¹⁶⁴Yb ε decay (75.8 min) 1982AdZZ

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

Parent: ¹⁶⁴Yb: E=0.0; $J^{\pi}=0^+$; $T_{1/2}=75.8 \text{ min } 17$; $Q(\varepsilon)\approx 1100$; $\%\varepsilon +\%\beta^+$ decay=100.0

¹⁶⁴Yb-T_{1/2}: From ¹⁶⁴Yb Adopted Levels.

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

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

1971De22: Measured E γ , I γ , $\gamma\gamma$ coin.

1997ZaZW: Measured ce for nine γ rays.

2001AlZU: studied ¹⁶⁴Yb 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 $Q(\varepsilon)$ value needs to be resolved.

¹⁶⁴Tm Levels

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

[†] From least-squares fit to $E\gamma$ data.

[‡] From Adopted Levels.

ε, β^+ radiations

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

E(decay)	E(level)	$\mathrm{I}\varepsilon^{\dagger\ddagger}$	Log ft	$I(\varepsilon + \beta^+)^{\ddagger}$	Comments
(39.86 15)	1060.14	0.06	4.2	0.06	ε L=0.68 5; ε M+=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
					I: expected $\% \epsilon < 0.07$ 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
					IE: feeding to the ground state estimated by 1982AdZZ, based on the

observed x-ray intensity and $I(\gamma+ce)$ feeding the ground state.

Continued on next page (footnotes at end of table)

$^{164} {\rm Yb} \ \varepsilon$ 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.

