^{156}Er ε decay 1999KaZV,2003KaZQ

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 113, 2537 (2012)	1-Mar-2012

Parent: ^{156}Er: E=0; J$^{\pi}$=0^{+}; T$_{1/2}$=19.5 min *10*; Q(ε)=1260 *65*; %ε+%β^{+} decay=100.0
^{156}Er-T$_{1/2}$: Additional information 1.
^{156}Er-Q(ε): Additional information 2.
^{156}Er-%ε+%β^{+} decay: %α=7×10^{-6} *3*, from the ^{156}Er Adopted Levels. It is assumed here that %ε+%β^{+}=100.
Additional information 3.
2003KaZQ: This represents a published version of the material contained in the private communication of 2002KaZL.
2002KaZL: Private communication to the evaluator from V. G. Kalinnikov (August, 2002). This information represents a further analysis of the data of 1999KaZV. They extend, and in some instances change, the conclusions of this earlier study.
1999KaZV: ^{156}Er from high-energy proton-induced spallation on a W target. Isotope-separated samples. Measured Eγ, Iγ, ce, $\gamma\gamma$. Report Eγ, Iγ, I_e, multipolarities, J$^{\pi}$ and Q(ε).
1995KaZS: Using isotope-separated ^{156}Ho sources, report T$_{1/2}$ for the 52-keV isomeric state.
1982Vy06: ^{156}Er from proton-induced spallation on a Ta target. E(p)=660 MeV. Chemical and isotope separation, γ's measured using Ge(Li) detectors. ce measured using a magnetic spectrometer and spectrograph. Measured γ-ce coin. Three Iγ values are identical to those in 1975Al26, so evaluator assumes that they were not remeasured.
1975Al26: ^{156}Er from proton-induced spallation on a Ta target. E(p)=660 MeV. Chemical and isotope separation γ's measured using Ge(Li) detectors. ce measured using a magnetic spectrometer. Report Eγ, Iγ, I(ce), and deduced multipolarities.
1978Sc10: ^{156}Er from proton-induced spallation on a Ta target. E(p)=660 MeV. Isotope separation. Measured half-lives by Kx-ce coin using a NaI(Tl) detector and a magnetic spectrometer.
Others: 1981BuZJ, 1975Gr44, 1965Zh02.
The level scheme is primarily that proposed by 2003KaZQ, together with the placement of several γ's unplaced in previous studies. It is in most instances similar to that of 1999KaZV. Where there are differences, these are pointed out. The placement of several γ's is that from the earlier studies.
2007KaZT discuss allowed-unhindered ("spin-flip") ε transitions involving ^{156}Ho, ^{158}Ho, and ^{160}Ho and, using nuclear-model considerations, configuration assignments for several of the low-lying bandheads in these nuclides.
From the 511-keV photon intensity, the total Iβ^{+}=0.21% *10* (1982Vy06).
The intensities of the ε+β^{+} branches are computed from intensity- balance considerations and should be regarded as questionable in some instances. For example, the small log *ft* value for the transition to the 52.37, 1^{-} level, together with the absence of a γ deexciting the 251.1 level, suggest that there are intensity imbalances in the proposed level scheme. Nonetheless, because of the strong population of the 1^{+} level at 117.58 keV in ε decay, the log *ft* value of the feeding transition is most probably≈4.5, indicating an allowed-unhindered transition.

^{156}Ho Levels

E(level)[†]	J$^{\pi}$[#]	T$_{1/2}$	Comments
0[@]	4^{-}	56 min *1*	T$_{1/2}$: From the adopted values.
52.37[&]	1^{-}	9.5 s *15*	See the discussion in the Adopted Levels, Gammas data set regarding the configuration of this level. T$_{1/2}$: From 1995KaZS, (ce(L)(52γ),t).
82.23[a]	2^{-}	1.38 ns *12*	T$_{1/2}$: Weighted average of 1.46 ns *15* (1975Al26) and 1.25 ns *20* (1978Sc10) from (γ+x)−30 coincidences. 1999KaZV report 1.25 ns. 1999KaZV report J$^{\pi}$=2^{-}. If the 82.18 γ is correctly placed, then the possible J$^{\pi}$ values, 0^{-} or 1^{-} are ruled out. In this case, little ε+β^{+} feeding of this level is expected (and observed).
91.0	1^{+}		
117.58[b]	1^{+}	58 ns *3*	T$_{1/2}$: From Kx-35γ coincidences (2005KaZY). From Kx-35γ coincidences, 1978Sc10 report T$_{1/2}$ = 58 ns *4*. 1999KaZV report 58 ns.
215.74	1^{-}		
251.09[‡]			
268.12	1		

