^{190}Re β^- decay (3.0 min) 1974Ya02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, [1] and Jun Chen[2]	NDS 169,1 (2020)	15-Oct-2020

Parent: ^{190}Re: E=0; $J^\pi=(2)^-$; $T_{1/2}$=3.0 min *2*; Q(β^-)=3125 *5*; %β^- decay=100

^{190}Re-J^π,$T_{1/2}$,Q(β^-): From ^{190}Re Adopted Levels. Other: Q(β^-)=3070 *70* (2017Wa10).

1974Ya02 (also 1974YaZU, 1972Da07): activities of the ^{190} g.s. were from the IT decay of ^{190}Re isomer in equilibrium with the β^- decay of the isomer, with the isomer produced by the ^{190}Os(d,α) reaction using 18 MeV deuterons provided by the ANL 152-cm cyclotron on a 50-mg target of natural osmium. γ rays were detected with Ge(Li) detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, γ(t). Deduced levels, J, π, parent $T_{1/2}$, configurations, γ-ray multipolarities, β-decay branching ratios. Comparisons with theoretical calculations. 1974Ya02 also report data on ^{190}Ir ε decay (11.78 d) and ^{189}Os(d,p).

Others:

γ: 1972Ru06, 1969Ha44 (also 1970HaYG), 1964Fl02, 1955At21.

$\gamma\gamma$: 1969Ha44 (also 1970HaYG).

β^-: 1969Ha44 (also 1970HaYG), 1955At21.

$T_{1/2}$ (^{190}Re): 1969Ha44 (also 1970HaYG), 1973DeWI, 1964Fl02, 1962Ba60, 1955At21.

Total deposit energy of 3058 keV *130* calculated by RADLIST code is in agreement with expected value of Q(β^-)=3125 keV *5*.

See also ^{190}Re β^- decay (3.2 h) for 28 unplaced γ rays belonging to either or both the 3.1-min and 3.2-h isomers of ^{190}Re.

^{190}Os Levels

E(level)[†]	J^π[‡]
0.0	0^+
186.69 *4*	2^+
547.90 *5*	4^+
557.92 *5*	2^+
755.90 *6*	3^+
955.22 *5*	4^+
1163.11 *5*	4^+
1386.91 *5*	3^-
1995.59 *24*	$(2)^+$
2352.36 *21*	$(2^+,3)$

[†] From a least-squares fit to γ-ray energies.

[‡] From the Adopted Levels.

β^- radiations

E(decay)	E(level)	Iβ^-[†‡]	Log *ft*	Comments
(773 *5*)	2352.36	0.9 *2*	5.9 *1*	av Eβ=252 *80*
(1129 *5*)	1995.59	1.1 *2*	6.4 *1*	av Eβ=389 *85*
(1738 *5*)	1386.91	98.0 *3*	5.1 *1*	av Eβ=639 *90* E(decay): 1800 *300* (1969Ha44), 1700 *300* (1955At21). Iβ^-: from 100−(Iβ^- of 1996 and 2352 levels).

[†] From I(γ+ce) intensity balance at each level, unless otherwise noted.

[‡] Absolute intensity per 100 decays.

$\gamma(^{190}Os)$

Iγ normalization: From Σ[I(γ+ce) from 1387, 1996, 2352 levels]=100. The β^- spectrum and γ-ray data (1969Ha44) from the 3.0-min activity alone (no apparent presence of 3.1-h ^{190}Re) suggest no β^- feeding to levels below 1387. Unplaced γ rays, listed in ^{190}Re β^- decay (3.1 h), are not expected to affect the normalization factor since most of these deexcite levels above 187. See also comments with ^{190}Re β^- decay (3.1 h).

Combined intensities given under comments are the total γ intensities for the 3.1-h (isomer) and 3.0-min (g.s.) activities in equilibrium (1974Ya02), where applicable.

