^{228}Pa ε decay 1998We13,1995Ba42

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Khalifeh Abusaleem	NDS 116, 163 (2014)	31-Dec-2012

Parent: ^{228}Pa: E=0.0; $J^{\pi}=3^{+}$; $T_{1/2}$=22 h *1*; Q(ε)=2152 *4*; %ε+%β^{+} decay=98.15 *17*
^{228}Pa-Q(ε): From 2012Wa38.
^{228}Pa-J^{π}: From quadrupole-octopole model: 1988Sh01.
^{228}Pa-$T_{1/2}$: From 1951Me10.
^{228}Pa-%ε+%β^{+} decay: %α=1.85 *17*.
1998We13 and 1995Ba42 works are from the same group.
1998We13: Mass-separated ^{228}Pa sources. Measured Eγ, Iγ, $\gamma\gamma$, ce-γ coin using five Compton-suppressed Ge detectors. The detectors were arranged on the faces of a cube. Two pairs make 180° to each other and 8 pairs make 90° with each other. This arrangement enables to extract information on $\gamma\gamma$ coincidences in addition to angular correlations between the coincidences. The level structure was compared with quasiparticle-phonon model. Assumed E1, M1, E2 or M1+E2 polarity. W(θ)-ratios were used to extract mixing ratios for the strong γ-rays.
1997We05: Describes the same experimental details of 1998We13. The latter work includes the results described in the former.
1995Ba42: measured γ, ce, $\gamma\gamma$, $\gamma(\theta$,H,T).
1993Ac02: measured γ, ce.
1973Ku09: measured γ, ce, $\gamma\gamma$, γ(ce).
1971Am05, 1970SpZW, 1960Ar06: measured ce.

^{228}Th Levels

The decay scheme from ^{228}Pa and the band assignments in ^{228}Th are those proposed by 1995Ba42 and 1998We13. For a discussion of the structure of the bands, and of the band parameters, see 1995Ba42 and 1998We13.

E(level)	J^{π}[†]	Comments
0.0[‡]	0^{+}	
57.775[‡] *14*	2^{+}	
186.849[‡] *16*	4^{+}	
328.034[#] *17*	1^{-}	
378.214[‡] *22*	6^{+}	
396.108[#] *17*	3^{-}	
519.212[#] *20*	5^{-}	
695.4 *3*	7^{-}	Possibly fed by multiply placed 601.7γ from the 1297.4 $(5)^{-}$ level.
831.72[@] *4*	0^{+}	
874.508[@] *22*	2^{+}	
938.63[a] *14*	0^{+}	
944.24[b] *4*	1^{-}	
968.38[b] *4*	2^{-}	J^{π}: γ to 1^{-} and 3^{-} levels in $K^{\pi}=0^{-}$ band, member of a rotational band.
968.45[@] *3*	4^{+}	J^{π}: γ to 3^{-} and 5^{-} levels in $K^{\pi}=0^{-}$ band; member of $K^{\pi}=0^{+}$ band.
968.986[c] *14*	2^{+}	
979.460[&] *24*	2^{+}	
1016.388[b] *24*	3^{-}	J^{π}: γs to 1^{-}, 2^{-}, 3^{-}, and 5^{-} levels, member of a rotational band. E(level): energy sequence suggests that levels at 944.2, 968.4, 1016.4, 1060, 1143 keV are the 1^{-}, 2^{-}, 3^{-}, 4^{-}, and 5^{-} members of the $K^{\pi}=1^{-}$ band.
1022.555[c] *16*	$(3)^{+}$	
1059.93[b] *3*	4^{-}	J^{π}: γ to 3^{-}, and 4^{-} levels, member of a rotational band (1998We13). 3^{-},4^{+},5^{-} ruled out by $\gamma(\theta$,H,T) (1995Ba42).
1074.74[&] *9*	4^{+}	

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^{228}Pa ε decay 1998We13,1995Ba42 (continued)

^{228}Th Levels (continued)

E(level)	J^{π} †	Comments
1091.067[c] *19*	4^+	
1119.9[a] *3*	0^+	
1122.968[d] *18*	2^-	
1143.15[b] *8*	5^-	J^{π}: γ to 4^-, 3^-, 6^+ and 4^+ levels, member of a rotational band.
1153.431[e] *21*	2^+	
1168.395[d] *16*	3^-	
1174.547[c] *23*	(5^+)	
1175.24[a] *7*	2^+	J^{π}: γs to 0^+, 2^+, and 4^+ in g.s. and to 1^- and 3^- in $K^{\pi}=1^-$ band; member of a rotational band.
1200.60[e] *3*	$3^{(+)}$	
1226.596[d] *17*	4^-	
1261.59[e] *8*	4^+	
1270.10[c] *18*	6^+	
1290.08[a] *8*	4^+	
1297.387[d] *24*	(5^-)	
1344.09 *12*	3^-	
1393.46 *8*	$1^+,2,3^-$	J^{π}: γ's to 1^-, 2^+, and 3^- levels.
1416.09 *11*	(3^-)	J^{π}: γs to 1^- and 4^+ levels.
1432.036 *16*	4^+	J^{π}: γs to 2^+ and 6^+ levels.
1448.87 *9*	$3,4^-$	
1450.408 *17*	4^-	J^{π}: γs to 2^- and 5^- levels; γ(θ,H,T) excludes J=3.
1497.69 *8*	(5^-)	
1531.51 *3*	3^+	
1539.0? *10*	2^-	E(level): This level was proposed in ^{228}Ac decay and possibly fed by the 389.36γ from the 1928.6 level. However, the γ's shown as deexciting this level in ^{228}Ac decay have either not been reported (416.30γ) or placed elsewhere in level scheme (1142.85γ). 1995Ba42 suggests that the existence of this level is doubtful.
1580.94 *7*	(2^-)	
1588.369 *20*	(4^-)	J^{π}: γs to 2^-,4^- and ; γ(θ,H,T) excludes 3^- (1995Ba42).
1618.04? *7*	4^+	E(level): Observed in 1995Ba42 only. J^{π}: γs to 2^+ and 4^+ levels.
1638.300 *25*	2^+	
1643.15 *4*	(3^-)	J^{π}: γs to 4^+,1^-, and 4^- levels.
1643.82 *7*	4^+	J^{π}: γs to 2^+, 3, and 4^+; (log *ft*=8.31 5 1998We13).
1645.933 *25*	3^+	J^{π}: multiple γs to 2^+, 3^-, and 4^+ levels; (log *ft*=7.34 5 1998We13).
1667.38 *15*	2^+	
1678.43 *7*	2^+	
1682.85 *4*	$(2^+,3^+,4^+)$	
1683.77 *4*	(4^-)	
1688.42 *5*	$2^+,3^+$	J^{π}: $J^{\pi}=3^-,4^+$ excluded by γ(θ,H,T) (1995Ba42).
1707.30 *16*	$(2,3^-)$	
1724.301 *19*	2^+	J^{π}: log *ft*=7.31 4 (1998We13).
1735.64 *9*	4^+	
1743.90 *4*	4^+	
1758.06 *20*	2^+	
1760.32 *5*	$2^{(+)},3^{(+)}$	J^{π}: γ(θ,H,T) excludes $J^{\pi}=4^+$ (1995Ba42); (log *ft*=8.9 4 1998We13).
1796.45 *8*	4^+	
1802.90 *18*	2^+	
1804.690 *24*	4^+	
1811.58 *15*	$(1^-,2,3^-)$	
1817.442 *25*	4^-	J^{π}: multiple γ's to 4^-, 2^-, and 5; γ(θ,H,T) excludes $J^{\pi}=3^-,5^-$.
1823.49 *16*	(4^+)	
1842.23 *11*	$(2,3)$	
1864.95 *6*	(2^+)	

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^{228}Pa ε decay 1998We13,1995Ba42 (continued)

^{228}Th Levels (continued)

E(level)	J$^{\pi}$†	Comments
1876.46 *22*	(3$^-$,4,5$^-$)	
1879.06 *22*	(3$^-$)	
1893.017 *21*	3$^+$	J$^{\pi}$: log *ft*=6.56 4 (1998We13).
1899.93 *3*	(2$^+$)	J$^{\pi}$: γs to 0$^+$ and 4$^+$.
1901.94 *7*	4$^+$	J$^{\pi}$: γ′s to 2$^+$ and 6$^+$.
1908.47 *8*	(3$^-$)	
1924.17 *6*	(2$^-$,3,4)	
1924.66 *9*	4$^+$,5$^-$	
1925.22 *4*	3$^+$,4$^+$	J$^{\pi}$: γs to 2+and 6$^+$.
1928.37 *7*	3$^+$	J$^{\pi}$: γ(θ,H,T) excludes J^{π}=2$^+$,3$^-$,4$^+$.
1939.10 *10*	(4$^+$)	
1944.916 *18*	3$^+$	
1945.74 *9*	4$^+$,5$^-$	
1949.74 *10*	2$^+$	
1958.19 *14*	(2$^+$)	
1965.05 *8*	(2$^+$)	
1974.20 *11*	(2$^+$,3$^-$)	
1981.90 *5*	(3$^-$)	
2010.10 *7*	(2$^+$)	
2016.76 *9*	(4$^+$,5$^-$)	
2022.88 *9*	(2)$^+$	

† From Adopted Levels.
‡ Band(A): g.s. Rotational band.
# Band(B): K$^{\pi}$=0$^-$ band.
@ Band(C): first K$^{\pi}$=0$^+$ band.
& Band(D): second K$^{\pi}$=0$^+$ band.
[a] Band(E): third K$^{\pi}$=0$^+$ band.
[b] Band(F): K$^{\pi}$=1$^-$ octupole-vibrational band.
[c] Band(G): first K$^{\pi}$=2$^+$ band.
[d] Band(H): K$^{\pi}$=2$^-$ band.
[e] Band(I): second K=2$^+$ band.

ε,β$^+$ radiations

J^{π}(^{228}Pa)=3$^+$.

E(decay)	E(level)	Iε†‡	Log *ft*	I(ε+β$^+$)†‡	Comments
(129 *4*)	2022.88	0.056 *24*	7.47 *20*	0.056 *24*	εK=0.13 *4*; εL=0.606 *21*; εM+=0.266 *12*
(135 *4*)	2016.76	0.08 *1*	7.38 *8*	0.08 *1*	εK=0.18 *4*; εL=0.575 *21*; εM+=0.249 *11*
(142 *4*)	2010.10	0.23 *2*	7.00 *7*	0.23 *2*	εK=0.23 *3*; εL=0.542 *20*; εM+=0.232 *10*
(170 *4*)	1981.90	0.27 *2*	7.20 *6*	0.27 *2*	εK=0.389 *19*; εL=0.433 *13*; εM+=0.178 *6*
(178 *4*)	1974.20	0.281 *21*	7.25 *5*	0.281 *21*	εK=0.421 *17*; εL=0.411 *11*; εM+=0.167 *6*
(187 *4*)	1965.05	0.139 *17*	7.63 *7*	0.139 *17*	εK=0.454 *14*; εL=0.389 *10*; εM+=0.157 *5*
(194 *4*)	1958.19	0.062 *7*	8.03 *6*	0.062 *7*	εK=0.476 *13*; εL=0.374 *9*; εM+=0.150 *4*
(202 *4*)	1949.74	0.09 *1*	7.93 *6*	0.09 *1*	εK=0.499 *11*; εL=0.358 *8*; εM+=0.143 *4*
(206 *4*)	1945.74	0.18 *3*	7.65 *8*	0.18 *3*	εK=0.509 *10*; εL=0.351 *7*; εM+=0.139 *4*
(207 *4*)	1944.916	7.8 *5*	6.02 *5*	7.8 *5*	εK=0.511 *10*; εL=0.350 *7*; εM+=0.139 *4*
(213 *4*)	1939.10	0.135 *16*	7.82 *6*	0.135 *16*	εK=0.525 *9*; εL=0.341 *7*; εM+=0.135 *3*

