^{170}Ta ε decay 2008Mc01,2007Wo08,1976Le04

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}Ta: E=0.0; J$^{\pi}$=(3$^+$); T$_{1/2}$=6.76 min *6*; Q(ε)=6116 *40*; %ε+%β^+ decay=100.0

2008Mc01: ^{170}Ta produced in the reaction ^{159}Tb(^{16}O,5n) with a 100 MeV beam provided by the Yale ESTU accelerator. Measured Eγ, Iγ, $\gamma\gamma$ coin using eight HPGe detectors. Deduced mixing between the 2$^+$ members of the γ and β bands.

2007Wo08: g factor measurement of first 2$^+$ state in ^{170}Hf. ^{170}Ta produced in the ^{159}Tb(^{16}O,5n) reaction at E=100 MeV; beam provided by Tandem accelerator, Yale University; measured Eγ, $\gamma(\theta)$, $\gamma\gamma$ coin using eight HPGe detectors; g-factors deduced from perturbed $\gamma\gamma(\theta$,H) measurements in static external magnetic fields of 4.40 T and 5.85 T (T=Tesla).

2000La11: ^{170}Ta sources produced by ^{159}Tb(^{16}O,5n), E≈88 MeV.

1976Le04: ^{170}Ta sources produced by ^{159}Tb(^{16}O,5n), E≈110 MeV; measured T$_{1/2}$, Eγ, Iγ, $\gamma\gamma$-coin.

^{170}Hf Levels

E(level)†	J$^{\pi}$‡	Comments
0.0#	0$^+$	
100.74# *4*	2$^+$	g-factor=0.28 *5* (2007Wo08).
321.74# *5*	4$^+$	
642.49# *7*	6$^+$	
880.31@ *7*	(0$^+$)	
961.96& *4*	(2$^+$)	
988.06@ *5*	(2$^+$)	
1087.83& *5*	(3$^+$)	
1158.90@ *7*	(4$^+$)	Please note comment on possible (0$^+$) β-vibrational band.
1219.4 *4*	4$^+$	Please note comment on possible (0$^+$) β-vibrational band.
1227.45& *6*	4$^+$	
1372.73 *9*	(5$^-$)	
1425.31 *6*		
1441.69 *7*	(2$^+$,3,4$^+$)	J$^{\pi}$: possible assignment as bandhead for a two-phonon vibrational mode (1976Le04) favors J$^{\pi}$=2$^+$.
1563.98 *7*	(4$^-$)	
1565.57 *9*		
1573.12 *10*		
1583.34 *6*		
1658.78 *8*		
1697.94 *9*		
1998.93 *8*		
2117.24 *6*		

† From least-squares fit to Eγ.

‡ From Adopted Levels.

Band(A): K$^{\pi}$=0$^+$ g.s. band.

@ Band(B): possible K$^{\pi}$=0$^+$ β-vibrational band (1976Le04). The authors assign the 1157 level as the J=4 member of this band; however, the 1220 level has the same population and deexcitation characteristics, and its energy lies much closer to that expected based on the rotational parameter A=17.9 deduced from the 0$^+$ and 2$^+$ band member energies.

& Band(C): possible K$^{\pi}$=(2$^+$) γ-vibrational band (1976Le04).

