^{170}Hf ε decay 1969Tr02

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}Hf: E=0.0; J$^{\pi}$=0^{+}; T$_{1/2}$=16.01 h *13*; Q(ε)=1052 *33*; %ε+%β^{+} decay=100.0

Sources produced, typically, by ^{175}Lu(p,6n) and ^{171}Yb(α,5n).

1970Ch17: measured Eγ, Iγ.

1969Tr02: E=66 MeV; measured Eγ, Iγ, E(ce), I(ce), ceγ-coin, $\gamma\gamma$-coin.

1968Ab08: measured $\beta\gamma$-coin, $\gamma\gamma$-coin, T$_{1/2}$.

1966Ha23: measured Eγ, Iγ, I(ce).

Other: 2000La11.

The decay scheme is that of 1969Tr02; portions of the scheme from 1966Ha23 differ significantly.

^{170}Lu Levels

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$[#]	Comments
0.0[@]	0^{+}		
44.50[@] *5*	2^{+}	3.00 ns *6*	
92.89 *9*	(4)$^{-}$	0.67 s *10*	from decay scheme, a 4.2% *12* intensity imbalance occurs at this level; no ε feeding is expected. See comment on 96 level. T$_{1/2}$: from Adopted Levels. J$^{\pi}$: probable configuration=((π 7/2[404])+(ν 1/2[521])) (1969Tr02).
96.01 *10*	(3)$^{-}$		J$^{\pi}$: possible configuration (π 1/2[541])-(ν 7/2[633]) (1988So04, who predict the (π 7/2[404])-(ν 1/2[521]) configuration suggested for this level in 1969Tr02 to be at higher energy). No transition has been observed to deexcite the 96 level. If a 3.09 transition to the 92.89 (4)$^{-}$ level existed, it presumably could not have been detected, but the other possible transitions (both ΔK=(3)) should have been within the experimental range of 1969Tr02. I(γ+ce)=19 *5* would be needed in order to remove the intensity imbalance at the 93 level, consistent with the expected absence of an ε branch to that level from the 0^{+} parent.
98.49[@] *6*	1^{+}		E(level): note that adopted band assignment differs from that shown here and In 1969Tr02 and 1988So04.
114.87 *7*	(3)$^{+}$		
116.00 *7*	(1)$^{+}$		
164.71[&] *6*	1^{-}	3.90 ns *20*	
170.00 *7*	2^{+}		
176.70[@] *11*	3^{+}		
198.37 *6*	1^{+}		
212.49[&] *7*	1^{-},2^{-}		
244.81[b] *6*	1^{-}		
283.86[b] *6*	(2)$^{-}$		
304.14 *10*	0^{-},1^{-},2^{-}		E(level): order of 481γ-208γ cascade not established, so E=577.28 *16* is also possible. However, E=304 is favored by the tentative placement of the 511γ from the 815 level.
349.00 *10*	1^{+}		Configuration (π 5/2[402])-(ν 7/2[633]) bandhead suggested in 1988So04, but ((π 1/2[541])+(ν 1/2[521])) suggested in 1969Tr02.
407.47[a] *6*	(0)$^{-}$		
436.90? *10*	(0^{+})		Possible configuration (π 1/2[541])-(ν 1/2[521]) (1969Tr02) not adopted; see comment in Adopted Levels.
470.24[a] *6*	1^{-}		
785.46 *6*	1^{+}		
801.70 *10*	(1^{-})		
814.60 *8*	(1)$^{-}$		
923.20 *15*	2^{+}		

Continued on next page (footnotes at end of table)

^{170}Hf ε decay 1969Tr02 (continued)

^{170}Lu Levels (continued)

† From a least-squares fit to Eγ, by evaluators.
‡ From Adopted Levels.
# From γγ(t) measurement (1968Ab08), except where noted.
@ Band(A): $K^\pi=0^+$ g.s. band. Configuration (π 7/2[404])-(ν 7/2[633]) (1969Tr02). Odd J members exhibit Newby shift.
& Band(B): $K^\pi=1^-$ band. Configuration (π 7/2[404])-(ν 5/2[512]) (1969Tr02).
a Band(C): proposed $K^\pi=0^-$ band; configuration (π 1/2[411])-(ν 1/2[521]) (1969Tr02).
b Band(D): $K^\pi=1^-$ band. Configuration (π 1/2[411])+(ν 1/2[521]) (1969Tr02).

ε,β$^+$ radiations

E(decay)	E(level)	Iε[†#]	Log ft[†]	Comments
(1.3×10^2[@] 3)	923.20	0.084 23	6.8 5	εK=0.59 18; εL=0.30 13; εM+=0.11 5
(2.4×10^2[@] 3)	814.60	0.18 5	7.21 20	εK=0.743 20; εL=0.194 14; εM+=0.063 6
(2.5×10^2[@] 3)	801.70	0.26 8	7.11 20	εK=0.749 17; εL=0.190 12; εM+=0.061 5
(2.7×10^2 3)	785.46	43 12	4.96 18	εK=0.756 14; εL=0.185 10; εM+=0.059 4
(5.8×10^2 3)	470.24	3.0 9	6.91 14	εK=0.8036 19; εL=0.1498 14; εM+=0.0466 5
(6.2×10^2[@] 3)	436.90?	0.0088 24	9.50 13	εK=0.8055 17; εL=0.1484 12; εM+=0.0461 5
(6.4×10^2 3)	407.47	6.0 17	6.71 14	εK=0.8069 15; εL=0.1474 11; εM+=0.0457 4
(7.0×10^2 3)	349.00	1.2 4	7.49 15	εK=0.8094 12; εL=0.1456 9; εM+=0.0451 4
(7.7×10^2[@] 3)	283.86	0.42 18	8.32[1u] 20	εK=0.781 3; εL=0.1660 20; εM+=0.0528 8
(8.1×10^2 3)	244.81	1.0 3	7.70 14	εK=0.8128 9; εL=0.1431 7; εM+=0.04415 24
(8.4×10^2 3)	212.49	3.2 10	7.23[‡] 14	εK=0.8136 8; εL=0.1425 6; εM+=0.04392 22
(8.5×10^2 3)	198.37	15 4	6.58 12	εK=0.8140 8; εL=0.1422 6; εM+=0.04382 21
(8.9×10^2 3)	164.71	2.7 9	7.36 15	εK=0.8148 8; εL=0.1416 6; εM+=0.04361 19
(9.4×10^2 3)	116.00	3.4 10	7.31 14	εK=0.8158 7; εL=0.1408 5; εM+=0.04333 17
(9.4×10^2[@] 3)	114.87	1.0 3	7.84 14	εK=0.8159 7; εL=0.1408 5; εM+=0.04332 17
(9.5×10^2 3)	98.49	2.3 7	7.49 14	εK=0.8162 6; εL=0.1406 5; εM+=0.04323 17
(1.05×10^3 3)	0.0	≤40	≥6.3	εK=0.8179 5; εL=0.1393 4; εM+=0.04277 13

