=6, feeding is expected to be zero.

† Absolute intensity per 100 decays.

‡ Existence of this branch is questionable.

γ(^{164}Er)

Iγ normalization: assuming no ε, β^+ feeding to levels of J≤4 and %IT≈80 (1971De22).

The following γ rays assigned tentatively by 1987Ad06 have been omitted since these are not reported by 1992Ch03 or 1971De22: 360.0, 362.2, 413.1, 536.2, 634.8, 672.4, 817.7, 1019.7, 1066.55 and 1488.17 keV. A 256.5γ reported by 1971DE22 only is also omitted.

Experimental conversion coefficients are from 1971De22.

E_γ[†]	I_γ[‡a]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ	α[&]	Comments
73.0[@] 3	1.9 3	1683.45	(5$^+$)	1610.36	(4$^-$,5$^-$)	(E1)		0.743 14	α(K)=0.611 11; α(L)=0.1037 19; α(M)=0.0230 5 α(N)=0.00524 10; α(O)=0.000685 13; α(P)=2.64×10^{-5} 5 Mult.: from α(exp)=0.9 3 (from intensity balance, 1992Ch03).
80.27 9	7.0 6	1744.54	(6)$^-$	1664.25	(5)$^-$	E2		6.88	α(K)=1.682 24; α(L)=3.99 6; α(M)=0.971 15 α(N)=0.219 4; α(O)=0.0255 4; α(P)=7.35×10^{-5} 11 α(K)exp=1.7 5; α(L)exp=6.6 22
91.40 3	41 6	91.40	2$^+$	0.0	0$^+$	E2		4.14	α(K)=1.314 19; α(L)=2.17 3; α(M)=0.528 8 α(N)=0.1194 17; α(O)=0.01396 20; α(P)=5.51×10^{-5} 8 α(K)exp=1.34 30; α(L)exp=2.9 10; α(M)exp=0.6 2
101.0[b]	<0.1	1845.58	7$^-$	1744.54	(6)$^-$				E_γ,I_γ: from 1992Ch03. Iγ<0.4 (1987Ad06), Iγ=1.7 9 (1971De22) for a 102.24γ.
139.44 8	26.3 10	1985.04	7$^-$	1845.58	7$^-$	E2+M1	15 5	0.872	α(K)=0.0457 7; α(L)=0.319 5; α(M)=0.0769 12; α(N)=0.0174 3; α(O)=0.00209 3 α(L)exp=0.27 6; α(M)exp=0.094 18 E_γ,I_γ: 139.80 6, Iγ=21.2 16 (1987Ad06) not used in averaging.
178.61[@] 20	1.5 2	2163.63	(8$^-$)	1985.04	7$^-$				
199.4 2	1.4 5	1744.54	(6)$^-$	1545.01	7$^+$	[E1]		0.0524	I_γ: <0.4 (1987Ad06).
208.10 3	155 5	299.50	4$^+$	91.40	2$^+$	E2		0.221	α(K)=0.1445 21; α(L)=0.0587 9; α(M)=0.01395 20 α(N)=0.00318 5; α(O)=0.000394 6; α(P)=6.87×10^{-6} 10 α(K)exp=0.161 16; α(L)exp=0.069 6; α(M)exp=0.016 2
240.49 3	81 4	1985.04	7$^-$	1744.54	(6)$^-$	M1		0.242	α(K)=0.204 3; α(L)=0.0301 5; α(M)=0.00668 10 α(N)=0.001557 22; α(O)=0.000225 4; α(P)=1.248×10^{-5} 18 α(K)exp=0.22 3; α(L)exp=0.042 12; α(M)exp<0.014
251.0[@] 2	2.2 2	1197.49	5$^+$	946.44	3$^+$				
299.8[@] 3	1.4 3	1358.76	6$^+$	1058.72	4$^+$	E2		0.0691	α(K)=0.0504 7; α(L)=0.01423 20; α(M)=0.00333 5 α(N)=0.000762 11; α(O)=9.80×10^{-5} 14; α(P)=2.60×10^{-6} 4
314.97 4	100	614.44	6$^+$	299.50	4$^+$	E2		0.0596	α(K)=0.0441 7; α(L)=0.01197 17; α(M)=0.00279 4 α(N)=0.000640 9; α(O)=8.27×10^{-5} 12; α(P)=2.29×10^{-6} 4 α(K)exp=0.044 4; α(L)exp=0.0104 12; α(M)exp=0.0030 7
347.2[@] 6	0.8 2	1545.01	7$^+$	1197.49	5$^+$				
385.59 14	2.9 2	1744.54	(6)$^-$	1358.76	6$^+$	[E1]		0.0101	It is possible that part or all of this γ populated a known 8$^+$ level at 1744 keV, which also decays through a 386-keV transition. I_γ: 7.2 15 (1987Ad06) is discrepant.