$ \begin{array}{c} \text{Fy normalization: } \Sigma(y+ec) \ \text{to } g_{s-3-5.5} \text{ assuming total } \text{feeding of } =96.5\% \ (1982AdZ2) \ \text{to } ^{10-10} \text{ mg } g_{s-1} \text{ the latter estimated from comparison of observed x-ray intensity and (ly-ec) feeding the ground state. \\ \text{Lee measured by } \beta_{spectrograph unless otherwise noted. Quoted lee data are relative to lee(K)(390.6y)=6.3. \\ \text{ce data normalizated using a(K)(32.84 MI)=0.076. \\ \hline \text{M} & \text{Tr } x \text{ rays}: \\ \hline \text{T(relative to } \text{ 1}_{7}(396.62y)=100) \text{designation} \\ \hline \text{M} & \text{for } x \text{ rays}: \\ \hline \text{T} & \text{for } x \text{ rays}: \\ \hline $								<u>/(1</u>	164		5-3
The measured by β -spectrogram unless otherwise noted. Quoted lee data are relative to lee(K)(390.6y)=6.3. ce data normalized using α (K)(362.84 MI)=0.076. The x rays: The x ray: The x ray	$I\gamma$ normalization intensity at	tion: Σ (γ nd I(γ+ce	+ce) to g.s.e) feeding the	≈3.5, assui e ground s	ming tota tate.	$l \varepsilon$ feeding	g of ≈96.5%	(1982AdZZ)) to ¹⁶⁴ Tm	g.s., the latter estimated from comparison of observed x-ray	
$\frac{\text{Tm x rays}}{122.07 \text{ f}^{2}} = \frac{\text{Tm x rays}}{122.036} + \frac{124.93}{122.036} + 124.9$	Ice measured	by β -spectrum by β -spectr	ectrograph uning $\alpha(\mathbf{K})(36)$	nless other 2.84 M1	wise note 0 076	ed. Quoted	l Ice data are	relative to l	Ice(K)(390.	6γ)=6.3.	
$\frac{1}{42.3964} \underbrace{4}{4} \underbrace{9725}_{0} \underbrace{60}_{0} \underbrace{1}{1010} \underbrace{70}_{0} \underbrace{1}{100} \underbrace{70}_{0} \underbrace{1}{1010} \underbrace{1}{1000} \underbrace{1}{100} \underbrace{1}{1000} $	E(x-ray	Tm x	rays: lative to	τν(390.6	52γ = 100)) des	ignation				
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	49.88	0 4	9725 60			K	$\gamma_2 \times rav$		-		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	50.83	63	17010 70 5720 80			Ka Ka	$x_1 \mathbf{x} \mathbf{ray}$				
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	59.15	09	1500 50			Kµ Kµ	B_2 x ray				
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$\mathrm{E}_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger d}$	E _i (level)	\mathbf{J}_i^π	\mathbf{E}_{f}	J_f^π	Mult. ^b	$\delta^{\boldsymbol{b}}$	α ^{<i>C</i>}	Comments	
² 29.03 ⁶⁰ ^x 37.44 ⁶⁰ 37.573 <i>I</i> 3 39 4 37.575 (2) ⁺ 0.0 1 ⁺ M1+E2 0.060 <i>I</i> 2 9.6 4 α (L)=7.5 3; α (M)=1.68 7 α (N)=0.392 <i>I</i> 6; α (O)=0.0552 <i>I</i> 8; α (P)=0.00277 4 Mult. <i>δ</i> : deduced by evaluators from L1/L2/L3=247 30/34 4/17 4. 1982AdZZ give M1+0.35% <i>I</i> 0 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 <i>I</i> 7 α (N)=0.00273 4; α (O)=0.00332 5; α (P)=0.0001039 <i>I</i> 5 Mult: from L1/L2/L3=90 <i>I</i> 0/47 5/64 7. δ (M2/E1)<0.018 from L-subshell ratios. Note that these ratios also give M1+E2 with δ =0.023 2, but the fit is somewhat poor with reduced χ^2 =2.9. Ey: from 1997ZaZW and 2001AIZU. ^x 65.22 ^x 69.95 ⁶⁰ 94.05 <i>I</i> 0 <18 ⁴ 134.93 (1.2) ⁺ 40.928 (0 ⁻ ,1 ⁻) [E1] 0.392 α (K)=0.324 5; α (L)=0.0531 8; α (M)=0.01183 <i>I</i> 7 α (N)=0.00271 4; α (O)=0.000328 6; α (P)=1.432×10 ⁻⁵ 2 <i>I</i> Le: ce(K)=6 2. 97.34 ^{&} 3 13 3 134.93 (1.2) ⁺ 37.575 (2) ⁺ M1+E2 0.055 3.35 α (K)=2.80 4; α (L)=0.429 6; α (M)=0.001720 25 δ ; from 1997ZaZW. Other: <0.19 from α (K)exp. Additional information 6. L1/L2=6 2/<0.5. Ey: from 1997ZaZW. Other: 120.60 in 2001AIZU. ^x 120.50 ^x 122.9 ⁶⁰ 135.0 <i>I</i> <7 ^d 134.93 (1.2) ⁺ 0.0 1 ⁺ (M1+E2) 1.16 <i>I</i> 6 α (K)=0.80 <i>3I</i> ; α (L)=0.28 <i>I</i> 2; α (M)=0.067 <i>3</i> 0	^x 27.77 [#]										