† Iε is from intensity imbalance At each level, assigning 0.5Iγ±0.5Iγ for transitions with uncertain placement. The indicated uncertainties in Iε are those which stem from uncertainty in g.s. ε branching; ΔIγ is not given in 1969Tr02. Also, unplaced lines could influence weak branches significantly (2.4% of Iγ remains unplaced). Consequently, Δ(log ft) represents a lower limit, and log ft values for weak branches do not constitute reliable arguments for J^π assignments.
‡ Apparently too low to allow J(213)=2; log $f^{1u}t$<8.5 for Iε>0.5%.
# Absolute intensity per 100 decays.
@ Existence of this branch is questionable.

γ(^{170}Lu)

Iγ normalization: no ε+β^+ branch to g.s. has been observed. log *ft*>6.4 is expected for this 0^+ to 0^+, isospin-forbidden transition; this implies ε+β^+ branching<40% to g.s. The evaluators, therefore, assume %ε+β^+=20 *20* to g.s., so Σ (I(γ+ce) to g.s.)=80% *20*. Δ(Iγ normalization) allows only for uncertainty in branching to g.s.; it would rise to 0.07 if ΔIγ were 20%.

Data are from 1969Tr02, except as noted. Conversion electron data are given in comments; uncertainty in Ice from 1969Tr02 is ≈20%. Conversion coefficients, when given, are calculated by the evaluator from authors′ stated Iγ and Ice (some values differ from those given in table 3 of 1969Tr02); the authors′ normalization gives values consistent with those expected based on subshell ratios for low energy transitions, and with E1 theory for the 164.7, 572.9 and 620.7 keV transitions. α(K)exp for other E1 transitions are, typically, within about 30% of E1 theory, but those for 541γ, 481γ, 470γ are 40-50% high.

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[b]	$I_{(\gamma+ce)}$[a]	Comments
16.39 *10*		114.87	(3)$^+$	98.49	1$^+$	E2+(M3)	≈0.03	≈2.52×10^4	22.0	ce(L)/(γ+ce)≈0.748; ce(M)/(γ+ce)≈0.200; ce(N+)/(γ+ce)≈0.052 ce(N)/(γ+ce)≈0.0466; ce(O)/(γ+ce)≈0.0055; ce(P)/(γ+ce)≈2.85×10^{-5} M1:M2:M3:N:O=32:180:250:100:20 (1969Tr02). I$_\gamma$: 0.00087, from Ice=22.0 (1969Tr02) and α=25200. Mult.,δ: from subshell ratios, γ is predominantly E2. Authors assign M1+E2 with δ=2.0. However the subshell ratios are also consistent with E2+M3, δ≈0.03 (from M1:M2). The latter is adopted for consistency with level scheme.
28.38 *10*	0.90	198.37	1$^+$	170.00	2$^+$	M1+E2	0.079	30.9 *6*		α(L)=23.9 *5*; α(M)=5.50 *11*; α(N+..)=1.48 *3* α(N)=1.288 *24*; α(O)=0.182 *4*; α(P)=0.00917 *16* L1:L2:L3:M1:M2:M3=1615:320:280:390:83:70 (1969Tr02). δ: from L1/L3.
32.35 *10*	0.30	244.81	1$^-$	212.49	1$^-$,2$^-$	M1+E2	0.09	20.9 *4*		α(L)=16.2 *3*; α(M)=3.72 *7*; α(N+..)=1.002 *18* α(N)=0.873 *16*; α(O)=0.1235 *22*; α(P)=0.00622 *11* L1:L2:M1=325:75:85 (1969Tr02) δ: from subshell ratios.
39.06 *10*	≈0.011	283.86	(2)$^-$	244.81	1$^-$	E2		218 *5*	≈2.5	ce(L)/(γ+ce)=0.760 *10*; ce(M)/(γ+ce)=0.188 *5*; ce(N+)/(γ+ce)=0.0481 *13* ce(N)/(γ+ce)=0.0430 *12*; ce(O)/(γ+ce)=0.00510 *14*; ce(P)/(γ+ce)=2.70×10^{-6} *7* L2:L3≈100:90 (1969Tr02) I$_\gamma$: from I(γ+ce) and α. I$_{(\gamma+ce)}$: based on I(ce(L23))≈1.90 (1969Tr02) and mult=E2.
44.52 *10*	1.15	44.50	2$^+$	0.0	0$^+$	E2		114.6 *21*		α(L)=87.4 *16*; α(M)=21.7 *4*; α(N+..)=5.55 *10* α(N)=4.96 *9*; α(O)=0.589 *11*; α(P)=0.000369 *6* L1:L2:L3:M2:M3:N=73:4830:5800:1285:1550:750 (1969Tr02).

From ENSDF

γ(^{170}Lu) (continued)

