^{170}Ho β^- decay (43 s) 1978Tu04,1974Ka21

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	C. M. Baglin[1], E. A. Mccutchan[2], S. Basunia[1]	NDS 153, 1 (2018)	1-Oct-2018

Parent: ^{170}Ho: E=120 *70*; J^π=(1$^+$); $T_{1/2}$=43 s *2*; Q(β^-)=3870 *50*; %β^- decay=100.0

Typically, sources are produced by ^{170}Er(n,p), E=14 MeV.

1969Sc01: measured Eβ, Eγ, Iγ, $\beta\gamma$ coin.

1974Ka21: measured Eγ, Iγ, $\gamma\gamma$-coin, Eβ, $\beta\gamma$-coin.

1978Tu04: measured $\beta\gamma$-coin, Eβ.

The adopted decay scheme is based on that of 1974Ka21; however, I(79γ) is taken from 1978Tu04, I(182γ) is deduced from intensity balance, and the following γ rays (unplaced in 1974Ka21) are tentatively placed by the evaluator from the same levels as were lines with the same Eγ in (n,n$'\gamma$): 1187.5γ, 1226.3γ, 1245.2γ, 1663.8, 1940.1, 1992.5γ, 2132.8γ, 2621.4γ, 2789.2γ. The scheme is not normalized because the β^- branch to the g.s. was not measured; log *ft* information which can, nevertheless, be deduced is indicated.

^{170}Er Levels

E(level)†	J^π‡	E(level)†	J^π‡	E(level)†	J^π‡	E(level)†	J^π‡
0.0	0^+	1304.9? *8*	(2^-)	1982.6 *4*	(1^+,2^+)	2700.0? *7*	1
78.58 *15*	2^+	1323.8? *5*	(0^+)	2018.7? *4*	(2^+)	2789.2? *15*	1^+
260.12 *23*	4^+	1415.80? *23*	(2^+)	2039.3 *3*	1	3606.2 *4*	(1^+,2^+)
890.90 *25*	(0^+)	1500.6 *3*	≤4	2071.1? *6*	(1,2^+)		
959.77 *21*	2^+	1742.4? *9*		2132.8? *6*	1		
1266.1? *4*	$(1)^-$	1972.60 *23*	$1^{(+)}$	2684.8 *3*	(1,2^+)		

† From least-squares fit to Eγ.
‡ From Adopted Levels.

β^- radiations

E(decay)†	E(level)	Iβ^-‡#	Comments
(3.8×10^2 *9*)	3606.2	1.00 *20*	av Eβ=112 *29* log *ft*=4.0 *4* if Iβ=1.0% 2.
(1.20×10^3@ *9*)	2789.2?	0.19 *6*	av Eβ=454 *36* log *ft*=6.45 *19* if Iβ=0.19% 6.
(1.29×10^3@ *9*)	2700.0?	0.13 *6*	av Eβ=454 *36* log *ft*=6.73 *23* if Iβ=0.13% 6.
(1.31×10^3 *9*)	2684.8	1.4 *3*	av Eβ=461 *36* log *ft*=5.71 *15* if Iβ=1.4% 3.
(1.86×10^3@ *9*)	2132.8?	0.19 *6*	av Eβ=695 *38* log *ft*=7.16 *16* if Iβ=0.19% 6.
(1.92×10^3@ *9*)	2071.1?	0.76 *17*	av Eβ=722 *38* log *ft*=6.62 *13* if Iβ=0.76% 17.
(1.95×10^3 *9*)	2039.3	0.89 *20*	av Eβ=736 *38* log *ft*=6.58 *13* if Iβ=0.89% 20.
(1.97×10^3@ *9*)	2018.7?	1.7 *4*	log *ft*=6.31 *13* if Iβ=1.7% 4.
(2.01×10^3 *9*)	1982.6	4.3 *9*	av Eβ=760 *38* log *ft*=5.94 *12* if Iβ=4.3% 9.
(2.02×10^3 *9*)	1972.60	13 *3*	av Eβ=765 *38* log *ft*=5.47 *12* if Iβ=13% 3. E(decay): other: 2015 (1978Tu04).
(2.25×10^3@ *9*)	1742.4?	0.22 *5*	log *ft*=7.43 *13* if Iβ=0.22% 5.

