^{160}Tm ε decay (9.4 min) 1975St12,1982By03

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

Parent: ^{160}Tm: E=0.0; $J^\pi=1^-$; $T_{1/2}$=9.4 min *3*; Q(ε)=5760 *40*; %ε+%β^+ decay=100.0

^{160}Tm-Q(ε): From 2021Wa16.

Additional information 1.

1975St12,1982By03: sources produced by proton spallation reactions in a Ta target, followed by isotope separation.

1975St12 also carried out chemical separation after the sample irradiation. They measured γ-ray singles, $\gamma\gamma$, and $\beta\gamma$ using Ge(Li) detectors and conversion-electron spectra using a magnetic spectrograph. γ multipolarities were determined from α(K)exp, K/L1 ratios and L- and M-subshell ratios.

1982By03 measured the β strength function of ^{160}Tm via "total-absorption" γ spectroscopy, using a system of three NaI(Tl) detectors.

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.
125.72# *10*	2^+		
389.73# *14*	4^+		
854.3@ *3*	2^+		J^π: bandhead of the γ-vibrational band.
893.6& *6*	0^+		J^π: possible bandhead of the first excited $K^\pi=0^+$ band.
987.1@ *4*	$(3)^+$		
1007.6& *4*	2^+		
1374.9 *5*	(4^+)		
1389.9 *6*	$2^+,3,4^+$		
1395.4? *7*			
1494.3 *5*			
1535.9 *5*	$1,2^+$		
1586.1 *5*	$1,2^+$		
1652.1 *4*			
1894.3 *7*	$1,2^+$		
2194.5? *7*			
2249.1 *6*			

† 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.
# Band(A): g.s. band.
@ Band(B): γ-vibrational band.
& Band(C): first excited $K^\pi=0^+$ band ?

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$\gamma(^{160}Er)$

Iγ normalization: Since the decay scheme is rather incomplete (no levels above 2.25 MeV are reported), a realistic value of Iγ normalization is not available. However, from the observed γ's only and the assumption that the ε+β^+ feeding of the ^{160}Er g.s.<2% (consistent with the measurements of 1982By03), Iγ normalization is computed to be 1.05 *3*.

I(Er K x rays)=88 *9*, relative to Iγ(125.7γ)=35 *5*.

I($\gamma^\pm$)=30 *4*, relative to Iγ(125.7γ)=35 *5*.

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult. ‡	α &	Comments
125.7 *1*	35 *5*	125.72	2^+	0.0	0^+	E2 #	1.263	α(K)=0.603 *9*; α(L)=0.506 *8*; α(M)=0.1224 *18* α(N)=0.0278 *4*; α(O)=0.00330 *5*; α(P)=2.56×10^{-5} *4*
264.0 *1*	9.4 *12*	389.73	4^+	125.72	2^+	E2 #	0.1025	α(K)=0.0726 *11*; α(L)=0.0230 *4*; α(M)=0.00542 *8* α(N)=0.001238 *18*; α(O)=0.0001570 *22*; α(P)=3.64×10^{-6} *6*
^{x}389.0 *8*	0.7 *3*							
520.2 *8*	0.5 *2*	1374.9	(4^+)	854.3	2^+			
^{x}527.0 *8*	0.8 *3*							
548.4 *8*	0.6 *3*	1535.9	$1,2^+$	987.1	$(3)^+$			
597.1 *6*	1.7 *3*	987.1	$(3)^+$	389.73	4^+			
617.5 *6*	1.6 *3*	1007.6	2^+	389.73	4^+			
^{x}636.4 *8*	0.8 *3*							
640.1 *7*	1.6 *3*	1494.3		854.3	2^+			
665.0 *8*	0.8 *3*	1652.1		987.1	$(3)^+$			
681.7 *7*	0.7 *3*	1535.9	$1,2^+$	854.3	2^+			
728.5 *5*	12.8 *12*	854.3	2^+	125.72	2^+	E0+M1+E2 @	0.0100 *35*	α(K)exp=0.0084 *14* (2014Bl12) α(K)=0.0084 *30*; α(L)=0.00127 *36*; α(M)=2.82×10^{-4} *77* α(N)=6.6×10^{-5} *18*; α(O)=9.4×10^{-6} *28*; α(P)=5.0×10^{-7} *19* α(K)exp from table III in 2014Bl12, uncertainty=0.0021 in text on page 5. Contribution to electron intensity from 729, E2 γ in ^{160}Dy subtracted. Mult.: α(K)exp agrees with M1+E2 with δ≈1, however E0 admixture cannot be ruled out (2014Bl12). X(E0/E2)=0.023 *5*, assuming no M1 component for multipolarity of 729γ (2014Bl12).
767.8 *6*	2.9 *3*	893.6	0^+	125.72	2^+	[E2]	0.00591	α(K)=0.00487 *7*; α(L)=0.000804 *12*; α(M)=0.000180 *3* α(N)=4.18×10^{-5} *6*; α(O)=5.84×10^{-6} *9*; α(P)=2.76×10^{-7} *4*
797.7 *6*	2.7 *4*	1652.1		854.3	2^+			
854.4 *5*	8.1 *7*	854.3	2^+	0.0	0^+	E2 #	0.00468	α(K)exp=0.0040 *9* (2014Bl12) α(K)=0.00388 *6*; α(L)=0.000619 *9*; α(M)=0.0001384 *20* α(N)=3.21×10^{-5} *5*; α(O)=4.52×10^{-6} *7*; α(P)=2.21×10^{-7} *4*
861.4 *5*	7.0 *6*	987.1	$(3)^+$	125.72	2^+	E2 #	0.00460	α(K)exp=0.0038 *8* (2014Bl12)

