^{167}Ho β^- decay 1962Ha24,1968Fu09

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 90, 431 (2000)	5-Jul-2000

Parent: ^{167}Ho: E=0.0; $J^\pi=7/2^-$; $T_{1/2}$=3.1 h *1*; Q(β^-)=1007 *5*; %β^- decay=100.0

The decay scheme and most data are from 1968Fu09 (sources from ^{168}Er(γ,p) (photons from 30-MeV betatron) and ^{164}Dy(α,p) (E(α)=27 MeV); measured Eβ, Iβ (mag spect), Eγ, Iγ (Ge(Li), scin), prompt and delayed $\beta\gamma$ and $\gamma\gamma$ coin); ce data are from 1962Ha24 (mag spect). Other: 1955Ha45.

^{167}Er Levels

E(level)	J^π[†]	$T_{1/2}$	Comments
0.0	$7/2^+$	stable	
79.3 *2*	$(9/2)^+$		
207.82 *15*	$1/2^-$	2.269 s *6*	$T_{1/2}$: from Adopted Levels.
264.91 *17*	$3/2^-$		
281.60 *19*	$5/2^-$		
346.50 *15*	$5/2^-$	1.0 ns *1*	$T_{1/2}$: $\gamma\gamma$(t), $\beta\gamma$(t) (1968Fu09).
413.20 *22*	$(7/2)^-$		
429.99 *18*	$(7/2)^-$		
442? *1*	$(9/2)^-$		
531.6 *3*	$3/2^+$		
536.3 *5*	$(9/2^-)$		
667.86 *16*	$(5/2)^-$		
745.01 *23*	$7/2^-$		

[†] From Adopted Levels.

β^- radiations

Experimental β^- data (1968Fu09)

Eβ(keV)	Iβ(%)
970 20	≈30
610	25
315	45

E(decay)	E(level)	Iβ^-[†#]	Log *ft*	Comments
(262 *5*)	745.01	3.0 *9*	5.42 *14*	av Eβ=73.0 *16*
(339 *5*)	667.86	43 *12*	4.61 *13*	av Eβ=97.2 *16*
(577[@] *5*)	429.99	2.7 *24*	6.6 *4*	av Eβ=177.5 *18*
(661 *5*)	346.50	21 *6*	5.89 *13*	av Eβ=207.5 *19*
(928 *5*)	79.3	15[‡] *15*	>6.3	av Eβ=308.5 *20*
(1007 *5*)	0.0	15[‡] *15*	>6.4	av Eβ=339.6 *20*

[†] β^- feedings to E(level)>79 are from intensity imbalance at each level. Iβ≈30% for β^- branch to the (0.0+79.3) levels combined (1968Fu09) (evaluator assumed 50% uncertainty in this intensity in order to obtain γ normalization).

[‡] See comment on Iβ.

[#] Absolute intensity per 100 decays.

[@] Existence of this branch is questionable.

$\gamma(^{167}Er)$

Iγ normalization: If total I(γ+ce) to (g.s.+79.3 level) minus Ti(79.3γ) is 70% 15 (1968Fu09 report Iβ≈30% for β group populating the (0.0+79.3) levels; evaluator assigns 50% uncertainty to this intensity).