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^{170}Ho β^- decay (43 s) 1978Tu04,1974Ka21 (continued)

β^- radiations (continued)

E(decay)†	E(level)	Iβ^-‡#	Log *ft*‡	Comments
(2.49×10^3 *9*)	1500.6	1.5 *4*		av Eβ=974 *39* log *ft*=6.77 *14* if Iβ=1.5% 4.
(2.57×10^3 *9*)	1415.80?	1.7 *4*		av Eβ=1011 *39* log *ft*=6.77 *12* if Iβ=1.7% 4.
(2.67×10^3@ *9*)	1323.8?	0.41 *12*		av Eβ=1052 *39* log *ft*=7.45 *14* if Iβ=0.41% 12.
(2.69×10^3@ *9*)	1304.9?	2.1 *5*		av Eβ=1061 *39* log *ft*=6.77 *12* if Iβ=2.1% 5.
(2.72×10^3@ *9*)	1266.1?	4.0 *8*		av Eβ=1078 *39* log *ft*=6.50 *11* if Iβ=4.0% 8.
(3.03×10^3@ *9*)	959.77	0.7 *4*		av Eβ=1216 *39* log *ft*=7.4 *3* if Iβ=0.7% 4.
(3.10×10^3 *9*)	890.90	16 *3*		av Eβ=1247 *39* E(decay): other: 3068 (1978Tu04). log *ft*≥5.88; log $f^{1u}t$<8.5 if Iβ>1.7% (which occurs if Iβ(g.s.)<93%).
(3.91×10^3 *9*)	78.58	14 *14*		av Eβ=1616 *40* log $f^{1u}t$<8.5 if Iβ>7%; log *ft*<11.0 if Iβ>0.0006%.
(3.99×10^3 *9*)	0.0	36 *CA*	>5.79	av Eβ=1652 *40* Iβ^-: rough estimate; see comment on Iγ normalization in γ table. log *ft*=5.79 if Iβ=100%, <5.9 if Iβ>76%, <6.4 if Iβ>25%; log $f^{1u}t$<8.5 if Iβ>8%.

† Values in comments are measured endpoint energies from γ-gated β- spectra (1978Tu04). Other endpoint energies: 4000 *200* (1974Ka21) and 4000 (1969Sc01) for β- branch to g.s. and/or 79 level.

‡ Intensity of g.s. branch has not been measured and an accurate decay scheme normalization cannot be deduced. An approximate normalization obtained from Iβ to 79 level and Alaga rule (see 1974Ka21) gives≈36% g.s. branch. Relative Iβ values are given here for excited states; they are normalized to give Iβ per 100 parent decays if Iβ(g.s.)=36% and presume that all placements are indeed correct.

Absolute intensity per 100 decays.

@ Existence of this branch is questionable.

γ(^{170}Er)

Iγ normalization: if Iβ(g.s.)=36%, deduced from Iβ to 79 level and Alaga rule as suggested in 1974Ka21 and 1978Tu04, Iγ normalization=0.16 3. However, accuracy of rule is not established and precision of γ intensity balance at the 79 level is very poor so evaluator does not consider normalization of this decay scheme to be warranted.

E_γ[†]	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ	α[&]	Comments
78.7 2	40[‡] 10	78.58	2^+	0.0	0^+	E2		7.45 13	α(K)=1.74 3; α(L)=4.38 8; α(M)=1.066 20; α(N+..)=0.269 5 α(N)=0.241 5; α(O)=0.0280 6; α(P)=7.67×10^{-5} 12
181.6 2	9.6[#] 4	260.12	4^+	78.58	2^+	E2		0.348	α(K)=0.215 3; α(L)=0.1028 16; α(M)=0.0246 4; α(N+..)=0.00629 10 α(N)=0.00559 9; α(O)=0.000684 10; α(P)=9.87×10^{-6} 15
482.0 3	12.1 5	1982.6	$(1^+,2^+)$	1500.6	≤4				
540.9 2	21.8 8	1500.6	≤4	959.77	2^+				
699.8 3	12.9 6	959.77	2^+	260.12	4^+	E2		0.00728 11	α=0.00728 11; α(K)=0.00597 9; α(L)=0.001018 15; α(M)=0.000229 4; α(N+..)=6.07×10^{-5} 9 α(N)=5.30×10^{-5} 8; α(O)=7.37×10^{-6} 11; α(P)=3.37×10^{-7} 5
812.3 2	100 3	890.90	(0^+)	78.58	2^+	(E2)		0.00522 8	α=0.00522 8; α(K)=0.00432 6; α(L)=0.000700 10; α(M)=0.0001566 22; α(N+..)=4.16×10^{-5} 6 α(N)=3.63×10^{-5} 5; α(O)=5.10×10^{-6} 8; α(P)=2.45×10^{-7} 4
881.2 2	19.7 8	959.77	2^+	78.58	2^+	E2+M1	+0.27 +19−8	0.0081 5	α=0.0081 5; α(K)=0.0069 4; α(L)=0.00098 5; α(M)=0.000216 11; α(N+..)=5.8×10^{-5} 3 α(N)=5.03×10^{-5} 25; α(O)=7.3×10^{-6} 4; α(P)=4.10×10^{-7} 24
959.4 5	12.4 12	959.77	2^+	0.0	0^+	E2		0.00366 6	α=0.00366 6; α(K)=0.00306 5; α(L)=0.000472 7; α(M)=0.0001052 15; α(N+..)=2.80×10^{-5} 4 α(N)=2.44×10^{-5} 4; α(O)=3.46×10^{-6} 5; α(P)=1.739×10^{-7} 25
1022.7 4	15.2 7	1982.6	$(1^+,2^+)$	959.77	2^+				
1187.5[@a] 3	25.5 10	1266.1?	$(1)^-$	78.58	2^+	E1		0.001018 15	α=0.001018 15; α(K)=0.000854 12; α(L)=0.0001144 16; α(M)=2.50×10^{-5} 4; α(N+..)=2.46×10^{-5} α(N)=5.82×10^{-6} 9; α(O)=8.41×10^{-7} 12; α(P)=4.70×10^{-8} 7; α(IPF)=1.79×10^{-5} 3 E_γ: reported 1188γ-700γ coin (1974Ka21) inconsistent with this placement.
1226.3[@a] 7	13.4 13	1304.9?	(2^-)	78.58	2^+				
1245.2[@a] 4	2.6 5	1323.8?	(0^+)	78.58	2^+				
1337.4 3	5.8 6	1415.80?	(2^+)	78.58	2^+	D+Q	+4.9 +12−9		
1415.6 3	5.0 5	1415.80?	(2^+)	0.0	0^+				
1663.8[@a] 8	1.4 5	1742.4?		78.58	2^+				