E_γ[†]	I_γ[‡f]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[e]	δ[e]	α[g]	Comments
186.68 *4*	110[@] *6*	186.69	2$^+$	0.0	0$^+$	E2		0.420	%Iγ=49 *9* α(K)=0.203 *3*; α(L)=0.1642 *23*; α(M)=0.0415 *6* α(N)=0.00997 *14*; α(O)=0.001504 *21*; α(P)=1.88×10^{-5} *3* Other: Eγ=186.9 *1*, Iγ=140 *19* (1969Ha44).
198.08 *20*	3.9[a] *7*	755.90	3$^+$	557.92	2$^+$	E2+M1	−9 +2−5	0.349 *7*	%Iγ=1.7 *3* α(K)=0.180 *5*; α(L)=0.1277 *19*; α(M)=0.0321 *5* α(N)=0.00773 *12*; α(O)=0.001171 *18*; α(P)=1.70×10^{-5} *6* Other: Eγ=199.3 *14*, weak (1969Ha44). combined intensity=8.7 *12*.
199.3 *3*	0.7[b] *2*	955.22	4$^+$	755.90	3$^+$	E2		0.336	%Iγ=0.31 *9* α(K)=0.1712 *25*; α(L)=0.1246 *20*; α(M)=0.0314 *5* α(N)=0.00755 *12*; α(O)=0.001143 *18*; α(P)=1.604×10^{-5} *24* combined intensity=2.0 *5*.
207.91[h] *6*	1.9[ha] *4*	755.90	3$^+$	547.90	4$^+$	E2(+M1)	−16 +5−20	0.293	%Iγ=0.84 *18* α(K)=0.155 *3*; α(L)=0.1045 *15*; α(M)=0.0263 *4* α(N)=0.00632 *9*; α(O)=0.000959 *14*; α(P)=1.47×10^{-5} *3* combined intensity=4.3 *8*.
207.91[h] *6*	0.3[hc] *1*	1163.11	4$^+$	955.22	4$^+$	(E2)		0.291	%Iγ=0.13 *5* α(K)=0.1533 *22*; α(L)=0.1045 *15*; α(M)=0.0263 *4* α(N)=0.00632 *9*; α(O)=0.000959 *14*; α(P)=1.446×10^{-5} *21* combined intensity=1.0 *3*.
223.81 *5*	59.0[d] *24*	1386.91	3$^-$	1163.11	4$^+$	E1		0.0500	%Iγ=26.1 *13* α(K)=0.0414 *6*; α(L)=0.00669 *10*; α(M)=0.001530 *22* α(N)=0.000370 *6*; α(O)=6.15×10^{-5} *9*; α(P)=3.76×10^{-6} *6* Other: Eγ=224.1 *1* (1969Ha44); all Iγ values in 1969Ha44 are re-normalized by the evaluators to Iγ=59.0 *24* of this γ here. combined intensity=61.8 *25*.
361.09 *5*	33 *2*	547.90	4$^+$	186.69	2$^+$	E2		0.0535	%Iγ=14.6 *10* α(K)=0.0370 *6*; α(L)=0.01255 *18*; α(M)=0.00307 *5* α(N)=0.000742 *11*; α(O)=0.0001169 *17*; α(P)=3.82×10^{-6} *6* Iγ: from total I(γ+ce) feeding to 548 level in this decay.

^{190}Re β^- decay (3.0 min) 1974Ya02 (continued)

$\gamma(^{190}Os)$ (continued)

