^{160}Tm ε decay (74.5 s) 1983Si20

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

Parent: ^{160}Tm: E=70 *20*; J^π=5; $T_{1/2}$=74.5 s *15*; Q(ε)=5760 *40*; %ε+%β^+ decay=15 *5*

^{160}Tm-Q(ε): From 2021Wa16.

^{160}Tm-%ε+%β^+ decay: 1983Si20 estimate I(ε+β^+)=15 *5* based on the intensities of the 74-s and 9.4-min components of the 264-keV γ ray measured at the beginning of the counting period, assuming that the production cross sections for the ^{160}Tm g.s. and the 74.5-s isomer in the (p,5n) reaction are comparable.

Additional information 1.

1983Si20: source produced in the ^{164}Er(p,5n) reaction, E(p)=57 MeV. γ radiation studied using three high-resolution Ge detectors, two to measure γ singles, γγ, and time-sequential data and one to measure γ singles and time-sequential data for x rays and low-energy γ rays. The internal-conversion electron spectrum measured using a mini-orange spectrometer and a cooled Si(Li) detector. Authors report Eγ, Iγ, γγ, γ(t), E(ce), Ice.

2014Bl12: ^{160}Tm source produced in ^{150}Sm(^{14}N,4n), E=72 MeV reaction at INFN-LNS tandem accelerator facility in Catania. Measured γ-ray and conversion electron spectra, latter using a mini-orange spectrometer of fixed magnets. Deduced E0 transitions, conversion coefficients, X(E0/E2) ratios for E0 transitions.

^{160}Er Levels

E(level)†	J^π‡	$T_{1/2}$	Comments
0.0	0$^+$	28.58 h *9*	$T_{1/2}$: adopted value.
125.82 *10*	2$^+$		
389.86 *14*	4$^+$		
765.66 *17*	6$^+$		
987.25 *14*	(3)$^+$		
1008.01 *22*	2$^+$		
1128.56 *17*	4$^+$		
1230.29 *24*	4$^+$		
1316.56 *25*	5$^+$		
1375.23 *23*	(4$^+$)		
1505.7 *4*			
1576.0 *4*			

† Calculated from a least-squares fit of the γ-ray energies. Where no uncertainties are available for the Eγ values, a value of 1 keV was assigned for this calculation.

‡ From Adopted Levels.

ε,β^+ radiations

The decay scheme is clearly incomplete, with many γ transitions from higher-lying levels not observed in the experiment reason for which the intensity and log *ft* are not adopted but listed in comments for illustrative purposes. It is expected that the ε+β^+ transition intensities, particularly those involving the lower-lying levels, are too large, and the log *ft* values too small. Consequently while the listed log *ft* values (and their uncertainties) are based on the known data they should rather be taken as lower limits.
Given in comments are (in this order): Iβ^+, Iε, log *ft*, I(ε+β^+). Intensities are per 100 decays of the isomer.

E(decay)	E(level)	Comments
(4.25×10^3 *5*)	1576.0	av Eβ=1464 *21*; εK=0.384 *9*; εL=0.0586 *14*; εM+=0.0174 *4* 0.21 *9*, 0.17 *8*, 6.96 *20*, 0.38 *17*.
(4.32×10^3 *5*)	1505.7	av Eβ=1496 *21*; εK=0.371 *9*; εL=0.0565 *13*; εM+=0.0168 *4* 0.26 *11*, 0.20 *9*, 6.91 *19*, 0.46 *20*.

