^{164}Yb ε decay (75.8 min) 1982AdZZ

History

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

Parent: ^{164}Yb: E=0.0; J$^{\pi}$=0^{+}; T$_{1/2}$=75.8 min *17*; Q(ε)≈1100; %ε+%β^{+} decay=100.0

^{164}Yb-T$_{1/2}$: From ^{164}Yb Adopted Levels.

^{164}Yb-Q(ε): 887 *29* in 2017Wa10, but the decay scheme proposed in 1982AdZZ gives 1100 keV.

1982AdZZ: Measured Eγ, Iγ, ce, I(x rays). Previous work from the same laboratory: 1972GrYR (also 1975Gr44), 1965Ab05, 1960Da16, 1960Ab05.

1971De22: Measured Eγ, Iγ, $\gamma\gamma$ coin.

1997ZaZW: Measured ce for nine γ rays.

2001AlZU: studied ^{164}Yb ε decay using a constant-field magnetic β-ray spectrograph, and report ce lines for previously unreported γ rays with energies of 29.03-, 37.44-, 65.22-, 69.95-, 120.60- and 122.29-keV, but give no other information.

The proposed level scheme is considered as tentative.

Problem about the Q(ε) value needs to be resolved.

^{164}Tm Levels

E(level)†	J$^{\pi}$‡	E(level)†	J$^{\pi}$‡	E(level)†	J$^{\pi}$‡	E(level)†	J$^{\pi}$‡
0.0	1^{+}	390.54 *17*	(0^{+},1^{+},2^{+})	581.69 *13*	(1)$^{+}$	928.40 *24*	(1^{+})
37.575 *13*	(2)$^{+}$	427.99 *19*	(0^{+},1,2,3)	626.40 *19*	(0,1)	951.98 *24*	(0,1)$^{-}$
40.928 *4*	(0^{-},1^{-})	550.0 *3*	(1,2)$^{+}$	675.55 *16*	(1)$^{+}$	1060.14 *15*	(1^{+})
134.93 *3*	(1,2)$^{+}$	554.99 *18*	(1)$^{+}$	732.72 *16*	(1)$^{+}$		
362.79 *18*	(0,1,2)$^{+}$	571.6 *4*	(1)$^{+}$	735.88 *13*	(1)$^{+}$		

† From least-squares fit to Eγ data.

‡ From Adopted Levels.

ε,β^{+} radiations

RADLST code gives a total absorbed energy of 1097 keV *3*.

E(decay)	E(level)	Iε†‡	Log *ft*	I($\varepsilon+\beta^{+}$)‡	Comments
(39.86 *15*)	1060.14	0.06	4.2	0.06	εL=0.68 *5*; εM+=0.32 *5*
(148.02 *24*)	951.98	0.16	5.6	0.16	εK=0.673 *21*; εL=0.245 *15*; εM+=0.082 *6* Iε: expected %ε<0.07 from log *ft*>5.9 for first-forbidden transition. Thus the feeding to this level may be too large by a factor of≈2.
(171.60 *24*)	928.40	0.10	6.0	0.10	εK=0.707 *13*; εL=0.221 *10*; εM+=0.072 *4*
(364.12 *13*)	735.88	0.09	5.8	0.09	εK=0.68 *7*; εL=0.24 *5*; εM+=0.080 *19*
(367.28 *16*)	732.72	0.07	6.0	0.07	εK=0.69 *7*; εL=0.24 *5*; εM+=0.078 *18*
(424.45 *16*)	675.55	0.50	5.5	0.50	εK=0.742 *23*; εL=0.195 *17*; εM+=0.063 *6*
(473.60 *19*)	626.40	0.04	6.8	0.04	εK=0.765 *13*; εL=0.178 *9*; εM+=0.057 *4*
(518.31 *13*)	581.69	0.32	6.1	0.32	εK=0.778 *8*; εL=0.169 *6*; εM+=0.0530 *22*
(528.4 *4*)	571.6	0.03	7.2	0.03	εK=0.781 *8*; εL=0.167 *6*; εM+=0.0524 *20*
(545.01 *18*)	554.99	0.20	6.4	0.20	εK=0.784 *7*; εL=0.164 *5*; εM+=0.0515 *17*
(550.0# *3*)	550.0	<0.1	>6.7	<0.1	εK=0.785 *6*; εL=0.164 *5*; εM+=0.0512 *17*
(1059.072 *4*)	40.928	1.5	6.4	1.5	εK=0.8185 *7*; εL=0.1392 *5*; εM+=0.04229 *19*
(1062.425# *13*)	37.575	<0.5	>6.9	<0.5	εK=0.8186 *7*; εL=0.1391 *5*; εM+=0.04227 *19*
(1100)	0.0	≈96.5	≈4.6	≈96.5	εK=0.8194 *7*; εL=0.1385 *5*; εM+=0.04206 *17* Iε: feeding to the ground state estimated by 1982AdZZ, based on the observed x-ray intensity and I(γ+ce) feeding the ground state.