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^{228}Pa ε decay 1998We13,1995Ba42 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iε[†‡]	Log *ft*	I(ε+β^+)[†‡]	Comments
(224 *4*)	1928.37	0.187 *22*	7.75 *6*	0.187 *22*	εK=0.546 *8*; εL=0.326 *6*; εM+=0.1276 *25*
(227 *4*)	1925.22	1.52 *11*	6.86 *5*	1.52 *11*	εK=0.552 *8*; εL=0.322 *5*; εM+=0.1258 *24*
(227 *4*)	1924.66	0.120 *16*	7.96 *7*	0.120 *16*	εK=0.553 *8*; εL=0.321 *5*; εM+=0.1255 *23*
(228 *4*)	1924.17	0.14 *2*	7.90 *7*	0.14 *2*	εK=0.554 *8*; εL=0.321 *5*; εM+=0.1252 *23*
(244 *4*)	1908.47	0.14 *2*	7.98 *7*	0.14 *2*	εK=0.579 *6*; εL=0.303 *4*; εM+=0.1174 *19*
(250 *4*)	1901.94	0.256 *22*	7.76 *5*	0.256 *22*	εK=0.588 *6*; εL=0.297 *4*; εM+=0.1146 *17*
(252 *4*)	1899.93	0.57 *3*	7.42 *4*	0.57 *3*	εK=0.591 *6*; εL=0.295 *4*; εM+=0.1137 *17*
(259 *4*)	1893.017	4.17 *13*	6.59 *3*	4.17 *13*	εK=0.599 *5*; εL=0.289 *4*; εM+=0.1111 *16*
(273 *4*)	1879.06	0.031 *8*	8.78 *12*	0.031 *8*	εK=0.615 *5*; εL=0.279 *3*; εM+=0.1063 *13*
(276 *4*)	1876.46	0.027 *8*	8.85 *14*	0.027 *8*	εK=0.618 *4*; εL=0.277 *3*; εM+=0.1055 *13*
(287 *4*)	1864.95	0.39 *2*	7.74 *4*	0.39 *2*	εK=0.628 *4*; εL=0.2695 *25*; εM+=0.1021 *12*
(310 *4*)	1842.23	0.11 *1*	8.38 *5*	0.11 *1*	εK=0.646 *3*; εL=0.2571 *20*; εM+=0.0966 *9*
(329 *4*)	1823.49	0.028 *6*	9.05 *10*	0.028 *6*	εK=0.6585 *25*; εL=0.2486 *17*; εM+=0.0929 *8*
(335 *4*)	1817.442	0.52 *4*	7.80 *5*	0.52 *4*	εK=0.6621 *24*; εL=0.2461 *17*; εM+=0.0918 *7*
(340 *4*)	1811.58	0.090 *14*	8.58 *8*	0.090 *14*	εK=0.6653 *23*; εL=0.2439 *16*; εM+=0.0908 *7*
(347 *4*)	1804.690	1.44 *18*	7.40 *6*	1.44 *18*	εK=0.6690 *21*; εL=0.2413 *15*; εM+=0.0897 *7*
(349 *4*)	1802.90	0.04 *1*	8.96 *12*	0.04 *1*	εK=0.6699 *21*; εL=0.2407 *15*; εM+=0.0894 *7*
(356 *4*)	1796.45	≤0.15	≥8.4	≤0.15	εK=0.6731 *20*; εL=0.2385 *14*; εM+=0.0884 *6*
(392 *4*)	1760.32	0.12 *4*	8.61 *15*	0.12 *4*	εK=0.6884 *15*; εL=0.2278 *11*; εM+=0.0838 *5*
(394 *4*)	1758.06	0.043 *9*	9.07 *10*	0.043 *9*	εK=0.6892 *15*; εL=0.2273 *11*; εM+=0.0835 *5*
(408 *4*)	1743.90	0.88 *6*	7.79 *4*	0.88 *6*	εK=0.6941 *14*; εL=0.2238 *10*; εM+=0.0820 *4*
(416 *4*)	1735.64	≤0.09	≥8.8	≤0.09	εK=0.6968 *13*; εL=0.2220 *9*; εM+=0.0812 *4*
(428 *4*)	1724.301	2.9 *2*	7.33 *4*	2.9 *2*	εK=0.7003 *12*; εL=0.2195 *9*; εM+=0.0802 *4*
(445 *4*)	1707.30	≤0.04	≥9.2	≤0.04	εK=0.7050 *11*; εL=0.2162 *8*; εM+=0.0788 *4*
(464 *4*)	1688.42	0.25 *8*	8.48 *14*	0.25 *8*	εK=0.7098 *10*; εL=0.2129 *7*; εM+=0.0773 *3*
(468 *4*)	1683.77	0.300 *23*	8.41 *4*	0.300 *23*	εK=0.7109 *10*; εL=0.2121 *7*; εM+=0.0770 *3*
(469 *4*)	1682.85	≤0.2	≥8.6	≤0.2	εK=0.7111 *10*; εL=0.2120 *7*; εM+=0.0769 *3*
(474 *4*)	1678.43	0.44 *3*	8.25 *4*	0.44 *3*	εK=0.7121 *10*; εL=0.2113 *7*; εM+=0.0766 *3*
(485 *4*)	1667.38	0.07 *2*	9.08 *13*	0.07 *2*	εK=0.7145 *9*; εL=0.2096 *6*; εM+=0.0759 *3*
(506 *4*)	1645.933	4.1 *3*	7.35 *4*	4.1 *3*	εK=0.7189 *8*; εL=0.2066 *6*; εM+=0.07458 *24*
(508 *4*)	1643.82	0.44 *4*	8.33 *5*	0.44 *4*	εK=0.7193 *8*; εL=0.2063 *6*; εM+=0.07446 *23*
(509 *4*)	1643.15	1.17 *5*	7.90 *3*	1.17 *5*	εK=0.7194 *8*; εL=0.2062 *6*; εM+=0.07442 *23*
(514 *4*)	1638.300	≤0.08	≥9.1	≤0.08	εK=0.7203 *8*; εL=0.2056 *6*; εM+=0.07415 *23*
(534 *4*)	1618.04?	0.13 *3*	8.91 *11*	0.13 *3*	εK=0.7239 *7*; εL=0.2031 *5*; εM+=0.07308 *21*
(564 *4*)	1588.369	5.8 *5*	7.31 *5*	5.8 *5*	εK=0.7285 *6*; εL=0.1998 *5*; εM+=0.07169 *18*
(571 *4*)	1580.94	0.166 *21*	8.87 *6*	0.166 *21*	εK=0.7296 *6*; εL=0.1991 *4*; εM+=0.07137 *18*
(620 *4*)	1531.51	0.89 *16*	8.23 *8*	0.89 *16*	εK=0.7359 *5*; εL=0.1946 *4*; εM+=0.06947 *14*
(654 *4*)	1497.69	0.12 *2*	9.15 *8*	0.12 *2*	εK=0.7396 *5*; εL=0.1920 *3*; εM+=0.06836 *13*
(702 *4*)	1450.408	8.7 *8*	7.36 *5*	8.7 *8*	εK=0.7441 *4*; εL=0.18890 *25*; εM+=0.06704 *11*
(703 *4*)	1448.87	≤0.07	≥9.5	≤0.07	εK=0.7442 *4*; εL=0.18881 *25*; εM+=0.06700 *11*
(720 *4*)	1432.036	31.8 *21*	6.82 *4*	31.8 *21*	εK=0.7456 *4*; εL=0.18782 *23*; εM+=0.06658 *10*
(736 *4*)	1416.09	≤0.09	≥9.4	≤0.09	εK=0.7469 *4*; εL=0.18693 *22*; εM+=0.06620 *10*
(759 *4*)	1393.46	0.04 *2*	9.77 *22*	0.04 *2*	εK=0.7486 *3*; εL=0.18574 *21*; εM+=0.06569 *9*
(808 *4*)	1344.09	0.04 *2*	9.83 *22*	0.04 *2*	εK=0.7519 *3*; εL=0.1834 *2*; εM+=0.06471 *8*
(855 *4*)	1297.387	≤0.16	≥9.6[1u]	≤0.16	εK=0.7019 *6*; εL=0.2181 *4*; εM+=0.08004 *18*
(862 *4*)	1290.08	0.12 *4*	9.42 *15*	0.12 *4*	εK=0.7550 *3*; εL=0.1812 *2*; εM+=0.06378 *7*
(882 *4*)	1270.10	≤0.001	≥11.5	≤0.001	εK=0.7561 *2*; εL=0.1805 *2*; εM+=0.06347 *7*
(890 *4*)	1261.59	0.21 *4*	9.21 *9*	0.21 *4*	εK=0.7565 *2*; εL=0.1802 *2*; εM+=0.06334 *6*
(925 *4*)	1226.596	≤0.3	≥9.1	≤0.3	εK=0.7582 *2*; εL=0.1790 *2*; εM+=0.06284 *6*
(951 *4*)	1200.60	≤0.13	≥9.5	≤0.13	εK=0.7593 *2*; εL=0.1782 *2*; εM+=0.06250 *6*
(977 *4*)	1175.24	0.052 *25*	9.90 *21*	0.052 *25*	εK=0.7604 *2*; εL=0.1774 *2*; εM+=0.06219 *5*
(977 *4*)	1174.547	0.05 *3*	9.9 *3*	0.05 *3*	εK=0.7604 *2*; εL=0.1774 *2*; εM+=0.06218 *5*
(984 *4*)	1168.395	0.07 *3*	9.78 *19*	0.07 *3*	εK=0.7606 *2*; εL=0.1772 *2*; εM+=0.06210 *5*
(999 *4*)	1153.431	0.51 *25*	8.93 *22*	0.51 *25*	εK=0.7612 *2*; εL=0.1768 *1*; εM+=0.06193 *5*
(1009 *4*)	1143.15	0.0026 *13*	11.23 *22*	0.0026 *13*	εK=0.7616 *2*; εL=0.1766 *1*; εM+=0.06181 *5*
(1029 *4*)	1122.968	0.06 *4*	9.9 *3*	0.06 *4*	εK=0.7624 *2*; εL=0.1760 *1*; εM+=0.06159 *5*
(1032 *4*)	1119.9	≤0.05	≥10.0	≤0.05	εK=0.7625 *2*; εL=0.1760 *1*; εM+=0.06156 *5*

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^{228}Pa ε decay 1998We13,1995Ba42 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ ‡	Iε †‡	Log *ft*	I($\varepsilon+\beta^+$) †‡	Comments
(1061 *4*)	1091.067		0.013 *19*	10.6 *7*	0.013 *19*	εK=0.7635 *2*; εL=0.1753 *1*; εM+=0.06126 *4*
(1077 *4*)	1074.74		0.011 *1*	10.67 *5*	0.011 *1*	εK=0.7640 *2*; εL=0.1749 *1*; εM+=0.06110 *4*
(1092 *4*)	1059.93		0.004 *4*	11.1 *5*	0.004 *4*	εK=0.7645 *2*; εL=0.17454 *9*; εM+=0.06096 *4*
(1129 *4*)	1022.555		0.1 *3*	9.8 *13*	0.1 *3*	εK=0.7656 *2*; εL=0.17374 *9*; εM+=0.06063 *4*
(1136 *4*)	1016.388		0.003 *10*	11.3 *15*	0.003 *10*	εK=0.7658 *2*; εL=0.17361 *9*; εM+=0.06057 *4*
(1173 *4*)	979.460		0.37 *5*	9.22 *7*	0.37 *5*	εK=0.7668 *1*; εL=0.17289 *8*; εM+=0.06027 *4*
(1183 *4*)	968.986		1.02 *19*	8.79 *9*	1.02 *19*	εK=0.7671 *1*; εL=0.17269 *8*; εM+=0.06019 *4*
(1184 *4*)	968.45		0.029 *10*	10.34 *16*	0.029 *10*	εK=0.7671 *1*; εL=0.17268 *8*; εM+=0.06018 *4*
(1184 *4*)	968.38		0.026 *6*	10.38 *11*	0.026 *6*	εK=0.7671 *1*; εL=0.17268 *8*; εM+=0.06018 *4*
(1208 *4*)	944.24		≤0.05	≥10.1	≤0.05	εK=0.7678 *1*; εL=0.17224 *8*; εM+=0.06000 *3*
(1213 *4*)	938.63		0.025 *13*	10.43 *23*	0.025 *13*	εK=0.7679 *1*; εL=0.17214 *7*; εM+=0.05996 *3*
(1277 *4*)	874.508		0.027 *9*	10.44 *15*	0.027 *9*	εK=0.76941 *9*; εL=0.17107 *7*; εM+=0.05951 *3*
(1320 *4*)	831.72		0.0019 *10*	11.62 *23*	0.0019 *10*	εK=0.77031 *9*; εL=0.17042 *6*; εM+=0.05923 *3*
(1633 *4*)	519.212		0.53 *13*	9.373[1u] *20*	0.53 *13*	εK=0.7749; εL=0.16665 *4*; εM+=0.05767 *2* Log *ft*,Iε: Allowed spectrum assumed for calcuations by L̂OGFT.
(1756 *4*)	396.108	0.00133 *3*	0.800 *5*	9.262 *20*	0.801 *5*	av Eβ=357.3 *18*; εK=0.7757; εL=0.16546 *4*; εM+=0.05718 *2*
(1824 *4*)	328.034		0.04 *4*	11.7[1u] *5*	0.04 *4*	εK=0.75733 *9*; εL=0.17923 *7*; εM+=0.06303 *3*
(1965 *4*)	186.849	0.001 *1*	0.3 *3*	9.8 *5*	0.3 *3*	av Eβ=449.7 *18*; εK=0.7758; εL=0.16357 *4*; εM+=0.05642 *2*
(2094 *4*)	57.775	0.001 *3*	0.2 *5*	10.0 *11*	0.2 *5*	av Eβ=505.8 *20*; εK=0.7750; εL=0.16242 *4*; εM+=0.05597 *2*

† Deduced from intensity balance in level scheme.

‡ Absolute intensity per 100 decays.

γ(^{228}Th)

Iγ normalization: From 1998We13. Uncertainty is assigned based on in-out intensity balance, which is consistent with ΣI(γ+ce)(g.s.)= 88 *12*, ΣI($\varepsilon+\beta^+$)(g.s.)= 12 *12*.

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	$I_{(\gamma+ce)}$[d]	Comments
18.41[b]	4.5 *7*	1450.408	4^-	1432.036	4^+	[E1]		6.46	28 *3*	ce(L)/(γ+ce)=0.513 *7*; ce(M)/(γ+ce)=0.268 *5*; ce(N+)/(γ+ce)=0.0851 *15* ce(N)/(γ+ce)=0.0690 *13*; ce(O)/(γ+ce)=0.0141 *3*; ce(P)/(γ+ce)=0.00195 *4*; ce(Q)/(γ+ce)=5.60$\times10^{-5}$ *11* I(γ+ce)=45 *7* (1998We13) E_γ: deduced from E(level). $I_{(\gamma+ce)}$: deduced from coin experiment which gives branching=18% *2* for decay from 1450 level to 1432 level (1995Ba42). I_γ: from I(γ+ce) and α.
42.47[b]	≤0.1	1688.42	$2^+,3^+$	1645.933	3^+	[M1]		46.3		α(L)=35.0 *5*; α(M)=8.42 *12*; α(N+..)=2.89 *4* α(N)=2.25 *4*; α(O)=0.532 *8*; α(P)=0.1033 *15*; α(Q)=0.00986 *14* I_γ: Both 1998We13 and 1995Ba42 give this upper limit.
56.86 *3*	1.06 *5*	1588.369	(4^-)	1531.51	3^+	E1[c]		0.524		α(L)=0.395 *6*; α(M)=0.0970 *14*; α(N+..)=0.0320 *5* α(N)=0.0254 *4*; α(O)=0.00565 *8*; α(P)=0.000946 *14*; α(Q)=4.46$\times10^{-5}$ *7*
57.76 *2*	5.5 *3*	57.775	2^+	0.0	0^+	E2		153.1		α(L)=112.1 *16*; α(M)=30.7 *5*; α(N+..)=10.35 *15* α(N)=8.22 *12*; α(O)=1.83 *3*; α(P)=0.302 *5*; α(Q)=0.000869 *13* Mult.: L1/L3=0.036 *11*, L2/L3=1.187 *5*, M1/M2=0.0328 *27*, M2/M3=1.137 *19* (1970SpZW); theory: L1/L3=0.0390, L2/L3=1.19, M1/M2=0.0382, M2/M3=1.14.
68.08[b]	≤0.04	396.108	3^-	328.034	1^-	[E2]		69.5		α(L)=50.8 *8*; α(M)=13.95 *20*; α(N+..)=4.70 *7* α(N)=3.74 *6*; α(O)=0.831 *12*; α(P)=0.1374 *20*; α(Q)=0.000435 *6* I_γ: limit of Iγ deduced from the limit of Ice(L2) (1993Ac02).
77.36[b]	0.44 *9*	1168.395	3^-	1091.067	4^+	[E1]		0.231		α(L)=0.1746 *25*; α(M)=0.0426 *6*; α(N+..)=0.01415 *20* α(N)=0.01117 *16*; α(O)=0.00252 *4*; α(P)=0.000435 *6*; α(Q)=2.30$\times10^{-5}$ *4* I_γ: deduced from branching ratio in adopted γ's. Iγ≤0.6 (1995Ba42).
99.47 *6*	1.8 *3*	1531.51	3^+	1432.036	4^+	M1		3.85		α(L)=2.91 *5*; α(M)=0.700 *10*; α(N+..)=0.240 *4* α(N)=0.187 *3*; α(O)=0.0442 *7*; α(P)=0.00858 *13*; α(Q)=0.000816 *12* Mult.: α(L12)exp=2.0, no ce(L3), L/M=2.0, L/N=6 (1960Ar06); theory: α(L12)=3.06, α(L3)=0.0165. δ: ≤0.4 from ce data (data not given) (1995Ba42).