E_γ[†]	I_γ[‡ f]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[e]	δ[e]	α[g]	Comments
									Other: Eγ=361.4 *1*, Iγ=74 *15* (1969Ha44). combined intensity=93 *4*.
371.24 *5*	48[&] *3*	557.92	2^+	186.69	2^+	E2+M1	−8.1 *8*	0.0510	%Iγ=21.3 *13* α(K)=0.0359 *6*; α(L)=0.01151 *17*; α(M)=0.00281 *4* α(N)=0.000679 *10*; α(O)=0.0001074 *16*; α(P)=3.73×10^{-6} *7* Other: Eγ=371.5 *1*, Iγ=68 *7* (1969Ha44). combined intensity=100.
397.36 *6*	18.1[b] *19*	955.22	4^+	557.92	2^+	E2		0.0412	%Iγ=8.0 *9* α(K)=0.0293 *5*; α(L)=0.00904 *13*; α(M)=0.00220 *3* α(N)=0.000532 *8*; α(O)=8.44×10^{-5} *12*; α(P)=3.05×10^{-6} *5* Other: Eγ=397.4 *3*, Iγ=30 *3* (1969Ha44). combined intensity=48.5 *29*.
407.22[h] *6*	13[hb] *2*	955.22	4^+	547.90	4^+	E2+M1	−3.4 *+6−9*	0.045 *3*	%Iγ=5.8 *9* α(K)=0.0330 *23*; α(L)=0.0089 *3*; α(M)=0.00214 *6* α(N)=0.000517 *14*; α(O)=8.3×10^{-5} *3*; α(P)=3.5×10^{-6} *3* Other: Eγ=407.3 *3*, Iγ=48 *6* for doublet (1969Ha44). combined intensity=34 *5*.
407.22[h] *6*	22[hc] *3*	1163.11	4^+	755.90	3^+	E2+M1	−2.6 *+8−14*	0.048 *8*	%Iγ=9.7 *13* α(K)=0.036 *8*; α(L)=0.0092 *8*; α(M)=0.00220 *16* α(N)=0.00053 *4*; α(O)=8.6×10^{-5} *8*; α(P)=3.9×10^{-6} *9* combined intensity=63 *6*.
431.62 *7*	38.3[d] *23*	1386.91	3^-	955.22	4^+	[E1]		0.01056	%Iγ=17.0 *11* α(K)=0.00882 *13*; α(L)=0.001348 *19*; α(M)=0.000307 *5* α(N)=7.44×10^{-5} *11*; α(O)=1.261×10^{-5} *18*; α(P)=8.55×10^{-7} *12* Other: Eγ=431.7 *2*, Iγ=50 *6* (1969Ha44). combined intensity=40.1 *24*.
557.95 *7*	65[&] *6*	557.92	2^+	0.0	0^+	E2		0.01748	%Iγ=29 *21* α(K)=0.01340 *19*; α(L)=0.00312 *5*; α(M)=0.000745 *11* α(N)=0.000181 *3*; α(O)=2.94×10^{-5} *5*; α(P)=1.430×10^{-6} *20* Other: Eγ=557.7 *2*, Iγ=107 *10* (1969Ha44). combined intensity=135 *8*.
569.30 *7*	56[a] *7*	755.90	3^+	186.69	2^+	E2+M1	−9.8 *10*	0.01699 *25*	%Iγ=25 *24* α(K)=0.01310 *20*; α(L)=0.00298 *5*; α(M)=0.000709 *10* α(N)=0.0001720 *25*; α(O)=2.81×10^{-5} *4*; α(P)=1.401×10^{-6} *21* Other: Eγ=569.1 *2*, Iγ=77 *8* (1969Ha44). combined intensity=125 *6*.
605.14 *7*	38[c] *3*	1163.11	4^+	557.92	2^+	E2		0.01447	%Iγ=16.8 *13* α(K)=0.01123 *16*; α(L)=0.00248 *4*; α(M)=0.000589 *9* α(N)=0.0001427 *20*; α(O)=2.34×10^{-5} *4*; α(P)=1.202×10^{-6} *17*

$^{190}_{76}Os_{114}$-3

^{190}Re β^- decay (3.0 min) 1974Ya02 (continued)

$\gamma(^{190}Os)$ (continued)