E_γ[†]	I_γ[c]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ	α[d]	$I_{(\gamma+ce)}$[c]	Comments
(16.7 *3*)	<0.021	281.60	5/2$^-$	264.91	3/2$^-$				≈2.0	Unobserved, but expected from decay scheme; Eγ deduced from energy difference between 281.6 and 264.9 levels. I(γ+ce) deduced from intensity balance at 264.9 level. I_γ: upper limit deduced from I(γ+ce) and minimum α for mult=M1,E2.
57.10[&] *9*	1.4 *6*	264.91	3/2$^-$	207.82	1/2$^-$	M1+E2	0.360 *11*	5.22 *3*		α(L)=4.01 *3*; α(M)=0.936 *6*; α(N+..)=0.2606 *16* I_γ: deduced from intensity balance at 207.8 level. Mult.,δ: from adopted gammas, based on subshell ratios.
73.8 *2*	0.8 *3*	281.60	5/2$^-$	207.82	1/2$^-$	E2		9.8		α(K)=1.94; α(L)=5.99; α(M)=1.45; α(N+..)=0.396 Mult.: from L1:L2:L3=(very weak):20:20 (1962Ha24).
79.3 *2*	3.8 *9*	79.3	(9/2)$^+$	0.0	7/2$^+$	M1+E2	−0.32	6.06		α(K)=4.65 *14*; α(L)=1.09 *4*; α(M)=0.251 *8*; α(N+..)=0.0708 *22* α(K)exp≈3.0, K:L1:L2=≈250:50:weak (1962Ha24). Mult.,δ: from adopted gammas (however, 1976Kr21 adopt δ=−0.20 *4*); α(K)exp in ^{167}Ho β^- decay gives M1+E2 with δ≈1.2.
83.5 *2*	2.7 *6*	429.99	(7/2)$^-$	346.50	5/2$^-$	M1+E2	≈0.4	≈5.05		α(K)≈3.76; α(L)≈0.99; α(M)≈0.229; α(N+..)≈0.0647 δ: from combined fit to α(K)exp≈2.6 and K:L1:L2=≈150:30:≈15 (1962Ha24).
106 *1*	0.16 *7*	536.3	(9/2$^-$)	429.99	(7/2)$^-$	[M1,E2]		2.43[b] *4*		α(K)=1.5 *6*; α(L)=0.7 *4*; α(M)=0.17 *10*; α(N+..)=0.05 *3*
131[e] *1*	≈0.08	667.86	(5/2)$^-$	536.3	(9/2$^-$)	[E2]		1.10		α(K)=0.546; α(L)=0.425; α(M)=0.102; α(N+..)=0.0285 Observed in coincidence spectrum only. I_γ: deduced from intensity balance at 536.3 level; Iγ(131γ+131.7γ)=0.2 *1*.
131.7 *3*	≈0.12	413.20	(7/2)$^-$	281.60	5/2$^-$	[M1,E2]		1.20[b] *13*		α(K)=0.8 *3*; α(L)=0.29 *13*; α(M)=0.07 *4*; α(N+..)=0.019 *9* I_γ: see comment with 131γ from 668 level; remaining intensity is attributed to 131.7γ.
148.3 *4*	0.2 *1*	413.20	(7/2)$^-$	264.91	3/2$^-$	[E2]		0.708		α(K)=0.386; α(L)=0.246; α(M)=0.0590; α(N+..)=0.0164
207.8 *2*	8.8 *6*	207.82	1/2$^-$	0.0	7/2$^+$	E3		1.36		α(K)=0.469; α(L)=0.679; α(M)=0.169; α(N+..)=0.0466 Mult.: from adopted gammas, based on ce subshell ratios and α(K)exp.

^{167}Ho β^- decay 1962Ha24,1968Fu09 (continued)

$\gamma(^{167}Er)$ (continued)