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[b]	$I_{(\gamma+ce)}$[a]	Comments
47.80 *10*	13.3	212.49	1⁻,2⁻	164.71	1⁻	M1+E2	0.048	5.43 *9*		α(L)=4.22 *7*; α(M)=0.953 *15*; α(N+..)=0.260 *4* α(N)=0.225 *4*; α(O)=0.0330 *5*; α(P)=0.00197 *3* L1:L2:L3:M1:M2:N=4500:540:150:1030:110:300 (1969Tr02). δ: from subshell ratios.
48.42 *10*		92.89	(4)⁻	44.50	2⁺	M2		223	19.5	ce(L)/(γ+ce)=0.754 *9*; ce(M)/(γ+ce)=0.189 *4*; ce(N+)/(γ+ce)=0.0518 *12* ce(N)/(γ+ce)=0.0452 *11*; ce(O)/(γ+ce)=0.00635 *15*; ce(P)/(γ+ce)=0.000311 *8* L1:L2:L3:M1:M2:M3:N=910:90:390:280:40:110:100 (1969Tr02). I_γ: 0.0871, from Ice=19.50 (1969Tr02) and α.
54.03 *10*	5.00	98.49	1⁺	44.50	2⁺	M1		3.67		α(L)=2.85 *5*; α(M)=0.641 *10*; α(N+..)=0.175 *3* α(N)=0.1515 *23*; α(O)=0.0224 *4*; α(P)=0.001381 *21* L1:L2:M1:N=1260:140:310:90 (1969Tr02)
55.19 *10*	5.10	170.00	2⁺	114.87	(3)⁺	M1+E2	0.13	4.06 *7*		α(L)=3.14 *5*; α(M)=0.719 *11*; α(N+..)=0.194 *3* α(N)=0.169 *3*; α(O)=0.0242 *4*; α(P)=0.001279 *20* L1:L2:L3:M1:M2:N=1270:215:150:320:80:80 (1969Tr02). δ: from L1/L3. however, subshell ratios are not mutually consistent.
62.8 *1*	0.50	470.24	1⁻	407.47	(0)⁻	M1		2.36		α(L)=1.83 *3*; α(M)=0.413 *6*; α(N+..)=0.1128 *17* α(N)=0.0975 *15*; α(O)=0.01443 *22*; α(P)=0.000889 *14* L1:M1≈85:20; α(L1)exp≈1.7 (1969Tr02)
70.42 *10*	1.00	114.87	(3)⁺	44.50	2⁺	M1		10.09		α(K)=8.40 *13*; α(L)=1.313 *20*; α(M)=0.295 *5*; α(N+..)=0.0807 *12* α(N)=0.0697 *11*; α(O)=0.01033 *15*; α(P)=0.000636 *10* α(L1)exp=1.0; L1:M1=100:25 (1969Tr02)
71.48 *10*	1.00	116.00	(1)⁺	44.50	2⁺	M1		9.66		α(K)=8.05 *12*; α(L)=1.257 *19*; α(M)=0.283 *5*; α(N+..)=0.0773 *12* α(N)=0.0668 *10*; α(O)=0.00989 *15*; α(P)=0.000609 *9* L1:M1:N=100:24:9; α(L1)exp=1.00 (1969Tr02)
71.58 *10*	0.40	170.00	2⁺	98.49	1⁺	E2		12.99		α(K)=1.513 *22*; α(L)=8.74 *14*; α(M)=2.17 *4*; α(N+..)=0.558 *9* α(N)=0.498 *8*; α(O)=0.0597 *10*; α(P)=0.0001106 *16* L2:L3:M2:M3:N=150:162:37:40:20 (1969Tr02).
[x]72.0[&] *1*	0.14									
74.9 *1*	0.78	244.81	1⁻	170.00	2⁺					
80.13 *10*	2.80	244.81	1⁻	164.71	1⁻	M1		6.96		α(K)=5.80 *9*; α(L)=0.901 *13*; α(M)=0.203 *3*; α(N+..)=0.0554 *8* α(N)=0.0479 *7*; α(O)=0.00709 *11*; α(P)=0.000437 *7* α(K)exp=5.96; K:L1:L2:M1=1670:240:20:65 (1969Tr02) E_γ: 80.19 in tables 3 and 4 of 1969Tr02.
98.55 *10*	15.0	98.49	1⁺	0.0	0⁺	M1		3.84		α(K)=3.20 *5*; α(L)=0.495 *7*; α(M)=0.1113 *16*; α(N+..)=0.0304 *5* α(N)=0.0263 *4*; α(O)=0.00389 *6*; α(P)=0.000240 *4* α(K)exp=2.52 (1969Tr02) K:L1:L2:M1:N=3780:690:60:170:45 (1969Tr02). ce(K) unresolved from ce(L3, 44.5).
99.93 *10*	9.00	198.37	1⁺	98.49	1⁺	M1+E2	0.61	3.60 *6*		α(K)=2.51 *4*; α(L)=0.839 *13*; α(M)=0.200 *3*; α(N+..)=0.0528 *8* α(N)=0.0465 *7*; α(O)=0.00612 *9*; α(P)=0.000183 *3* α(K)exp=2.51 (1969Tr02)

$^{170}_{71}$Lu$_{99}$-4

γ(^{170}Lu) (continued)

E_γ[†]	I_γ[‡a]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[b]	Comments
									K:L1:L2:L3:M:N=2260:315:250:205:200:50 (1969Tr02). δ: from α(K)exp.
[x]112.8[&] *1*	≈0.40								
113.9[&c] *1*	0.80	283.86	(2)$^-$	170.00	2$^+$				
[x]115.0[&] *1*	≈0.90								
115.95 *10*	2.90	116.00	(1)$^+$	0.0	0$^+$	[M1]		2.41	α(K)=2.01 *3*; α(L)=0.310 *5*; α(M)=0.0697 *10*; α(N+..)=0.0191 *3* α(N)=0.01646 *24*; α(O)=0.00244 *4*; α(P)=0.0001506 *22* α(K)exp=0.62; K:L1=180:35 (1969Tr02) I_γ: 3.5 *4* in 1970Ch17, but this may include I(115γ). Mult.: E2(+M1) from α(K)exp, but K/L1=5 cf. 10 and 7 for E2 and M1, respectively, favors M1; feeds 0$^+$ state so cannot be M1+E2. I(ceK) probably includes ce(M1) of 55.2γ (1969Tr02).
[x]116.9[&] *1*	≈1.70								
[x]117.8[&] *1*	≈2.00								
119.15 *10*	3.80	283.86	(2)$^-$	164.71	1$^-$	M1(+E2)	<1.3	2.07 *16*	α(K)=1.5 *4*; α(L)=0.45 *17*; α(M)=0.11 *5*; α(N+..)=0.028 *11* α(N)=0.025 *10*; α(O)=0.0033 *11*; α(P)=0.00011 *4* α(K)exp=1.47; K:L1=560:75 (1969Tr02) Mult.,δ: from α(L1)exp, allowing 30% uncertainty in α(L1)exp.
120.19 *10*	68.5	164.71	1$^-$	44.50	2$^+$	E1		0.216	α(K)=0.179 *3*; α(L)=0.0290 *5*; α(M)=0.00653 *10*; α(N+..)=0.001733 *25* α(N)=0.001514 *22*; α(O)=0.000209 *3*; α(P)=9.88×10^{-6} *14* α(K)exp=0.146 K:L1:L2:L3:M1:N=1000:145:37:42:50:13 (1969Tr02). I_γ: other: 65 *6* in 1970Ch17.
123.6[&c] *1*	0.13	407.47	(0)$^-$	283.86	(2)$^-$				
[x]127.4[&] *1*	0.14								
132.20 *10*	0.20	176.70	3$^+$	44.50	2$^+$	M1+E2		1.42 *24*	α(K)=0.9 *5*; α(L)=0.36 *15*; α(M)=0.09 *4*; α(N+..)=0.023 *10* α(N)=0.020 *9*; α(O)=0.0026 *10*; α(P)=7.E−5 *4* Mult.: from Adopted Gammas. α(K)exp=3.0, but Ice imprecise due to presence of contaminant.
[x]139.2[&] *1*	0.08								May connect 315.6 and 176.7 levels As In Adopted Levels, Gammas.
[x]143.6[&] *1*									Weak line.
146.32 *10*	5.20	244.81	1$^-$	98.49	1$^+$	E1		0.1290	α(K)=0.1072 *16*; α(L)=0.01697 *24*; α(M)=0.00381 *6*; α(N+..)=0.001016 *15* α(N)=0.000886 *13*; α(O)=0.0001238 *18*; α(P)=6.09×10^{-6} *9* α(K)exp=0.077(1969Tr02) I_γ: other: 5.6 *6* in 1970Ch17.
[x]147.7[&] *1*									Weak line.
153.9 *1*	0.30	198.37	1$^+$	44.50	2$^+$	M1+E2	0.84	0.914	α(K)=0.670 *10*; α(L)=0.188 *3*; α(M)=0.0446 *7*; α(N+..)=0.01183 *17* α(N)=0.01039 *15*; α(O)=0.001391 *20*; α(P)=4.72×10^{-5} *7* α(K)exp=0.67 δ: from α(K)exp.
162.65 *10*	6.20	407.47	(0)$^-$	244.81	1$^-$	[M1]		0.922	α(K)=0.770 *11*; α(L)=0.1182 *17*; α(M)=0.0266 *4*; α(N+..)=0.00727 *11*