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$x^{29.03}^{@}$										ц
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	37.573 13	39 4	37.575	(2)+	0.0	1+	M1+E2	0.060 12	9.6 4	$\alpha(L) = 7.5 \ 3; \ \alpha(M) = 1.68 \ 7$	rom
$\begin{array}{cccccccccccccccccccccccccccccccccccc$										$\alpha(N)=0.392$ 16; $\alpha(O)=0.0552$ 18; $\alpha(P)=0.002774$ Mult., δ : deduced by evaluators from L1/L2/L3=247 30/34 4/17 4.	ENSI
$ \begin{array}{c} \alpha(\mathrm{N})=0.0273 \ 4; \ \alpha(\mathrm{O})=0.00332 \ 5; \ \alpha(\mathrm{P})=0.0001039 \ 15 \\ \mathrm{Mult: \ from \ L}_{subshell \ ratios \ Alot \ that \ these \ ratios \ Alot \ M1+E2 \ with \ \delta=0.23 \ 2, \ but \ he \ fit \ is \ somewhat \ poor \ with \ reduced \ \chi^2=2.9. \\ \mathrm{E}_{\gamma}: \ from \ 1997ZaZW \ and \ 2001AlZU. \\ & \delta=0.23 \ 2, \ but \ he \ fit \ is \ somewhat \ poor \ with \ reduced \ \chi^2=2.9. \\ \mathrm{E}_{\gamma}: \ from \ 1997ZaZW \ and \ 2001AlZU. \\ & \delta=0.23 \ 2, \ but \ he \ fit \ is \ somewhat \ poor \ with \ reduced \ \chi^2=2.9. \\ \mathrm{E}_{\gamma}: \ from \ 1997ZaZW \ and \ 2001AlZU. \\ & \delta=0.23 \ 2, \ but \ he \ fit \ is \ somewhat \ poor \ with \ reduced \ \chi^2=2.9. \\ & \mathrm{E}_{\gamma}: \ from \ 1997ZaZW \ and \ 2001AlZU. \\ & \delta=0.23 \ 2, \ but \ he \ fit \ somewhat \ poor \ with \ reduced \ \chi^2=2.9. \\ & \mathrm{E}_{\gamma}: \ from \ 1997ZaZW \ and \ 2001AlZU. \\ & \delta=0.21 \ 4; \ \alpha(\mathrm{O})=0.000358 \ 6; \ \alpha(\mathrm{M})=0.01183 \ 17 \ \alpha(\mathrm{M})=0.00183 \ 17 \ \alpha(\mathrm{M})=0.000271 \ 4; \ \alpha(\mathrm{O})=0.000358 \ 6; \ \alpha(\mathrm{M})=0.01183 \ 17 \ \alpha(\mathrm{M})=0.000271 \ 4; \ \alpha(\mathrm{O})=0.000321 \ 5; \ \alpha(\mathrm{M})=0.00182 \ 14 \ \alpha(\mathrm{M})=0.00182 \ 15 \ 21 \ \mathrm{Ice: \ ce(\mathrm{K})=6 \ 2. \ 2. \ 2.80 \ 4; \ \alpha(\mathrm{L})=0.429 \ 6; \ \alpha(\mathrm{M})=0.0958 \ 14 \ \alpha(\mathrm{M})=0.00172 \ 25 \ 5; \ from \ 1997ZaZW. \ Other: \ <0.19 \ 6; \ \alpha(\mathrm{M})=0.00172 \ 25 \ 5; \ from \ 1997ZaZW. \ Other: \ <0.19 \ from \ \alpha(\mathrm{K})exp. \ Additional \ information \ 6. \ \mathrm{L}[1]_{L2=6 \ 2}^{2} \ 0.5 \ \mathrm{E}_{\gamma}: \ from \ 1997ZaZW. \ Other: \ <0.19 \ from \ \alpha(\mathrm{K})exp. \ Additional \ information \ 6. \ \mathrm{L}[1]_{L2=6 \ 2}^{2} \ 0.5 \ \mathrm{E}_{\gamma}: \ from \ 1997ZaZW. \ Other: \ <0.19 \ from \ \alpha(\mathrm{K})=0.80 \ 3]; \ \alpha(\mathrm{L})=0.028 \ 12; \ \alpha(\mathrm{M})=0.067 \ 30 \ \mathrm{C}$	40.928 4	370 5	40.928	$(0^{-}, 1^{-})$	0.0	1+	(E1)		0.690	1982AdZZ give M1+0.35% 10 E2 (implying δ =0.059 8). α (L)=0.538 8; α (M)=0.1210 17	OF
$ \begin{array}{c} x_{60.95} @ \\ 94.05 \ 10 \\ sigma \\ sig$										$\alpha(N)=0.0273 4$; $\alpha(O)=0.00332 5$; $\alpha(P)=0.0001039 15$ Mult from 1.1/1.2/1.3=90 10/47 5/64 7 $\delta(M2/E1)<0.018$ from	