γ(^{228}Th) (continued)

E_γ‡	I_γ‡d	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	δ@	α†&	$I_{(\gamma+ce)}$d	Comments
100.42b	<0.5	1122.968	2−	1022.555	(3)+	(E1+M2)	≈0.23	≈3.10		α(L)≈2.27; α(M)≈0.614; α(N+..)≈0.215 α(N)≈0.1675; α(O)≈0.0393; α(P)≈0.00737; α(Q)≈0.000589 I_γ: deduced from I(ce(L1)).
114.49 *10*	0.10 *2*	1645.933	3+	1531.51	3+	[M1,E2]		9 *4*		α(K)=5 *5*; α(L)=3.2 *13*; α(M)=0.8 *4*; α(N+..)=0.28 *13* α(N)=0.22 *10*; α(O)=0.051 *22*; α(P)=0.009 *4*; α(Q)=0.00030 *24*
116.26 *5*	0.16 *2*	1804.690	4+	1688.42	2+,3+	[M1,E2]		9 *4*		α(K)=5 *5*; α(L)=3.0 *12*; α(M)=0.8 *4*; α(N+..)=0.27 *12* α(N)=0.21 *10*; α(O)=0.048 *20*; α(P)=0.008 *3*; α(Q)=0.00029 *23*
121.18 *7*	0.19 *3*	1804.690	4+	1683.77	(4−)	[E1]		0.311		α(K)=0.240 *4*; α(L)=0.0536 *8*; α(M)=0.01299 *19*; α(N+..)=0.00435 *7* α(N)=0.00342 *5*; α(O)=0.000781 *11*; α(P)=0.0001395 *20*; α(Q)=8.54×10^{-6} *12* E_γ: Poor fit in level scheme. Energy level difference =120.9.
121.87 *3*	0.33 *3*	1804.690	4+	1682.85	(2+,3+,4+)	[M1,E2]		8 *3*		α(K)=4 *4*; α(L)=2.5 *9*; α(M)=0.6 *3*; α(N+..)=0.22 *9* α(N)=0.17 *7*; α(O)=0.039 *15*; α(P)=0.0069 *22*; α(Q)=0.00025 *21*
129.06 *2*	45.7 *23*	186.849	4+	57.775	2+	E2		3.74		α(K)=0.264 *4*; α(L)=2.54 *4*; α(M)=0.697 *10*; α(N+..)=0.236 *4* α(N)=0.187 *3*; α(O)=0.0417 *6*; α(P)=0.00696 *10*; α(Q)=4.23×10^{-5} *6* Mult.: L12/L3=1.62 *12* (1960Ar06); theory: L12/L3=1.70.
134.9 *2*	0.20 *8*	1432.036	4+	1297.387	(5−)					
135.51 *2*	1.04 *6*	1226.596	4−	1091.067	4+	E1c		0.238		α(K)=0.185 *3*; α(L)=0.0401 *6*; α(M)=0.00971 *14*; α(N+..)=0.00326 *5* α(N)=0.00256 *4*; α(O)=0.000586 *9*; α(P)=0.0001053 *15*; α(Q)=6.67×10^{-6} *10*
137.95 *2*	6.6 *3*	1588.369	(4−)	1450.408	4−	M1+(E2)		7.44		α(K)=5.94 *9*; α(L)=1.134 *16*; α(M)=0.273 *4*; α(N+..)=0.0937 *14* α(N)=0.0728 *11*; α(O)=0.01723 *25*; α(P)=0.00334 *5*; α(Q)=0.000318 *5* Mult.: α(L12)exp=1.23, ce(L3) not seen (1960Ar06); theory: M1: α(L12)=1.20, α(L3)=0.00622; E2: α(L12)=1.22, α(L3)=0.690. δ: −0.2≤δ≤1.4 (γ(θ,H,T)), ≤0.3 (α) (1995Ba42).
141.00 *2*	2.08 *10*	519.212	5−	378.214	6+	E1c		0.217		α(K)=0.1690 *24*; α(L)=0.0362 *5*; α(M)=0.00876 *13*; α(N+..)=0.00294 *5* α(N)=0.00231 *4*; α(O)=0.000529 *8*; α(P)=9.53×10^{-5} *14*; α(Q)=6.10×10^{-6} *9*
x141.9 *1*	0.21 *3*									
145.82 *2*	2.57 *13*	1168.395	3−	1022.555	(3)+	E1c		0.200		α(K)=0.1562 *22*; α(L)=0.0332 *5*; α(M)=0.00803 *12*; α(N+..)=0.00269 *4*

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	$I_{(\gamma+ce)}$[d]	Comments
										α(N)=0.00212 *3*; α(O)=0.000485 *7*; α(P)=8.77×10^{-5} *13*; α(Q)=5.66×10^{-6} *8* Mult.: ce not seen (1960Ar06).
148.4 *2*	0.3 *1*	1944.916	3$^+$	1796.45	4$^+$					
153.02 *2*	1.11 *6*	1450.408	4$^-$	1297.387	(5$^-$)	M1+E2[c]	0.60 *8*	4.56 *21*		α(K)=3.32 *23*; α(L)=0.932 *22*; α(M)=0.235 *7*; α(N+..)=0.0801 *24* α(N)=0.0627 *19*; α(O)=0.0145 *4*; α(P)=0.00269 *6*; α(Q)=0.000180 *12*
153.95 *2*	5.5 *3*	1122.968	2$^-$	968.986	2$^+$	E1[c]		0.1758		α(K)=0.1376 *20*; α(L)=0.0289 *4*; α(M)=0.00698 *10*; α(N+..)=0.00234 *4* α(N)=0.00184 *3*; α(O)=0.000423 *6*; α(P)=7.66×10^{-5} *11*; α(Q)=5.02×10^{-6} *7* Mult.: no ce(K) observed (1960Ar06).
156.34 *2*	1.36 *7*	1588.369	(4$^-$)	1432.036	4$^+$	E1[c]		0.1694		α(K)=0.1327 *19*; α(L)=0.0278 *4*; α(M)=0.00671 *10*; α(N+..)=0.00225 *4* α(N)=0.001769 *25*; α(O)=0.000406 *6*; α(P)=7.37×10^{-5} *11*; α(Q)=4.85×10^{-6} *7*
157.5 *2*	0.18 *5*	1893.017	3$^+$	1735.64	4$^+$					
158.74 *3*	1.25 *7*	1804.690	4$^+$	1645.933	3$^+$	M1+E2[c]	0.55 *15*	4.2 *4*		α(K)=3.1 *4*; α(L)=0.82 *3*; α(M)=0.204 *10*; α(N+..)=0.070 *3* α(N)=0.054 *3*; α(O)=0.0127 *5*; α(P)=0.00236 *6*; α(Q)=0.000168 *19*
161.6 *4*	0.08 *3*	1432.036	4$^+$	1270.10	6$^+$					
168.05	0.1	1928.37	3$^+$	1760.32	2$^{(+)}$,3$^{(+)}$	[M1,E2]		2.8 *15*		α(K)=1.8 *16*; α(L)=0.71 *7*; α(M)=0.18 *3*; α(N+..)=0.063 *10* α(N)=0.049 *8*; α(O)=0.0113 *15*; α(P)=0.00202 *13*; α(Q)=0.00010 *8* E_γ: From level-energy difference (1998We13).
168.4 *3*	0.06 *3*	1344.09	3$^-$	1175.24	2$^+$					
170.6 *2*	0.10 *2*	1261.59	4$^+$	1091.067	4$^+$					
174.02 *4*	0.30 *3*	1153.431	2$^+$	979.460	2$^+$	M1+E2	1.2 *+11−6*	2.2 *9*		α(K)=1.4 *10*; α(L)=0.63 *3*; α(M)=0.166 *14*; α(N+..)=0.056 *5* α(N)=0.044 *4*; α(O)=0.0101 *7*; α(P)=0.00179 *5*; α(Q)=8.E−5 *5*
178.14 *7*	≤0.2	1200.60	3$^{(+)}$	1022.555	(3)$^+$	E0			1.2	E_γ: from ce(L1) (1995Ba42). Mult.: no γ seen. No ce(L3) seen, α(L12)exp>6 (1960Ar06). $I_{(\gamma+ce)}$: I(ce(L12)) (1960Ar06). ce(K)=68.49, ce(L1)=157.67, ce(L2)=158.45.
178.7 *2*	0.07 *3*	1122.968	2$^-$	944.24	1$^-$					
184.61[fa] *5*	0.17[f] *2*	1153.431	2$^+$	968.986	2$^+$	E0+M1		3.26 *5*		E_γ: Poor fit in level scheme. 184.325 keV from level difference. Mult.: α(L12)exp=15 (1960Ar06); α(L12)=10.2

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	Comments
									for 5.4% M1 (10.5 for 1.4%E2) transition deduced from ^{228}Ac β^- decay. α: from ^{228}Ac β^- decay.
184.61[fa] 5	0.3[f] 1	1944.916	3^+	1760.32	$2^{(+)},3^{(+)}$	(M1)[c]		3.26	α(K)=2.61 4; α(L)=0.495 7; α(M)=0.1189 17; α(N+..)=0.0408 6 α(N)=0.0317 5; α(O)=0.00751 11; α(P)=0.001457 21; α(Q)=0.0001383 20
191.35 2	4.60 23	378.214	6^+	186.849	4^+	E2		0.776	α(K)=0.1710 24; α(L)=0.443 7; α(M)=0.1209 17; α(N+..)=0.0409 6 α(N)=0.0324 5; α(O)=0.00726 11; α(P)=0.001224 18; α(Q)=1.375×10^{-5} 20 Mult.: α(L3)exp=0.16 (1960Ar06); theory: α(L3)=0.141.
199.40[a] 2	4.5 3	1168.395	3^-	968.986	2^+	E1[c]		0.0950	α(K)=0.0752 11; α(L)=0.01502 21; α(M)=0.00362 5; α(N+..)=0.001220 17 α(N)=0.000956 14; α(O)=0.000221 3; α(P)=4.05×10^{-5} 6; α(Q)=2.84×10^{-6} 4 Mult.: ce not seen (1960Ar06).
199.8[a] 2	0.18 5	1168.395	3^-	968.45	4^+				
204.05 2	6.0 3	1226.596	4^-	1022.555	$(3)^+$	E1[c]		0.0900	α(K)=0.0713 10; α(L)=0.01418 20; α(M)=0.00341 5; α(N+..)=0.001152 17 α(N)=0.000902 13; α(O)=0.000208 3; α(P)=3.83×10^{-5} 6; α(Q)=2.70×10^{-6} 4 Mult.: ce not seen (1960Ar06).
[x]206.30 5	0.50 7								
206.3 1	0.50 7	1297.387	(5^-)	1091.067	4^+				
209.26 2	26.3 13	396.108	3^-	186.849	4^+	E1		0.0848	α(K)=0.0672 10; α(L)=0.01332 19; α(M)=0.00321 5; α(N+..)=0.001082 16 α(N)=0.000847 12; α(O)=0.000196 3; α(P)=3.60×10^{-5} 5; α(Q)=2.55×10^{-6} 4 Mult.: K/L12=4.4 (1960Ar06); theory: K/L12(E1)=5.9, K/L12(E2)=0.69, K/L12(M1)=5.3. α(K)exp=0.075 (1960Ar06); theory: α(K)(E1)=0.0678, α(K)(M1)=1.94.
209.28[g]		1153.431	2^+	944.24	1^-				
214.6[a] 1	≤0.1	1893.017	3^+	1678.43	2^+				
214.9[a] 2	0.76 11	1153.431	2^+	938.63	0^+				I_γ: From ^{228}Ac β^- decay.
[x]216.1 1	1.1 3								γ dominant in ^{224}Ra. Mult.: possibly E1, no ce seen (1960Ar06).
216.3 1	1.1 3	1804.690	4^+	1588.369	(4^-)				
220.61 2	1.24 6	1944.916	3^+	1724.301	2^+	(M1)[c]		1.98	α(K)=1.581 23; α(L)=0.299 5; α(M)=0.0719 10; α(N+..)=0.0247 4 α(N)=0.0192 3; α(O)=0.00454 7; α(P)=0.000881 13; α(Q)=8.36×10^{-5} 12
223.80[a] 2	13.1 7	1450.408	4^-	1226.596	4^-	M1+E2	−0.18 5	1.85 4	α(K)=1.48 4; α(L)=0.286 5; α(M)=0.0688 10; α(N+..)=0.0236 4 α(N)=0.0184 3; α(O)=0.00434 7; α(P)=0.000840 13;

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[†&]	Comments
								α(Q)=7.81×10^{-5} *18* δ: −0.41 from α(K)exp (evaluator). Mult.: α(K)exp=1.32, K/L1=5.1 *6*, ce(L3) not seen (1960Ar06).
224.0[a] *2*	0.17 *6*	1168.395	3$^-$	944.24	1$^-$			
229.3[a] *2*	0.29 *17*	1817.442	4$^-$	1588.369	(4$^-$)			
229.9[ag] *4*	0.16 *6*	1645.933	3$^+$	1416.09	(3$^-$)			
231.05	≤0.02	1175.24	2$^+$	944.24	1$^-$			E_γ: From level-energy difference (1998We13).
231.4[a] *1*	0.83 *5*	1432.036	4$^+$	1200.60	3$^{(+)}$			
231.50[a] *5*	0.10 *2*	1200.60	3$^{(+)}$	968.986	2$^+$	[M1,E2]	1.1 *7*	α(K)=0.8 *7*; α(L)=0.23 *4*; α(M)=0.058 *5*; α(N+..)=0.0199 *17* α(N)=0.0156 *12*; α(O)=0.0036 *4*; α(P)=0.00066 *11*; α(Q)=4.E−5 *4*
237.7 *3*	0.18 *8*	1944.916	3$^+$	1707.30	(2,3$^-$)			
239.1 *3*	0.15 *4*	1261.59	4$^+$	1022.555	(3)$^+$			
253.9 *5*	0.05 *2*	1899.93	(2$^+$)	1645.933	3$^+$			
255.2[a] *3*	0.06 *2*	1893.017	3$^+$	1638.300	2$^+$			
255.9[a] *2*	0.14 *6*	1901.94	4$^+$	1645.933	3$^+$			
257.49 *2*	1.40 *7*	1432.036	4$^+$	1174.547	(5$^+$)	(M1)[c]	1.285	α(K)=1.028 *15*; α(L)=0.194 *3*; α(M)=0.0466 *7*; α(N+..)=0.01601 *23* α(N)=0.01244 *18*; α(O)=0.00294 *5*; α(P)=0.000571 *8*; α(Q)=5.42×10^{-5} *8*
258.1[f] *2*	0.12[f] *6*	1226.596	4$^-$	968.45	4$^+$			
258.1[f] *2*	0.12[f] *6*	1226.596	4$^-$	968.38	2$^-$			
261.6 *2*	0.11 *4*	1899.93	(2$^+$)	1638.300	2$^+$			
263.62 *2*	2.17 *11*	1432.036	4$^+$	1168.395	3$^-$	E1[c]	0.0497	α(K)=0.0397 *6*; α(L)=0.00759 *11*; α(M)=0.00182 *3*; α(N+..)=0.000616 *9* α(N)=0.000482 *7*; α(O)=0.0001119 *16*; α(P)=2.08×10^{-5} *3*; α(Q)=1.553×10^{-6} *22*
270.25 *2*	33.9 *17*	328.034	1$^-$	57.775	2$^+$	E1	0.0470	α(K)=0.0376 *6*; α(L)=0.00716 *10*; α(M)=0.001717 *24*; α(N+..)=0.000581 *9* α(N)=0.000454 *7*; α(O)=0.0001054 *15*; α(P)=1.96×10^{-5} *3*; α(Q)=1.473×10^{-6} *21* Mult.: α(K)exp=0.032 (1960Ar06); theory: α(K)=0.0379.
275.85 *4*	0.82 *7*	1450.408	4$^-$	1174.547	(5$^+$)	[E1]	0.0449	α(K)=0.0359 *5*; α(L)=0.00682 *10*; α(M)=0.001635 *23*; α(N+..)=0.000553 *8* α(N)=0.000433 *6*; α(O)=0.0001004 *14*; α(P)=1.87×10^{-5} *3*; α(Q)=1.410×10^{-6} *20*
278.66[a] *2*	1.61 *21*	1432.036	4$^+$	1153.431	2$^+$	[E2]	0.212	α(K)=0.0844 *12*; α(L)=0.0939 *14*; α(M)=0.0253 *4*; α(N+..)=0.00857 *12* α(N)=0.00677 *10*; α(O)=0.001528 *22*; α(P)=0.000262 *4*; α(Q)=5.40×10^{-6} *8* Mult.: for the doublet: α(K)exp=0.26 (1960Ar06); theory: α(K)(M1)=0.872, α(K)(E2)=0.0854.
278.9[a] *2*	0.41 *4*	1153.431	2$^+$	874.508	2$^+$	(M1+E2)	0.6 *4*	α(K)=0.5 *4*; α(L)=0.12 *3*; α(M)=0.031 *6*; α(N+..)=0.0107 *22* α(N)=0.0084 *16*; α(O)=0.0019 *5*; α(P)=0.00036 *10*; α(Q)=2.4×10^{-5} *19* E_γ: Adopted based on value deduced from gtol computer code available at Brookhaven lab′s website. Mult.: 1995Ba42 gives M=(E2), data not given. For the doublet: α(K)exp=0.26 (1960Ar06); theory: α(K)(M1)=0.872, α(K)(E2)=0.0854.