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ε,β⁺ radiations

E(decay)	E(level)	Iβ⁺ †	Iε†	Log *ft*	I(ε+β⁺)†	Comments
(4.00×10³ *4*)	2117.24	0.42 *4*	0.63 *5*	7.22 *4*	1.05 *9*	av Eβ=1347 *19*; εK=0.495 *8*; εL=0.0790 *13*; εM+=0.0241 *4*
(4.12×10³ *4*)	1998.93	0.16 *1*	0.21 *2*	7.72 *4*	0.37 *3*	av Eβ=1401 *19*; εK=0.472 *8*; εL=0.0752 *13*; εM+=0.0229 *4*
(4.42×10³ *4*)	1697.94	0.56 *4*	0.56 *4*	7.36 *4*	1.12 *8*	av Eβ=1539 *19*; εK=0.416 *8*; εL=0.0662 *12*; εM+=0.0202 *4*
(4.46×10³ *4*)	1658.78	0.47 *4*	0.45 *4*	7.46 *4*	0.92 *7*	av Eβ=1557 *19*; εK=0.409 *7*; εL=0.0650 *12*; εM+=0.0198 *4*
(4.53×10³ *4*)	1583.34	0.58 *6*	0.53 *5*	7.41 *5*	1.11 *11*	av Eβ=1592 *19*; εK=0.396 *7*; εL=0.0629 *12*; εM+=0.0192 *4*
(4.54×10³ *4*)	1573.12	1.18 *8*	1.07 *7*	7.10 *4*	2.25 *15*	av Eβ=1596 *19*; εK=0.394 *7*; εL=0.0627 *11*; εM+=0.0191 *4*
(4.55×10³ *4*)	1565.57	0.17 *3*	0.15 *2*	7.95 *7*	0.32 *5*	av Eβ=1600 *19*; εK=0.392 *7*; εL=0.0624 *11*; εM+=0.0190 *4*
(4.55×10³ *4*)	1563.98	0.47 *4*	0.42 *4*	7.51 *5*	0.89 *8*	av Eβ=1601 *19*; εK=0.392 *7*; εL=0.0624 *11*; εM+=0.0190 *4*
(4.67×10³ *4*)	1441.69	1.54 *9*	1.25 *8*	7.06 *3*	2.79 *16*	av Eβ=1657 *19*; εK=0.372 *7*; εL=0.0591 *11*; εM+=0.0180 *4*
(4.69×10³ *4*)	1425.31	2.3 *2*	1.8 *2*	6.90 *5*	4.1 *4*	av Eβ=1664 *19*; εK=0.369 *7*; εL=0.0587 *11*; εM+=0.0179 *4*
(4.74×10³ *4*)	1372.73	0.25 *2*	0.19 *2*	7.89 *5*	0.44 *4*	av Eβ=1689 *19*; εK=0.361 *7*; εL=0.0573 *11*; εM+=0.0175 *4*
(4.89×10³ *4*)	1227.45	1.00 *6*	0.69 *4*	7.36 *3*	1.69 *10*	av Eβ=1756 *19*; εK=0.338 *6*; εL=0.0537 *10*; εM+=0.0164 *3*
(4.90×10³ *4*)	1219.4	0.90 *7*	0.62 *5*	7.41 *4*	1.52 *11*	av Eβ=1759 *19*; εK=0.337 *6*; εL=0.0535 *10*; εM+=0.0163 *3*
(4.96×10³ *4*)	1158.90	1.13 *9*	0.74 *6*	7.34 *4*	1.87 *15*	av Eβ=1787 *19*; εK=0.328 *6*; εL=0.0521 *10*; εM+=0.0159 *3*
(5.03×10³ *4*)	1087.83	1.84 *14*	1.15 *9*	7.16 *4*	2.99 *22*	av Eβ=1820 *19*; εK=0.318 *6*; εL=0.0505 *10*; εM+=0.0154 *3*
(5.13×10³ *4*)	988.06	3.9 *4*	2.3 *2*	6.88 *5*	6.2 *6*	av Eβ=1866 *19*; εK=0.304 *6*; εL=0.0483 *9*; εM+=0.0147 *3*
(5.15×10³ *4*)	961.96	2.8 *3*	1.6 *1*	7.04 *5*	4.4 *4*	av Eβ=1879 *19*; εK=0.301 *6*; εL=0.0477 *9*; εM+=0.0145 *3*
(5.24×10³‡ *4*)	880.31	0.70 *5*	0.37 *3*	7.69 *4*	1.07 *8*	av Eβ=1916 *19*; εK=0.290 *6*; εL=0.0460 *9*; εM+=0.0140 *3* Iε: ε+β⁺ feeding of this level from (3⁺) parent is inconsistent with adopted J^π; possibly, the level is indirectly fed by as yet unobserved transitions.
(5.79×10³ *4*)	321.74	6.0 *4*	2.3 *2*	6.99 *4*	8.3 *6*	av Eβ=2177 *19*; εK=0.227 *4*; εL=0.0359 *7*; εM+=0.01092 *20*
(6.02×10³ *4*)	100.74	41 *3*	14 *1*	6.24 *4*	55 *4*	av Eβ=2280 *19*; εK=0.206 *4*; εL=0.0326 *6*; εM+=0.00991 *18*

† Absolute intensity per 100 decays.
‡ Existence of this branch is questionable.