Continued on next page (footnotes at end of table)

^{164}Yb ε decay (75.8 min) 1982AdZZ (continued)

ε,β^{+} radiations (continued)

† From intensity balance at each level.
‡ Absolute intensity per 100 decays.
# Existence of this branch is questionable.

γ(^{164}Tm)

Iγ normalization: Σ (γ+ce) to g.s.≈3.5, assuming total ε feeding of ≈96.5% (1982AdZZ) to ^{164}Tm g.s., the latter estimated from comparison of observed x-ray intensity and I(γ+ce) feeding the ground state.

Ice measured by β-spectrograph unless otherwise noted. Quoted Ice data are relative to Ice(K)(390.6γ)=6.3.

ce data normalized using α(K)(362.84 M1)=0.076.

Tm x rays:

E(x-ray)	I(relative to Iγ(390.62γ)=100)	designation
49.880 4	9725 60	$K\alpha_2$ x ray
50.836 3	17010 70	$K\alpha_1$ x ray
57.485 5	5720 80	$K\beta_1$ x ray
59.150 9	1500 50	$K\beta_2$ x ray

E_γ[†]	I_γ[†d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[b]	δ[b]	α[c]	Comments
[x]27.77[#]									
[x]29.03[@]									
[x]37.44[@]									
37.573 13	39 4	37.575	(2)$^+$	0.0	1$^+$	M1+E2	0.060 12	9.6 4	α(L)=7.5 3; α(M)=1.68 7 α(N)=0.392 16; α(O)=0.0552 18; α(P)=0.00277 4 Mult.,δ: deduced by evaluators from L1/L2/L3=247 30/34 4/17 4. 1982AdZZ give M1+0.35% 10 E2 (implying δ=0.059 8).
40.928 4	370 5	40.928	(0$^-$,1$^-$)	0.0	1$^+$	(E1)		0.690	α(L)=0.538 8; α(M)=0.1210 17 α(N)=0.0273 4; α(O)=0.00332 5; α(P)=0.0001039 15 Mult.: from L1/L2/L3=90 10/47 5/64 7. δ(M2/E1)<0.018 from L-subshell ratios. Note that these ratios also give M1+E2 with δ=0.23 2, but the fit is somewhat poor with reduced χ^2=2.9.
[x]65.22									E_γ: from 1997ZaZW and 2001AlZU.
[x]69.95[@]									
94.05 10	<18[a]	134.93	(1,2)$^+$	40.928	(0$^-$,1$^-$)	[E1]		0.392	α(K)=0.324 5; α(L)=0.0531 8; α(M)=0.01183 17 α(N)=0.00271 4; α(O)=0.000358 6; α(P)=1.432×10^{-5} 21 Ice: ce(K)=6 2.
97.34[&] 3	13 3	134.93	(1,2)$^+$	37.575	(2)$^+$	M1+E2	0.055	3.35	α(K)exp=3.3 7 α(K)=2.80 4; α(L)=0.429 6; α(M)=0.0958 14 α(N)=0.0224 4; α(O)=0.00321 5; α(P)=0.0001720 25 δ: from 1997ZaZW. Other: <0.19 from α(K)exp. Additional information 6. L1/L2=6 2/≈0.5.
[x]120.50									E_γ: from 1997ZaZW. Other: 120.60 in 2001AlZU.
[x]122.29[@]									
135.0 1	<7[a]	134.93	(1,2)$^+$	0.0	1$^+$	(M1+E2)		1.16 16	α(K)=0.80 31; α(L)=0.28 12; α(M)=0.067 30

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γ(^{164}Tm) (continued)