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	Comments
282.01 *2*	18.6 *9*	1450.408	4^-	1168.395	3^-	M1+E2	−0.51 *12*	0.83 *7*	α(K)=0.65 *6*; α(L)=0.138 *6*; α(M)=0.0337 *11*; α(N+..)=0.0115 *4* α(N)=0.0090 *3*; α(O)=0.00211 *7*; α(P)=0.000403 *16*; α(Q)=3.4×10^{-5} *3* Mult.: α(K)exp=0.62, K/L12=4.1 *5*, K/L3=58 *6* (1960Ar06); theory: α(K)=0.69 *6*, K/L12=4.9 *6*, K/L3=133 *43*.
282.37[g]		1226.596	4^-	944.24	1^-				
288.9 *1*	≤0.2	1432.036	4^+	1143.15	5^-				
292.5	≤0.1	1261.59	4^+	968.986	2^+				
293.1 *2*	0.13 *3*	1261.59	4^+	968.45	4^+				
299.0[ag] *2*	0.13 *6*	1643.15	(3^-)	1344.09	3^-				
299.10[a] *10*	0.43 *5*	1944.916	3^+	1645.933	3^+	M1[c]		0.849	α(K)=0.680 *10*; α(L)=0.1280 *18*; α(M)=0.0307 *5*; α(N+..)=0.01055 *15* α(N)=0.00819 *12*; α(O)=0.00194 *3*; α(P)=0.000377 *6*; α(Q)=3.57×10^{-5} *5* Mult.: from ce data (data not given) (1995Ba42).
306.61 *2*	2.0 *1*	1944.916	3^+	1638.300	2^+	M1		0.793	α(K)=0.635 *9*; α(L)=0.1195 *17*; α(M)=0.0287 *4*; α(N+..)=0.00985 *14* α(N)=0.00765 *11*; α(O)=0.00181 *3*; α(P)=0.000351 *5*; α(Q)=3.33×10^{-5} *5* Mult.,δ: from ce data, δ≤0.3 (data not given) (1995Ba42).
308.2[g] *2*	0.45 *15*	1724.301	2^+	1416.09	(3^-)				
317.2 *3*	0.12 *6*	695.4	7^-	378.214	6^+				
321.71 *3*	0.67 *4*	1153.431	2^+	831.72	0^+	[E2]		0.1368	α(K)=0.0635 *9*; α(L)=0.0540 *8*; α(M)=0.01443 *21*; α(N+..)=0.00489 *7* α(N)=0.00386 *6*; α(O)=0.000874 *13*; α(P)=0.0001513 *22*; α(Q)=3.87×10^{-6} *6*
321.75[g]		1965.05	(2^+)	1643.15	(3^-)				
326.1[a] *3*	0.25 *6*	1200.60	$3^{(+)}$	874.508	2^+				
327.45[a] *4*	31 *3*	1450.408	4^-	1122.968	2^-	[E2]		0.1299	α(K)=0.0613 *9*; α(L)=0.0505 *7*; α(M)=0.01349 *19*; α(N+..)=0.00458 *7* α(N)=0.00361 *5*; α(O)=0.000818 *12*; α(P)=0.0001416 *20*; α(Q)=3.72×10^{-6} *6* Mult.: α(K)exp=0.055 (1960Ar06) based on the division of Iγ and E1 mult. in alternate placement. Theory: α(K)(E2)=0.0619, α(K)(M1)=0.559.
328.03[a] *4*	30 *3*	328.034	1^-	0.0	0^+	E1		0.0305	α(K)=0.0245 *4*; α(L)=0.00455 *7*; α(M)=0.001089 *16*; α(N+..)=0.000369 *6* α(N)=0.000288 *4*; α(O)=6.71×10^{-5} *10*; α(P)=1.256×10^{-5} *18*; α(Q)=9.82×10^{-7} *14* Mult.: α(K)exp=0.019 *2* (1960Ar06); theory: α(K)(E1)=0.0245.
332.37 *2*	21.0 *11*	519.212	5^-	186.849	4^+	E1[c]		0.0297	α(K)=0.0238 *4*; α(L)=0.00441 *7*; α(M)=0.001056 *15*; α(N+..)=0.000358 *5* α(N)=0.000280 *4*; α(O)=6.51×10^{-5} *10*; α(P)=1.219×10^{-5} *17*; α(Q)=9.56×10^{-7} *14* Mult.: ce(K) not seen (1960Ar06).
338.32 *2*	82 *4*	396.108	3^-	57.775	2^+	E1		0.0285	α(K)=0.0229 *4*; α(L)=0.00424 *6*; α(M)=0.001014 *15*;

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
									α(N+..)=0.000344 *5* α(N)=0.000269 *4*; α(O)=6.25×10^{-5} *9*; α(P)=1.172×10^{-5} *17*; α(Q)=9.22×10^{-7} *13* Mult.: α(K)exp=0.019 (1960Ar06); theory: α(K)(E1)=0.0231.
340.98 *2*	20.5 *10*	1432.036	4$^+$	1091.067	4$^+$	E2+M1	−5.2 *18*	0.133 *21*	α(K)=0.071 *19*; α(L)=0.0451 *21*; α(M)=0.0119 *5*; α(N+..)=0.00405 *16* α(N)=0.00319 *13*; α(O)=0.00073 *3*; α(P)=0.000127 *7*; α(Q)=4.2×10^{-6} *10* Mult.: from K:L12:L3=140:90:30, α(K)exp=0.061 (1960Ar06); theory: K:L12:L3=140:74:18, α(K)=0.071 *19*.
354.21	≤0.16	1804.690	4$^+$	1450.408	4$^-$	[E1]		0.0258	α(K)=0.0208 *3*; α(L)=0.00382 *6*; α(M)=0.000913 *13*; α(N+..)=0.000310 *5* α(N)=0.000242 *4*; α(O)=5.64×10^{-5} *8*; α(P)=1.057×10^{-5} *15*; α(Q)=8.39×10^{-7} *12*
354.43	≤0.08	1580.94	(2$^-$)	1226.596	4$^-$	[E2]		0.1036	α(K)=0.0524 *8*; α(L)=0.0377 *6*; α(M)=0.01002 *14*; α(N+..)=0.00340 *5* α(N)=0.00268 *4*; α(O)=0.000609 *9*; α(P)=0.0001060 *15*; α(Q)=3.11×10^{-6} *5*
354.5 *2*	≈0.1	1497.69	(5$^-$)	1143.15	5$^-$				
356.95[b]	≤0.04	1531.51	3$^+$	1174.547	(5$^+$)	[E2]		0.1015	α(K)=0.0517 *8*; α(L)=0.0367 *6*; α(M)=0.00976 *14*; α(N+..)=0.00331 *5* α(N)=0.00261 *4*; α(O)=0.000593 *9*; α(P)=0.0001033 *15*; α(Q)=3.07×10^{-6} *5* I_γ: 0.024 *5* from branching ratio (1995Ba42).
357.1[ag] *2*	0.37 *4*	1432.036	4$^+$	1074.74	4$^+$				
[x]357.3 *1*	0.37 *4*								
359.36 *3*	1.30 *7*	1450.408	4$^-$	1091.067	4$^+$	[E1]		0.0250	α(K)=0.0202 *3*; α(L)=0.00370 *6*; α(M)=0.000884 *13*; α(N+..)=0.000300 *5* α(N)=0.000234 *4*; α(O)=5.46×10^{-5} *8*; α(P)=1.024×10^{-5} *15*; α(Q)=8.15×10^{-7} *12*
367.04 *2*	2.45 *12*	1817.442	4$^-$	1450.408	4$^-$	M1+(E2)		0.484	α(K)=0.388 *6*; α(L)=0.0728 *11*; α(M)=0.01747 *25*; α(N+..)=0.00599 *9* α(N)=0.00466 *7*; α(O)=0.001103 *16*; α(P)=0.000214 *3*; α(Q)=2.03×10^{-5} *3* Mult.,δ: −0.2≤δ≤1.4 (γ(θ,H,T)), ≤0.3 (α) (1995Ba42).
371.88	≤0.02	2010.10	(2$^+$)	1638.300	2$^+$				
372.2[a] *2*	0.09 *3*	1432.036	4$^+$	1059.93	4$^-$				
372.60[a] *3*	1.57 *8*	1804.690	4$^+$	1432.036	4$^+$	[M1,E2]		0.28 *19*	α(K)=0.21 *17*; α(L)=0.051 *20*; α(M)=0.013 *5*; α(N+..)=0.0043 *15* α(N)=0.0034 *12*; α(O)=0.0008 *3*; α(P)=0.00015 *6*; α(Q)=1.1×10^{-5} *9*
377.99[b]	0.036 *7*	1531.51	3$^+$	1153.431	2$^+$	[M1,E2]		0.27 *18*	α(K)=0.20 *16*; α(L)=0.049 *19*; α(M)=0.012 *5*; α(N+..)=0.0041 *15* α(N)=0.0032 *11*; α(O)=0.0007 *3*; α(P)=0.00014 *6*; α(Q)=1.1×10^{-5} *8* I_γ: from branching ratio in adopted γ′s; Iγ≤0.2 (1995Ba42),
384.44	≤0.1	2022.88	(2)$^+$	1638.300	2$^+$				

$^{228}_{90}Th_{138}$-12

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
387.0 *3*	0.09 *3*	1261.59	4+	874.508	2+				
389.1[a] *2*	≤0.4	1448.87	3,4−	1059.93	4−				
389.36[bg]	0.31 *5*	1928.37	3+	1539.0?	2−				E_γ: Not reported in 1998We13. I_γ: from branching ratio in adopted γ′s; Iγ≤0.4 (1995Ba42). Possibility feeds the 1539.2 level; see comment with that level.
390.45[a] *5*	1.11 *6*	1450.408	4−	1059.93	4−	[M1,E2]		0.24 *17*	α(K)=0.19 *15*; α(L)=0.044 *18*; α(M)=0.011 *4*; α(N+..)=0.0037 *14* α(N)=0.0029 *11*; α(O)=0.0007 *3*; α(P)=0.00013 *6*; α(Q)=1.0×10^{-5} *8*
399.8 *2*	0.35 *4*	1416.09	(3−)	1016.388	3−				
399.94[g] *7*	0.35 *4*	1743.90	4+	1344.09	3−	[E1]		0.0199	α(K)=0.01610 *23*; α(L)=0.00291 *4*; α(M)=0.000695 *10*; α(N+..)=0.000236 *4* α(N)=0.000184 *3*; α(O)=4.30×10^{-5} *6*; α(P)=8.10×10^{-6} *12*; α(Q)=6.57×10^{-7} *10* E_γ: observed only in 1995Ba42. Possibly feeds the 1344.08 level; see comment with that level.
409.45 *2*	100 *5*	1432.036	4+	1022.555	(3)+	E2+M1	−5.4 *8*	0.080 *4*	α(K)=0.048 *3*; α(L)=0.0236 *5*; α(M)=0.00618 *12*; α(N+..)=0.00210 *5* α(N)=0.00165 *4*; α(O)=0.000378 *8*; α(P)=6.69×10^{-5} *15*; α(Q)=2.69×10^{-6} *16* Mult.: α(K)exp=0.049, K:L12:L3=54 *3*:21 *1*:4.6 *3* (1960Ar06); theory: α(K)(M1+E2)=0.048 *4*, K:L12:L3=54:22:4.3.
415.6[a] *1*	0.48 *5*	1432.036	4+	1016.388	3−				
416.15[g]	0.49 *5*	1760.32	2(+),3(+)	1344.09	3−	[E1]		0.0184	α(K)=0.01483 *21*; α(L)=0.00267 *4*; α(M)=0.000637 *9*; α(N+..)=0.000216 *3* α(N)=0.0001688 *24*; α(O)=3.94×10^{-5} *6*; α(P)=7.43×10^{-6} *11*; α(Q)=6.08×10^{-7} *9* Possibly feeds the 1344.08 level; see comment with that level.
416.5[a] *1*	0.27 *5*	1643.15	(3−)	1226.596	4−				
419.3 *2*	0.28 *5*	1645.933	3+	1226.596	4−	[E1]		0.0181	α(K)=0.01461 *21*; α(L)=0.00263 *4*; α(M)=0.000627 *9*; α(N+..)=0.000213 *3* α(N)=0.0001660 *24*; α(O)=3.88×10^{-5} *6*; α(P)=7.32×10^{-6} *11*; α(Q)=5.99×10^{-7} *9*
420.03 *8*	0.68 *5*	1588.369	(4−)	1168.395	3−	[M1,E2]		0.20 *14*	α(K)=0.15 *12*; α(L)=0.036 *15*; α(M)=0.009 *4*; α(N+..)=0.0030 *12* α(N)=0.0023 *9*; α(O)=0.00055 *22*; α(P)=0.00010 *5*; α(Q)=8.E−6 *6*
425.0 *2*	0.16 *3*	1393.46	1+,2,3−	968.45	4+				
[x]425.4 *1*	0.41 *5*								
427.90 *3*	1.24 *8*	1450.408	4−	1022.555	(3)+	[E1]		0.01733	α(K)=0.01401 *20*; α(L)=0.00251 *4*; α(M)=0.000599 *9*; α(N+..)=0.000203 *3* α(N)=0.0001588 *23*; α(O)=3.71×10^{-5} *6*; α(P)=7.00×10^{-6} *10*; α(Q)=5.75×10^{-7} *8*
432.5[a] *3*	≤0.3	1448.87	3,4−	1016.388	3−				
434.01 *3*	1.73 *10*	1450.408	4−	1016.388	3−	[D,E2]		0.18 *13*	

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[†&]	Comments
440.4 2	0.15 7	1531.51	3+	1091.067	4+	M1	0.295	α(K)=0.237 4; α(L)=0.0442 7; α(M)=0.01061 15; α(N+..)=0.00364 6 α(N)=0.00283 4; α(O)=0.000670 10; α(P)=0.0001300 19; α(Q)=1.234×10^{-5} 18
442.9[a] 3	0.10 5	1643.82	4+	1200.60	3(+)			
x443.8 1	0.62 7							
444.0[a] 2	0.5 1	1893.017	3+	1448.87	3,4−			
444.9[a] 3	0.10 5	1645.933	3+	1200.60	3(+)			
447.6 2	0.13 5	1416.09	(3−)	968.45	4+			
449.2[a] 1	0.25 9	1393.46	1+,2,3−	944.24	1−			
449.23[a] 3	2.25 25	968.45	4+	519.212	5−			
452.52 6	1.02 8	1432.036	4+	979.460	2+	[E2]	0.0544	α(K)=0.0326 5; α(L)=0.01612 23; α(M)=0.00422 6; α(N+..)=0.001433 20 α(N)=0.001128 16; α(O)=0.000257 4; α(P)=4.56×10^{-5} 7; α(Q)=1.83×10^{-6} 3
457.38 6	0.30 3	1683.77	(4−)	1226.596	4−	[M1,E2]	0.16 11	α(K)=0.12 10; α(L)=0.028 13; α(M)=0.007 3; α(N+..)=0.0023 10 α(N)=0.0018 8; α(O)=0.00043 18; α(P)=8.E−5 4; α(Q)=6.E−6 5 E_γ: level-energy difference=457.17. Poor fit in level scheme.
463.02[a] 2	222 11	1432.036	4+	968.986	2+	E2	0.0514	α(K)=0.0312 5; α(L)=0.01495 21; α(M)=0.00390 6; α(N+..)=0.001326 19 α(N)=0.001044 15; α(O)=0.000238 4; α(P)=4.23×10^{-5} 6; α(Q)=1.744×10^{-6} 25 Mult.: α(K)exp=0.044 5 (1973Ku09), α(K)exp=0.035, K/L12=2.64 21, K/L3=11.6 8 (1960Ar06); theory: α(K)=0.0316, K/L12=2.44, K/L3=13.7; K/L3(M1)=1220.
463.3[a] 1	1.6 4	1432.036	4+	968.45	4+			
465.4[a] 1	1.2 2	1588.369	(4−)	1122.968	2−			
469.9[a] 5	0.14 8	1638.300	2+	1168.395	3−	[E1]	0.01430	α(K)=0.01159 17; α(L)=0.00206 3; α(M)=0.000490 7; α(N+..)=0.0001663 24 α(N)=0.0001297 19; α(O)=3.04×10^{-5} 5; α(P)=5.75×10^{-6} 9; α(Q)=4.79×10^{-7} 7
470.6[ag] 2	0.12 5	1645.933	3+	1175.24	2+			
x471.7 2	0.37 9							
471.8 2	0.39 9	1416.09	(3−)	944.24	1−			
474.7 3	0.7 2	1643.15	(3−)	1168.395	3−	[M1,E2]	0.14 10	α(K)=0.11 9; α(L)=0.025 12; α(M)=0.006 3; α(N+..)=0.0021 9 α(N)=0.0016 7; α(O)=0.00038 17; α(P)=7.E−5 4; α(Q)=6.E−6 5
476.7[a] 2	0.10 5	1925.22	3+,4+	1448.87	3,4−			
477.1[ag] 3	0.30 5	1893.017	3+	1416.09	(3−)			
477.5[a] 1	0.34 5	1645.933	3+	1168.395	3−			
478.45 4	3.17 17	874.508	2+	396.108	3−	E1[c]	0.01379	α(K)=0.01118 16; α(L)=0.00198 3; α(M)=0.000471 7; α(N+..)=0.0001601 23 α(N)=0.0001248 18; α(O)=2.92×10^{-5} 4; α(P)=5.53×10^{-6} 8; α(Q)=4.63×10^{-7} 7
480.6[a] 2	≤0.3	1448.87	3,4−	968.45	4+			
481.4[a] 2	0.33 9	1497.69	(5−)	1016.388	3−			