$ \begin{array}{c} \lambda = 0.23 \ 2, \ \text{but the fit is somewhat poor with reduced } \chi^2 = 2.9. \\ E_{\gamma}: \ \text{from 1997ZaZW and 2001AIZU.} \\ \end{array} \\ \begin{array}{c} \lambda = 0.23 \ 2, \ \text{but the fit is somewhat poor with reduced } \chi^2 = 2.9. \\ E_{\gamma}: \ \text{from 1997ZaZW and 2001AIZU.} \\ \end{array} \\ \begin{array}{c} \lambda = 0.392 \\ \alpha(\text{K}) = 0.00271 \ 4; \ \alpha(\text{O}) = 0.00358 \ 6; \ \alpha(\text{M}) = 0.01183 \ 17 \\ \alpha(\text{N}) = 0.00271 \ 4; \ \alpha(\text{O}) = 0.00358 \ 6; \ \alpha(\text{P}) = 1.432 \times 10^{-5} \ 21 \\ \text{Ice: ce(K)} = 6 \ 2. \\ \end{array} \\ \begin{array}{c} \gamma = 0.392 \\ \alpha(\text{K}) = 0.2021 \ 4; \ \alpha(\text{O}) = 0.00358 \ 6; \ \alpha(\text{M}) = 0.0958 \ 14 \\ \alpha(\text{N}) = 0.0224 \ 4; \ \alpha(\text{O}) = 0.00321 \ 5; \ \alpha(\text{M}) = 0.001720 \ 25 \\ \delta; \ from 1997ZaZW. \ Other: \ 20.19 \ from \ \alpha(\text{K)exp.} \\ \text{Additional information 6.} \\ \ L1/L2 = 6 \ 2/\approx 0.5. \\ E_{\gamma}: \ from 1997ZaZW. \ Other: \ 120.60 \ in \ 2001AIZU. \\ \end{array} \\ \begin{array}{c} x_{122.29}@\\ x_{122.29}@\\ 135.0 \ 1 \ <7^{a} \ 134.93 \ (1,2)^{+} \ 0.0 \ 1^{+} \ (\text{M1+E2}) \\ \end{array} $										L-subshell ratios. Note that these ratios also give M1+E2 with	
	^x 65.22									δ =0.23 2, but the fit is somewhat poor with reduced χ^2 =2.9. E _y : from 1997ZaZW and 2001AIZU.	
94.03 10° <18 134.93 (1,2) 40.328 (0,1) [E1] 0.392 $a(K)=0.3243; a(L)=0.0313; a(M)=0.0118517$ $a(N)=0.002714; a(O)=0.0003586; a(P)=1.432\times10^{-5}21$ Ice: ce(K)=6 2. 97.34 $a(K)=2.804; a(L)=0.4296; a(M)=0.095814$ a(N)=0.002244; a(O)=0.003215; a(P)=0.000172025 $\delta:$ from 1997ZaZW. Other: <0.19 from $a(K)$ exp. Additional information 6. $L1/L2=62/\approx0.5.$ $E_{\gamma}:$ from 1997ZaZW. Other: 120.60 in 2001AIZU. *122.29 $a(K)=0.8031; a(L)=0.2812; a(M)=0.06730$	$x_{69.95}^{a}$	~10 <mark>0</mark>	124.02	$(1 2)^{+}$	40.029	(0 - 1 -)	[171]		0.202	$\alpha(W) = 0.224.5$, $\alpha(L) = 0.0521.8$, $\alpha(M) = 0.01192.17$	
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. 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	94.05 10	<18"	154.95	(1,2)*	40.928	(0,1)	[E1]		0.392	$\alpha(K)=0.324$ 5; $\alpha(L)=0.0531$ 8; $\alpha(M)=0.01185$ 17 $\alpha(N)=0.00271$ 4; $\alpha(O)=0.000358$ 6; $\alpha(P)=1.432\times10^{-5}$ 21 Ice: ce(K)=6 2.	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	97.34 ^{&} 3	13 <i>3</i>	134.93	$(1,2)^+$	37.575	(2)+	M1+E2	0.055	3.35	$\alpha(K) \exp = 3.37$	
$ \begin{array}{c} \delta: \text{ from } 1997\text{ZaZW}. \text{ Other: } <0.19 \text{ from } \alpha(\text{K})\text{exp.} \\ \text{Additional information } 6. \\ \text{L1/L2=6 } 2/\approx 0.5. \\ \text{E}_{\gamma}: \text{ from } 1997\text{ZaZW}. \text{ Other: } 120.60 \text{ in } 2001\text{ AlZU}. \\ \end{array} \\ \begin{array}{c} x_{122.29}@\\ \\ 135.0 \ I & <7^a & 134.93 & (1,2)^+ & 0.0 & 1^+ & (\text{M1+E2}) \end{array} \\ \begin{array}{c} 1.16 \ I6 & \alpha(\text{K})=0.80 \ 3I; \ \alpha(\text{L})=0.28 \ I2; \ \alpha(\text{M})=0.067 \ 30 \end{array} \end{array} $										$\alpha(N)=2.804; \alpha(L)=0.4296; \alpha(M)=0.093814$ $\alpha(N)=0.02244; \alpha(O)=0.003215; \alpha(P)=0.000172025$	
$ \begin{array}{c} L1/L2=6\ 2/\approx 0.5. \\ E_{\gamma}: \ \text{from 1997ZaZW. Other: 120.60 in 2001A1ZU.} \\ 122.29^{@} \\ 135.0\ 1 & <7^{a} & 134.93 & (1,2)^{+} & 0.0 & 1^{+} & (M1+E2) \end{array} $										δ: from 1997ZaZW. Other: <0.19 from $α$ (K)exp. Additional information 6.	
$ \begin{array}{c} x_{122.29}@\\ 135.0 \ l \\ <7^{a} \\ 134.93 \\ (1,2)^{+} \\ 0.0 \\ 1^{+} \\ (M1+E2) \\ \end{array} $	^x 120 50									L1/L2=6 2/≈0.5. E _v : from 19977aZW. Other: 120.60 in 2001AIZU	
135.0 $I < 7^{\prime\prime}$ 134.93 (1,2) ⁺ 0.0 1 ⁺ (M1+E2) 1.16 <i>I</i> 6 α (K)=0.80 <i>31</i> ; α (L)=0.28 <i>I</i> 2; α (M)=0.067 <i>30</i>	x122.29 [@]	~								_,	
	135.0 1	<7 4	134.93	$(1,2)^+$	0.0	1+	(M1+E2)		1.16 <i>16</i>	α (K)=0.80 31; α (L)=0.28 12; α (M)=0.067 30	$^{164}_{69}$ T