E_γ [†]	I_γ [†d]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [b]	δ [b]	α [c]	Comments
									α(N)=0.0153 *67*; α(O)=0.00192 *68*; α(P)=4.4×10^{-5} *24* Mult.: from 1997ZaZW. Ice: ce(K)=8 *2*.
154.18[&] *4*	19 *7*	735.88	(1)$^+$	581.69	(1)$^+$	M1+E2	0.055	0.904	α(K)exp=0.7 *3* α(K)=0.757 *11*; α(L)=0.1145 *16*; α(M)=0.0255 *4* α(N)=0.00597 *9*; α(O)=0.000858 *12*; α(P)=4.63×10^{-5} *7* Additional information 22. Mult.,δ: from 1997ZaZW. α(K)exp and L1/L2 give δ(E2/M1)=0.26 *+18−12*. L1/L2=2.0 *5*/0.3 *1*.
164.45 *3*	40 *5*	554.99	(1)$^+$	390.54	(0$^+$,1$^+$,2$^+$)	M1+E2	1.1 *+7−4*	0.62 *6*	α(K)exp=0.45 *8* α(K)=0.44 *8*; α(L)=0.135 *16*; α(M)=0.032 *5* α(N)=0.0073 *10*; α(O)=0.00093 *9*; α(P)=2.5×10^{-5} *6* Additional information 11.
187.8 *4*	29 *15*	550.0	(1,2)$^+$	362.79	(0,1,2)$^+$	M1(+E2)	<2.8	0.43 *9*	α(K)exp=0.3 *2* α(K)=0.33 *11*; α(L)=0.079 *14*; α(M)=0.018 *4* α(N)=0.0042 *9*; α(O)=0.00056 *7*; α(P)=1.89×10^{-5} *79* Additional information 9. L1/L2=1.0 *3*/≈0.1.
190.8 *4*	32 *15*	581.69	(1)$^+$	390.54	(0$^+$,1$^+$,2$^+$)	E2(+M1)	>4	0.31 *1*	α(K)exp=0.13 *7* α(K)=0.19 *1*; α(L)=0.0891 *8*; α(M)=0.0214 *2* α(N)=0.00489 *5*; α(O)=0.000595 *5*; α(P)=9.2×10^{-6} *5* Additional information 14.
[x]192.14[#]									
199.1[‡] *4*	13 *5*	626.40	(0,1)	427.99	(0$^+$,1,2,3)				Mult.: E1 or E2 from α(K)exp<0.15. Additional information 18.
[x]293.9[#]									
324.26[‡] *15*	<9[a]	1060.14	(1$^+$)	735.88	(1)$^+$				Ice: ce(K)=1.0 *2*.
327.43[‡] *15*	<9[a]	1060.14	(1$^+$)	732.72	(1)$^+$				Ice: ce(K)=0.9 *2*.
[x]333.5[#]									
[x]358.0 *4*	12 *3*								α(K)exp<0.2 Mult.: M1, E2 or E1 from α(K)exp. Additional information 1.
362.84[&] *19*	68 *7*	362.79	(0,1,2)$^+$	0.0	1$^+$	M1(+E2)	<1.1	0.075 *13*	α(K)exp=0.076 *25* α(K)=0.062 *12*; α(L)=0.0100 *9*; α(M)=0.00225 *17* α(N)=0.00052 *4*; α(O)=7.4×10^{-5} *8*; α(P)=3.7×10^{-6} *8* Additional information 7. L1/L2=0.7 *1*/≈0.05.
390.60[e&] *21*	100[e] *9*	390.54	(0$^+$,1$^+$,2$^+$)	0.0	1$^+$	(M1(+E2))	<0.6	0.067 *6*	α(K)exp=0.063 *10*

γ(^{164}Tm) (continued)