γ(^{170}Lu) (continued)

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[b]	Comments
									α(N)=0.00628 *9*; α(O)=0.000931 *14*; α(P)=5.76×10^{-5} *9* α(K)exp=0.435; K:L12=270:41 (1969Tr02) Mult.,δ: α(L12)exp midway between E1 and E2,M1 theory; mult=M1+E2 from α(K)exp, but E2 component inconsistent with placement; inconsistency attributable to interference from ce(N)(99.9γ).
164.71 *10*	119.5	164.71	1$^-$	0.0	0$^+$	E1		0.0946	α(K)=0.0788 *11*; α(L)=0.01232 *18*; α(M)=0.00276 *4*; α(N+..)=0.000739 *11* α(N)=0.000644 *9*; α(O)=9.05×10^{-5} *13*; α(P)=4.55×10^{-6} *7* α(K)exp=0.080 K:L1:L2:L3:M=950:100:20:22:33 (1969Tr02).
168.0 *1*	1.80	212.49	1$^-$,2$^-$	44.50	2$^+$	E1		0.0898	α(K)=0.0748 *11*; α(L)=0.01168 *17*; α(M)=0.00262 *4*; α(N+..)=0.000701 *10* α(N)=0.000611 *9*; α(O)=8.59×10^{-5} *12*; α(P)=4.33×10^{-6} *6* α(K)exp≈0.11
169.0 *1*	2.70	283.86	(2)$^-$	114.87	(3)$^+$	E1		0.0885	α(K)=0.0737 *11*; α(L)=0.01150 *17*; α(M)=0.00258 *4*; α(N+..)=0.000690 *10* α(N)=0.000601 *9*; α(O)=8.45×10^{-5} *12*; α(P)=4.27×10^{-6} *6* α(K)exp≈0.074
^{x}183.9[&] *1*	0.14								
185.4 *1*	0.95	283.86	(2)$^-$	98.49	1$^+$				
186.5 *1*	0.30	470.24	1$^-$	283.86	(2)$^-$				
187.87 *10*	0.40	283.86	(2)$^-$	96.01	(3)$^-$	M1		0.616	α(K)=0.515 *8*; α(L)=0.0788 *12*; α(M)=0.01772 *25*; α(N+..)=0.00485 *7* α(N)=0.00419 *6*; α(O)=0.000621 *9*; α(P)=3.84×10^{-5} *6* α(K)exp=0.55
^{x}189.3[&] *1*	0.25								
191.0 *1*	0.30	283.86	(2)$^-$	92.89	(4)$^-$				
198.48 *10*	0.62	198.37	1$^+$	0.0	0$^+$	M1		0.529	α(K)=0.442 *7*; α(L)=0.0676 *10*; α(M)=0.01520 *22*; α(N+..)=0.00416 *6* α(N)=0.00359 *5*; α(O)=0.000532 *8*; α(P)=3.30×10^{-5} *5* α(K)exp=0.60
208.1 *1*	12.20	304.14	0$^-$,1$^-$,2$^-$	96.01	(3)$^-$	M1(+E2)	≤0.8	0.42 *5*	α(K)=0.34 *5*; α(L)=0.062 *3*; α(M)=0.0142 *9*; α(N+..)=0.00383 *20* α(N)=0.00333 *19*; α(O)=0.000476 *12*; α(P)=2.5×10^{-5} *4* α(K)exp=0.393; K:L1:M=480:53:18 (1969Tr02) I_γ: other: 18.8 *19* in 1970Ch17 for (208.1γ+209.3γ). δ: 0.3 *+5−3* from K/M; 0.7 *4* from L1/M.
209.3 *1*	2.30	407.47	(0)$^-$	198.37	1$^+$	(E1)		0.0509	α(K)=0.0425 *6*; α(L)=0.00651 *10*; α(M)=0.001458 *21*; α(N+..)=0.000391 *6* α(N)=0.000340 *5*; α(O)=4.83×10^{-5} *7*; α(P)=2.53×10^{-6} *4* α(K)exp≈0.087
^{x}218.3[&] *1*	0.35								
225.5 *1*	3.90	470.24	1$^-$	244.81	1$^-$	M1		0.372	α(K)=0.311 *5*; α(L)=0.0474 *7*; α(M)=0.01066 *15*; α(N+..)=0.00291 *4* α(N)=0.00252 *4*; α(O)=0.000373 *6*; α(P)=2.32×10^{-5} *4* α(K)exp=0.36 K:L12:M=140:30:8 (1969Tr02). I_γ: other: 7.1 *7* in 1970Ch17. Mult.: from α(K)exp.
242.75 *10*	0.36	407.47	(0)$^-$	164.71	1$^-$	M1		0.304	α(K)=0.254 *4*; α(L)=0.0387 *6*; α(M)=0.00869 *13*; α(N+..)=0.00238 *4*

$^{170}_{71}$Lu$_{99}$-6

^{170}Hf ε decay 1969Tr02 (continued)

γ(^{170}Lu) (continued)