E_γ[†]	I_γ[c]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ	α[d]	Comments
208.7 *4*	0.30 *15*	745.01	7/2$^-$	536.3	(9/2$^-$)	[M1,E2]		0.29[b] *8*	α(K)=0.23 *9*; α(L)=0.052 *7*; α(M)=0.0120 *19*; α(N+..)=0.0033 *5* Observed in coincidence spectrum only.
237.9 *2*	9.0 *6*	667.86	(5/2)$^-$	429.99	(7/2)$^-$	M1		0.255	α(K)=0.214; α(L)=0.0317; α(M)=0.00701; α(N+..)=0.00199 α(K)exp=0.31; K/L1=6.0 (1962Ha24).
250.2[#] *5*	[@]	531.6	3/2$^+$	281.60	5/2$^-$				
254.7 *2*	0.37 *10*	667.86	(5/2)$^-$	413.20	(7/2)$^-$	[M1,E2]		0.16[b] *5*	α(K)=0.13 *5*; α(L)=0.0265 *1*; α(M)=0.0060 *2*; α(N+..)=0.00168 *3*
266.5[#] *5*	[@]	531.6	3/2$^+$	264.91	3/2$^-$	E1[a]		0.0250	α(K)=0.0211; α(L)=0.00306; α(M)=0.00067; α(N+..)=0.00019
303[e] *1*	≤0.06	745.01	7/2$^-$	442?	(9/2)$^-$				
315.0 *5*	1.3 *3*	745.01	7/2$^-$	429.99	(7/2)$^-$	[M1,E2]		0.09[b] *3*	α(K)=0.07 *3*; α(L)=0.0134 *14*; α(M)=0.00303 *23*; α(N+..)=0.00084 *8*
321.3 *2*	42.0 *15*	667.86	(5/2)$^-$	346.50	5/2$^-$	M1+E2	0.17	0.112	α(K)=0.094; α(L)=0.0139; α(M)=0.00307; α(N+..)=0.00086 δ: from combined fit to α(K)exp=0.087 and K:L1=80:15 (1962Ha24).
323.7[#] *5*	[@]	531.6	3/2$^+$	207.82	1/2$^-$	E1[a]		0.0154	α(K)=0.0130; α(L)=0.00187; α(M)=0.00041; α(N+..)=0.00011
332 *1*	0.30 *15*	745.01	7/2$^-$	413.20	(7/2)$^-$	[M1,E2]		0.08[b] *3*	α(K)=0.063 *25*; α(L)=0.0114 *15*; α(M)=0.0026 *3*; α(N+..)=0.00071 *8*
346.5 *2*	100	346.50	5/2$^-$	0.0	7/2$^+$	E1		0.0130	α(K)=0.0110; α(L)=0.00158; α(M)=0.00035 α(K)exp=0.016; K:L1=35:6 (1962Ha24).
(351.31 *25*)	1.4 *11*	429.99	(7/2)$^-$	79.3	(9/2)$^+$				E_γ: from adopted gammas; transition probably not resolved from 346.5γ in ^{167}Ho β^- decay. I_γ: deduced from Iγ(83.5γ) and adopted photon branching for 430.0 level.
386.2 *2*	6.0 *3*	667.86	(5/2)$^-$	281.60	5/2$^-$	M1		0.0698	α(K)=0.0588; α(L)=0.0086; α(M)=0.00189; α(N+..)=0.00052 α(K)exp=0.12.
398.6 *3*	1.6 *3*	745.01	7/2$^-$	346.50	5/2$^-$	[M1,E2]		0.047[b] *17*	α(K)=0.039 *16*; α(L)=0.0066 *13*; α(M)=0.0015 *3*; α(N+..)=0.00041 *8*
403.0 *2*	5.8 *3*	667.86	(5/2)$^-$	264.91	3/2$^-$	[M1,E2]		0.046[b] *17*	α(K)=0.038 *15*; α(L)=0.0064 *13*; α(M)=0.0014 *3*; α(N+..)=0.00039 *8*
430.0 *5*	0.22 *6*	429.99	(7/2)$^-$	0.0	7/2$^+$				
460.0 *2*	3.7 *4*	667.86	(5/2)$^-$	207.82	1/2$^-$	[E2]		0.0205	α(K)=0.0162; α(L)=0.00337; α(M)=0.00077; α(N+..)=0.00021
463 *1*	0.8 *3*	745.01	7/2$^-$	281.60	5/2$^-$				
480.0 *5*	0.26 *5*	745.01	7/2$^-$	264.91	3/2$^-$				
531.5[&] *8*	<0.03	531.6	3/2$^+$	0.0	7/2$^+$	E2[a]		0.0142	α(K)=0.0113; α(L)=0.00218
668.0 *5*	0.4 *2*	667.86	(5/2)$^-$	0.0	7/2$^+$				I_γ: 0.4 *+1−2*.
745.0 *5*	0.3 *1*	745.01	7/2$^-$	0.0	7/2$^+$				

[†] From 1968Fu09 (^{167}Ho source), except where noted.
[‡] From α(K)exp unless otherwise specified; the Iγ (adopted here) and ce intensity (1962Ha24) scales are normalized through α(K)=0.469 (E3 theory) for 207.8γ.
[#] From adopted gammas.
[@] Negligible relative to Iγ(531.5γ) (from adopted branching).
[&] From ce data (1962Ha24).
[a] From adopted gammas.

$^{167}_{68}Er_{99}$-3

^{167}Ho β^- decay 1962Ha24,1968Fu09 (continued)

$\gamma(^{167}Er)$ (continued)

[b] Value and uncertainty cover combined range for M1 and E2.
[c] For absolute intensity per 100 decays, multiply by 0.57 *15*.
[d] 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.
[e] Placement of transition in the level scheme is uncertain.

$^{167}_{68}Er_{99}$-4

^{167}Ho β^- decay 1962Ha24,1968Fu09

Decay Scheme

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