ω

 $^{164}_{69}$ Tm₉₅-3

					164 Yb ε deca	y (75.8 min)	1982AdZZ	(continued)	
						γ ⁽¹⁶⁴ Tm) (continued)		
E_{γ}^{\dagger}	$I_{\gamma}^{\dagger d}$	E _i (level)	${ m J}^{\pi}_i$	\mathbf{E}_{f}	J_f^{π}	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.
164.45 <i>3</i>	40 5	554.99	(1)+	390.54	(0 ⁺ ,1 ⁺ ,2 ⁺)	M1+E2	1.1 +7-4	0.62 6	L1/L2=2.0 5/0.3 1. 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	Additional information 11. $\alpha(K)\exp=0.3\ 2$ $\alpha(K)=0.33\ 11;\ \alpha(L)=0.079\ 14;\ \alpha(M)=0.018\ 4$ $\alpha(N)=0.0042\ 9;\ \alpha(O)=0.00056\ 7;\ \alpha(P)=1.89\times10^{-5}\ 79$ Additional information 9. $1.1(12-10)^{2}(\alpha 0)$
190.8 4	32 15	581.69	(1)+	390.54	(0+,1+,2+)	E2(+M1)	>4	0.31 1	$\begin{array}{l} \alpha(\text{K}) = 0.13 \ 7 \\ \alpha(\text{K}) = 0.19 \ l; \ \alpha(\text{L}) = 0.0891 \ 8; \ \alpha(\text{M}) = 0.0214 \ 2 \\ \alpha(\text{N}) = 0.00489 \ 5; \ \alpha(\text{O}) = 0.000595 \ 5; \ \alpha(\text{P}) = 9.2 \times 10^{-6} \ 5 \\ \text{Additional information 14.} \end{array}$
x192.14# 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: $ce(K)=1.02$.
327.43 + 15	<94	1060.14	(1^{+})	732.72	(1)'				Ice: $ce(K)=0.92$.
x358.0 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	$\alpha(K) \exp = 0.063 \ 10$