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
482.03[a] *5*	1.51 *13*	1450.408	4^-	968.38	2^-	[E2]		0.0466 *7*	α(K)=0.11 *8*; α(L)=0.024 *11*; α(M)=0.0059 *25*; α(N+..)=0.0020 *9* α(N)=0.0016 *7*; α(O)=0.00037 *16*; α(P)=7.E−5 *4*; α(Q)=6.E−6 *4*
490.4 *2*	0.82 *4*	1643.82	4^+	1153.431	2^+				
[x]490.7[a] *1*	0.82 *4*								
492.22 *10*	0.28 *3*	1645.933	3^+	1153.431	2^+	[M1,E2]		0.13 *9*	α(K)=0.10 *8*; α(L)=0.022 *11*; α(M)=0.0055 *24*; α(N+..)=0.0019 *8* α(N)=0.0015 *7*; α(O)=0.00035 *15*; α(P)=7.E−5 *3*; α(Q)=5.E−6 *4*
497.0 *2*	0.18 *4*	1016.388	3^-	519.212	5^-				
497.72[b]	≤0.04	1724.301	2^+	1226.596	4^-	[M2]		0.581	α(K)=0.437 *7*; α(L)=0.1073 *15*; α(M)=0.0268 *4*; α(N+..)=0.00926 *13* α(N)=0.00721 *10*; α(O)=0.001703 *24*; α(P)=0.000327 *5*; α(Q)=2.94×10^{-5} *5*
503.0[ag] *2*	0.06 *2*	1678.43	2^+	1175.24	2^+				
503.7[a] *2*	0.74 *9*	831.72	0^+	328.034	1^-	(E1)		0.01244	α(K)=0.01009 *15*; α(L)=0.001776 *25*; α(M)=0.000423 *6*; α(N+..)=0.0001436 *21* α(N)=0.0001120 *16*; α(O)=2.62×10^{-5} *4*; α(P)=4.97×10^{-6} *7*; α(Q)=4.20×10^{-7} *6*
506.5 *2*	≤0.2	1899.93	(2^+)	1393.46	1^+,2,3^-				
509.13 *8*	0.7 *1*	1531.51	3^+	1022.555	$(3)^+$	E2(+M1)	>1.1	0.08 *4*	α(K)=0.06 *3*; α(L)=0.015 *5*; α(M)=0.0038 *10*; α(N+..)=0.0013 *4* α(N)=0.0010 *3*; α(O)=0.00024 *7*; α(P)=4.4×10^{-5} *13*; α(Q)=3.0×10^{-6} *16*
512.79[a] *11*	1.33 *13*	1944.916	3^+	1432.036	4^+	[M1,E2]		0.12 *8*	α(K)=0.09 *7*; α(L)=0.020 *10*; α(M)=0.0049 *22*; α(N+..)=0.0017 *8* α(N)=0.0013 *6*; α(O)=0.00031 *14*; α(P)=6.E−5 *3*; α(Q)=5.E−6 *4*
515.1[a] *1*	0.36 *6*	1683.77	(4^-)	1168.395	3^-				
515.20[a] *11*	0.21 *10*	1638.300	2^+	1122.968	2^-	[E1]		0.01189	α(K)=0.00966 *14*; α(L)=0.001694 *24*; α(M)=0.000403 *6*; α(N+..)=0.0001370 *20* α(N)=0.0001068 *15*; α(O)=2.50×10^{-5} *4*; α(P)=4.75×10^{-6} *7*; α(Q)=4.02×10^{-7} *6* I_γ: Does not agree with 0.17 *2* in ^{228}Ac decay.
520.17 *8*	0.92 *10*	1643.15	(3^-)	1122.968	2^-	(M1)		0.189	α(K)=0.1515 *22*; α(L)=0.0282 *4*; α(M)=0.00675 *10*; α(N+..)=0.00232 *4* α(N)=0.00180 *3*; α(O)=0.000426 *6*; α(P)=8.27×10^{-5} *12*; α(Q)=7.86×10^{-6} *11*
523.16[a] *11*	1.1 *2*	1645.933	3^+	1122.968	2^-	[E1]		0.01153	α(K)=0.00937 *14*; α(L)=0.001641 *23*; α(M)=0.000390 *6*; α(N+..)=0.0001327 *19* α(N)=0.0001035 *15*; α(O)=2.42×10^{-5} *4*; α(P)=4.60×10^{-6} *7*; α(Q)=3.90×10^{-7} *6*
523.5[a] *1*	0.5 *1*	1724.301	2^+	1200.60	$3^{(+)}$				
528.5[a] *2*	0.09 *2*	1588.369	(4^-)	1059.93	4^-				
529.0[a] *3*	0.05 *2*	1497.69	(5^-)	968.986	2^+				
540.66 *5*	0.89 *6*	1059.93	4^-	519.212	5^-	[M1,E2]		0.10 *7*	α(K)=0.08 *6*; α(L)=0.017 *9*; α(M)=0.0042 *19*; α(N+..)=0.0014 *7* α(N)=0.0011 *5*; α(O)=0.00026 *12*; α(P)=5.0×10^{-5} *25*; α(Q)=4.E−6 *3*

From ENSDF

γ(^{228}Th) (continued)

Eγ[‡]	Iγ[‡d]	E_i(level)	$J^π_i$	E_f	$J^π_f$	Mult.[#]	δ[@]	α[†&]	Comments
546.45 *2*	2.80 *14*	874.508	2⁺	328.034	1⁻	[E1]		0.01058	α(K)=0.00861 *12*; α(L)=0.001500 *21*; α(M)=0.000357 *5*; α(N+..)=0.0001212 *17* α(N)=9.45×10^{-5} *14*; α(O)=2.22×10^{-5} *4*; α(P)=4.21×10^{-6} *6*; α(Q)=3.60×10^{-7} *5*
547.8 *2*	0.16 *4*	944.24	1⁻	396.108	3⁻				
548.74[g] *11*	0.41 *5*	1724.301	2⁺	1175.24	2⁺	[M1,E2]		0.10 *7*	α(K)=0.08 *6*; α(L)=0.017 *8*; α(M)=0.0040 *18*; α(N+..)=0.0014 *7* α(N)=0.0011 *5*; α(O)=0.00025 *12*; α(P)=4.8×10^{-5} *24*; α(Q)=4.E−6 *3*
548.9 *11*	≤0.08	1965.05	(2⁺)	1416.09	(3⁻)				
551.3 *2*	≤0.2	1944.916	3⁺	1393.46	1⁺,2,3⁻				
552.9 *2*	0.18 *4*	1643.82	4⁺	1091.067	4⁺				
554.8[a] *3*	0.40 *4*	1645.933	3⁺	1091.067	4⁺	[M1,E2]		0.10 *7*	α(K)=0.07 *6*; α(L)=0.016 *8*; α(M)=0.0039 *18*; α(N+..)=0.0013 *6* α(N)=0.0010 *5*; α(O)=0.00025 *12*; α(P)=4.7×10^{-5} *23*; α(Q)=4.E−6 *3*
555.5 *1*	0.57 *6*	1074.74	4⁺	519.212	5⁻				
[x]555.7 *1*	1.5 *2*								
557.4 *1*	0.55 *6*	1432.036	4⁺	874.508	2⁺				
562.50 *4*	1.40 *8*	1531.51	3⁺	968.986	2⁺	E2+M1	+1.6 *6*	0.07 *3*	α(K)=0.050 *23*; α(L)=0.012 *4*; α(M)=0.0030 *8*; α(N+..)=0.0010 *3* α(N)=0.00081 *20*; α(O)=0.00019 *5*; α(P)=3.5×10^{-5} *10*; α(Q)=2.6×10^{-6} *12*
570.88 *4*	2.8 *3*	1724.301	2⁺	1153.431	2⁺	(M1)		0.1472	α(K)=0.1182 *17*; α(L)=0.0219 *3*; α(M)=0.00525 *8*; α(N+..)=0.00180 *3* α(N)=0.001401 *20*; α(O)=0.000332 *5*; α(P)=6.44×10^{-5} *9*; α(Q)=6.12×10^{-6} *9*
571.1[ag] *1*	0.57 *25*	1645.933	3⁺	1074.74	4⁺				
571.8[a] *2*	0.06 *3*	1091.067	4⁺	519.212	5⁻				
572.3[a] *1*	2.24 *24*	968.38	2⁻	396.108	3⁻				
572.3[a] *1*	3.9 *4*	968.45	4⁺	396.108	3⁻				
583.2[a] *2*	0.12 *3*	1643.15	(3⁻)	1059.93	4⁻				
583.4[a] *1*	1.8 *2*	979.460	2⁺	396.108	3⁻	[E1]		0.00932 *13*	α=0.00932 *13*; α(K)=0.00759 *11*; α(L)=0.001313 *19*; α(M)=0.000312 *5*; α(N+..)=0.0001061 α(N)=8.27×10^{-5} *12*; α(O)=1.94×10^{-5} *3*; α(P)=3.69×10^{-6} *6*; α(Q)=3.18×10^{-7} *5*
584.4[a] *3*	≤0.03	1928.37	3⁺	1344.09	3⁻	[E1]		0.00929 *13*	α=0.00929 *13*; α(K)=0.00756 *11*; α(L)=0.001308 *19*; α(M)=0.000311 *5*; α(N+..)=0.0001057 α(N)=8.24×10^{-5} *12*; α(O)=1.93×10^{-5} *3*; α(P)=3.68×10^{-6} *6*; α(Q)=3.17×10^{-7} *5* γ feeds the 1344 level.
584.75[b]	≤0.04	1760.32	2$^{(+)}$,3$^{(+)}$	1175.24	2⁺	[M1,E2]		0.08 *6*	α(K)=0.07 *5*; α(L)=0.014 *7*; α(M)=0.0034 *16*;

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^{228}Pa ε decay 1998We13,1995Ba42 (continued)

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
									α(N+..)=0.0012 6 α(N)=0.0009 4; α(O)=0.00021 10; α(P)=4.0×10^{-5} 20; α(Q)=3.4×10^{-6} 24 Possibly feeds the 1175.4 level.
586.2 2	0.12 3	1645.933	3$^+$	1059.93	4$^-$				
590.1 3	0.06 2	968.45	4$^+$	378.214	6$^+$				
590.40[b]	<0.1	1743.90	4$^+$	1153.431	2$^+$	[E2]		0.0292	α(K)=0.0197 3; α(L)=0.00703 10; α(M)=0.00180 3; α(N+..)=0.000613 9 α(N)=0.000481 7; α(O)=0.0001107 16; α(P)=2.00×10^{-5} 3; α(Q)=1.056×10^{-6} 15 Mult.: α(K)exp=0.088 17 (1973Ku09); theory: α(K)(E2)=0.0200, α(K)(M1)=0.115.
590.7 1	0.33 7	1817.442	4$^-$	1226.596	4$^-$				
596.8 2	0.15 4	1823.49	(4$^+$)	1226.596	4$^-$				
601.48	<0.04	1580.94	(2$^-$)	979.460	2$^+$	[E1]		0.00878 13	α=0.00878 13; α(K)=0.00716 10; α(L)=0.001234 18; α(M)=0.000293 5; α(N+..)=9.97×10^{-5} 14 α(N)=7.77×10^{-5} 11; α(O)=1.82×10^{-5} 3; α(P)=3.47×10^{-6} 5; α(Q)=3.01×10^{-7} 5
602.0[g]	≤0.2	1297.387	(5$^-$)	695.4	7$^-$	[E2]		0.0280	α(K)=0.0190 3; α(L)=0.00664 10; α(M)=0.001699 24; α(N+..)=0.000578 8 α(N)=0.000454 7; α(O)=0.0001045 15; α(P)=1.89×10^{-5} 3; α(Q)=1.016×10^{-6} 15 Feeds the 695.6 level; see comment with that level. Mult.: α(K)exp≥0.24 5 (1973Ku09); theory: α(K)(E1)=0.00716, α(K)(E2)=0.0192, α(K)(M1)=0.108.
610.7 2	0.24 7	938.63	0$^+$	328.034	1$^-$				
616.15 5	1.07 8	944.24	1$^-$	328.034	1$^-$	(M1+E2)	+1.5 5	0.055 18	α(K)=0.042 15; α(L)=0.0098 23; α(M)=0.0024 6; α(N+..)=0.00083 18 α(N)=0.00064 14; α(O)=0.00015 4; α(P)=2.8×10^{-5} 7; α(Q)=2.2×10^{-6} 8
620.27 5	1.41 10	1016.388	3$^-$	396.108	3$^-$	[E0,M1,E2]			Mult.: α(K)exp=0.16 3 (1973Ku09); theory: α(K)(E1)=0.00677, α(K)(E2)=0.0183, α(K)(M1)=0.100.
621.4[a] 1	0.92 10	1643.82	4$^+$	1022.555	(3)$^+$				
[x]621.6[a] 3	1.0 2								
621.9[a] 2	0.16 5	1796.45	4$^+$	1174.547	(5$^+$)				
623.7[a] 2	0.13 4	1645.933	3$^+$	1022.555	(3)$^+$	[M1,E2]		0.07 5	α(K)=0.06 4; α(L)=0.012 6; α(M)=0.0028 13; α(N+..)=0.0010 5 α(N)=0.0008 4; α(O)=0.00018 9; α(P)=3.4×10^{-5} 17; α(Q)=2.9×10^{-6} 20
623.7[a] 2	0.14 3	1683.77	(4$^-$)	1059.93	4$^-$	[M1,E2]		0.07 5	α(K)=0.06 4; α(L)=0.012 6; α(M)=0.0028 13; α(N+..)=0.0010 5 α(N)=0.0008 4; α(O)=0.00018 9; α(P)=3.4×10^{-5} 17; α(Q)=2.9×10^{-6} 20
624.0[a] 2	0.14 4	1143.15	5$^-$	519.212	5$^-$				

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γ(^{228}Th) (continued)