Continued on next page (footnotes at end of table)

^{156}Er ε decay 1999KaZV,2003KaZQ (continued)

^{156}Ho Levels (continued)

E(level)[†]	Jπ[#]
303.52[‡]	
434.2 *10*	1
504.95[‡]	
571.64[‡]	

[†] Computed from the listed γ-ray energies.
[‡] New level introduced by 2003KaZQ, but no properties other than the level energy are given.
[#] From the adopted values.
[@] Band(A): $K^\pi=4^-$ Bandhead. Probable conf=π5/2[402]+ν3/2[521]. The Σ=1 coupling of these two orbitals lies below the Σ=0 coupling, in agreement with the expectations of 1958Ga27.
[&] Band(B): $K^\pi=1^-$ Bandhead. Probable conf=π5/2[402]-ν3/2[521]. The Σ=0 coupling of these two orbitals lies above the Σ=1 coupling, in agreement with the expectations of 1958Ga27.
[a] Band(C): $K^\pi=2^-$ Bandhead. Probable conf=π7/2[404]-ν3/2[521].
[b] Band(D): $K^\pi=1^+$ Bandhead. Conf=π7/2[523]-ν5/2[523].

ε,β^+ radiations

E(decay)	E(level)	Iε[†]	Log *ft*	I(ε+β^+)[†]	Comments
(6.9×10^2 *7*)	571.64	0.33 *8*	6.22 *15*	0.33 *8*	εK=0.8189 *24*; εL=0.1392 *18*; εM+=0.0418 *7*
(7.6×10^2 *7*)	504.95	1.5 *2*	5.64 *11*	1.5 *2*	εK=0.8209 *20*; εL=0.1378 *15*; εM+=0.0413 *5*
(8.3×10^2 *7*)	434.2	0.4 *2*	6.30 *24*	0.4 *2*	εK=0.8227 *16*; εL=0.1365 *12*; εM+=0.0409 *5*
(9.6×10^2 *7*)	303.52	0.70 *12*	6.19 *10*	0.70 *12*	εK=0.8251 *12*; εL=0.1347 *9*; εM+=0.0402 *3*
(9.9×10^2 *7*)	268.12	1.3 *2*	5.96 *10*	1.3 *2*	εK=0.8257 *11*; εL=0.1343 *8*; εM+=0.0401 *3*
(1.04×10^3 *7*)	215.74	2.6 *5*	5.70 *11*	2.6 *5*	εK=0.8264 *10*; εL=0.1337 *7*; εM+=0.03987 *25*
(1.14×10^3 *7*)	117.58	52 *6*	4.48 *8*	52 *6*	εK=0.8276 *8*; εL=0.1328 *6*; εM+=0.03956 *20*
(1.17×10^3 *7*)	91.0	18 *7*	4.97 *18*	18 *7*	εK=0.8279 *8*; εL=0.1326 *6*; εM+=0.03948 *19*
(1.18×10^3 *7*)	82.23			0 *9*	
(1.21×10^3 *7*)	52.37	23 *13*	4.9 *3*	23 *13*	εK=0.8283 *7*; εL=0.1323 *5*; εM+=0.03938 *18*

[†] Absolute intensity per 100 decays.

γ(^{156}Ho)

Iγ normalization: Note that the energy of the γ connecting the 52.37 level and the g.s. is essentially identical to that deduced from the energy difference of the 286 and 215 levels. If a significant portion of the intensity in this peak is in fact to be associated with this latter placement, then the basis for the intensity normalization chosen here is called into question. (The possibility of this additional placement has been pointed out by the reviewer.).