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$\gamma(^{170}Hf)$

Iγ normalization: assuming Σ(I(γ+ce) to g.s.)=100%. No significant branch to g.s. is expected because ΔJ=(3).

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[b]	Comments
100.75 *4*	134 *4*	100.74	2+	0.0	0+	(E2)	3.43	α(K)=0.939 *14*; α(L)=1.89 *3*; α(M)=0.472 *7*; α(N+..)=0.1233 *18* α(N)=0.1094 *16*; α(O)=0.01384 *20*; α(P)=5.85×10^{-5} *9* other Eγ: 100.8 *2* (1976Le04). I_γ: from 1976Le04. %Iγ=20.70 *24* assuming adopted decay scheme normalization.
191.3 *2*	0.42 *11*	1563.98	(4−)	1372.73	(5−)			
221.05 *5*	100 *2*	321.74	4+	100.74	2+	E2	0.206	α(K)=0.1267 *18*; α(L)=0.0609 *9*; α(M)=0.01487 *21*; α(N+..)=0.00393 *6* α(N)=0.00347 *5*; α(O)=0.000459 *7*; α(P)=8.50×10^{-6} *12* other Eγ (Iγ): 221.2 *2* (100 *3*) (1976Le04).
320.79 *7*	5.3 *2*	642.49	6+	321.74	4+	E2	0.0649	α(K)=0.0459 *7*; α(L)=0.01459 *21*; α(M)=0.00350 *5*; α(N+..)=0.000935 *14* α(N)=0.000819 *12*; α(O)=0.0001121 *16*; α(P)=3.32×10^{-6} *5* other Eγ (Iγ): 320.9 *2* (4.4 *3*) (1976Le04).
337.53 *10*	5.3 *4*	1425.31		1087.83	(3+)			
405.06 *8*	0.94 *11*	1563.98	(4−)	1158.90	(4+)			
437.18 *9*	5.4 *4*	1425.31		988.06	(2+)			
463.37 *8*	15.2 *20*	1425.31		961.96	(2+)			
476.08 *7*	3.6 *4*	1563.98	(4−)	1087.83	(3+)			
516.3 *2*	0.81 *27*	1158.90	(4+)	642.49	6+			other Eγ: 512.5 *5* (1976Le04).
573.59 *8*	1.28 *16*	1998.93		1425.31				
576.5 *6*	1.87 *27*	1219.4	4+	642.49	6+			E_γ,I_γ: from 1976Le04; absent In 2008Mc01.
585.04 *8*	0.78 *9*	1227.45	4+	642.49	6+			other Eγ (Iγ): 584.3 *6* (2.1 *3*) (1976Le04).
595.26 *7*	4.0 *5*	1583.34		988.06	(2+)			
621.3 *1*	0.38 *4*	1583.34		961.96	(2+)			
640.19 *9*	4.3 *3*	961.96	(2+)	321.74	4+			other Eγ (Iγ): 639.4 *2* (3.1 *4*) (1976Le04).
666.35 *8*	11.2 *9*	988.06	(2+)	321.74	4+			other Eγ (Iγ): 665.0 *3* (7.1 *8*) (1976Le04).
703.2 *2*	1.05 *8*	1583.34		880.31	(0+)			
710.00 *11*	4.3 *3*	1697.94		988.06	(2+)			
730.2 *1*	0.50 *7*	1372.73	(5−)	642.49	6+			
735.88 *10*	3.0 *3*	1697.94		961.96	(2+)			
766.13 *7*	6.9 *4*	1087.83	(3+)	321.74	4+			other Eγ (Iγ): 765.5 *2* (6.2 *9*) (1976Le04).
779.58 *6*	8.0 *4*	880.31	(0+)	100.74	2+			other Eγ (Iγ): 778.8 *2* (5.8 *4*) (1976Le04).
837.16 *7*	12.3 *8*	1158.90	(4+)	321.74	4+			other Eγ (Iγ): 834.8 *4* (9.8 *8*) (1976Le04).
861.18 *6*	43.7 *13*	961.96	(2+)	100.74	2+			other Eγ (Iγ): 860.4 *2* (47.7 *16*) (1976Le04).
887[@d]	<1.0	988.06	(2+)	100.74	2+			other Eγ (Iγ): 886.2 *5* (2.4 *5*) (1976Le04).
897.6 *5*	0.9 *3*	1219.4	4+	321.74	4+			E_γ,I_γ: from 1976Le04; absent In 2008Mc01.
905.66 *6*	3.2 *3*	1227.45	4+	321.74	4+			other Eγ (Iγ): 905.3 *6* (2.5 *4*) (1976Le04).
923.1 *1*	0.78 *8*	1565.57		642.49	6+			
961.95 *7*	2.4 *2*	961.96	(2+)	0.0	0+			other Eγ (Iγ): 961.3 *4* (2.9 *12*) (1976Le04).
987.04[c] *5*	23[c] *1*	1087.83	(3+)	100.74	2+			other Eγ (Iγ): 987.0 *3* (21.4 *8*) (1976Le04).
988.04[c] *6*	46[c] *3*	988.06	(2+)	0.0	0+			other Eγ (Iγ): 987.0 *3* (37.5 *13*) (1976Le04).
1010.9 *1*	1.13 *9*	1998.93		988.06	(2+)			
1029.38 *8*	1.6 *3*	2117.24		1087.83	(3+)			
1051.02 *10*	2.8 *2*	1372.73	(5−)	321.74	4+			
1058[@d]	<0.70	1158.90	(4+)	100.74	2+			other Eγ (Iγ): 1054.3 *12* (1.9 *4*) (1976Le04).