Continued on next page (footnotes at end of table)

^{160}Tm ε decay (74.5 s) 1983Si20 (continued)

ε,β^+ radiations (continued)

E(decay)	E(level)	Comments
(4.45×10^3 *5*)	1375.23	av Eβ=1557 *21*; εK=0.347 *8*; εL=0.0529 *12*; εM+=0.0157 *4* 0.34 *15*, 0.25 *10*, 6.86 *19*, 0.59 *25*.
(4.51×10^3 *5*)	1316.56	av Eβ=1584 *21*; εK=0.337 *8*; εL=0.0514 *12*; εM+=0.0152 *4* 0.4 *2*, 0.2 *1*, 6.87 *22*, 0.6 *3*.
(4.60×10^3 *5*)	1230.29	av Eβ=1624 *21*; εK=0.323 *8*; εL=0.0492 *12*; εM+=0.0146 *4* 0.5 *2*, 0.3 *2*, 6.78 *22*, 0.8 *4*.
(4.70×10^3 *5*)	1128.56	av Eβ=1671 *21*; εK=0.307 *7*; εL=0.0467 *11*; εM+=0.0139 *4* 0.7 *3*, 0.40 *18*, 6.69 *20*, 1.1 *5*.
(4.82×10^3 *5*)	1008.01	av Eβ=1727 *21*; εK=0.289 *7*; εL=0.0439 *10*; εM+=0.0130 *3* 0.29 *12*, 0.15 *7*, 7.13 *19*, 0.44 *19*. Log *ft*: this value is too small for a J=5 to $J^\pi=2^+$ transition. This may indicate simply that the gammas feeding this level have not been detected.
(4.84×10^3 *5*)	987.25	av Eβ=1736 *21*; εK=0.286 *7*; εL=0.0435 *10*; εM+=0.0129 *3* 1.1 *4*, 0.55 *21*, 6.58 *17*, 1.6 *6*.
(5.06×10^3 *5*)	765.66	av Eβ=1839 *21*; εK=0.256 *6*; εL=0.0389 *9*; εM+=0.0115 *3* 1.8 *8*, 0.8 *3*, 6.46 *19*, 2.6 *11*.
(5.44×10^3 *5*)	389.86	av Eβ=2015 *21*; εK=0.212 *5*; εL=0.0322 *8*; εM+=0.00956 *22* 3.3 *13*, 1.1 *4*, 6.37 *17*, 4.4 *17*.

γ(^{160}Er)

I_γ normalization: multiply by 0.61 *10* for γ intensities per 100 ε+β^+ decays of the isomer (obtained from $\Sigma I_{\gamma+ce}$=100 to g.s.) and by 0.09 *4* for γ intensities per 100 decays of the isomer. Due to the incompletness of the level scheme the normalization is not adopted but given for illustrative purposes.

E_γ	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult.†	δ†#	α‡	Comments
125.8 *1*	72 *12*	125.82	2^+	0.0	0^+	E2		1.259	α(K)=0.602 *9*; α(L)=0.504 *8*; α(M)=0.1220 *18* α(N)=0.0277 *4*; α(O)=0.00329 *5*; α(P)=2.56×10^{-5} *4*
264.1 *1*	100	389.86	4^+	125.82	2^+	E2		0.1024	α(K)=0.0726 *11*; α(L)=0.0230 *4*; α(M)=0.00541 *8* α(N)=0.001236 *18*; α(O)=0.0001568 *22*; α(P)=3.64×10^{-6} *6*
375.8 *1*	27 *4*	765.66	6^+	389.86	4^+	E2		0.0356	α(K)=0.0273 *4*; α(L)=0.00647 *9*; α(M)=0.001496 *21* α(N)=0.000344 *5*; α(O)=4.52×10^{-5} *7*; α(P)=1.458×10^{-6} *21*
597.6 *3*	2.9 *7*	987.25	$(3)^+$	389.86	4^+				
738.7 *1*	12 *2*	1128.56	4^+	389.86	4^+	M1+E2	−7 *+3−17*	0.0066 *3*	α(K)exp=0.006 *2* (2014Bl12) α(K)=0.00541 *24*; α(L)=0.00090 *3*; α(M)=0.000202 *7* α(N)=4.68×10^{-5} *15*; α(O)=6.54×10^{-6} *23*; α(P)=3.07×10^{-7} *15* Mult.,δ: α(K)exp consistent with M1+E2, δ=−7 *+3−17* as measured earlier in 2006Du02 (HI dataset). No E0 admixture is evident. X(E0/E2)=0 (2014Bl12).
840.8 *3*	3.8 *9*	1230.29	4^+	389.86	4^+	E0+M1+E2		0.032 *7*	α(K)exp=0.028 *6* (2014Bl12) α(K)=0.0060 *20*; α(L)=8.9×10^{-4} *25*;