Eγ[†]	Iγ[†d]	Ei(level)	J_i^π	Ef	J_f^π	Mult.[b]	δ[b]	α[c]	Comments
									α(K)=0.056 *5*; α(L)=0.0085 *4*; α(M)=0.00190 *8* α(N)=0.000445 *20*; α(O)=6.4×10^{-5} *4*; α(P)=3.3×10^{-6} *3* Additional information 8. L1/L2=0.9 *1*/≈0.06.
390.60[e] *21*	≈14[e]	427.99	(0$^+$,1,2,3)	37.575	(2)$^+$	[D,E2]		0.04 *3*	
402.1[&] *3*	30 *5*	951.98	(0,1)$^-$	550.0	(1,2)$^+$	E1		0.00953	α(K)exp=0.007 *2* α(K)=0.00806 *12*; α(L)=0.001153 *17*; α(M)=0.000255 *4* α(N)=5.93×10^{-5} *9*; α(O)=8.34×10^{-6} *12*; α(P)=4.22×10^{-7} *6* δ(M2/E1)<0.07 from α(K)exp. Additional information 25.
[x]415.79[&] *25*	35 *4*					E1		0.00882	α(K)exp=0.006 *2* α(K)=0.00746 *11*; α(L)=0.001065 *15*; α(M)=0.000236 *4* α(N)=5.48×10^{-5} *8*; α(O)=7.72×10^{-6} *11*; α(P)=3.91×10^{-7} *6* δ(M2/E1)<0.06 from α(K)exp. Additional information 2.
419.5[‡] *4*	13 *3*	554.99	(1)$^+$	134.93	(1,2)$^+$	M1(+E2)	<0.9	0.052 *8*	α(K)exp=0.054 *16* α(K)=0.044 *7*; α(L)=0.0068 *6*; α(M)=0.00152 *12* α(N)=0.00035 *3*; α(O)=5.0×10^{-5} *5*; α(P)=2.6×10^{-6} *5* Additional information 12.
[x]444.6 *3*	62 *8*					E1		0.00757	α(K)exp=0.0064 *20* α(K)=0.00640 *9*; α(L)=0.000911 *13*; α(M)=0.000201 *3* α(N)=4.68×10^{-5} *7*; α(O)=6.61×10^{-6} *10*; α(P)=3.37×10^{-7} *5* δ(M2/E1)<0.13 from α(K)exp. Additional information 3.
446.7[‡&] *3*	90 *9*	581.69	(1)$^+$	134.93	(1,2)$^+$	E2+M1	34 *4*	0.0230	α(K)exp=0.018 *3* α(K)=0.0179 *3*; α(L)=0.00392 *6*; α(M)=0.000906 *13* α(N)=0.000209 *3*; α(O)=2.77×10^{-5} *4*; α(P)=9.77×10^{-7} *14* Additional information 15. L1/L2/L3=0.20 *3*/0.10 *3*/≈0.05.
[x]475.9 *4*	≤7.4[a]								α(K)exp>0.14 Mult.: α(K)exp suggests multipolarity higher than E2. Additional information 4.
491.3[‡&] *2*	≈2[a]	626.40	(0,1)	134.93	(1,2)$^+$				Ice: ce(K)≈0.07.
534.0[‡] *4*	<5[a]	571.6	(1)$^+$	37.575	(2)$^+$				Ice: ce(K)=0.13 *4*.
543.6[‡&] *3*	28 *5*	581.69	(1)$^+$	37.575	(2)$^+$	M1(+E2)	<0.9	0.027 *4*	α(K)exp=0.025 *6* α(K)=0.022 *4*; α(L)=0.0034 *4*; α(M)=0.00076 *8* α(N)=0.000177 *18*; α(O)=2.5×10^{-5} *3*; α(P)=1.34×10^{-6} *21* Additional information 16. K/L1=0.7 *1*/0.09 *2*.
[x]546.9 *3*	27 *4*					M1+E2	1.0 *9*	0.0219 *81*	α(K)exp=0.018 *6*

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γ(^{164}Tm) (continued)