Continued on next page (footnotes at end of table)

^{170}Ta ε decay 2008Mc01,2007Wo08,1976Le04 (continued)

γ(^{170}Hf) (continued)

Eγ[†]	Iγ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Comments
1119.0 *6*	7.1 *5*	1219.4	4+	100.74	2+	Eγ,Iγ: from 1976Le04; absent In 2008Mc01.
1119.91 *8*	9.9 *7*	1441.69	(2+,3,4+)	321.74	4+	
1126.7 *1*	7.0 *4*	1227.45	4+	100.74	2+	other Eγ (Iγ): 1126.5 *8* (3.2 *3*) (1976Le04).
1129.18 *9*	2.0 *3*	2117.24		988.06	(2+)	
1155.29 *8*	3.2 *3*	2117.24		961.96	(2+)	
1242.8 *2*	0.82 *18*	1563.98	(4−)	321.74	4+	
1243.8 *1*	1.3 *3*	1565.57		321.74	4+	
1251.35 *9*	5.7 *4*	1573.12		321.74	4+	
1324.5 *2*	2.3 *3*	1425.31		100.74	2+	
1337.05 *9*	1.5 *2*	1658.78		321.74	4+	
1340.97 *8*	8.2 *5*	1441.69	(2+,3,4+)	100.74	2+	other Eγ (Iγ): 1344.2 *6* (9.1 *7*) (1976Le04).
[x]1444.8 *14*	0.8 *3*					Eγ,Iγ: from 1976Le04 only. Placed by 1976Le04 (along with an Eγ=1344.2 *6*, Iγ=9.1 *7* line) from a 1445 level which the evaluator does not adopt.
1472.5[&] *2*	8.9 *7*	1573.12		100.74	2+	
1482.64 *9*	1.8 *4*	1583.34		100.74	2+	
1558.0 *1*	4.5 *3*	1658.78		100.74	2+	