E_γ [†]	I_γ [‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	δ [@]	α [b]	$I_{(\gamma+ce)}$ [a]	Comments
										α(N)=0.00205 *3*; α(O)=0.000305 *5*; α(P)=1.89×10^{-5} *3* α(K)exp=0.333
257.8 *1*	0.40	470.24	1$^-$	212.49	1$^-$,2$^-$	M1+E2	≈1.5	≈0.1638		α(K)≈0.1229; α(L)≈0.0315; α(M)≈0.00742; α(N+..)≈0.00197 α(N)≈0.001729; α(O)≈0.000233; α(P)≈8.38×10^{-6} α(K)exp=0.13
[x]262.0 [&] *1*	0.40									
[x]269.0 [&] *1*	0.50									
[x]278.8 [&] *1*	0.40									
291.4 *1*	4.80	407.47	(0)$^-$	116.00	(1)$^+$	E1		0.0222		α(K)=0.0186 *3*; α(L)=0.00278 *4*; α(M)=0.000621 *9*; α(N+..)=0.0001673 *24* α(N)=0.0001453 *21*; α(O)=2.09×10^{-5} *3*; α(P)=1.147×10^{-6} *16* α(K)exp=0.025
[x]304.2 *1*	1.37					M1		0.1647		α(K)=0.1379 *20*; α(L)=0.0209 *3*; α(M)=0.00469 *7*; α(N+..)=0.001282 *18* α(N)=0.001107 *16*; α(O)=0.0001643 *23*; α(P)=1.022×10^{-5} *15* α(K)exp=0.153 (1969Tr02) E_γ: fits 304.2 to g.s. transition, but mult not consistent.
308.9 *1*	9.4	407.47	(0)$^-$	98.49	1$^+$	E1		0.0192		α(K)=0.01614 *23*; α(L)=0.00240 *4*; α(M)=0.000536 *8*; α(N+..)=0.0001447 *21* α(N)=0.0001256 *18*; α(O)=1.81×10^{-5} *3*; α(P)=1.001×10^{-6} *14* α(K)exp=0.021 I_γ: other: 12.4 *12* in 1970Ch17.
[x]310.5 [&] *1*	0.43									
315.4 *1*	0.49	785.46	1$^+$	470.24	1$^-$					
349.0 *1*	4.90	349.00	1$^+$	0.0	0$^+$	M1		0.1140		α(K)=0.0955 *14*; α(L)=0.01440 *21*; α(M)=0.00323 *5*; α(N+..)=0.000884 *13* α(N)=0.000764 *11*; α(O)=0.0001134 *16*; α(P)=7.06×10^{-6} *10* α(K)exp=0.129; K:L1=63:11 (1969Tr02)
378.0 *1*	0.56	785.46	1$^+$	407.47	(0)$^-$					
425.7 *1*	3.96	470.24	1$^-$	44.50	2$^+$	E1		0.00904 *13*		α=0.00904 *13*; α(K)=0.00761 *11*; α(L)=0.001107 *16*; α(M)=0.000247 *4*; α(N+..)=6.69×10^{-5} *10* α(N)=5.80×10^{-5} *9*; α(O)=8.42×10^{-6} *12*; α(P)=4.84×10^{-7} *7* α(K)exp=0.0101
436.9 [c] *1*		436.90?	(0$^+$)	0.0	0$^+$	(E0)			0.04	K:L=3.3:0.6 (1969Tr02) ce(K)/ce=0.86. I(ce)≈0.04 (1969Tr02) (from ce(K)+ce(L)=0.039). Mult.: ce is observed, but γ is not (1969Tr02).
[x]462.0 *1*	≈0.20					M1		0.0545		α(K)=0.0457 *7*; α(L)=0.00683 *10*; α(M)=0.001532 *22*; α(N+..)=0.000419 *6* α(N)=0.000362 *5*; α(O)=5.38×10^{-5} *8*; α(P)=3.36×10^{-6} *5* α(K)exp=0.11 (1969Tr02)
470.2 *1*	2.40	470.24	1$^-$	0.0	0$^+$	E1		0.00723 *11*		α=0.00723 *11*; α(K)=0.00610 *9*; α(L)=0.000881 *13*;

γ(^{170}Lu) (continued)

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[b]	Comments
								α(M)=0.000196 *3*; α(N+..)=5.32×10^{-5} *8* α(N)=4.61×10^{-5} *7*; α(O)=6.71×10^{-6} *10*; α(P)=3.90×10^{-7} *6* α(K)exp=0.0092
481.3 *1*	16.7	785.46	1$^+$	304.14	0$^-$,1$^-$,2$^-$	E1	0.00686 *10*	α=0.00686 *10*; α(K)=0.00579 *9*; α(L)=0.000835 *12*; α(M)=0.000186 *3*; α(N+..)=5.05×10^{-5} *7* α(N)=4.37×10^{-5} *7*; α(O)=6.37×10^{-6} *9*; α(P)=3.71×10^{-7} *6* α(K)exp=0.0085 Mult, α(K)exp: for doubly-placed γ.
^{x}494.8 *1*	0.18					M1	0.0456	α(K)=0.0383 *6*; α(L)=0.00571 *8*; α(M)=0.001279 *18*; α(N+..)=0.000350 *5* α(N)=0.000302 *5*; α(O)=4.49×10^{-5} *7*; α(P)=2.81×10^{-6} *4* α(K)exp=0.050
501.6 *1*	16.8	785.46	1$^+$	283.86	(2)$^-$	E1	0.00627 *9*	α=0.00627 *9*; α(K)=0.00529 *8*; α(L)=0.000761 *11*; α(M)=0.0001697 *24*; α(N+..)=4.60×10^{-5} *7* α(N)=3.98×10^{-5} *6*; α(O)=5.81×10^{-6} *9*; α(P)=3.40×10^{-7} *5* α(K)exp=0.0059; K:L=10:1.45 (1969Tr02) Mult.: for multiply-placed γ. I_γ: other: 13.6 *14* in 1970Ch17.
510.9[c] *1*	0.74	814.60	(1)$^-$	304.14	0$^-$,1$^-$,2$^-$	M1	0.0420	α(K)=0.0352 *5*; α(L)=0.00525 *8*; α(M)=0.001176 *17*; α(N+..)=0.000322 *5* α(N)=0.000278 *4*; α(O)=4.13×10^{-5} *6*; α(P)=2.59×10^{-6} *4* α(K)exp=0.039
^{x}533.5[&] *1*	0.18							
540.7 *1*	11.1	785.46	1$^+$	244.81	1$^-$	E1	0.00533 *8*	α=0.00533 *8*; α(K)=0.00450 *7*; α(L)=0.000644 *9*; α(M)=0.0001435 *21*; α(N+..)=3.89×10^{-5} *6* α(N)=3.37×10^{-5} *5*; α(O)=4.93×10^{-6} *7*; α(P)=2.90×10^{-7} *4* α(K)exp=0.0066
^{x}554.1[&] *1*	0.28							
572.9 *1*	66.0	785.46	1$^+$	212.49	1$^-$,2$^-$	E1	0.00471 *7*	α=0.00471 *7*; α(K)=0.00398 *6*; α(L)=0.000568 *8*; α(M)=0.0001265 *18*; α(N+..)=3.43×10^{-5} *5* α(N)=2.97×10^{-5} *5*; α(O)=4.35×10^{-6} *6*; α(P)=2.57×10^{-7} *4* α(K)exp=0.0041; K:L=27:3.7 (1969Tr02) I_γ: other: 61 *6* in 1970Ch17.
587.1 *1*	1.20	785.46	1$^+$	198.37	1$^+$	M1	0.0294	α(K)=0.0247 *4*; α(L)=0.00366 *6*; α(M)=0.000819 *12*; α(N+..)=0.000224 *4* α(N)=0.000193 *3*; α(O)=2.88×10^{-5} *4*; α(P)=1.81×10^{-6} *3* α(K)exp=0.032
^{x}602.2[&] *1*	0.40							
^{x}605.2[&] *1*								Weak line.
608.8[&c] *1*	0.75	785.46	1$^+$	176.70	3$^+$			
615.5 *1*	1.70	785.46	1$^+$	170.00	2$^+$	M1	0.0260	α(K)=0.0219 *3*; α(L)=0.00324 *5*; α(M)=0.000725 *11*; α(N+..)=0.000198 *3* α(N)=0.0001712 *24*; α(O)=2.55×10^{-5} *4*; α(P)=1.599×10^{-6} *23* α(K)exp=0.025
620.7 *1*	81.7	785.46	1$^+$	164.71	1$^-$	E1	0.00398 *6*	α=0.00398 *6*; α(K)=0.00337 *5*; α(L)=0.000478 *7*; α(M)=0.0001064 *15*;