Continued on next page (footnotes at end of table)

^{160}Tm ε decay (74.5 s) 1983Si20 (continued)

γ(^{160}Er) (continued)

E_γ	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult.[†]	δ[†#]	α[‡]	Comments
									α(M)=1.97×10^{-4} *53* α(N)=4.6×10^{-5} *13*; α(O)=6.6×10^{-6} *19*; α(P)=3.5×10^{-7} *13* α: estimated from α(K)exp and theoretical K/Tot≈0.87. Mult.: based on α(K)exp (2014Bl12, photon and electron spectra). α(K)exp from table III in 2014Bl12, uncertainty=0.005 in text on page 5. X(E0/E2)=0.330 *82* (2014Bl12).
861.4 *1*	12 *2*	987.25	(3)$^+$	125.82	2$^+$	E2		0.00460	α(K)exp=0.0038 *8* (2014Bl12) α(K)=0.00382 *6*; α(L)=0.000607 *9*; α(M)=0.0001357 *19* α(N)=3.15×10^{-5} *5*; α(O)=4.43×10^{-6} *7*; α(P)=2.17×10^{-7} *3* Mult.: based on α(K)exp (2014Bl12). α(K)exp from table III in 2014Bl12, listed as 0.0034 *8* in text on page 5.
882.0 *3*	2.5 *7*	1008.01	2$^+$	125.82	2$^+$	E0+M1+E2		0.070 *17*	α(K)exp=0.061 *15* (2014Bl12) α(K)=0.0054 *18*; α(L)=7.9×10^{-4} *22*; α(M)=1.75×10^{-4} *47* α(N)=4.1×10^{-5} *11*; α(O)=5.9×10^{-6} *17*; α(P)=3.2×10^{-7} *11* α: estimated from α(K)exp and theoretical K/Tot≈0.87. Mult.: based on α(K)exp (2014Bl12, photon and electron spectra). X(E0/E2)=0.97 *21* (2014Bl12). Contribution to electron intensity from 879, M1+E2 γ in ^{160}Dy subtracted. E_γ: incorrectly listed as 894 in level-scheme figure 7 of 2014Bl12.
926.7 *2*	6.7 *12*	1316.56	5$^+$	389.86	4$^+$	M1+E2	−5.5 *+9−12*	0.00405 *8*	α(K)=0.00338 *7*; α(L)=0.000524 *9*; α(M)=0.0001167 *20* α(N)=2.71×10^{-5} *5*; α(O)=3.83×10^{-6} *7*; α(P)=1.93×10^{-7} *4* δ: from 2006Du02 (HI dataset).
1008.2 *3*	2.3 *5*	1008.01	2$^+$	0.0	0$^+$	E2		0.00330	α(K)exp=0.0032 *7* (2014Bl12) α(K)=0.00276 *4*; α(L)=0.000422 *6*; α(M)=9.39×10^{-5} *14* α(N)=2.18×10^{-5} *3*; α(O)=3.09×10^{-6} *5*;

Continued on next page (footnotes at end of table)

^{160}Tm ε decay (74.5 s) 1983Si20 (continued)

$\gamma(^{160}Er)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Comments
						α(P)=1.574×10^{-7} *22* α(K)exp from table III in 2014Bl12, listed as 0.0033 *8* in text on page 5.
1104.1 *3*	5.3 *10*	1230.29	4^+	125.82	2^+	
1115.8 *3*	5.0 *10*	1505.7		389.86	4^+	
1186.1 *3*	4.2 *9*	1576.0		389.86	4^+	
1249.4 *2*	6.5 *12*	1375.23	(4^+)	125.82	2^+	

† From adopted values. Some values reported by articles quoted in this dataset are mentioned separately.

‡ Additional information 2.

Additional information 3.

^{160}Tm ε decay (74.5 s) 1983Si20