[†] From 2008Mc01, except As noted. Data from 1976Le04 are In fair to poor agreement and are given In comments for comparison.
[‡] Relative photon intensities from 2008Mc01, normalized so I(100.8γ)=100, except as noted. Renormalized data from 1976Le04 are given In comments.
[#] From Adopted Gammas.
[@] γ with similar Eγ reported by 1976Le04 is not observed by 2008Mc01; energy from level-energy difference.
[&] According to e-mail reply of July 28, 2008 from first author of 2008Mc01 to B. Singh, Eγ=1476.5 in the table is a misprint; it should be 1472.5.
[a] For absolute intensity per 100 decays, multiply by 0.154 *5*.
[b] 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.
[c] Multiply placed with intensity suitably divided.
[d] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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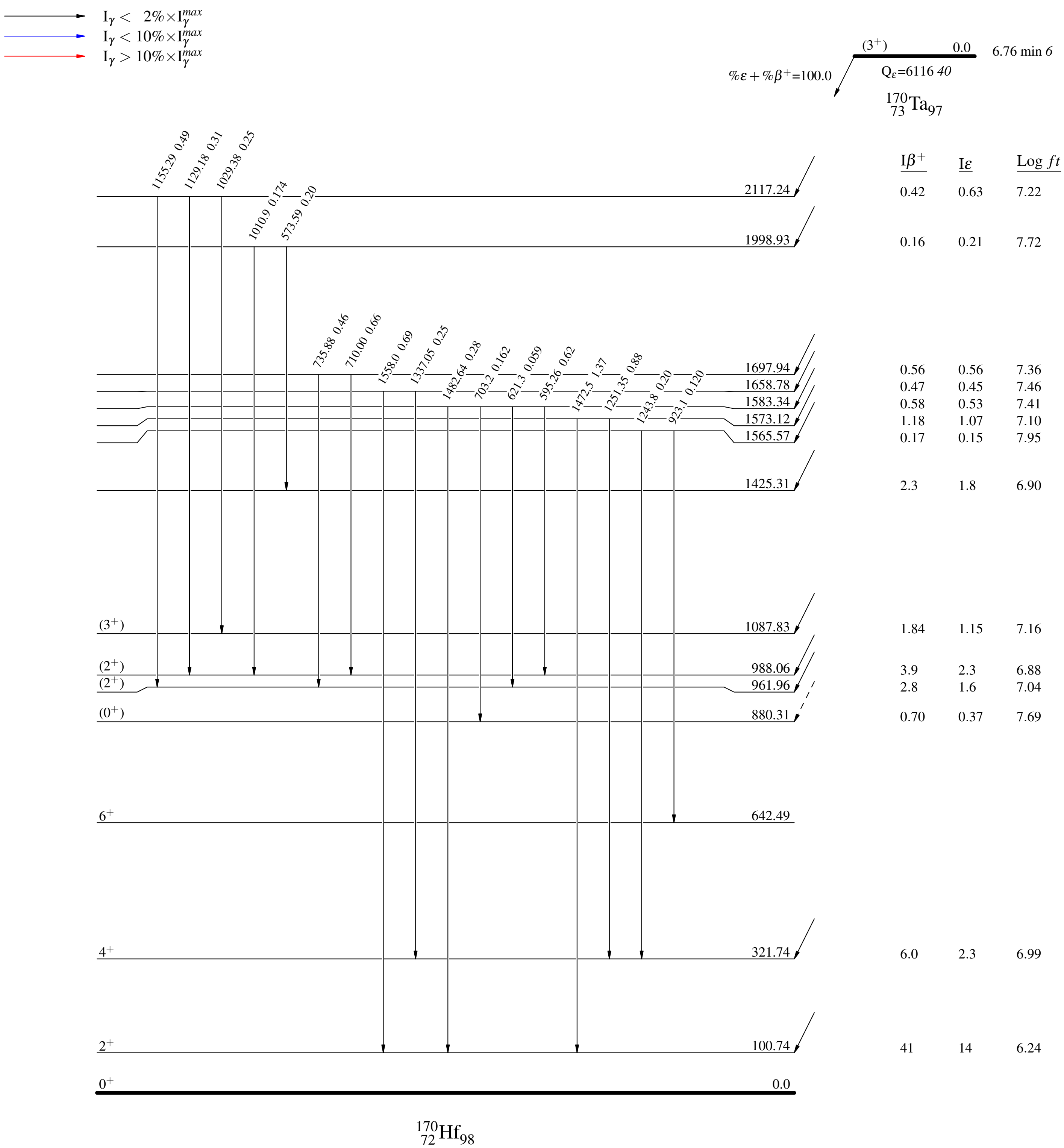
Decay Scheme