^{170}Hf ε decay 1969Tr02 (continued)

$\gamma(^{170}Lu)$ (continued)

E_γ[†]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[b]	Comments
									α(N+..)=2.89×10^{-5} *4* α(N)=2.50×10^{-5} *4*; α(O)=3.66×10^{-6} *6*; α(P)=2.19×10^{-7} *3* α(K)exp=0.0035; K:L:M=28.8:3.6:1.0 (1969Tr02) I_γ: other: 87 *9* in 1970Ch17.
[x]632.7[&] *1*	0.15								
639.4[&c] *1*	0.08	923.20	2$^+$	283.86	(2)$^-$				
[x]654.5[&] *1*	0.06								
[x]661[&]	0.10								
669.4[&c] *1*	0.75	785.46	1$^+$	116.00	(1)$^+$				
[x]674[&]	0.15								
686.7[c] *1*	1.17	801.70	(1$^-$)	114.87	(3)$^+$				α(K)exp=0.0128 Mult.: from α(K)exp, mult=M1(+E2) or E1+M2 with δ=0.55; from decay scheme, $\Delta\pi$=yes if mult(757γ)=E1.
[x]692.8[&] *1*	0.11								
[x]711.4[&] *1*	0.06								
[x]724[&]	0.03								
740.8 *1*	0.83	785.46	1$^+$	44.50	2$^+$	E2(+M1)	≈1.5	≈0.01009	α(K)≈0.00835; α(L)≈0.001352; α(M)≈0.000306; α(N+..)≈8.31×10^{-5} α(N)≈7.20×10^{-5}; α(O)≈1.047×10^{-5}; α(P)≈5.92×10^{-7} α(K)exp=0.0084
746.5 *1*	0.38	923.20	2$^+$	176.70	3$^+$	M1+E2	≈1.7	≈0.00947	α≈0.00947; α(K)≈0.00782; α(L)≈0.001279; α(M)≈0.00029; α(N+..)≈7.86×10^{-5} α(N)≈6.82×10^{-5}; α(O)≈9.88×10^{-6}; α(P)≈5.52×10^{-7} α(K)exp≈0.0079
757.1[c] *1*	1.84	801.70	(1$^-$)	44.50	2$^+$	E1		0.00266 *4*	α=0.00266 *4*; α(K)=0.00226 *4*; α(L)=0.000317 *5*; α(M)=7.04×10^{-5} *10*; α(N+..)=1.91×10^{-5} *3* α(N)=1.655×10^{-5} *24*; α(O)=2.44×10^{-6} *4*; α(P)=1.476×10^{-7} *21* α(K)exp≈0.0027
770.2 *1*	0.56	814.60	(1)$^-$	44.50	2$^+$				
785.5[&c] *1*	0.20	785.46	1$^+$	0.0	0$^+$				
801.7 *1*	1.20	801.70	(1$^-$)	0.0	0$^+$				
808.1[&c] *1*	0.07	923.20	2$^+$	114.87	(3)$^+$				
814.5 *1*	0.27	814.60	(1)$^-$	0.0	0$^+$				
878.7[&c] *1*	0.13	923.20	2$^+$	44.50	2$^+$				
923.1[&c] *1*	0.05	923.20	2$^+$	0.0	0$^+$				

[†] From table 1 of 1969Tr02 for transitions listed in that table; from tables 4 and 5 otherwise. For several transitions, slight energy differences (≤0.1 keV) exist between data in these tables. ΔE=0.1 for photon data (1969Tr02); internal consistency of ce energies from different subshells is at least of that precision, so evaluator assigns ΔE=0.1 to all transitions, except 661, 674, 724, which 1969Tr02 quote to nearest keV only.

γ(^{170}Lu) (continued)

‡ Relative photon intensities from 1969Tr02 normalized so I(165γ)=119.50; uncertainties not stated by authors. Iγ values (±10%) given by 1970Ch17 are in excellent agreement with those of 1969Tr02 for 10 of the 12 lines measured by 1970Ch17.

From available subshell ratios and/or α(K)exp.

@ From conversion electron intensities; uncertainties unknown.

& Assignment probable although only photons were observed (1969Tr02).

a For absolute intensity per 100 decays, multiply by 0.22 *6*.