$^{164}_{68}$Er$_{96}$-3

γ(^{164}Er) (continued)

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ	α[&]	Comments
410.20 *10*	15.0 *9*	1024.71	8^+	614.44	6^+	E2		0.0279	α(K)=0.0216 *3*; α(L)=0.00484 *7*; α(M)=0.001114 *16* α(N)=0.000256 *4*; α(O)=3.40×10^{-5} *5*; α(P)=1.171×10^{-6} *17* α(K)exp=0.018 *6*; α(L)exp=0.0076 *44*
486.00[@] *8*	0.7 *2*	1683.45	(5^+)	1197.49	5^+				
520.3[@] *10*	0.5 *3*	1545.01	7^+	1024.71	8^+	E2+M1	2.1 *+26−7*	0.018 *3*	α(K)=0.0146 *23*; α(L)=0.00259 *24*; α(M)=0.00059 *5* α(N)=0.000136 *12*; α(O)=1.87×10^{-5} *19*; α(P)=8.3×10^{-7} *15*
547.08 *7*	50.6 *25*	1744.54	$(6)^-$	1197.49	5^+	E1		0.00459	α(K)=0.00389 *6*; α(L)=0.000542 *8*; α(M)=0.0001191 *17* α(N)=2.76×10^{-5} *4*; α(O)=3.94×10^{-6} *6*; α(P)=2.09×10^{-7} *3* α(K)exp=0.0033 *10*
551.5[@] *5*	0.5 *1*	1610.36	$(4^-,5^-)$	1058.72	4^+				
583.21 *10*	8.1 *5*	1197.49	5^+	614.44	6^+	E2+M1	3.1 *8*	0.0124 *9*	α(K)=0.0101 *8*; α(L)=0.00178 *9*; α(M)=0.000401 *18* α(N)=9.3×10^{-5} *5*; α(O)=1.28×10^{-5} *7*; α(P)=5.7×10^{-7} *5* α(K)exp=0.016 *8* α(K)exp gives M1,E2.
624.6 *2*	2.6 *3*	1683.45	(5^+)	1058.72	4^+				I_γ: 8.6 *19* (1987Ad06) for a 624.0 *3* γ is discrepant.
626.4[@] *8*	0.5 *3*	1985.04	7^-	1358.76	6^+				
646.94 *7*	1.7 *2*	946.44	3^+	299.50	4^+	E2+M1	2.7 *10*	0.0099 *13*	α(K)=0.0081 *12*; α(L)=0.00137 *13*; α(M)=0.00031 *3* α(N)=7.1×10^{-5} *7*; α(O)=9.9×10^{-6} *11*; α(P)=4.6×10^{-7} *8*
663.90 *20*	3.1 *2*	1610.36	$(4^-,5^-)$	946.44	3^+				E_γ,I_γ: from 1992Ch03. Iγ=6.5 *17* (1987Ad06).
736.9 *2*	2.3 *7*	1683.45	(5^+)	946.44	3^+				
744.05 *20*	1.7 *5*	1358.76	6^+	614.44	6^+	E2+M1	3.7 *+19−8*	0.0068 *3*	α(K)=0.00559 *23*; α(L)=0.00092 *3*; α(M)=0.000205 *7* α(N)=4.75×10^{-5} *15*; α(O)=6.67×10^{-5} *22*; α(P)=3.19×10^{-7} *15*
758.95 *16*	4.2 *3*	1058.72	4^+	299.50	4^+	E2(+M1)	>+7	0.00618 *15*	α(K)=0.00510 *13*; α(L)=0.000841 *13*; α(M)=0.000189 *4* α(N)=4.37×10^{-5} *9*; α(O)=6.11×10^{-6} *13*; α(P)=2.90×10^{-7} *8*
820.78 *11*	13.2 *6*	1845.58	7^-	1024.71	8^+	E1		0.00199	α(K)=0.001697 *24*; α(L)=0.000231 *4*; α(M)=5.07×10^{-5} *7* α(N)=1.177×10^{-5} *17*; α(O)=1.693×10^{-6} *24*; α(P)=9.26×10^{-8} *13* α(K)exp<0.0022
855.01 *8*	8.0 *6*	946.44	3^+	91.40	2^+	E2+M1	−2.8 *7*	0.0052 *4*	α(K)=0.0043 *3*; α(L)=0.00067 *4*; α(M)=0.000150 *8* α(N)=3.47×10^{-5} *18*; α(O)=4.9×10^{-6} *3*; α(P)=2.47×10^{-7} *18* I_γ: 26 *4* (1987Ad06) is discrepant.
897.97 *7*	43.0 *20*	1197.49	5^+	299.50	4^+	E2+M1	2.5 *+17−7*	0.0047 *4*	α(K)=0.0040 *4*; α(L)=0.00061 *5*; α(M)=0.000135 *9* α(N)=3.14×10^{-5} *21*; α(O)=4.5×10^{-6} *4*; α(P)=2.28×10^{-7} *21* α(K)exp=0.0028 *9* α(K)exp gives E2(+M1), δ>4.0.
930.2 *4*	1.5 *2*	1545.01	7^+	614.44	6^+	E2+M1	−2.4 *3*		
960.4 *3*	2.3 *5*	1985.04	7^-	1024.71	8^+				
967.5 *2*	1.5 *5*	1058.72	4^+	91.40	2^+	E2		0.00360	α(K)=0.00300 *5*; α(L)=0.000463 *7*; α(M)=0.0001031 *15* α(N)=2.39×10^{-5} *4*; α(O)=3.39×10^{-6} *5*; α(P)=1.709×10^{-7} *24*