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

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.‡	α&	Comments
								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* α(K)exp from table III in 2014Bl12, listed as 0.0034 *8* in text on page 5.
882.0 *6*	2.2 *3*	1007.6	2^+	125.72	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. 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.
894		893.6	0^+	0.0	0^+	E0@		X(E0/E2)=0.11 *3* from 2014Bl12, who corrected for M1+E2 766γ in ^{160}Dy.
985.5 *7*	0.9 *3*	1374.9	(4^+)	389.73	4^+			
1000.2 *8*	0.7 *3*	1389.9	2^+,3,4^+	389.73	4^+			
1007.7 *6*	2.5 *3*	1007.6	2^+	0.0	0^+	E2@	0.00331	α(K)exp=0.0032 *7* (2014Bl12) α(K)=0.00277 *4*; α(L)=0.000423 *6*; α(M)=9.40×10^{-5} *14* α(N)=2.18×10^{-5} *3*; α(O)=3.10×10^{-6} *5*; α(P)=1.575×10^{-7} *23* α(K)exp from table III in 2014Bl12, listed as 0.0033 *8* in text on page 5.
^{x}1102.7 *12*	0.6 *3*							
^{x}1151.8 *8*	1.1 *3*							
1249.1 *6*	2.8 *4*	1374.9	(4^+)	125.72	2^+			
1264.1 *8*	1.3 *3*	1389.9	2^+,3,4^+	125.72	2^+			
1269.7 *7*	3.0 *3*	1395.4?		125.72	2^+			
1340.5 *10*	0.5 *2*	2194.5?		854.3	2^+			
1368.5 *5*	8.6 *7*	1494.3		125.72	2^+			
1394.7 *6*	3.6 *4*	2249.1		854.3	2^+			
1409.4 *10*	0.7 *3*	1535.9	1,2^+	125.72	2^+			
1460.6 *6*	4.3 *5*	1586.1	1,2^+	125.72	2^+			
1526.4 *6*	3.8 *4*	1652.1		125.72	2^+			
1536.6 *8*	1.1 *2*	1535.9	1,2^+	0.0	0^+			
1585.9 *7*	1.0 *2*	1586.1	1,2^+	0.0	0^+			
1768.5 *8*	0.8 *2*	1894.3	1,2^+	125.72	2^+			
^{x}1801.1 *10*	0.6 *2*							
^{x}1862.6 *9*	0.8 *2*							
1894.4 *11*	0.9 *3*	1894.3	1,2^+	0.0	0^+			
2068.5 *8*	1.1 *3*	2194.5?		125.72	2^+			
2123.4 *8*	1.1 *3*	2249.1		125.72	2^+			
^{x}2202.2 *7*	1.9 *3*							
^{x}2214.1 *8*	1.1 *3*							
^{x}2403.9 *9*	0.7 *3*							
^{x}2924.3 *10*	0.8 *3*							