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



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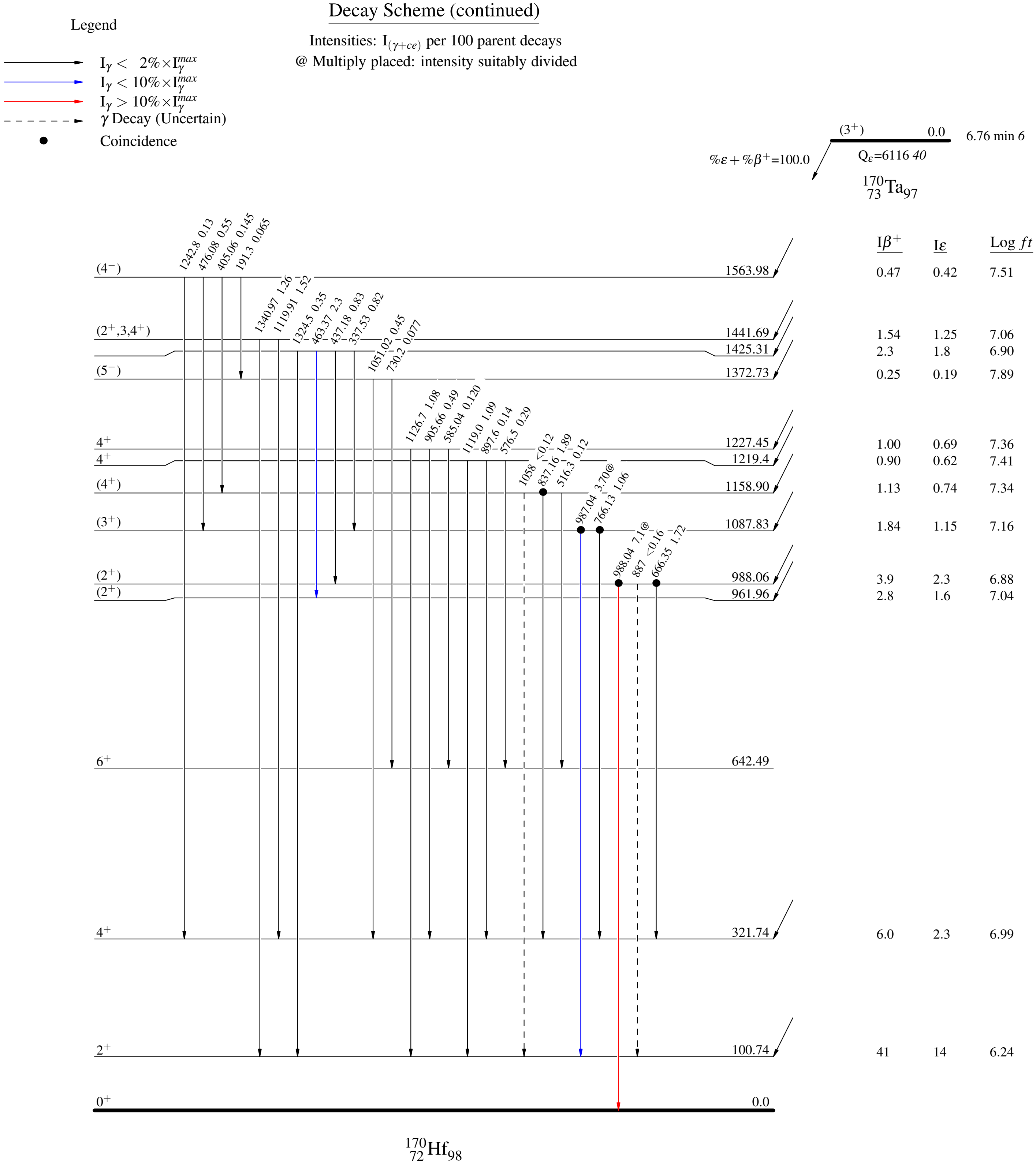
Decay Scheme (continued)