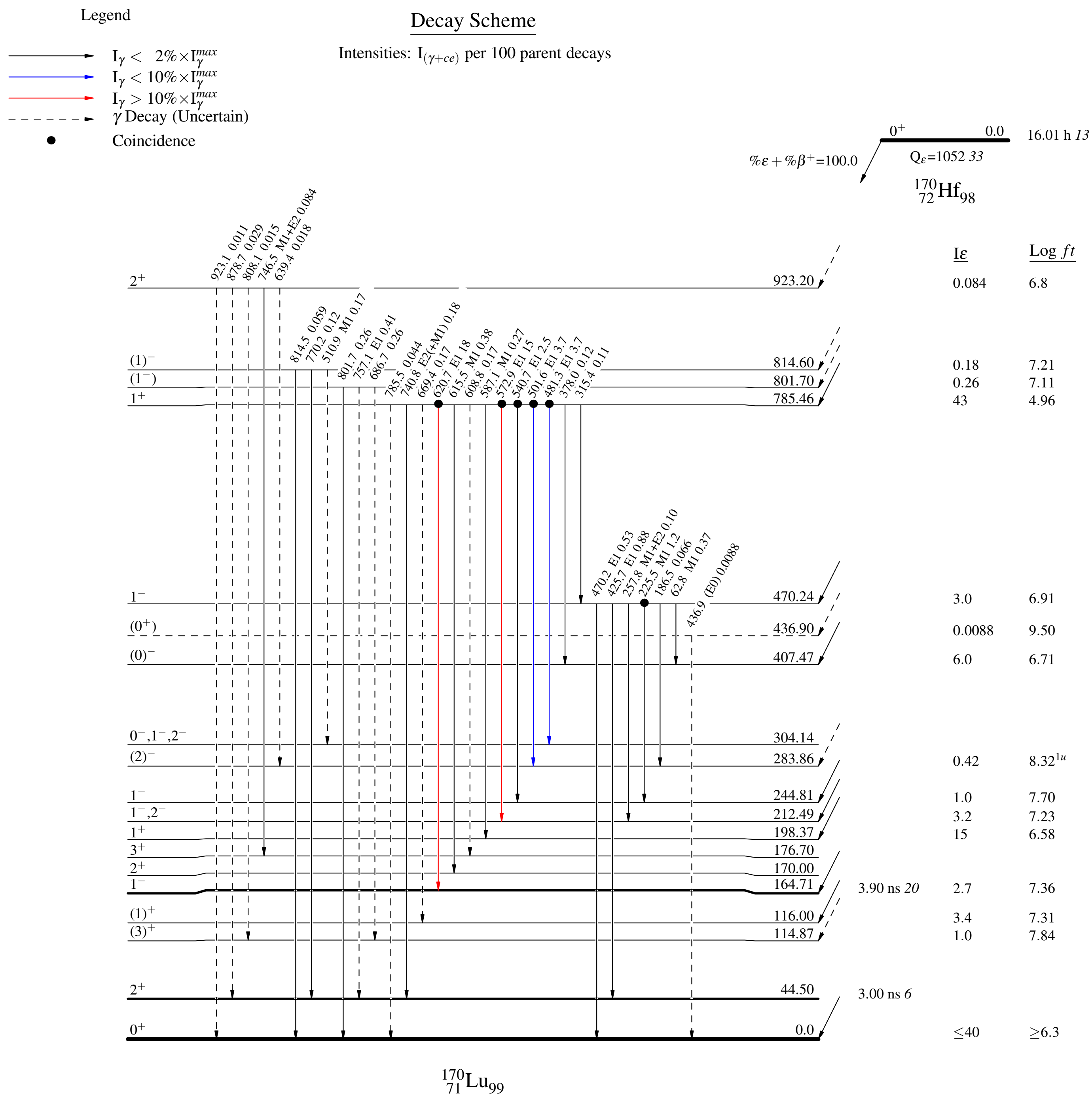
b Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

c Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

$^{170}_{71}Lu_{99}$-10

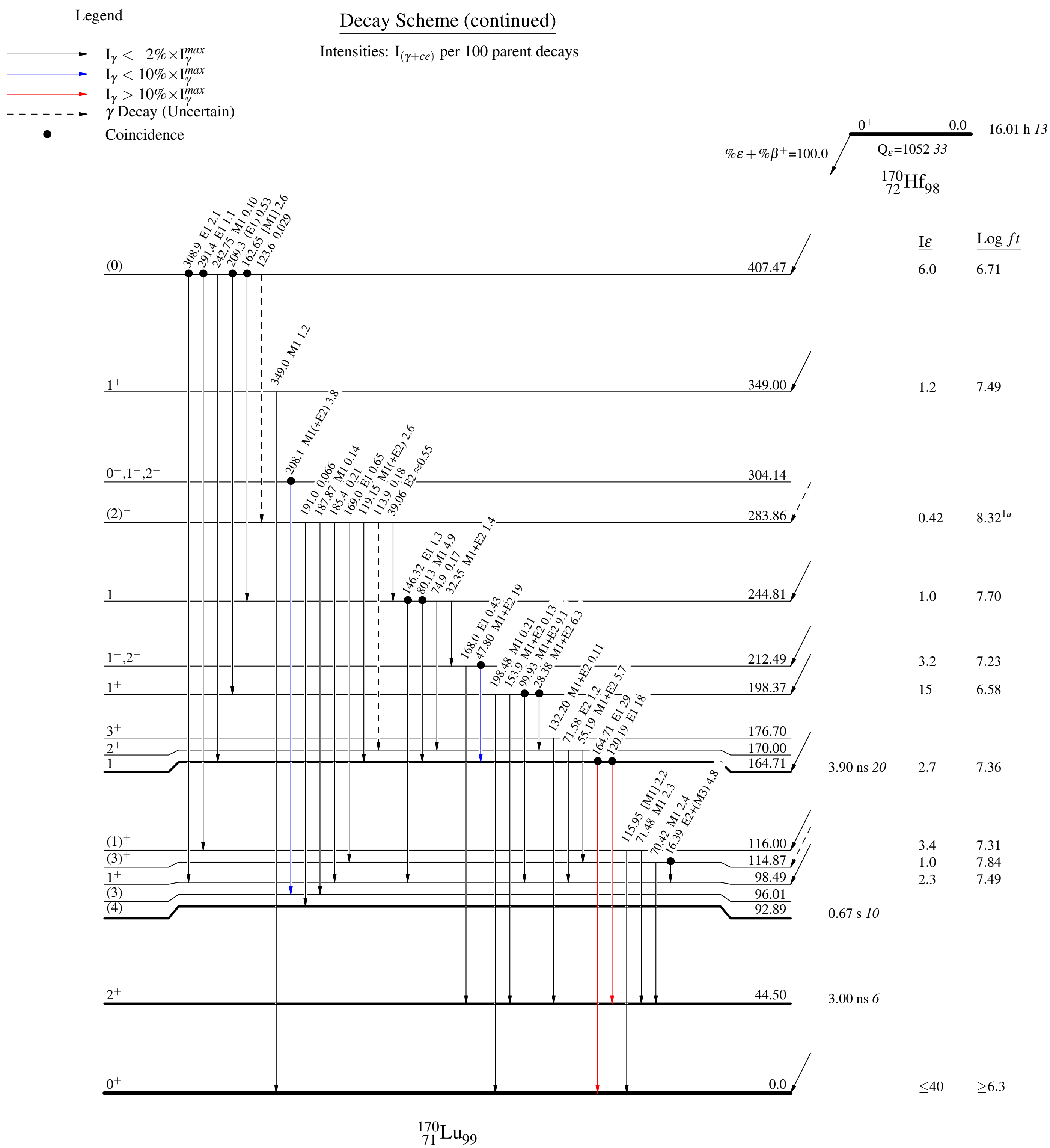
^{170}Hf ε decay 1969Tr02



^{170}Hf ε decay 1969Tr02

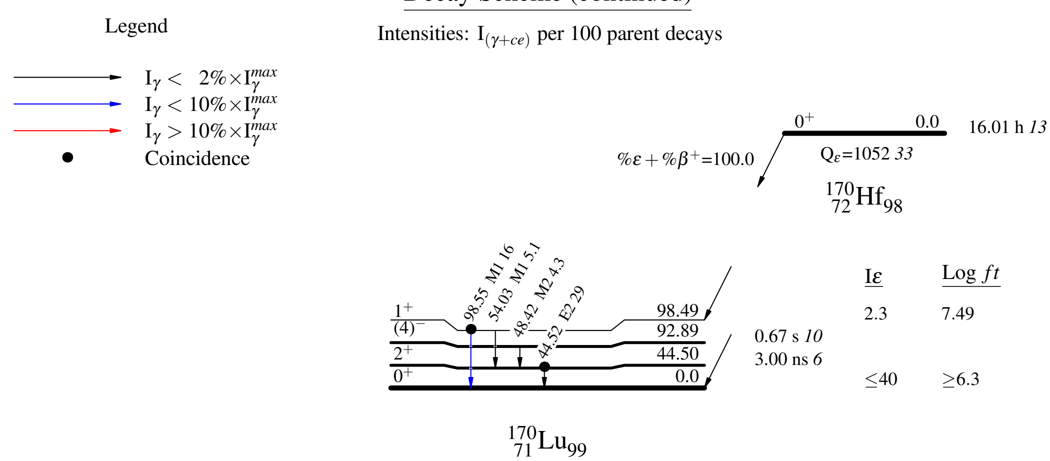
Decay Scheme (continued)

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

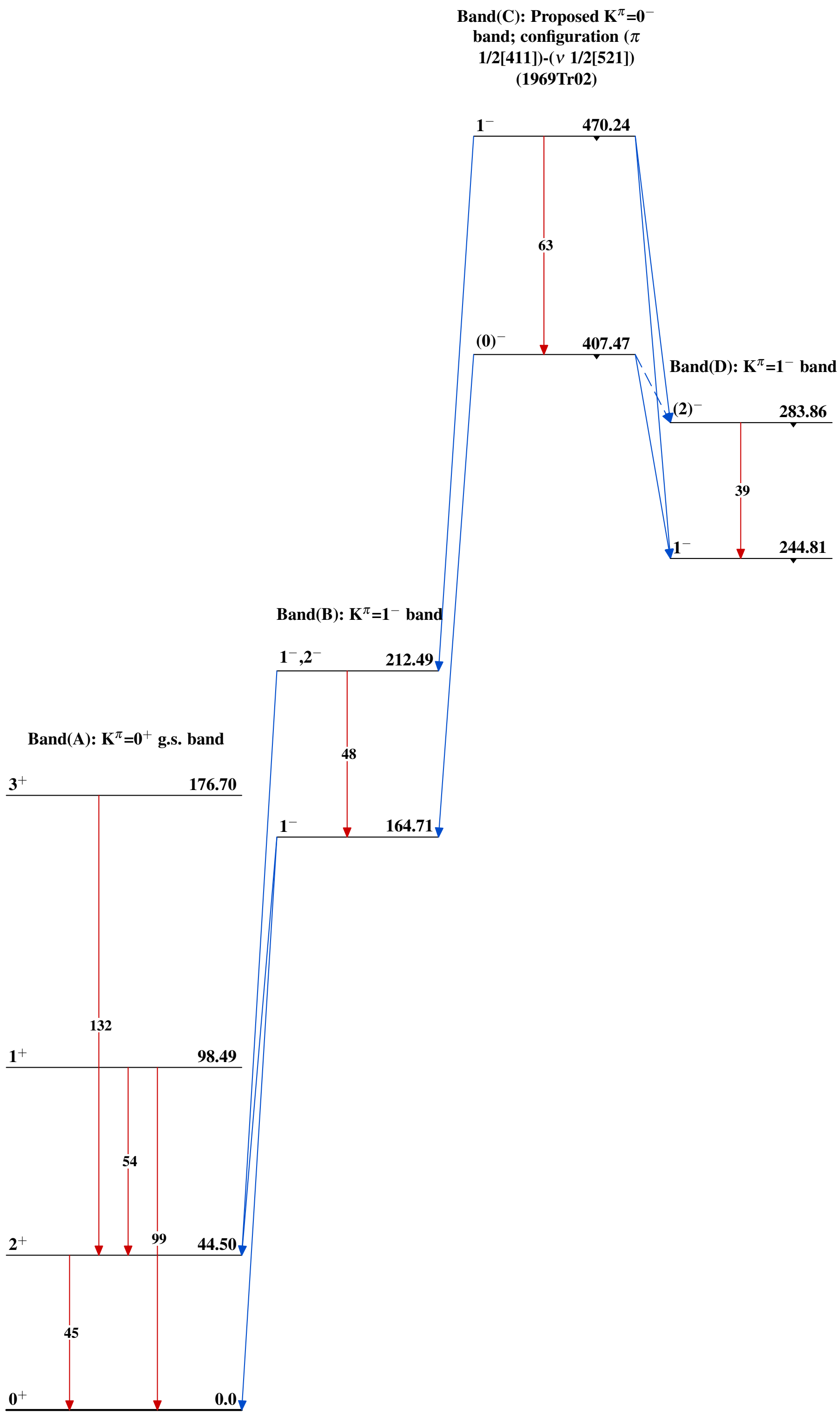


^{170}Hf ε decay 1969Tr02

Decay Scheme (continued)



^{170}Hf ε decay 1969Tr02



$^{170}_{71}Lu_{99}$