E_γ [‡]	I_γ [‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	δ [@]	α [†&]	Comments
626.7[a] 1	0.49 9	1643.15	(3⁻)	1016.388	3⁻				
629.4 2	0.37 6	1645.933	3⁺	1016.388	3⁻	[D,E2]		0.07 5	
640.3[a] 2	0.12 5	1901.94	4⁺	1261.59	4⁺				
640.33[a] 5	1.4 2	968.38	2⁻	328.034	1⁻				
642.7 2	0.28 8	1817.442	4⁻	1174.547	(5⁺)				
649.0[a] 1	0.59 8	1817.442	4⁻	1168.395	3⁻				
649.12[ea] 7	0.097[e] 9	1618.04?	4⁺	968.986	2⁺				
649.3[a] 1	0.51 6	1168.395	3⁻	519.212	5⁻	[E2]		0.0238	α(K)=0.01658 24; α(L)=0.00535 8; α(M)=0.001361 19; α(N+..)=0.000464 7 α(N)=0.000364 5; α(O)=8.39×10^{-5} 12; α(P)=1.530×10^{-5} 22; α(Q)=8.74×10^{-7} 13
651.40[a] 5	0.159 10	979.460	2⁺	328.034	1⁻	[E1]		0.00754 11	α=0.00754 11; α(K)=0.00616 9; α(L)=0.001053 15; α(M)=0.000250 4; α(N+..)=8.50×10^{-5} 12 α(N)=6.62×10^{-5} 10; α(O)=1.556×10^{-5} 22; α(P)=2.97×10^{-6} 5; α(Q)=2.60×10^{-7} 4
651.5[a] 2	0.34 5	1804.690	4⁺	1153.431	2⁺	[E2]		0.0236	α(K)=0.01647 23; α(L)=0.00530 8; α(M)=0.001347 19; α(N+..)=0.000459 7 α(N)=0.000360 5; α(O)=8.30×10^{-5} 12; α(P)=1.514×10^{-5} 22; α(Q)=8.68×10^{-7} 13
660.30[b]	≤0.2	1682.85	(2⁺,3⁺,4⁺)	1022.555	(3)⁺	[M1,E2]		0.06 4	α(K)=0.05 4; α(L)=0.010 5; α(M)=0.0024 12; α(N+..)=0.0008 4 α(N)=0.0006 3; α(O)=0.00015 8; α(P)=2.9×10^{-5} 15; α(Q)=2.5×10^{-6} 17 I_γ: from branching ratio in adopted γ′s; Iγ≤0.2 (1995Ba42).
663.5[a] 2	0.28 5	1925.22	3⁺,4⁺	1261.59	4⁺				
663.92[a] 8	1.2 2	1059.93	4⁻	396.108	3⁻	(M1+E2)	≈0.77	0.06 4	α(K)=0.05 4; α(L)=0.010 5; α(M)=0.0024 12; α(N+..)=0.0008 4 α(N)=0.0006 3; α(O)=0.00015 8; α(P)=2.9×10^{-5} 15; α(Q)=2.5×10^{-6} 17 δ: calculated from experimental conversion coefficient (evaluator). Mult.: α(K)exp=0.10 3 (1973Ku09), 0.075 (1960Ar06); theory: α(K)(M1)=0.0842, α(K)(E2)=0.0161.
666.47[a] 4	0.68 8	1645.933	3⁺	979.460	2⁺	[M1,E2]		0.06 4	α(K)=0.05 4; α(L)=0.010 5; α(M)=0.0024 11; α(N+..)=0.0008 4 α(N)=0.0006 3; α(O)=0.00015 7; α(P)=2.8×10^{-5} 15; α(Q)=2.4×10^{-6} 16 Mult.: for the doublet (Iγ=2.47 13): α(K)exp=0.053 16 (1973Ku09), 0.025 (1960Ar06); theory: α(K)(M1)=0.0831, α(K)(E2)=0.0160.

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[†&]	Comments
666.47[a] *4*	1.83 *9*	1893.017	3^+	1226.596	4^-	[E1]	0.00722 *11*	α=0.00722 *11*; α(K)=0.00590 *9*; α(L)=0.001007 *14*; α(M)=0.000239 *4*; α(N+..)=8.13×10^{-5} *12* α(N)=6.33×10^{-5} *9*; α(O)=1.487×10^{-5} *21*; α(P)=2.84×10^{-6} *4*; α(Q)=2.50×10^{-7} *4* Mult.: for the doublet (Iγ=2.47 *13*): α(K)exp=0.053 *16* (1973Ku09), 0.025 (1960Ar06); theory: α(K)(E1)=0.00591, α(K)(E2)=0.0160.
667.5 *3*	0.16 *5*	1683.77	(4^-)	1016.388	3^-			
668.9 *2*	0.22 *7*	1760.32	$2^{(+)},3^{(+)}$	1091.067	4^+			
671.94[b]	≤0.1	1688.42	$2^+,3^+$	1016.388	3^-			
674.6[a] *3*	≤0.2	1817.442	4^-	1143.15	5^-			
674.7[a] *2*	0.21 *7*	1643.15	(3^-)	968.45	4^+			
674.7[a] *1*	2.5 *3*	1643.82	4^+	968.986	2^+			
676.9[a] *2*	0.80 *15*	1645.933	3^+	968.986	2^+		0.06 *4*	α(K)=0.05 *3*; α(L)=0.009 *5*; α(M)=0.0023 *11*; α(N+..)=0.0008 *4* α(N)=0.0006 *3*; α(O)=0.00014 *7*; α(P)=2.7×10^{-5} *14*; α(Q)=2.3×10^{-6} *16* Mult.: α(K)exp=0.17 *5* (1973Ku09), 0.10 (1960Ar06); theory: α(K)(M1)=0.0936, α(K)(E2)=0.0217, α(K)(M1+E2)= 0.06 for δ=1 probably a E0 component is involved.
677.8 *2*	0.11 *4*	1939.10	(4^+)	1261.59	4^+			
678.6 *2*	0.51 *6*	1074.74	4^+	396.108	3^-			
683.4 *2*	0.10 *4*	1944.916	3^+	1261.59	4^+			
683.97 *3*	<0.06	1743.90	4^+	1059.93	4^-	[E1]	0.00688 *10*	α=0.00688 *10*; α(K)=0.00562 *8*; α(L)=0.000957 *14*; α(M)=0.000227 *4*; α(N+..)=7.72×10^{-5} *11* α(N)=6.02×10^{-5} *9*; α(O)=1.413×10^{-5} *20*; α(P)=2.70×10^{-6} *4*; α(Q)=2.38×10^{-7} *4*
684.6 *3*	0.14 *6*	1981.90	(3^-)	1297.387	(5^-)			
687.8[a] *2*	0.48 *10*	874.508	2^+	186.849	4^+	[E2]	0.0210	α(K)=0.01490 *21*; α(L)=0.00455 *7*; α(M)=0.001153 *17*; α(N+..)=0.000393 *6* α(N)=0.000308 *5*; α(O)=7.12×10^{-5} *10*; α(P)=1.303×10^{-5} *19*; α(Q)=7.79×10^{-7} *11* E_γ: Poor fit in level scheme.
688.14[a] *8*	0.83 *11*	1016.388	3^-	328.034	1^-			
692.47 *7*	2.01 *15*	1893.017	3^+	1200.60	$3^{(+)}$	(M1+E2+E0)	0.05 *4*	α(K)=0.04 *3*; α(L)=0.009 *5*; α(M)=0.0021 *10*; α(N+..)=0.0007 *4* α(N)=0.0006 *3*; α(O)=0.00013 *7*; α(P)=2.6×10^{-5} *13*; α(Q)=2.2×10^{-6} *15* Mult.: α(K)exp=0.17 *3* (1973Ku09), 0.13 (1960Ar06); theory: α(K)(E2)=0.0148, α(K)(M1)=0.0751. α(K)exp may indicate E0 presence. α: from α(K)exp.
694.5[a] *1*	0.5 *1*	1817.442	4^-	1122.968	2^-			

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γ(^{228}Th) (continued)

$E_γ$[‡]	$I_γ$[‡d]	E_i(level)	$J_i^π$	E_f	$J_f^π$	Mult.[#]	α[†&]	Comments
694.8[a] *2*	0.26 *5*	1091.067	4⁺	396.108	3⁻	[E1]	0.00668 *10*	α=0.00668 *10*; α(K)=0.00546 *8*; α(L)=0.000928 *13*; α(M)=0.000220 *3*; α(N+..)=7.49×10⁻⁵ *11* α(N)=5.83×10⁻⁵ *9*; α(O)=1.371×10⁻⁵ *20*; α(P)=2.62×10⁻⁶ *4*; α(Q)=2.31×10⁻⁷ *4*
696.5[a] *2*	0.24 *5*	1864.95	(2⁺)	1168.395	3⁻			
697.1[a] *4*	0.09 *2*	1074.74	4⁺	378.214	6⁺			
697.6[a] *1*	0.48 *8*	1924.17	(2⁻,3,4)	1226.596	4⁻			
698.9[a] *1*	0.63 *9*	1643.15	(3⁻)	944.24	1⁻	[E2]	0.02	$I_γ$: part of a multiplet, Iγ from ^{228}Ac β⁻ decay.
701.72 *4*	3.76 *21*	1724.301	2⁺	1022.555	(3)⁺	(M1)	0.0850	α(K)=0.0684 *10*; α(L)=0.01261 *18*; α(M)=0.00302 *5*; α(N+..)=0.001036 *15* α(N)=0.000805 *12*; α(O)=0.000191 *3*; α(P)=3.70×10⁻⁵ *6*; α(Q)=3.52×10⁻⁶ *5* Mult.: α(K)exp=0.081 *14* (1973Ku09), 0.057 (1960Ar06); theory: α(K)=0.0726.
705.3 *2*	0.6 *2*	1796.45	4⁺	1091.067	4⁺			
707.40 *3*	7.9 *4*	1226.596	4⁻	519.212	5⁻	(E2)	0.0198	α(K)=0.01417 *20*; α(L)=0.00423 *6*; α(M)=0.001067 *15*; α(N+..)=0.000364 *5* α(N)=0.000285 *4*; α(O)=6.59×10⁻⁵ *10*; α(P)=1.209×10⁻⁵ *17*; α(Q)=7.38×10⁻⁷ *11* Mult.,δ: α(K)exp=0.020 *6* (1973Ku09), thus δ≥2; theory: α(K)(E2)=0.0143, α(K)(M1)=0.0711. δ: −4.0 13 from 1/δ=−0.25 *8* (1998We13).
713.1[a] *3*	0.48 *11*	1091.067	4⁺	378.214	6⁺	[E2]	0.0195	α(K)=0.01397 *20*; α(L)=0.00413 *6*; α(M)=0.001044 *15*; α(N+..)=0.000356 *5* α(N)=0.000279 *4*; α(O)=6.45×10⁻⁵ *9*; α(P)=1.184×10⁻⁵ *17*; α(Q)=7.26×10⁻⁷ *11*
713.6[a] *2*	0.10 *5*	1804.690	4⁺	1091.067	4⁺			
718.0[a] *2*	0.16 *6*	1893.017	3⁺	1175.24	2⁺			
718.31[a] *2*	6.2 *3*	1944.916	3⁺	1226.596	4⁻	(E1)	0.00628 *9*	α=0.00628 *9*; α(K)=0.00513 *8*; α(L)=0.000870 *13*; α(M)=0.000206 *3*; α(N+..)=7.02×10⁻⁵ *10* α(N)=5.47×10⁻⁵ *8*; α(O)=1.285×10⁻⁵ *18*; α(P)=2.46×10⁻⁶ *4*; α(Q)=2.18×10⁻⁷ *3* Mult.: α(K)exp=0.0074 *36* (1973Ku09); theory: α(K)(E1)=0.00514, α(K)(E2)=0.0140.
723.6 *1*	0.6 *1*	1924.17	(2⁻,3,4)	1200.60	3⁽⁺⁾			
724.42 *11*	0.76 *9*	1925.22	3⁺,4⁺	1200.60	3⁽⁺⁾	[M1,E2]	0.05 *3*	α(K)=0.038 *25*; α(L)=0.008 *4*; α(M)=0.0019 *9*; α(N+..)=0.0006 *3* α(N)=0.00050 *24*; α(O)=0.00012 *6*; α(P)=2.3×10⁻⁵ *12*; α(Q)=2.0×10⁻⁶ *13*
724.5[a] *1*	0.57 *9*	1893.017	3⁺	1168.395	3⁻	[E1]	0.00618 *9*	α=0.00618 *9*; α(K)=0.00505 *7*; α(L)=0.000856 *12*; α(M)=0.000203 *3*; α(N+..)=6.90×10⁻⁵ *10* α(N)=5.38×10⁻⁵ *8*; α(O)=1.264×10⁻⁵ *18*; α(P)=2.42×10⁻⁶ *4*; α(Q)=2.15×10⁻⁷ *3*
724.7[ag] *3*	0.10 *5*	1899.93	(2⁺)	1175.24	2⁺			

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γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
726.3[a] *2*	0.19 *6*	1817.442	4^-	1091.067	4^+				
726.90[a] *10*	4.2 *6*	1122.968	2^-	396.108	3^-	(E2)		0.0187	α(K)=0.01349 *19*; α(L)=0.00393 *6*; α(M)=0.000990 *14*; α(N+..)=0.000337 *5* α(N)=0.000264 *4*; α(O)=6.12×10^{-5} *9*; α(P)=1.125×10^{-5} *16*; α(Q)=6.99×10^{-7} *10*
727.2[a] *3*	0.07 *2*	1743.90	4^+	1016.388	3^-				
732.9 *4*	0.07 *3*	1823.49	(4^+)	1091.067	4^+				
737.8 *2*	0.74 *13*	1760.32	$2^{(+)},3^{(+)}$	1022.555	$(3)^+$	[M1,E2]		0.05 *3*	α(K)=0.037 *24*; α(L)=0.007 *4*; α(M)=0.0018 *9*; α(N+..)=0.0006 *3* α(N)=0.00048 *23*; α(O)=0.00011 *6*; α(P)=2.2×10^{-5} *11*; α(Q)=1.9×10^{-6} *12*
739.2 *2*	0.57 *9*	1893.017	3^+	1153.431	2^+	[M1,E2]		0.05 *3*	α(K)=0.036 *24*; α(L)=0.007 *4*; α(M)=0.0018 *9*; α(N+..)=0.0006 *3* α(N)=0.00048 *23*; α(O)=0.00011 *6*; α(P)=2.1×10^{-5} *11*; α(Q)=1.9×10^{-6} *12* Mult.: α(K)exp=0.18 *5* (1973Ku09); theory: α(K)(M1)=0.0637, α(K)(E2)=0.013, ce(K) may include the ce(K)(737.8γ).
741.8[a] *2*	0.40 *6*	1864.95	(2^+)	1122.968	2^-				
741.9[a] *3*	0.14 *5*	1758.06	2^+	1016.388	3^-				
744.2 *1*	0.35 *10*	1944.916	3^+	1200.60	$3^{(+)}$				
747.0 *4*	0.09 *3*	1143.15	5^-	396.108	3^-				
750.10 *10*	0.67 *8*	1924.66	$4^+,5^-$	1174.547	(5^+)				
751.1 *2*	0.18 *7*	1842.23	(2,3)	1091.067	4^+				
755.32[a] *2*	19.2 *10*	1724.301	2^+	968.986	2^+	M1		0.0700	α(K)=0.0563 *8*; α(L)=0.01036 *15*; α(M)=0.00248 *4*; α(N+..)=0.000851 *12* α(N)=0.000661 *10*; α(O)=0.0001566 *22*; α(P)=3.04×10^{-5} *5*; α(Q)=2.90×10^{-6} *4* Mult.: α(K)exp=0.063 *6* (1973Ku09), 0.057 (1960Ar06); theory: α(K)(M1)=0.0599.
755.7[a] *1*	0.42 *10*	1924.17	$(2^-,3,4)$	1168.395	3^-				
757.4 *2*	0.19 *5*	1817.442	4^-	1059.93	4^-				
764.0[a] *3*	0.18 *10*	1939.10	(4^+)	1175.24	2^+				
764.3[a] *3*	0.12 *5*	1743.90	4^+	979.460	2^+				
764.5[a] *3*	0.05 *2*	1143.15	5^-	378.214	6^+				
769.6[ag] *1*	0.4 *2*	1944.916	3^+	1175.24	2^+				
770.2[a] *2*	2.28 *15*	1893.017	3^+	1122.968	2^-	[E1]		0.00552 *8*	α=0.00552 *8*; α(K)=0.00452 *7*; α(L)=0.000761 *11*; α(M)=0.000180 *3*; α(N+..)=6.14×10^{-5} *9* α(N)=4.78×10^{-5} *7*; α(O)=1.124×10^{-5} *16*; α(P)=2.15×10^{-6} *3*; α(Q)=1.93×10^{-7} *3*
771.72[b]	≤0.1	1925.22	$3^+,4^+$	1153.431	2^+				
772.28 *2*	25.2 *13*	1168.395	3^-	396.108	3^-	E2+M1	−3.7 *2*	0.021 *3*	α(K)=0.0154 *22*; α(L)=0.0039 *4*; α(M)=0.00096 *9*;