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γ(^{160}Er) (continued)

† From 1975St12.
‡ From specific mesurements done by studies quoted in this dataset. All values in this dataset coincide with those Adopted Levels, Gammas dataset.
# From Iγ and Ice(K) data of 1975St12, normalized to α(K)(125.7γ)=0.608 (E2 theory). Mult(125.7γ) determined from K/L. Mult(264.0γ) confirmed by K/L.
@ From Iγ and Ice(K) data of 2014Bl12.
& Additional information 2.
^{x} γ ray not placed in level scheme.

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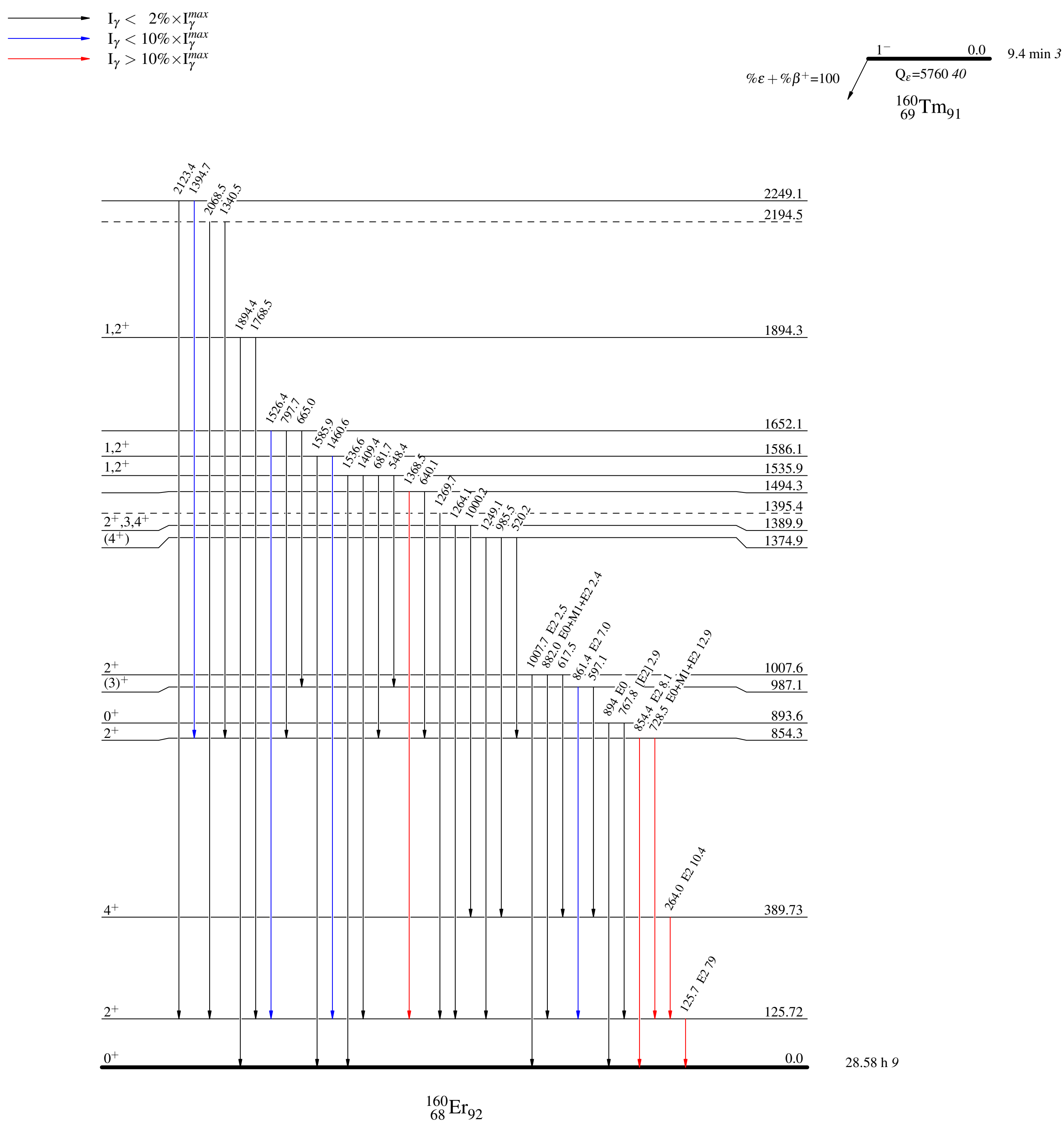
Decay Scheme