E_γ [†]	I_γ [†d]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [b]	δ [b]	α [c]	Comments
									α(K)=0.0181 *71*; α(L)=0.00291 *77*; α(M)=0.00065 *17* α(N)=1.52×10^{-4} *39*; α(O)=2.14×10^{-5} *61*; α(P)=1.06×10^{-6} *45* Additional information 5.
549.8 *4*	14 *4*	550.0	(1,2)$^+$	0.0	1$^+$	M1+E2	1.1 *8*	0.0208 *76*	α(K)exp=0.017 *5* α(K)=0.0172 *66*; α(L)=0.00279 *72*; α(M)=0.00063 *16* α(N)=0.00015 *4*; α(O)=2.05×10^{-5} *57*; α(P)=1.01×10^{-6} *42* Additional information 10.
571.5 *6*	10 *3*	571.6	(1)$^+$	0.0	1$^+$	E2+M1	9.2 *22*	0.01244 *22*	α(K)exp=0.010 *3* α(K)=0.01000 *18*; α(L)=0.00189 *3*; α(M)=0.000431 *7* α(N)=0.0001000 *16*; α(O)=1.359×10^{-5} *22*; α(P)=5.57×10^{-7} *11* Additional information 13.
581.6 *3*	<5[a]	581.69	(1)$^+$	0.0	1$^+$				Additional information 17.
589.12[&] *20*	33 *4*	951.98	(0,1)$^-$	362.79	(0,1,2)$^+$	E1		0.00408	α(K)exp=0.004 *1* α(K)=0.00346 *5*; α(L)=0.000484 *7*; α(M)=0.0001069 *15* α(N)=2.49×10^{-5} *4*; α(O)=3.54×10^{-6} *5*; α(P)=1.85×10^{-7} *3* δ(M2/E1)<0.17 from α(K)exp. Additional information 26.
601.8[&f] *3*	≈3[a]	735.88	(1)$^+$	134.93	(1,2)$^+$				Ice: ce(K)=0.1.
638.12[‡&] *23*	75 *8*	675.55	(1)$^+$	37.575	(2)$^+$	M1+E2	0.9 *+9−6*	0.0154 *40*	α(K)exp=0.013 *3* α(K)=0.0129 *35*; α(L)=0.0020 *4*; α(M)=0.00044 *9* α(N)=0.000104 *21*; α(O)=1.5×10^{-5} *4*; α(P)=7.6×10^{-7} *22* Additional information 19. K/L=1.0 *2*/0.15 *5*.
675.41[&] *22*	123 *11*	675.55	(1)$^+$	0.0	1$^+$	M1(+E2)	<0.8	0.0158 *19*	α(K)exp=0.015 *3* α(K)=0.0133 *16*; α(L)=0.00196 *19*; α(M)=0.00044 *4* α(N)=0.000102 *10*; α(O)=1.46×10^{-5} *15*; α(P)=7.9×10^{-7} *10* Additional information 20. K/L=1.9 *3*/0.3 *1*.
695.2[‡&] *3*	26 *5*	732.72	(1)$^+$	37.575	(2)$^+$	M1(+E2)	<0.9	0.0144 *20*	α(K)exp=0.016 *5* α(K)=0.0121 *17*; α(L)=0.00179 *21*; α(M)=0.00040 *5* α(N)=9.3×10^{-5} *11*; α(O)=1.34×10^{-5} *16*; α(P)=7.2×10^{-7} *11* Additional information 21.
732.7 *3*	≈6[a]	732.72	(1)$^+$	0.0	1$^+$				Ice: ce(K)=0.08 *3*.
887.3[&] *3*	17 *4*	928.40	(1$^+$)	40.928	(0$^-$,1$^-$)	(E1)		0.00179	α(K)exp<0.005 α(K)=0.001526 *22*; α(L)=0.000209 *3*; α(M)=4.59×10^{-5} *7* α(N)=1.071×10^{-5} *15*; α(O)=1.533×10^{-6} *22*; α(P)=8.27×10^{-8} *12* Mult.: α(K)exp consistent with E1 or E2, but E1 is consistent with ΔJ^π. Additional information 23.

^{164}Yb ε decay (75.8 min) 1982AdZZ (continued)

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

E_γ [†]	I_γ [†d]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [b]	α [c]	Comments
[x]926.8 [#]								
928.7 *4*	24 *10*	928.40	(1$^+$)	0.0	1$^+$	(M1)	0.00797	α(K)exp=0.04 *2* α(K)=0.00674 *10*; α(L)=0.000963 *14*; α(M)=0.000213 *3* α(N)=4.99×10^{-5} *7*; α(O)=7.21×10^{-6} *11*; α(P)=4.00×10^{-7} *6* Mult.: from 1997ZaZW. Note that α(K)exp=0.04 *2* in 1982AdZZ is too high for M1, E2 or M2, thus the authors proposed mult=E0+E2. Additional information 24.
1019.2 *4*	13 *3*	1060.14	(1$^+$)	40.928	(0$^-$,1$^-$)			
1059.8		1060.14	(1$^+$)	0.0	1$^+$	(M1+E2)	0.0045 *14*	α(K)=0.0038 *12*; α(L)=5.5×10^{-4} *15*; α(M)=1.22×10^{-4} *32* α(N)=2.84×10^{-5} *76*; α(O)=4.1×10^{-6} *12*; α(P)=2.19×10^{-7} *71* E_γ,Mult.: from 1997ZaZW.

[†] From 1982AdZZ. Values for 16 γ rays (including 8 γ rays with uncertain isotopic assignment) are also listed by 1971De22. While Eγ values from 1971De22 are in general agreement with those from 1982AdZZ, Iγ values differ significantly.

[‡] γ coincidence with ce(L1)(37.57γ).

[#] From ce data of 1997ZaZW only.

[@] From ce data of 2001AlZU.

[&] γ reported by 1971De22 also.

[a] Iγ values deduced by evaluators from the limit on total transition intensities and α(K)exp values given by 1982AdZZ.

[b] From ce data of 1982AdZZ, and also 1997ZaZW for a few transitions. Mixing ratios have been deduced by evaluators from ce data of 1982AdZZ, unless otherwise stated. The same assignments are given in the Adopted Levels, Gammas dataset.

[c] Additional information 27.

[d] For absolute intensity per 100 decays, multiply by ≈0.0025.

[e] Multiply placed with intensity suitably divided.

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

[x] γ ray not placed in level scheme.

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