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γ(^{170}Er) (continued)

E_γ [†]	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α [&]	Comments
[x]1836.6 *5*	0.7 *3*							
[x]1876.3 *5*	0.8 *3*							
1894.0 *3*	45.2 *15*	1972.60	$1^{(+)}$	78.58	2^+			
1940.1 [@a] *3*	10.5 *5*	2018.7?	(2^+)	78.58	2^+			E_γ: the 1059γ which accompanies this γ in (n,n′γ) may be too weak to have been seen here.
1960.7 *4*	2.7 *3*	2039.3	1	78.58	2^+			
1972.6 *3*	36.5 *13*	1972.60	$1^{(+)}$	0.0	0^+	D		
1992.5 [@a] *5*	4.8 *4*	2071.1?	$(1,2^+)$	78.58	2^+	D+Q		
2039.3 *4*	2.9 *3*	2039.3	1	0.0	0^+	D		
2132.8 [@a] *6*	1.2 *3*	2132.8?	1	0.0	0^+	D		E_γ: the 2054γ which accompanies this γ in (n,n′γ) may be too weak to have been seen here.
2606.1 *4*	4.3 *4*	2684.8	$(1,2^+)$	78.58	2^+			I_γ: branching reported in (n,n′γ) is much lower than this Iγ implies.
2621.4 [@a] *6*	0.8 *3*	2700.0?	1	78.58	2^+			R: the 2701γ which accompanies this γ in (n,n′γ) is stronger than the 2621γ so it should have been seen here.
2646.5 *4*	3.8 *3*	3606.2	$(1^+,2^+)$	959.77	2^+			E_γ: this γ is absent in (n,n′γ).
2684.8 *4*	4.5 *3*	2684.8	$(1,2^+)$	0.0	0^+			
2715.1 *8*	2.5 *3*	3606.2	$(1^+,2^+)$	890.90	(0^+)			
[x]2759.5 *12*	0.8 *5*							E_γ: probably same γ as unplaced 2760.0 *20* γ in (n,n′γ).
2789.2 [@a] *15*	1.2 *3*	2789.2?	1^+	0.0	0^+	M1	0.001352 *19*	α=0.001352 *19*; α(K)=0.000476 *7*; α(L)=6.50×10^{-5} *10*; α(M)=1.428×10^{-5} *20*; α(N+..)=0.000797 α(N)=3.33×10^{-6} *5*; α(O)=4.86×10^{-7} *7*; α(P)=2.79×10^{-8} *4*; α(IPF)=0.000793 *12*

[†] From 1974Ka21.

[‡] From 1978Tu04. 1974Ka21 report Iγ=170 *40*.

[#] Since no β^- branch to 4^+ is expected, Iγ(181)=9.6 *4* is implied by intensity balance at 260 level if mult(181γ)=E2. Evaluator adopts this value in preference to measured I(181γ)=14.5 *15* (1974Ka21); a measurement error is at least plausible given that 1974Ka21 overestimate I(79γ) (cf. 1978Tu04). Alternatively, the decay scheme may omit some additional γ transition(s) feeding the 260 level.

[@] Placement shown as tentative because γ was placed by the evaluator.

[&] 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.

[x] γ ray not placed in level scheme.

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