^{160}Yb ε decay (4.8 min) 1978Ad03

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 176, 1 (2021)	1-May-2021

Parent: ^{160}Yb: E=0.0; $J^{\pi}=0^{+}$; $T_{1/2}$=4.8 min *2*; Q(ε)=2140 *30*; %ε+%β^{+} decay=100.0

^{160}Yb-Q(ε): From 2021Wa16.

Additional information 1.

Source produced in 660-MeV proton spallation of Ta and Hf targets followed by mass separation. Measured Eγ, Iγ, E(ce), Ice, prompt and delayed $\gamma\gamma$, γce. Plastic, Ge(Li) detectors, magnetic lens β spectrometer.

^{160}Tm Levels

E(level)[†]	J^{π}[‡]	$T_{1/2}$	Comments
0.0	1^{-}	9.4 min *3*	$T_{1/2}$: adopted value; 9.2 min *4* from 1970De13 and 1970DeZF (this dataset).
42.10 *5*	2^{-}	1.6 ns *3*	$T_{1/2}$: delayed γce (1978Ad03).
99.43 *4*	$1^{(-)}$		
140.33 *4*	$0^{+},1^{+},2^{+}$		
174.38 *5*	1^{+}	17 ns *1*	$T_{1/2}$: delayed γce (1978Ad03).
215.84 *4*	1^{+}	0.65 ns *15*	$T_{1/2}$: deduced from centroid shift in delayed $\gamma\gamma$ (1978Ad03).
494.49 *14*	1^{+}		
543.36 *13*	$(1,2,3)^{+}$		
547.38 *11*	1^{+}		
605.37 *13*	1^{+}		
797.96 *21*	1^{+}		

[†] From least-squares fit to Eγ data.

[‡] From Adopted Levels.

ε,β^{+} radiations

E(decay)	E(level)	Iβ^{+} [†]	Iε[†]	Log *ft*	I($\varepsilon+\beta^{+}$)[†]	Comments
(1.34×10^{3} *3*)	797.96		1.29 *21*	5.69 *8*	1.29 *21*	εK=0.8253 *2*; εL=0.13401 *21*; εM+=0.04044 *8*
(1.53×10^{3} *3*)	605.37	0.012 *5*	5.7 *16*	5.17 *13*	5.7 *16*	av Eβ=246 *14*; εK=0.8252 *3*; εL=0.13271 *21*; εM+=0.03999 *8*
(1.59×10^{3} *3*)	547.38	0.014 *3*	4.3 *5*	5.32 *6*	4.3 *5*	av Eβ=272 *14*; εK=0.8247 *4*; εL=0.13230 *23*; εM+=0.03985 *8*
(1.65×10^{3} *3*)	494.49	0.0087 *20*	1.93 *24*	5.70 *6*	1.94 *24*	av Eβ=295 *14*; εK=0.8239 *6*; εL=0.13190 *24*; εM+=0.03972 *8*
(1.92×10^{3} *3*)	215.84	1.4 *2*	79 *8*	4.23 *5*	80 *8*	av Eβ=418 *14*; εK=0.8144 *17*; εL=0.1292 *4*; εM+=0.03886 *12*
(1.97×10^{3} *3*)	174.38	0.1 *1*	7 *3*	5.31 *19*	7 *3*	av Eβ=436 *14*; εK=0.8121 *19*; εL=0.1287 *4*; εM+=0.03870 *13*
(2.04×10^{3} *3*)	99.43	0.072 *13*	2.6 *4*	5.76 *7*	2.7 *4*	av Eβ=469 *14*; εK=0.8072 *22*; εL=0.1277 *5*; εM+=0.03838 *14*
(2.14×10^{3} *3*)	0.0	0.05 *5*	1.4 *14*	6.1 *5*	1.5 *15*	av Eβ=513 *14*; εK=0.799 *3*; εL=0.1262 *5*; εM+=0.03791 *16*

[†] Absolute intensity per 100 decays.