E_γ [†]	I_γ [‡ f]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [e]	δ [e]	α [g]	Comments
									Other: Eγ=605.3 *3*, Iγ=47 *6* (1969Ha44). combined intensity=111 *5*.
(615.39[#])	0.45[#]	1163.11	4^+	547.90	4^+	[M1,E2]		0.026 *13*	%Iγ=0.199 *8* α(K)=0.021 *11*; α(L)=0.0037 *14*; α(M)=0.0009 *3* α(N)=0.00021 *8*; α(O)=3.5×10^{-5} *13*; α(P)=2.4×10^{-6} *13*
630.91 *16*	40[d] *6*	1386.91	3^-	755.90	3^+	[E1]		0.00472	%Iγ=17.7 *23* α(K)=0.00396 *6*; α(L)=0.000588 *9*; α(M)=0.0001335 *19* α(N)=3.24×10^{-5} *5*; α(O)=5.54×10^{-6} *8*; α(P)=3.92×10^{-7} *6* Other: Eγ=630.6 *3*, Iγ=50 *6* (1969Ha44). combined intensity=42 *6*.
768.57 *8*	6.3[b] *7*	955.22	4^+	186.69	2^+	E2		0.00853	%Iγ=2.8 *4* α(K)=0.00682 *10*; α(L)=0.001318 *19*; α(M)=0.000309 *5* α(N)=7.50×10^{-5} *11*; α(O)=1.250×10^{-5} *18*; α(P)=7.32×10^{-7} *11* Other: Eγ=768.9 *5*, weak (1969Ha44). combined intensity=17.0 *10*.
828.99 *7*	52[d] *5*	1386.91	3^-	557.92	2^+	E1		0.00276	%Iγ=23.0 *19* α(K)=0.00232 *4*; α(L)=0.000339 *5*; α(M)=7.68×10^{-5} *11* α(N)=1.87×10^{-5} *3*; α(O)=3.20×10^{-6} *5*; α(P)=2.33×10^{-7} *4* Other: Eγ=828.9 *2*, Iγ=84 *10* (1969Ha44). combined intensity=55 *5*.
839.14 *12*	18.1[d] *9*	1386.91	3^-	547.90	4^+	(E1)		0.00270	%Iγ=8.0 *5* α(K)=0.00227 *4*; α(L)=0.000331 *5*; α(M)=7.50×10^{-5} *11* α(N)=1.82×10^{-5} *3*; α(O)=3.13×10^{-6} *5*; α(P)=2.27×10^{-7} *4* Other: Eγ=838.8 *4*, Iγ=17 *6* (1969Ha44). combined intensity=19.0 *9*.
1200.24 *12*	7.2[d] *8*	1386.91	3^-	186.69	2^+	(E1)			%Iγ=3.2 *4* Other: Eγ=1200.3 *6*, weak (1969Ha44). combined intensity=7.5 *8*.
1386.95 *12*	3.0[d] *4*	1386.91	3^-	0.0	0^+	(E3)			%Iγ=1.33 *19* Other: Eγ=1387.7 *15*, weak (1969Ha44). combined intensity=3.1 *4*.
1397.1 *4*	0.35 *12*	2352.36	$(2^+,3)$	955.22	4^+				%Iγ=0.16 *6*
1437.5 *3*	1.5 *3*	1995.59	$(2)^+$	557.92	2^+	E2(+M1)	>2		%Iγ=0.66 *14*
1447.7 *5*	0.52 *16*	1995.59	$(2)^+$	547.90	4^+				%Iγ=0.23 *8*
1596.4 *5*	0.33 *10*	2352.36	$(2^+,3)$	755.90	3^+				%Iγ=0.15 *5*
1794.5 *3*	1.2 *3*	2352.36	$(2^+,3)$	557.92	2^+				%Iγ=0.53 *14*
1809.3 *5*	0.40 *12*	1995.59	$(2)^+$	186.69	2^+				%Iγ=0.18 *6*
2165.5 *7*	0.13 *6*	2352.36	$(2^+,3)$	186.69	2^+				%Iγ=0.06 *3*

$\gamma(^{190}\text{Os})$ (continued)

† From 1974Ya02, obtained by the author from weighted averages when possible from ^{190}Ir ε decay (11.78 d) and ^{190}Re β^- decay (3.2 h and 3.1 min). 28 unplaced weak γ rays, belonging to ^{190}Re (3.1 min) and/or ^{190}Re (3.2 h) are given in ^{190}Re β^- decay (3.2 h).