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γ(^{228}Th) (continued)

E$_γ$‡	I$_γ$‡d	E$_i$(level)	J$_i^π$	E$_f$	J$_f^π$	Mult.#	δ@	α†&	Comments
									α(N+..)=0.00033 *3* α(N)=0.000256 *22*; α(O)=6.0×10^{-5} *6*; α(P)=1.11×10^{-5} *11*; α(Q)=7.9×10^{-7} *12* Mult.: α(K)exp=0.0157 *22* (1973Ku09), 0.015 (1960Ar06); theory: α(K)(E2)=0.0122, α(K)(M1)=0.0565. δ=3.41 from α(K)exp. δ: from 1/δ=−0.27 *6* (1998We13). 1995Ba42 lists −19≤δ≤−3 from γ(θ,H,T).
774.06[b]	≈0.26	831.72	0$^+$	57.775	2$^+$	[E2]		0.01649	α(K)=0.01204 *17*; α(L)=0.00333 *5*; α(M)=0.000835 *12*; α(N+..)=0.000285 *4* α(N)=0.000223 *4*; α(O)=5.17×10^{-5} *8*; α(P)=9.55×10^{-6} *14*; α(Q)=6.19×10^{-7} *9*
774.86[b]	≤0.1	1928.37	3$^+$	1153.431	2$^+$				
776.52 *3*	7.9 *4*	1944.916	3$^+$	1168.395	3$^-$	[E1]		0.00544 *8*	α=0.00544 *8*; α(K)=0.00445 *7*; α(L)=0.000750 *11*; α(M)=0.0001774 *25*; α(N+..)=6.04×10^{-5} *9* α(N)=4.70×10^{-5} *7*; α(O)=1.107×10^{-5} *16*; α(P)=2.12×10^{-6} *3*; α(Q)=1.90×10^{-7} *3* Mult.: α(K)exp=0.009 *3* (1973Ku09); theory: α(K)(E1)=0.00446, α(K)(E2)=0.0121.
778.1[a] *2*	2.7 *3*	1297.387	(5$^-$)	519.212	5$^-$	(E2+M1)	−3.0 *18*	0.021 *15*	α(K)=0.016 *13*; α(L)=0.0039 *20*; α(M)=0.0010 *5*; α(N+..)=0.00033 *16* α(N)=0.00026 *13*; α(O)=6.E−5 *3*; α(P)=1.1×10^{-5} *6*; α(Q)=8.E−7 *7* δ: from 1/δ=−0.33 *20* (1998We13).
779.5 *6*	0.06 *3*	1175.24	2$^+$	396.108	3$^-$				
780.0 *3*	0.19 *9*	1899.93	(2$^+$)	1119.9	0$^+$				
780.2[a] *3*	0.10 *3*	1724.301	2$^+$	944.24	1$^-$				
781.8[a] *1*	0.68 *9*	1804.690	4$^+$	1022.555	(3)$^+$				E$_γ$: Poor fit in level scheme.
781.9[a] *3*	0.52 *12*	968.45	4$^+$	186.849	4$^+$				
782.08[a] *3*	3.5 *3*	968.986	2$^+$	186.849	4$^+$	[E2]		0.01615	α(K)=0.01182 *17*; α(L)=0.00324 *5*; α(M)=0.000813 *12*; α(N+..)=0.000277 *4* α(N)=0.000217 *3*; α(O)=5.03×10^{-5} *7*; α(P)=9.30×10^{-6} *13*; α(Q)=6.07×10^{-7} *9* Mult.: α(K)exp=0.029 (1960Ar06); theory: α(K)(E2)=0.0119.
785.7 *2*	0.20 *6*	1908.47	(3$^-$)	1122.968	2$^-$				
791.43[a] *9*	0.23 *3*	1760.32	2$^{(+)}$,3$^{(+)}$	968.986	2$^+$	[M1,E2]		0.039 *23*	α(K)=0.031 *19*; α(L)=0.006 *3*; α(M)=0.0015 *7*; α(N+..)=0.00051 *25* α(N)=0.00040 *19*; α(O)=9.E−5 *5*; α(P)=1.8×10^{-5} *9*; α(Q)=1.6×10^{-6} *10*
791.43[a] *9*	3.6 *4*	1944.916	3$^+$	1153.431	2$^+$	(M1)		0.0618	α(K)=0.0498 *7*; α(L)=0.00915 *13*; α(M)=0.00219 *3*; α(N+..)=0.000751 *11* α(N)=0.000584 *9*; α(O)=0.0001382 *20*; α(P)=2.68×10^{-5} *4*;

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$\gamma(^{228}$Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	$I_{(\gamma+ce)}$[d]	Comments
										α(Q)=2.56×10^{-6} *4* Mult.: α(K)exp(doublet)=0.054 *11* (1973Ku09), Iγ(doublet)=3.8; theory: α(K)(M1)=0.0530.
792.6[a] *2*	0.55 *6*	979.460	2^+	186.849	4^+	[E2]		0.01572		α(K)=0.01154 *17*; α(L)=0.00313 *5*; α(M)=0.000784 *11*; α(N+..)=0.000267 *4* α(N)=0.000209 *3*; α(O)=4.86×10^{-5} *7*; α(P)=8.98×10^{-6} *13*; α(Q)=5.91×10^{-7} *9* I_γ: deduced from branching in ^{228}Ac β^- decay.
794.97 *2*	34.4 *17*	1122.968	2^-	328.034	1^-	E2+M1	−4.4 *10*	0.0179 *14*		α(K)=0.0133 *12*; α(L)=0.00340 *19*; α(M)=0.00085 *5*; α(N+..)=0.000289 *16* α(N)=0.000226 *12*; α(O)=5.3×10^{-5} *3*; α(P)=9.8×10^{-6} *6*; α(Q)=6.8×10^{-7} *6* Mult.: α(K)exp=0.014 *3* (1973Ku09), 0.014 (1960Ar06); theory: α(K)(E2)=0.0116, α(K)(M1)=0.0524. δ=4 from α(K)exp.
796.2 *1*	1.6 *3*	1174.547	(5^+)	378.214	6^+					E_γ: Seen in 1998We13 and 1973Ku09.
801.1 *1*	0.46 *5*	1817.442	4^-	1016.388	3^-					Mult.: α(K)exp=0.14 *4* (1973Ku09); theory: α(K)(E2)=0.0141, α(K)(M1)=0.0512.
801.7[a] *3*	0.11 *4*	1893.017	3^+	1091.067	4^+					
803.8 *2*	0.08 *4*	1678.43	2^+	874.508	2^+					
810.7 *2*	0.12 *4*	1901.94	4^+	1091.067	4^+					
813.93[b]	<0.05	1688.42	$2^+,3^+$	874.508	2^+	[M1,E2]		0.036 *2*	2	α(K)=0.029 *18*; α(L)=0.006 *3*; α(M)=0.0014 *7*; α(N+..)=0.00047 *23* α(N)=0.00037 *18*; α(O)=9.E−5 *5*; α(P)=1.7×10^{-5} *9*; α(Q)=1.5×10^{-6} *9* I_γ: from 1998We13; Iγ≤0.1 (1995Ba42).
816.50 *12*	0.33 *4*	874.508	2^+	57.775	2^+	[M1,E2]		0.036 *21*		α(K)=0.028 *18*; α(L)=0.006 *3*; α(M)=0.0014 *7*; α(N+..)=0.00047 *23* α(N)=0.00037 *18*; α(O)=9.E−5 *5*; α(P)=1.7×10^{-5} *9*; α(Q)=1.5×10^{-6} *9*
817.4 *3*	0.10 *3*	1908.47	(3^-)	1091.067	4^+					
819.9 *2*	0.17 *5*	1842.23	(2,3)	1022.555	$(3)^+$					
825.1 *2*	0.14 *3*	1344.09	3^-	519.212	5^-					
826.6[ag] *3*	0.2 *1*	1901.94	4^+	1074.74	4^+					
827.1[a] *3*	0.25 *8*	1949.74	2^+	1122.968	2^-					
829.55	≤0.14	1016.388	3^-	186.849	4^+					
830.48 *3*	29.0 *15*	1226.596	4^-	396.108	3^-	E2(+M1)	−7.7 *9*	0.0150 *3*		α(K)=0.01117 *22*; α(L)=0.00287 *5*; α(M)=0.000715 *12*; α(N+..)=0.000244 *4* α(N)=0.000191 *3*; α(O)=4.43×10^{-5} *8*; α(P)=8.24×10^{-6} *14*; α(Q)=5.69×10^{-7} *12* Mult.: α(K)exp=0.0140 *18* (1973Ku09); theory: α(K)(E2)=0.0107, α(K)(M1)=0.0468. δ: −12 5 from 1/δ=−0.08 *3* (1998We13).

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γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	Comments
834.1[a] 1	2.5 4	1925.22	$3^+,4^+$	1091.067	4^+				
835.63[b]		1804.690	4^+	968.986	2^+				
835.65[a] 2	39.0 25	1022.555	$(3)^+$	186.849	4^+	E2+(M1)	−72.4 18	0.034 20	α(K)=0.027 17; α(L)=0.005 3; α(M)=0.0013 6; α(N+..)=0.00044 21 α(N)=0.00034 17; α(O)=8.E−5 4; α(P)=1.6×10^{-5} 8; α(Q)=1.4×10^{-6} 9 Mult.: α(K)exp=0.0119 17 (1973Ku09), 0.0105 15 (1960Ar06); theory: α(K)=0.0106. δ: ≤−9 from γ(θ,H,T) (1995Ba42). δ: from 1/δ=−0.014 25 (1998We13).
837.0[a] 1	0.45 10	1928.37	3^+	1091.067	4^+				
840.36 4	15.9 8	1168.395	3^-	328.034	1^-	E2		0.01400	α(K)=0.01039 15; α(L)=0.00270 4; α(M)=0.000673 10; α(N+..)=0.000230 4 α(N)=0.000180 3; α(O)=4.18×10^{-5} 6; α(P)=7.75×10^{-6} 11; α(Q)=5.29×10^{-7} 8 Mult.: α(K)exp=0.0092 24 (1973Ku09), 0.0113 (1960Ar06); theory: α(K)=0.0105.
847.1 4	0.05 2	1175.24	2^+	328.034	1^-				
847.8 3	0.05 2	1939.10	(4^+)	1091.067	4^+				
848.6 2	0.08 3	1908.47	(3^-)	1059.93	4^-				
849.5[a] 2	0.10 4	1724.301	2^+	874.508	2^+				
850.5[ag] 2	0.33 15	1925.22	$3^+,4^+$	1074.74	4^+				
853.97 8	0.82 7	1944.916	3^+	1091.067	4^+	[M1,E2]		0.032 19	α(K)=0.025 16; α(L)=0.0050 25; α(M)=0.0012 6; α(N+..)=0.00042 20 α(N)=0.00032 16; α(O)=8.E−5 4; α(P)=1.5×10^{-5} 8; α(Q)=1.3×10^{-6} 8 Mult.: α(K)exp=0.055 25 (1973Ku09,1960Ar06); theory: α(K)(M1)=0.0436; α(K)(E2)=0.010.
862.8 3	0.11 4	1842.23	(2,3)	979.460	2^+				
865.2 2	0.06 2	1925.22	$3^+,4^+$	1059.93	4^-				
870.45 2	15.9 8	1893.017	3^+	1022.555	$(3)^+$	M1		0.0481	α(K)=0.0387 6; α(L)=0.00710 10; α(M)=0.001699 24; α(N+..)=0.000583 9 α(N)=0.000453 7; α(O)=0.0001073 15; α(P)=2.08×10^{-5} 3; α(Q)=1.99×10^{-6} 3 Mult.: α(K)exp=0.038 5 (1973Ku09), 0.046 (1960Ar06): theory: α(K)(M1)=0.0414. δ: −0.1 1 from γ(θ,H,T) (1995Ba42).
873.0 2	1.66 17	1059.93	4^-	186.849	4^+	[E1]		0.00440 7	α=0.00440 7; α(K)=0.00361 5; α(L)=0.000601 9; α(M)=0.0001422 20; α(N+..)=4.84×10^{-5} 7 α(N)=3.77×10^{-5} 6; α(O)=8.88×10^{-6} 13; α(P)=1.705×10^{-6} 24; α(Q)=1.547×10^{-7} 22
874.5 2	0.77 12	874.508	2^+	0.0	0^+	[E2]		0.01294	α(K)=0.00968 14; α(L)=0.00245 4; α(M)=0.000608 9;

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
									α(N+..)=0.000208 *3* α(N)=0.0001623 *23*; α(O)=3.77×10^{-5} *6*; α(P)=7.03×10^{-6} *10*; α(Q)=4.90×10^{-7} *7*
876.7[a] *2*	0.21 *8*	1893.017	3$^+$	1016.388	3$^-$				
877.35[a] *7*	0.80 *10*	1899.93	(2$^+$)	1022.555	(3)$^+$	[M1,E2]		0.030 *18*	α(K)=0.024 *15*; α(L)=0.0047 *23*; α(M)=0.0011 *6*; α(N+..)=0.00039 *19* α(N)=0.00030 *15*; α(O)=7.E−5 *4*; α(P)=1.4×10^{-5} *7*; α(Q)=1.2×10^{-6} *8*
879.1 *3*	0.06 *2*	1939.10	(4$^+$)	1059.93	4$^-$				
880.8[b]	≤0.2	938.63	0$^+$	57.775	2$^+$				
883.4 *3*	0.11 *3*	1261.59	4$^+$	378.214	6$^+$				
883.53[a] *3*	<0.05	1899.93	(2$^+$)	1016.388	3$^-$				
885.7 *2*	0.19 *4*	1908.47	(3$^-$)	1022.555	(3)$^+$				
886.44[b]	≤0.04	944.24	1$^-$	57.775	2$^+$				
887.2[a] *2*	0.25 *8*	2010.10	(2$^+$)	1122.968	2$^-$				
887.9[a] *3*	0.15 *3*	1074.74	4$^+$	186.849	4$^+$				
890.6 *3*	0.10 *3*	1981.90	(3$^-$)	1091.067	4$^+$				
891.8[a] *2*	0.09 *3*	1270.10	6$^+$	378.214	6$^+$				
891.9[a] *2*	0.20 *7*	1908.47	(3$^-$)	1016.388	3$^-$				
895.9 *1*	1.41 *7*	1864.95	(2$^+$)	968.986	2$^+$				
901.4[a] *3*	2.0 *3*	1297.387	(5$^-$)	396.108	3$^-$	[E2]		0.01220	α(K)=0.00917 *13*; α(L)=0.00227 *4*; α(M)=0.000564 *8*; α(N+..)=0.000192 *3* α(N)=0.0001503 *21*; α(O)=3.50×10^{-5} *5*; α(P)=6.53×10^{-6} *10*; α(Q)=4.63×10^{-7} *7*
902.1[a] *5*	0.3 *1*	1924.66	4$^+$,5$^-$	1022.555	(3)$^+$				
904.19 *3*	26.5 *13*	1091.067	4$^+$	186.849	4$^+$	E2		0.01212	α(K)=0.00912 *13*; α(L)=0.00225 *4*; α(M)=0.000559 *8*; α(N+..)=0.000191 *3* α(N)=0.0001492 *21*; α(O)=3.47×10^{-5} *5*; α(P)=6.48×10^{-6} *9*; α(Q)=4.60×10^{-7} *7* Mult.: α(K)exp=0.012 *3* (1973Ku09), 0.0092 (1960Ar06) theory: α(K)(E2)=0.00921, α(K)(M1)=0.0374. δ: ≥+3.7 from γ(θ,H,T) (1995Ba42).
906.0 *6*	0.17 *6*	1928.37	3$^+$	1022.555	(3)$^+$				
908.7 *3*	0.29 *9*	1925.22	3$^+$,4$^+$	1016.388	3$^-$				
910.6[a] *1*	2.2 *2*	968.38	2$^-$	57.775	2$^+$				
910.7[a] *1*	1.8 *3*	968.45	4$^+$	57.775	2$^+$				
911.20[a] *2*	242 *12*	968.986	2$^+$	57.775	2$^+$	E2+M1	+24 *8*	0.01200 *18*	α(K)=0.00904 *14*; α(L)=0.00222 *4*; α(M)=0.000550 *8*; α(N+..)=0.000188 *3* α(N)=0.0001468 *22*; α(O)=3.42×10^{-5} *5*; α(P)=6.38×10^{-6} *10*; α(Q)=4.56×10^{-7} *7* Mult.: α(K)(E2)=0.0090 used for normalization of I(ce(K)) of 1973Ku09, 1960Ar06 to the Iγ of 1995Ba42.