E_γ[†]	I_γ[†@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[#]	α[&]	$I_{(\gamma+ce)}$[@]	Comments
8.72 *5*	6.5 *22*	91.0	1$^+$	82.23	2$^-$	E1		11	78 *24*	α(M)=8.30; α(N+..)=2.7 E_γ: From identification (2003KaZQ) of a 6.98 *5* keV conversion line as an M_3 line from an E1 transition. 1999KaZV assign it as an M_1 line from a 9.11-keV M1 transition. I_γ: Computed from Ice(M_3)=18 *6* (2003KaZQ) and α(M3)=2.77 for an 8.72 E1 γ. Mult.: From 2003KaZQ. 1999KaZV identify the 6.98 *5* electron line as an M_1 line and report mult=M1. $I_{(\gamma+ce)}$: From Iγ and α. 2003KaZQ estimate I(γ+ce)≈60. 1999KaZV report I_e=27 *9* for a 9.11γ.
26.55 *10*	0.20 *5*	117.58	1$^+$	91.0	1$^+$	M1+E2	0.12	35.1 *7*		α(L)=27.2 *6*; α(M)=6.23 *13*; α(N+..)=1.62 *4* α(N)=1.42 *3*; α(O)=0.188 *4*; α(P)=0.00654 *12* I_γ: From Ice(L_1)=3.0 *8* (2003KaZQ) and α(L1)=14.6. Mult.,δ: From α(L1)exp≥11 and the relative intensity ratios of 1, ≈0.40,≈0.65, respectively, for the L1, L2, L3 lines, 2003KaZQ conclude mult is M1+1.5%E2 for this transition. 1999KaZV report E1.
29.86	18.3 *13*	82.23	2$^-$	52.37	1$^-$	M1+E2	0.033 *6*	15.0 *4*		α(L)=11.7 *3*; α(M)=2.60 *6*; α(N+..)=0.694 *15* α(N)=0.603 *14*; α(O)=0.0867 *17*; α(P)=0.00466 *7* I_γ: Weighted average of: 17.0 *17* (1975Al26); and 20.0 *20* (1999KaZV). 1982Vy06 list 17.0 *17*. Mult.,δ: From L and M subshell ratios (1975Al26,1982Vy06). 1999KaZV indicate mult=M1.
35.37	100	117.58	1$^+$	82.23	2$^-$	E1		0.968		α(L)=0.757 *11*; α(M)=0.1687 *24*; α(N+..)=0.0424 *6* α(N)=0.0376 *6*; α(O)=0.00460 *7*; α(P)=0.0001448 *21* E_γ,Mult.: From 1999KaZV.
52.37	0.091 *9*	52.37	1$^-$	0	4$^-$	M3		4.17×10^3	380 *40*	ce(L)/(γ+ce)=0.740 *8*; ce(M)/(γ+ce)=0.205 *4*; ce(N+)/(γ+ce)=0.0541 *11* ce(N)/(γ+ce)=0.0480 *10*; ce(O)/(γ+ce)=0.00592 *12*; ce(P)/(γ+ce)=0.000135 *3* I_γ: Computed from α and the listed I(γ+ce) value. Mult.: From L and M subshell ratios (1975Al26,1982Vy06). $I_{(\gamma+ce)}$: Value is I_e for this transition (1999KaZV).
65.16[a]	≈0.65	117.58	1$^+$	52.37	1$^-$	E1		0.977		α(K)=0.801 *12*; α(L)=0.1375 *20*; α(M)=0.0304 *5*; α(N+..)=0.00781 *11*