‡ From decomposition (by evaluators) of the combined intensities given by 1974Ya02 for the 3.1-h (isomer) and 3.0-min (g.s.) activities in equilibrium, unless otherwise noted. Note that the combined intensities are listed for ^{190}Re isomer β^- decay in 1974Ya02 but are actually for the combination of two activities, with the ground state fed by the IT decays of ^{190}Re isomer in equilibrium. The combined intensities are given under comments for transitions seen in both activities. The unplaced γ rays belong to ^{190}Re (3.0 min) and/or ^{190}Re (3.1 h). The decomposition of the combined intensities is based on that 2352, 1996 and 1387 levels are the only levels fed directly by the β^- decay of the 3.0-min g.s. but not by the β^- decay of the 3.1-h isomer and the 2352 and 1996 levels are not populated in the β^- decay of the 3.1-h isomer, as claimed by 1974Ya02, and it is performed from higher levels to lower levels. Intensity values in 1974Ya02 are relative to combined I(371.2γ)=100. Values are also reported by 1969Ha44 for intense transitions only, relative to I(224γ)=100, and they agree well with the values given here after being renormalized to I(224γ)=59.0 *24* here, as given under comments.

γ ray reported in ^{190}Ir ε decay (12 d) (1974Ya02). Iγ deduced from branching ratios in ^{190}Ir ε decay and Iγ value of the strongest branch from the parent level in this decay.

@ From intensity balance at 187 level. This value agrees with 140 *19* from 1969Ha44, but disagrees with 170 *23* obtained from 310 *22* (1974Ya02) combined for 3.1-h ^{190}Re and 3.1-min ^{190}Re in equilibrium and 140 *7* for 3.1-h ^{190}Re. The combined intensity of 310 *22* from 1974Ya02 is probably in error since it implies β^- feeding of ≈28% to 187 level in this decay, too high to be explained by the β^- spectrum given by 1969Ha44 which essentially indicates only one β^- group (to 1387 level). The 1387 level is claimed to be the only level that is strongly fed in this decay also by 1974Ya02.

& Corrected for I(γ+ce from 558 level) equal to the total I(γ+ce) of 198.1γ, 397.4γ, 605.1γ, 829.0γ, 1437.5γ, and 1794.5γ that feed the 756 level in this decay in decomposition of combined intensities.

a Corrected for I(γ+ce from 756 level) equal to the total I(γ+ce) of 199.3γ, 407.2γ, 630.9γ, and 1596.4γ that feed the 756 level in this decay in decomposition of combined intensities.

b Corrected for I(γ+ce from 955 level) equal to the total I(γ+ce) of 207.9γ, 431.6γ, and 1397.1γ that feed the 955 level in this decay in decomposition of combined intensities.

c Corrected for I(γ+ce from 1163 level)=I(γ+ce)(223.8γ) in this decay in decomposition of combined intensities.

d Corrected for a 4.6% *4* contribution from the decay of the 3.1-h ^{190}Re isomer in decomposition of combined intensities, which is from a total I(γ+ce)=10.6 *7* of 197γ, 295γ and 485γ to 1387 level from higher levels only populated in that decay. See ^{190}Re β^- decay (3.1 h) for Iγ values for those γ rays. The total I(γ+ce) of γ transitions from 1387 level for combined activities is 232 *9*.

e From the Adopted Gammas.

f For absolute intensity per 100 decays, multiply by 0.443 *17*.