γ(^{160}Tm)

Iγ normalization: Listed value was calculated by the evaluator assuming a g.s. ε+β$^+$ branch of 1.5% *15*. This value was deduced from the requirement that log *ft* for the first-forbidden ε+β$^+$ transition to the g.s. be ≥5.9, which implies that this intensity be ≤3%. 1978Ad03 report an upper limit of ≈25% for this direct g.s. feeding, inferred from their measured K x ray intensity and the intensity balance in ^{160}Tm.

E$_\gamma$	I$_\gamma$$^{\#a}$	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.†	δ$^\&$	α$^@$	I$_{(\gamma+ce)}$^{a}	Comments
34.18 *10*	3.1 *5*	174.38	1$^+$	140.33	0$^+$,1$^+$,2$^+$	M1		11.69 *20*		%Iγ=1.33 *21* α(L)=9.11 *15*; α(M)=2.03 *4* α(N)=0.475 *8*; α(O)=0.0682 *12*; α(P)=0.00368 *6*
(41.46 *7*)	≈0.4	215.84	1$^+$	174.38	1$^+$	(M1+E2)	≥0.65	92 *46*	≈40	%Iγ=0.17 *8* ce(L)/(γ+ce)=0.76 *26*; ce(M)/(γ+ce)=0.18 *12* ce(N)/(γ+ce)=0.042 *29*; ce(O)/(γ+ce)=0.0048 *34*; ce(P)/(γ+ce)=1.02×10^{-5} *84* α(L)=70 *36*; α(M)=17.1 *87* α(N)=3.9 *20*; α(O)=0.44 *22*; α(P)=9.4×10^{-4} *62* E$_\gamma$: from level-energy difference. Mult.,δ,I$_\gamma$: 1978Ad03 have deduced I(γ+ce)≈40 based upon analysis of their coincidence results. From this and their measured I(ce(L1)) they deduced an E2 component of ≥30%. I$_{ce(L1)}$<3 (1978Ad03).
42.02 *10*	7.3 *6*	42.10	2$^-$	0.0	1$^-$	M1+E2	0.31 *3*	17.1 *20*		%Iγ=3.12 *24* α(L)=13.2 *16*; α(M)=3.1 *4* α(N)=0.71 *9*; α(O)=0.088 *10*; α(P)=0.00185 *4* Mult.,δ: based on α deduced from intensity balance at 42 level and relative ce intensity ratios L1:L2:L3=33:31:30 (1978Ad03).
62.05 *10*	0.46 *15*	605.37	1$^+$	543.36	(1,2,3)$^+$	(M1,E2)		16.6 *45*		%Iγ=0.20 *7* α(K)=6.0 *42*; α(L)=8.2 *66*; α(M)=2.0 *17* α(N)=0.45 *37*; α(O)=0.053 *41*; α(P)=3.8×10^{-4} *26* Mult.: if E1 intensity at 543 level cannot be balanced.
^{x}94.29 *7*	0.92 *8*									%Iγ=0.39 *5*
98.24 *5*	2.8 *2*	140.33	0$^+$,1$^+$,2$^+$	42.10	2$^-$	[E1]		0.350		%Iγ=1.20 *13* α(K)=0.289 *4*; α(L)=0.0470 *7*; α(M)=0.01048 *15* α(N)=0.00240 *4*; α(O)=0.000318 *5*; α(P)=1.287×10^{-5} *18*
99.46 *5*	2.1 *1*	99.43	1$^{(-)}$	0.0	1$^-$	[M1]		3.15		%Iγ=0.90 *9* α(K)=2.64 *4*; α(L)=0.400 *6*; α(M)=0.0891 *13* α(N)=0.0208 *3*; α(O)=0.00300 *5*; α(P)=0.0001620 *23*
116.44 *5*	1.96 *16*	215.84	1$^+$	99.43	1$^{(-)}$	(E1)		0.223		%Iγ=0.84 *10*

γ(^{160}Tm) (continued)