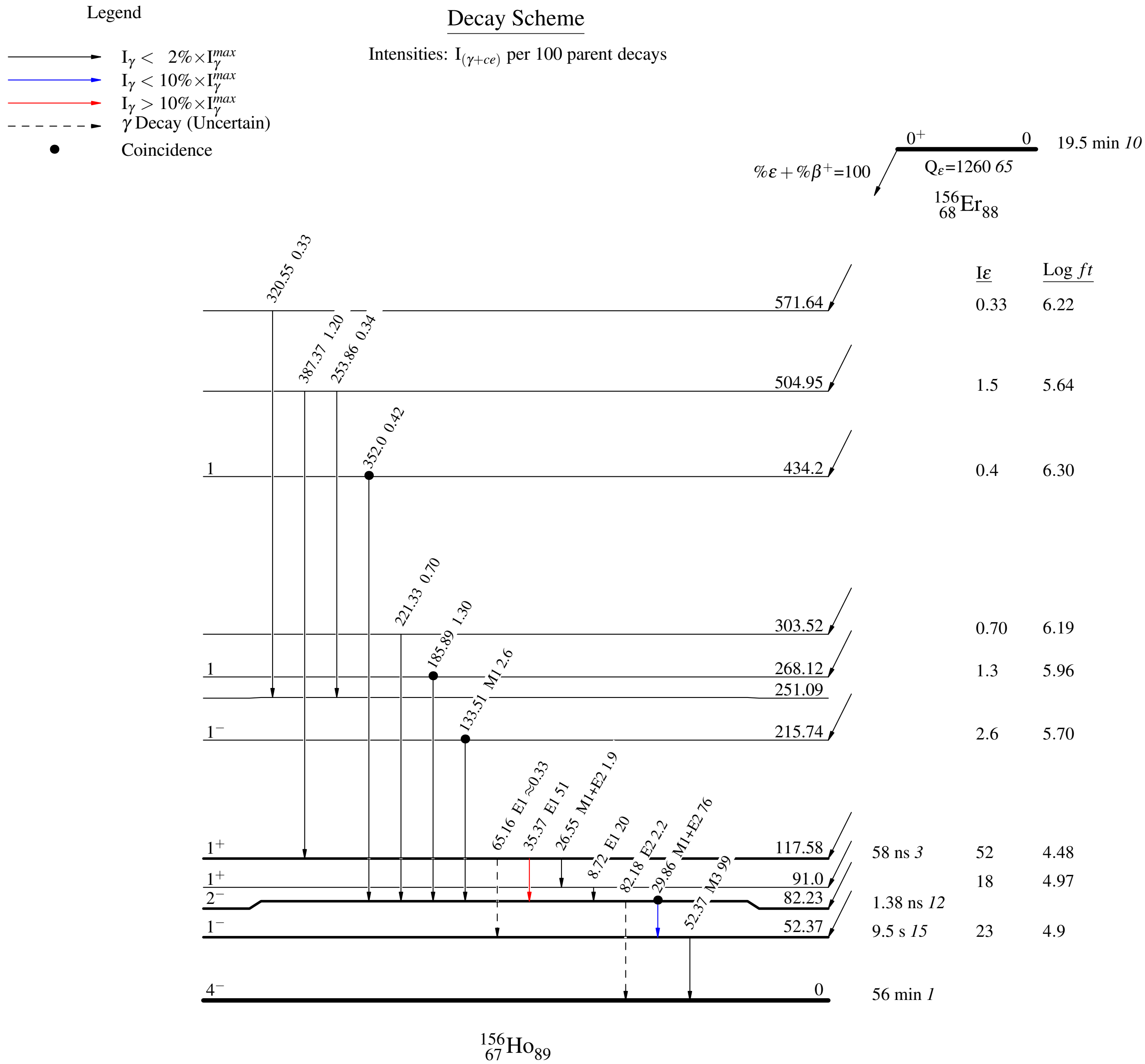
From ENSDF

$\gamma(^{156}$Ho) (continued)