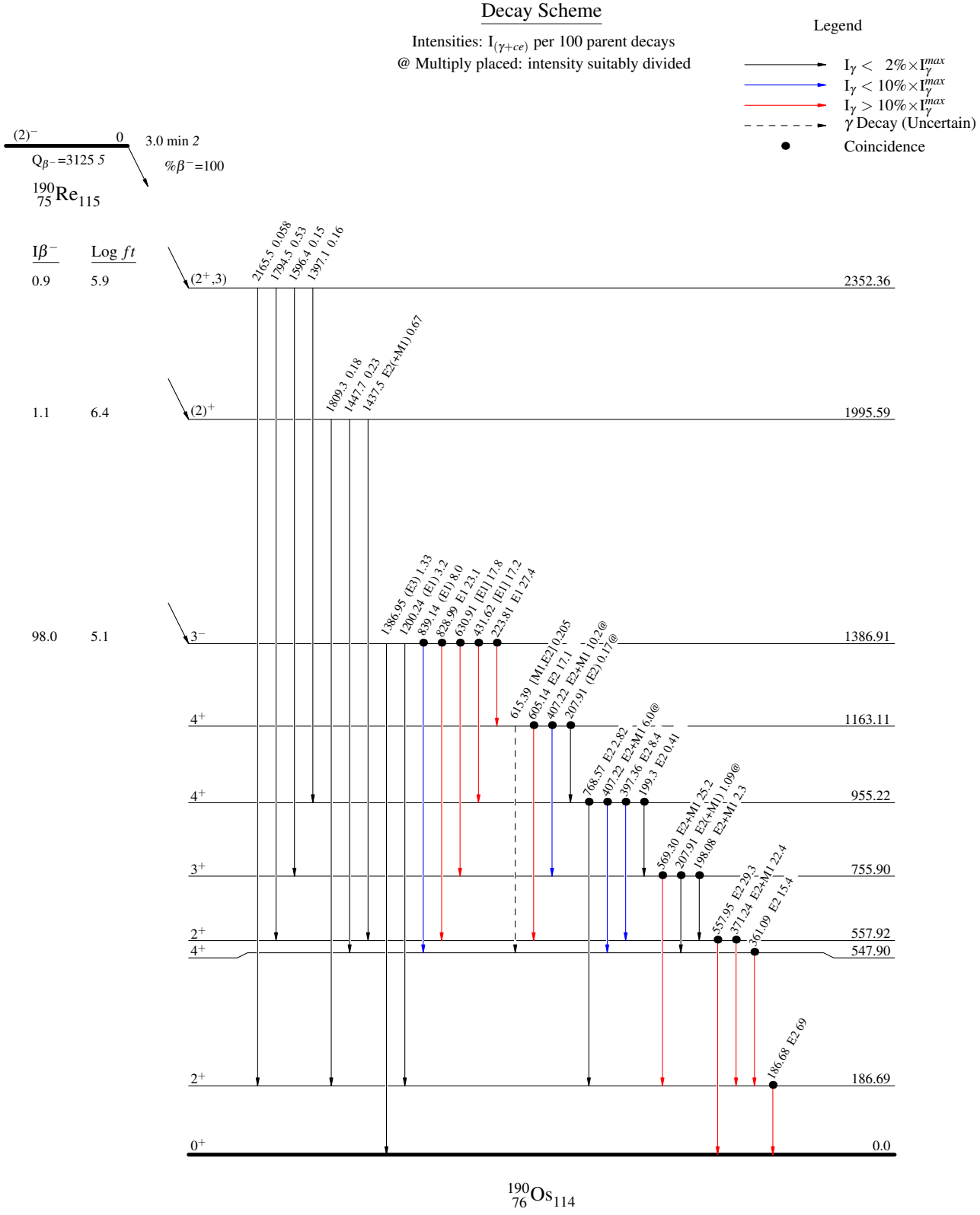
g Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

h Multiply placed with intensity suitably divided.

^{190}Re β^- decay (3.0 min) 1974Ya02

Decay Scheme

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



$^{190}_{76}Os_{114}$