Intensities: Relative $I_{(\gamma+ce)}$



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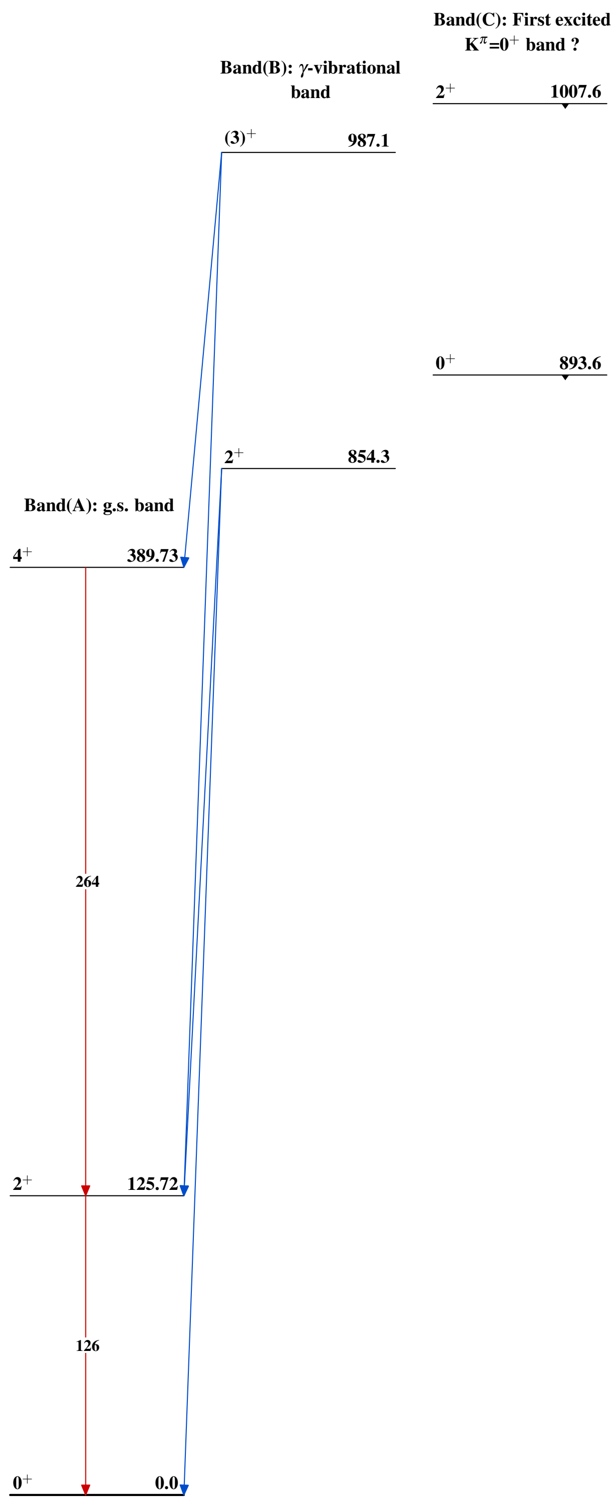

$^{160}_{68}Er_{92}$