$\gamma(^{164}$Er) (continued)

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[&]	Comments
1049.86 *9*	16.7 *8*	1664.25	(5)$^-$	614.44	6$^+$	E1	1.25×10^{-3}	α(K)=0.001067 *15*; α(L)=0.0001436 *21*; α(M)=3.14×10^{-5} *5* α(N)=7.31×10^{-6} *11*; α(O)=1.055×10^{-6} *15*; α(P)=5.85×10^{-8} *9*
1059.4[@] *10*	0.6 *2*	1358.76	6$^+$	299.50	4$^+$	E2	0.0029 *9*	α(K)=0.00250 *4*; α(L)=0.000378 *6*; α(M)=8.40×10^{-5} *12* α(N)=1.95×10^{-5} *3*; α(O)=2.78×10^{-6} *4*; α(P)=1.426×10^{-7} *20*
1130.06 *10*	3.5 *3*	1744.54	(6)$^-$	614.44	6$^+$	[E1]	0.0011	
1139.5 *3*	1.9 *2*	3303.1	(6$^-$,7$^-$)	2163.63	(8$^-$)			
1149.6[@] *4*	1.6 *2*	1764.0	(7)$^-$	614.44	6$^+$	E1	0.00107	α(K)=0.000905 *13*; α(L)=0.0001214 *17*; α(M)=2.66×10^{-5} *4* α(N)=6.18×10^{-6} *9*; α(O)=8.93×10^{-7} *13*; α(P)=4.97×10^{-8} *7*; α(IPF)=7.47×10^{-6} *14*
1184.3[@] *5*	2.8 *4*	1798.5	(5)$^-$	614.44	6$^+$	E1	0.00102	
1231.17 *7*	40.8 *20*	1845.58	7$^-$	614.44	6$^+$	E1		
1317.6[@] *10*	0.5 *3*	3303.1	(6$^-$,7$^-$)	1985.04	7$^-$			
1364.68 *9*	40.0 *25*	1664.25	(5)$^-$	299.50	4$^+$			
1370.73 *10*	9.9 *10*	1985.04	7$^-$	614.44	6$^+$			
1498.6 *6*	1.2 *4*	1798.5	(5)$^-$	299.50	4$^+$			E_γ: unweighted average of 1971De22 and 1992Ch03.

† Weighted averages of 1992Ch03, 1971De22 and 1987Ad06.
‡ Unweighted averages of 1992Ch03, 1971De22 and 1987Ad06.
\# From ce data (1971De22).
@ From 1992Ch03 only.
& Additional information 1.
a For absolute intensity per 100 decays, multiply by ≈0.096.
b Placement of transition in the level scheme is uncertain.

$^{164}_{68}$Er$_{96}$-5

^{164}Tm ε decay (5.1 min) 1992Ch03,1987Ad06,1971De22