Eγ	Iγ[#a]	Ei(level)	J^π_i	E_f	J^π_f	Mult.[†]	α[@]	Comments
								α(K)=0.185 *3*; α(L)=0.0294 *5*; α(M)=0.00654 *10* α(N)=0.001504 *22*; α(O)=0.000201 *3*; α(P)=8.45×10^{-6} *12*
132.23 *5*	14.0 *7*	174.38	1^+	42.10	2^-	E1	0.1593	%Iγ=6.0 *6* α(K)=0.1328 *19*; α(L)=0.0207 *3*; α(M)=0.00461 *7* α(N)=0.001061 *15*; α(O)=0.0001430 *20*; α(P)=6.16×10^{-6} *9* $I_{ce(K)}$<1.8 (1978Ad03).
140.35 *5*	22.2 *10*	140.33	$0^+,1^+,2^+$	0.0	1^-	E1	0.1360	%Iγ=9.5 *9* α(K)=0.1135 *16*; α(L)=0.01759 *25*; α(M)=0.00391 *6* α(N)=0.000901 *13*; α(O)=0.0001219 *18*; α(P)=5.31×10^{-6} *8* $I_{ce(K)}$<2.5 (1978Ad03).
^{x}155.76 *7*	1.7 *2*							%Iγ=0.73 *11*
173.74 *6*	100 *4*	215.84	1^+	42.10	2^-	E1	0.0775	%Iγ=43 *4* α(K)=0.0649 *10*; α(L)=0.00985 *14*; α(M)=0.00219 *3* α(N)=0.000505 *7*; α(O)=6.90×10^{-5} *10*; α(P)=3.12×10^{-6} *5*
174.40 *10*	13.2 *15*	174.38	1^+	0.0	1^-	E1	0.0767	%Iγ=5.6 *8* α(K)=0.0643 *9*; α(L)=0.00975 *14*; α(M)=0.00217 *3* α(N)=0.000500 *7*; α(O)=6.84×10^{-5} *10*; α(P)=3.09×10^{-6} *5*
215.78 *6*	48 *2*	215.84	1^+	0.0	1^-	E1	0.0441	%Iγ=20.5 *18* α(K)=0.0370 *6*; α(L)=0.00553 *8*; α(M)=0.001226 *18* α(N)=0.000284 *4*; α(O)=3.91×10^{-5} *6*; α(P)=1.83×10^{-6} *3* $I_{ce(K)}$<1.5 (1978Ad03).
^{x}278.0[‡] *3*	1.0 *2*							%Iγ=0.43 *10*
320.00 *15*	3.4 *3*	494.49	1^+	174.38	1^+			%Iγ=1.45 *18*
327.60 *15*	5.6 *4*	543.36	$(1,2,3)^+$	215.84	1^+			%Iγ=2.4 *3*
354.6 *3*	1.1 *2*	494.49	1^+	140.33	$0^+,1^+,2^+$			%Iγ=0.47 *10*
^{x}356.9[‡] *5*	0.74 *20*							%Iγ=0.32 *9*
^{x}366.2[‡] *3*	1.05 *25*							%Iγ=0.45 *12*
373.00 *10*	10.0 *5*	547.38	1^+	174.38	1^+			%Iγ=4.3 *4*
^{x}386.30 *20*	3.0 *3*							%Iγ=1.28 *17*
389.45 *15*	5.2 *3*	605.37	1^+	215.84	1^+			%Iγ=2.22 *4*
^{x}395.16 *25*	1.61 *23*							%Iγ=0.69 *12*
^{x}429.0[‡] *4*	1.2 *3*							%Iγ=0.51 *14*
^{x}465.2[‡] *4*	1.4 *3*							%Iγ=0.60 *14*
^{x}563.1 *3*	1.8 *4*							%Iγ=0.77 *18*
582.12 *20*	3.0 *4*	797.96	1^+	215.84	1^+			%Iγ=1.28 *22*
^{x}588.7[‡] *3*	1.50 *35*							%Iγ=0.64 *16*

[†] From relative Iγ and Ice values, normalized so that α(L1)+α(L2)=8.8 for the 42 γ.

[‡] Assignment to ^{160}Yb decay uncertain.

γ(^{160}Tm) (continued)

[#] I(Kα_1 x ray)=129 *9*, relative to Iγ(173.7γ)=100.

[@] Additional information 2.

[&] Additional information 3.

[a] For absolute intensity per 100 decays, multiply by 0.43 *4*.

[x] γ ray not placed in level scheme.

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Decay Scheme

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