4

From ENSDF

 $^{164}_{69}\mathrm{Tm}_{95}$ -4

 $^{164}_{69}$ Tm₉₅-4

					¹⁶⁴ Υb ε	e decay (75.8	min) 1	982AdZZ (co	ontinued)
						$\gamma(^{164}$	⁴ Tm) (con	tinued)	
E_{γ}^{\dagger}	$I_{\gamma}^{\dagger d}$	E _i (level)	\mathbf{J}_i^π	\mathbf{E}_{f}	J_f^{π}	Mult. ^b	$\delta^{\boldsymbol{b}}$	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 $1/\approx$ 0.06.
390.60 ^e 21	≈14 ^{<i>e</i>}	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 <i>I6</i> α (K)=0.044 <i>7</i> ; α (L)=0.0068 <i>6</i> ; α (M)=0.00152 <i>I2</i> α (N)=0.00035 <i>3</i> ; α (O)=5.0×10 ⁻⁵ <i>5</i> ; α (P)=2.6×10 ⁻⁶ <i>5</i> Additional information 12
^x 444.6 3	62 8					E1		0.00757	$\alpha(K) \exp = 0.0064 \ 20$ $\alpha(K) = 0.00640 \ 9; \ \alpha(L) = 0.000911 \ 13; \ \alpha(M) = 0.000201 \ 3$ $\alpha(N) = 4.68 \times 10^{-5} \ 7; \ \alpha(O) = 6.61 \times 10^{-6} \ 10; \ \alpha(P) = 3.37 \times 10^{-7} \ 5$ $\delta(M2/E1) < 0.13 \ \text{from } \alpha(K) \exp.$ 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 <i>3</i> α (K)=0.0179 <i>3</i> ; α (L)=0.00392 <i>6</i> ; α (M)=0.000906 <i>13</i> α (N)=0.000209 <i>3</i> ; α (O)=2.77×10 ⁻⁵ <i>4</i> ; α (P)=9.77×10 ⁻⁷ <i>14</i> Additional information 15. L1/L 2/L 3=0 20 3/0 10 3/≈0 05
^x 475.9 4	≤7.4 ^{<i>a</i>}								α (K)exp>0.14 Mult.: α (K)exp suggests multipolarity higher than E2. Additional information 4.
491.3 ^{‡&} 2	≈2 ^{<i>a</i>}	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 <i>81</i>	$\alpha(K)\exp=0.018\ 6$

S

L

	¹⁶⁴ Yb ε decay (75.8 min) 1982AdZZ (continued)										
γ ⁽¹⁶⁴ Tm) (continued)											
${\rm E_{\gamma}}^{\dagger}$	$I_{\gamma}^{\dagger d}$	E _i (level)	\mathbf{J}_i^{π}	E_f	\mathbf{J}_f^{π}	Mult. ^b	$\delta^{\boldsymbol{b}}$	α^{c}	Comments		
									$ \begin{array}{l} \alpha(\mathrm{K}) = 0.0181 \ 71; \ \alpha(\mathrm{L}) = 0.00291 \ 77; \ \alpha(\mathrm{M}) = 0.00065 \ 17 \\ \alpha(\mathrm{N}) = 1.52 \times 10^{-4} \ 39; \ \alpha(\mathrm{O}) = 2.14 \times 10^{-5} \ 61; \ \alpha(\mathrm{P}) = 1.06 \times 10^{-6} \\ 45 \end{array} $		
549.8 <i>4</i>	14 4	550.0	(1,2)+	0.0	1+	M1+E2	1.1 8	0.0208 76	Additional information 5. 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 <i>3</i>	571.6	$(1)^+$	0.0	1+	E2+M1	9.2 22	0.01244 22	Additional information 10. $\alpha(K)\exp=0.010 \ 3$ $\alpha(K)=0.01000 \ 18; \ \alpha(L)=0.00189 \ 3; \ \alpha(M)=0.000431 \ 7$ $\alpha(N)=0.0001000 \ 16; \ \alpha(O)=1.359\times10^{-5} \ 22; \ \alpha(P)=5.57\times10^{-7} \ 11$ Additional information 13. Additional information 17		
589.12 ^{&} 20	33 4	951.98	(0,1) ⁻	362.79	(0,1,2)+	E1		0.00408	$\alpha(K)\exp=0.004 \ I$ $\alpha(K)=0.00346 \ 5; \ \alpha(L)=0.000484 \ 7; \ \alpha(M)=0.0001069 \ I5$ $\alpha(N)=2.49\times10^{-5} \ 4; \ \alpha(O)=3.54\times10^{-6} \ 5; \ \alpha(P)=1.85\times10^{-7} \ 3$ $\delta(M2/E1)<0.17 \ from \ \alpha(K)exp.$ Additional information 26.		
601.8 ^{&} f 3	≈3 ^{<i>a</i>}	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 <i>19</i>	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	$\begin{array}{l} \alpha(\text{K}) \exp = 0.016 \ 5 \\ \alpha(\text{K}) = 0.0121 \ 17; \ \alpha(\text{L}) = 0.00179 \ 21; \ \alpha(\text{M}) = 0.00040 \ 5 \\ \alpha(\text{N}) = 9.3 \times 10^{-5} \ 11; \ \alpha(\text{O}) = 1.34 \times 10^{-5} \ 16; \ \alpha(\text{P}) = 7.2 \times 10^{-7} \\ 11 \end{array}$		
737 7 3	$\sim 6^{a}$	רד רבד	$(1)^{+}$	0.0	1+				Additional information 21. Let $ce(K) = 0.08$ 3		
887.3 ^{&} 3	~0 17 <i>4</i>	928.40	(1)	40.928	(0 ⁻ ,1 ⁻)	(E1)		0.00179	$ α(K) = 0.0055. $ $ α(K) = 0.001526 22; \ α(L) = 0.000209 3; \ α(M) = 4.59 \times 10^{-5} 7 $ $ α(N) = 1.071 \times 10^{-5} 15; \ α(O) = 1.533 \times 10^{-6} 22; $ $ α(P) = 8.27 \times 10^{-8} 12 $ Mult.: α(K)exp consistent with E1 or E2, but E1 is consistent with ΔJ ^π .		
I									Additional information 23.		