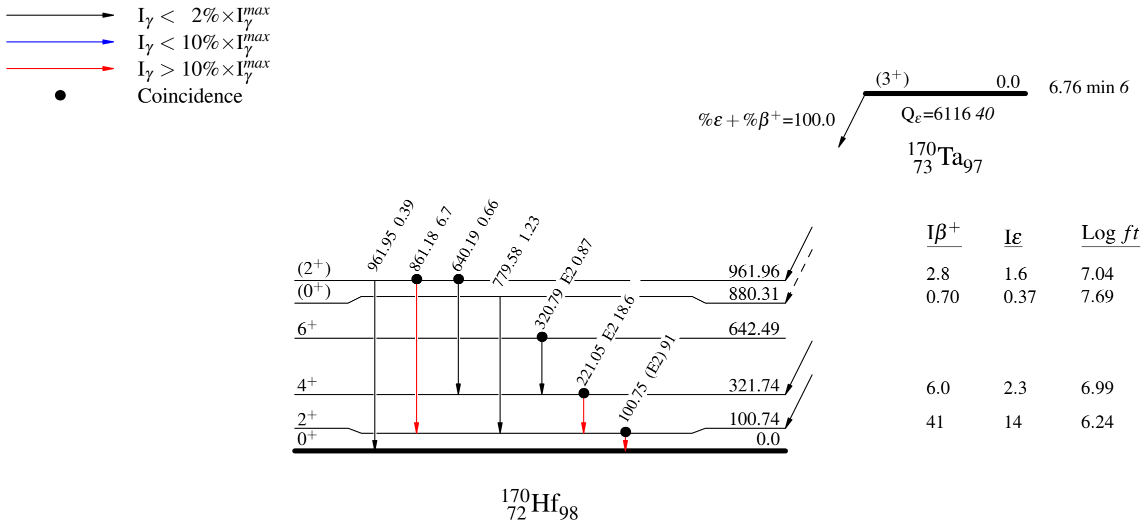
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
@ Multiply placed: intensity suitably divided



^{170}Ta ε decay 2008Mc01,2007Wo08,1976Le04

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
@ Multiply placed: intensity suitably divided



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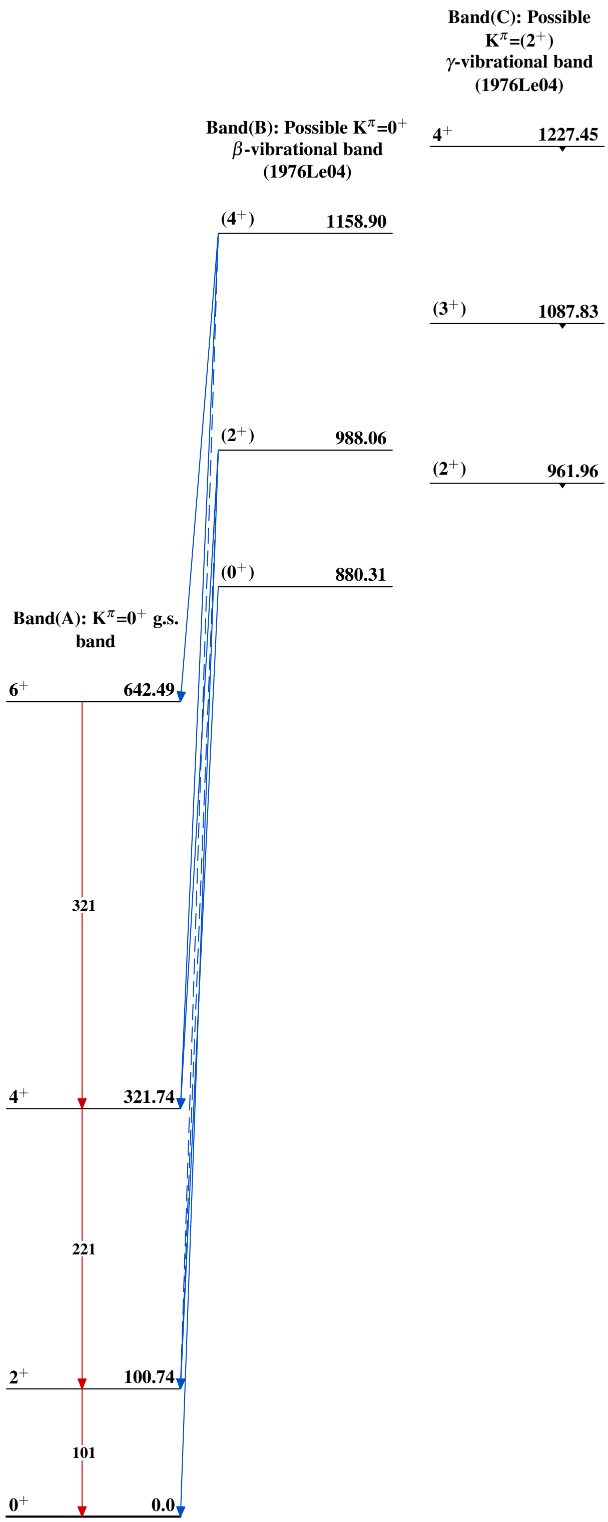

$^{170}_{72}Hf_{98}$