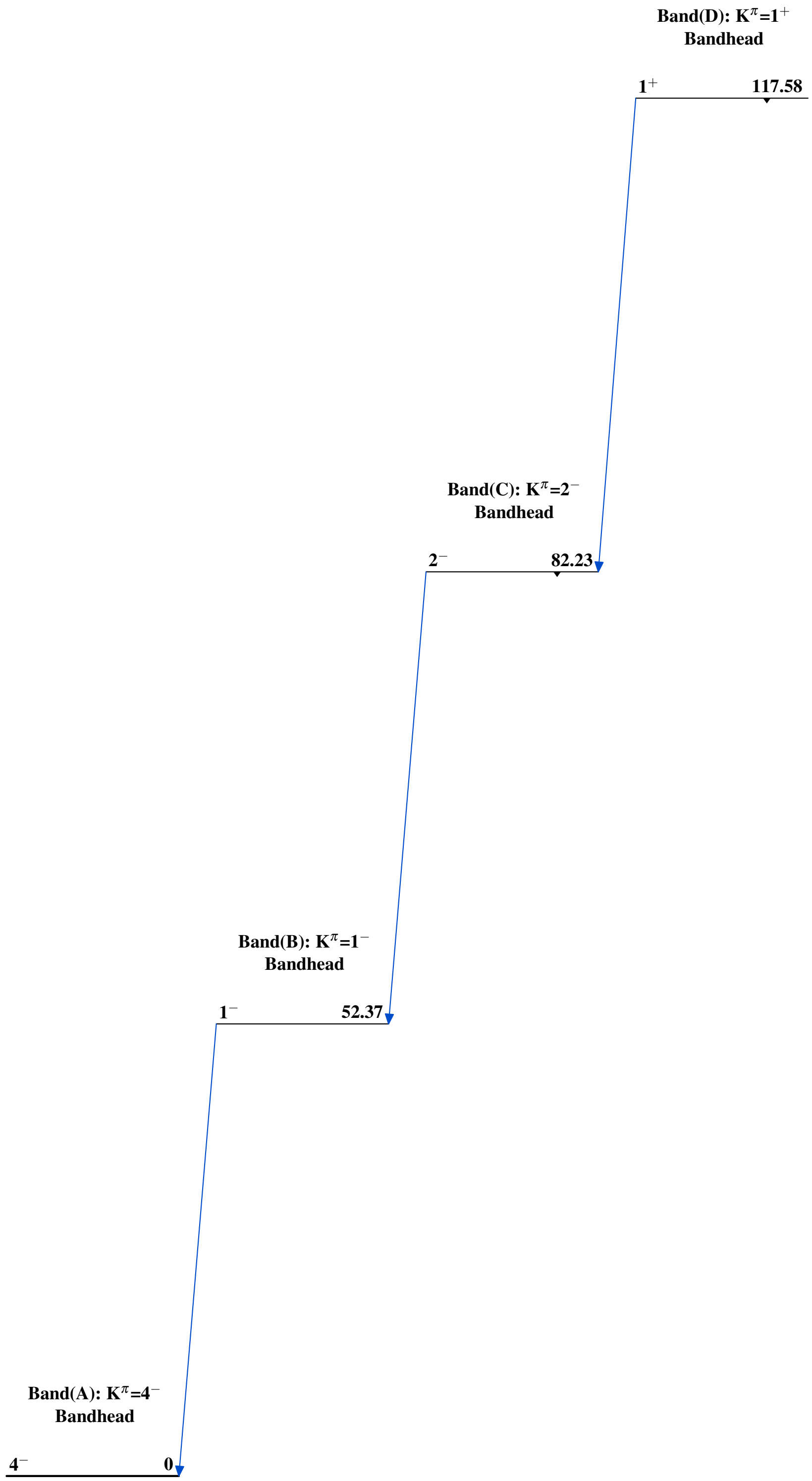
E_γ [†]	I_γ [†@]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	α [&]	Comments
								α(N)=0.00688 *10*; α(O)=0.000900 *13*; α(P)=3.45×10^{-5} *5* E_γ: Placement is that of 1999KaZV, but 2003KaZQ question its association with the ^{156}Er decay. Mult.: From 1999KaZV.
82.18[a]	1.2 *3*	82.23	2$^-$	0	4$^-$	E2	5.98	α(K)=1.688 *24*; α(L)=3.29 *5*; α(M)=0.796 *12*; α(N+..)=0.200 *3* α(N)=0.179 *3*; α(O)=0.0211 *3*; α(P)=7.16×10^{-5} *10* 1999KaZV place this γ from the 82.2 level. However, 2003KaZQ do not definitely assign this γ to the ^{156}Er decay. Mult.: From 1999KaZV.
133.51	4.7 *5*	215.74	1$^-$	82.23	2$^-$	M1	1.145	α(K)=0.963 *14*; α(L)=0.1425 *20*; α(M)=0.0315 *5*; α(N+..)=0.00843 *12* α(N)=0.00730 *11*; α(O)=0.001062 *15*; α(P)=5.96×10^{-5} *9* I_γ: From 1999KaZV. 1975Al26 (and 1982Vy06) report Iγ=4.4 *14*.
185.89	5.0 *7*	268.12	1	82.23	2$^-$			I_γ: From 1999KaZV. 1982Vy06 report Iγ=1.5 *6*.
221.33[‡] *5*	2.7 *3*	303.52		82.23	2$^-$			
253.86[‡]	1.3 *3*	504.95		251.09				
320.55[‡]	1.25 *25*	571.64		251.09				
352.0 *10*	1.6 *8*	434.2	1	82.23	2$^-$			I_γ: From 1982Vy06.
387.37[‡]	4.6 *5*	504.95		117.58	1$^+$			

[†] From 2003KaZQ, unless noted otherwise.
[‡] γ reported by 2003KaZQ, but not explicitly placed by them. Placement is that of the evaluator.
[#] From ce data of 1975Al26, unless noted otherwise.
[@] For absolute intensity per 100 decays, multiply by 0.26 *3*.
[&] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
[a] Placement of transition in the level scheme is uncertain.

^{156}Er ε decay 1999KaZV,2003KaZQ



^{156}Er ε decay 1999KaZV,2003KaZQ



$^{156}_{67}Ho_{89}$