6

¹⁶⁴₆₉Tm₉₅-6

L

						¹⁶⁴ Υbε α	lecay (75.8 m	in) 1982AdZZ (continued)			
γ (¹⁶⁴ Tm) (continued)											
E_{γ}^{\dagger}	$I_{\gamma}^{\dagger d}$	E _i (level)	\mathbf{J}_i^{π}	E_f	\mathbf{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 <i>10</i> ; α (L)=0.000963 <i>14</i> ; α (M)=0.000213 <i>3</i> α (N)=4.99×10 ⁻⁵ <i>7</i> ; α (O)=7.21×10 ⁻⁶ <i>11</i> ; α (P)=4.00×10 ⁻⁷ <i>6</i> Mult.: from 1997ZaZW. Note that α (K)exp=0.04 <i>2</i> in 1982AdZZ is too high for M1, E2 or M2, thus the authors proposed mult=E0+E2. Additional information 24.			
1019.2 <i>4</i> 1059.8	13 3	1060.14 1060.14	(1^+) (1^+)	40.928 0.0	$(0^{-},1^{-})$ 1 ⁺	(M1+E2)	0.0045 14	α (K)=0.0038 <i>12</i> ; α (L)=5.5×10 ⁻⁴ <i>15</i> ; α (M)=1.22×10 ⁻⁴ <i>32</i> α (N)=2.84×10 ⁻⁵ <i>76</i> ; α (O)=4.1×10 ⁻⁶ <i>12</i> ; α (P)=2.19×10 ⁻⁷ <i>71</i> E_{γ} ,Mult.: from 1997ZaZW.			
 [†] From are in [‡] γ coi: [#] From [@] From [@] γ rep ^a Ιγ va ^b From othery ^c Addit 	1982Ad2 general a ncidence ce data c ce data c orted by lues dedu ce data c vise state	ZZ. Values a agreement v with ce(L1) of 1997ZaZ' of 2001AIZV 1971De22 a ced by eval of 1982AdZ d. The same	for 16 γ with those $\alpha(37.57\gamma$ W only. U. ulso. uators f Z, and a e assign	y rays (in se from y). From the also 1997 ments ar	limit on to 7ZaZW for re given in	γ rays with t , Iγ values d tal transition r a few transi the Adopted	incertain isoto iffer significar intensities an itions. Mixing Levels, Gam	ppic assignment) are also listed by 1971De22. While E γ values from 1971De22 ntly. d $\alpha(K)$ exp values given by 1982AdZZ. ratios have been deduced by evaluators from ce data of 1982AdZZ, unless mas dataset.			
d For a e Multi f Place $x \gamma$ ray	bsolute in ply place ment of t not place	d with inter ransition in d in level s	100 dec nsity sui the leve scheme.	cays, mu tably div el schem	ltiply by ≈ vided. e is uncert	0.0025. ain.					

7

 $^{164}_{69}\mathrm{Tm}_{95}$ -7

¹⁶⁴Yb ε decay (75.8 min) 1982AdZZ



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