$^{228}_{90}$Th$_{138}$-25

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	Comments
911.7[a] 1	0.8 4	1290.08	4+	378.214	6+				
913.3 2	0.39 13	1893.017	3+	979.460	2+				
916.6 3	0.17 5	1939.10	(4+)	1022.555	(3)+				
919.1 2	0.36 9	2010.10	(2+)	1091.067	4+				
920.46[a] 3	<0.1	1899.93	(2+)	979.460	2+	[M1,E2]		0.027 15	α(K)=0.021 13; α(L)=0.0041 20; α(M)=0.0010 5; α(N+..)=0.00034 16 α(N)=0.00027 13; α(O)=6.E−5 3; α(P)=1.2×10^{-5} 6; α(Q)=1.1×10^{-6} 7 γ not reported in ^{228}Ac decay.
921.6[ab] 3	0.19 4	979.460	2+	57.775	2+	[M1,E2]		0.027 15	α(K)=0.021 13; α(L)=0.0041 20; α(M)=0.0010 5; α(N+..)=0.00034 16 α(N)=0.00027 13; α(O)=6.E−5 3; α(P)=1.2×10^{-5} 6; α(Q)=1.1×10^{-6} 7
922.5[a] 2	2.06 12	1944.916	3+	1022.555	(3)+	[M1,E2]		0.026 15	α(K)=0.021 13; α(L)=0.0041 20; α(M)=0.0010 5; α(N+..)=0.00034 16 α(N)=0.00026 13; α(O)=6.E−5 3; α(P)=1.2×10^{-5} 6; α(Q)=1.1×10^{-6} 7
924.0[a] 1	1.6 2	1893.017	3+	968.986	2+				
924.5[a] 1	1.0 3	1893.017	3+	968.45	4+				
924.6[a] 1	0.5 2	1893.017	3+	968.38	2−				
927.2[a] 2	0.28 5	1949.74	2+	1022.555	(3)+				
928.4[a] 2	0.89 8	1944.916	3+	1016.388	3−				
931.02[a] 7	0.65 6	1899.93	(2+)	968.986	2+	[M1,E2]		0.026 15	α(K)=0.021 12; α(L)=0.0040 20; α(M)=0.0010 5; α(N+..)=0.00033 16 α(N)=0.00026 12; α(O)=6.E−5 3; α(P)=1.2×10^{-5} 6; α(Q)=1.0×10^{-6} 7
931.1[a] 2	0.39 7	1450.408	4−	519.212	5−				
933.1 3	0.25 10	1901.94	4+	968.986	2+				
935.8 2	0.26 5	1958.19	(2+)	1022.555	(3)+				
939.9 2	0.23 5	1908.47	(3−)	968.45	4+				
944.31 6	0.98 8	944.24	1−	0.0	0+				
948.0 2	0.27 5	1344.09	3−	396.108	3−				
956.6[a] 2	0.3 1	1143.15	5−	186.849	4+				
956.8[a] 2	2.2 5	1925.22	3+,4+	968.45	4+				
958.69[a] 11	4.4 6	1016.388	3−	57.775	2+				
959.1[a] 1	0.59 8	1981.90	(3−)	1022.555	(3)+				
964.3[a] 3	0.30 13	1908.47	(3−)	944.24	1−				
964.80[a] 2	120 7	1022.555	(3)+	57.775	2+	E2+(M1)	−7.2 10	0.01119 23	α(K)=0.00853 19; α(L)=0.00199 4; α(M)=0.000492 9; α(N+..)=0.000168 3 α(N)=0.0001312 23; α(O)=3.06×10^{-5} 6; α(P)=5.74×10^{-6} 11;

From ENSDF

$^{228}_{90}$Th$_{138}$-26

γ(^{228}Th) (continued)

Eγ[‡]	Iγ[‡d]	Ei(level)	J^π_i	Ef	J^π_f	Mult.[#]	α[†&]	Comments
								α(Q)=4.28×10^{-7} 10 Mult.: α(K)exp=0.012 5 (1973Ku09), 0.011 (1960Ar06); theory: α(K)(E2)=0.00821; α(K)(M1)=0.0295. δ: +33 20 from 1/δ=+0.03 4 (1998We13).
965.3[a] 2	1.2 2	1944.916	3^+	979.460	2^+			
966.64[b]	≤0.5	1153.431	2^+	186.849	4^+	[E2]	0.01066	α(K)=0.00810 12; α(L)=0.00192 3; α(M)=0.000474 7; α(N+..)=0.0001619 23 α(N)=0.0001265 18; α(O)=2.95×10^{-5} 5; α(P)=5.52×10^{-6} 8; α(Q)=4.06×10^{-7} 6
968.98 2	149 8	968.986	2^+	0.0	0^+	E2	0.01061	α(K)=0.00806 12; α(L)=0.00191 3; α(M)=0.000472 7; α(N+..)=0.0001610 23 α(N)=0.0001258 18; α(O)=2.93×10^{-5} 5; α(P)=5.49×10^{-6} 8; α(Q)=4.04×10^{-7} 6 Mult.: α(K)exp=0.0074 30 (1973Ku09), 0.0082 (1960Ar06); theory: α(K)(E1)=0.0030, α(K)(E2)=0.00815.
976.00[a] 5	12.4 10	1944.916	3^+	968.986	2^+	M1	0.0356	α(K)=0.0287 4; α(L)=0.00524 8; α(M)=0.001254 18; α(N+..)=0.000430 6 α(N)=0.000334 5; α(O)=7.91×10^{-5} 11; α(P)=1.537×10^{-5} 22; α(Q)=1.468×10^{-6} 21 Mult.: α(K)exp=0.025 6 (1973Ku09), 0.034 (1960Ar06); theory: α(K)(M1)=0.0306, α(K)(E2)=0.00804. δ: 0.00 5 from γ(θ,H,T) (1995Ba42).
976.5[fa] 1	0.6[f] 2	1944.916	3^+	968.45	4^+			
976.5[f] 1	0.7[f] 3	1944.916	3^+	968.38	2^-			
978.3 3	0.16 6	1497.69	(5^-)	519.212	5^-			
979.3 3	0.42 5	979.460	2^+	0.0	0^+	[E2]	0.01039	α(K)=0.00791 11; α(L)=0.00186 3; α(M)=0.000460 7; α(N+..)=0.0001569 22 α(N)=0.0001226 18; α(O)=2.86×10^{-5} 4; α(P)=5.36×10^{-6} 8; α(Q)=3.96×10^{-7} 6
980.7 2	0.15 5	1949.74	2^+	968.986	2^+			
981.5 2	≤0.1	1168.395	3^-	186.849	4^+	[E1]	0.00357 5	α=0.00357 5; α(K)=0.00293 5; α(L)=0.000485 7; α(M)=0.0001145 16; α(N+..)=3.90×10^{-5} 6 α(N)=3.04×10^{-5} 5; α(O)=7.16×10^{-6} 10; α(P)=1.377×10^{-6} 20; α(Q)=1.264×10^{-7} 18
987.7[a] 1	3.3 4	1174.547	(5^+)	186.849	4^+	[M1,E2]	0.022 13	α(K)=0.018 10; α(L)=0.0035 17; α(M)=0.0008 4; α(N+..)=0.00029 14 α(N)=0.00022 11; α(O)=5.2×10^{-5} 25; α(P)=1.0×10^{-5} 5; α(Q)=9.E−7 6
988.4[a] 1	0.99 10	1175.24	2^+	186.849	4^+			
990.3 2	0.22 6	1864.95	(2^+)	874.508	2^+			
1000.4 3	0.07 3	2022.88	$(2)^+$	1022.555	$(3)^+$			
1000.68[b]	≤0.01	1944.916	3^+	944.24	1^-			
1005.5 2	0.12 4	1949.74	2^+	944.24	1^-			
1013.44[a]	≤0.02	1981.90	(3^-)	968.45	4^+			

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α[†&]	Comments
1013.54[ea] 13	0.1[e] 5	1200.60	3$^{(+)}$	186.849	4$^+$	[M1,E2]	0.021 12	α(K)=0.017 10; α(L)=0.0032 16; α(M)=0.0008 4; α(N+..)=0.00027 13 α(N)=0.00021 10; α(O)=4.9×10^{-5} 23; α(P)=9.E−6 5; α(Q)=8.E−7 5
1013.54[e] 13	0.3[e] 1	1981.90	(3$^-$)	968.38	2$^-$			
1016.1[b]	≤0.07	1344.09	3$^-$	328.034	1$^-$			
1016.41[ab]	≤0.045	1016.388	3$^-$	0.0	0$^+$			I_γ: from branching ratio in ^{228}Ac β^- decay; Iγ≤0.7 (1995Ba42).
1017.0 3	0.21 3	1074.74	4$^+$	57.775	2$^+$			
^{x}1017.2[a] 2	0.82 12							
1018.5 1	1.3 3	1893.017	3$^+$	874.508	2$^+$			
1019.9[b]		1416.09	(3$^-$)	396.108	3$^-$			
^{x}1024.4 2	0.43 6							
1033.27 7	7.6 4	1091.067	4$^+$	57.775	2$^+$	E2	0.00938 14	α=0.00938 14; α(K)=0.00720 10; α(L)=0.001643 23; α(M)=0.000404 6; α(N+..)=0.0001380 α(N)=0.0001078 15; α(O)=2.52×10^{-5} 4; α(P)=4.73×10^{-6} 7; α(Q)=3.58×10^{-7} 5 Mult.: E2 in 1995Ba42; possibly from γ(θ,H,T), although not listed in table 3.
1039.87 6	2.92 15	1226.596	4$^-$	186.849	4$^+$			
1040.9 2	0.58 11	2010.10	(2$^+$)	968.986	2$^+$			
1048.2 3	0.13 5	2016.76	(4$^+$,5$^-$)	968.45	4$^+$			
1052.7[a] 2	≤0.3	1448.87	3,4$^-$	396.108	3$^-$			
1053.8 1	0.36 14	1432.036	4$^+$	378.214	6$^+$			
1053.8[a] 4	0.11 5	2022.88	(2)$^+$	968.986	2$^+$			
1054.23[a] 6	3.3 3	1450.408	4$^-$	396.108	3$^-$	[M1,E2]	0.019 10	α(K)=0.015 9; α(L)=0.0029 14; α(M)=0.0007 4; α(N+..)=0.00024 11 α(N)=0.00019 9; α(O)=4.4×10^{-5} 21; α(P)=9.E−6 4; α(Q)=8.E−7 5
^{x}1058.5 1	0.66 7							
^{x}1062.4 1	0.57 6							
1062.4[g] 1	0.15 10	1119.9	0$^+$	57.775	2$^+$			
1065.21[a] 7	1.03 7	1122.968	2$^-$	57.775	2$^+$	[E1]	0.00310 5	α=0.00310 5; α(K)=0.00254 4; α(L)=0.000418 6; α(M)=9.87×10^{-5} 14; α(N+..)=3.36×10^{-5} 5 α(N)=2.62×10^{-5} 4; α(O)=6.17×10^{-6} 9; α(P)=1.189×10^{-6} 17; α(Q)=1.100×10^{-7} 16
1065.4[a] 4	0.11 4	1393.46	1$^+$,2,3$^-$	328.034	1$^-$			
1070.40 7	1.20 8	1944.916	3$^+$	874.508	2$^+$			
^{x}1074.7[a] 3	0.42 5							
1074.7[a] 3	0.28 5	1261.59	4$^+$	186.849	4$^+$			
1075.1[a] 2	0.14 4	1949.74	2$^+$	874.508	2$^+$			
^{x}1077.5[a] 3	0.36 5							
1088.0[b]	≤0.1	1416.09	(3$^-$)	328.034	1$^-$			
1095.74 14	0.32 6	1153.431	2$^+$	57.775	2$^+$	[M1,E2]	0.017 9	α(K)=0.014 8; α(L)=0.0026 13; α(M)=0.0006 3; α(N+..)=0.00022 10 α(N)=0.00017 8; α(O)=4.0×10^{-5} 19; α(P)=8.E−6 4; α(Q)=7.E−7 4
1103.4 1	0.44 4	1290.08	4$^+$	186.849	4$^+$			

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	Comments
1110.55[fa] *5*	4.7[f] *5*	1168.395	3⁻	57.775	2⁺	E1		0.00288 *4*	α=0.00288 *4*; α(K)=0.00237 *4*; α(L)=0.000388 *6*; α(M)=9.15×10⁻⁵ *13*; α(N+..)=3.20×10⁻⁵ *5* α(N)=2.43×10⁻⁵ *4*; α(O)=5.73×10⁻⁶ *8*; α(P)=1.104×10⁻⁶ *16*; α(Q)=1.026×10⁻⁷ *15*; α(IPF)=7.70×10⁻⁷ *11* I_γ: Iγ(doublet)=7.1 *4* and Iγ(γ from 1297.42 level)=2.4 *2* (from coin). Mult.: for the 1110.55 doublet: α(K)exp=0.0013 *3* (1973Ku09), 0.0019 (1960Ar06); theory: α(K)=0.00237.
1110.55[fa] *5*	2.4[f] *2*	1297.387	(5⁻)	186.849	4⁺	E1		0.00288 *4*	α=0.00288 *4*; α(K)=0.00237 *4*; α(L)=0.000388 *6*; α(M)=9.15×10⁻⁵ *13*; α(N+..)=3.20×10⁻⁵ *5* α(N)=2.43×10⁻⁵ *4*; α(O)=5.73×10⁻⁶ *8*; α(P)=1.104×10⁻⁶ *16*; α(Q)=1.026×10⁻⁷ *15*; α(IPF)=7.70×10⁻⁷ *11* Mult.: for the 1110.55 doublet: α(K)exp=0.0013 *3* (1973Ku09), 0.0019 (1960Ar06); theory: α(K)=0.00237.
1117.3 *2*	0.44 *5*	1175.24	2⁺	57.775	2⁺				
1119.5 *3*	0.10 *4*	1497.69	(5⁻)	378.214	6⁺				
1135.39[b]	0.014 *4*	1531.51	3⁺	396.108	3⁻				I_γ: from branching ratio in adopted γ′s; Iγ≤0.1 (1995Ba42); 1998We13 list <0.1.
1142.78 *15*	0.10 *3*	1200.60	3⁽⁺⁾	57.775	2⁺	[M1,E2]		0.016 *8*	α(K)=0.012 *7*; α(L)=0.0024 *11*; α(M)=0.0006 *3*; α(N+..)=0.00020 *9* α(N)=0.00015 *7*; α(O)=3.6×10⁻⁵ *16*; α(P)=7.E−6 *4*; α(Q)=6.E−7 *4*; α(IPF)=1.1×10⁻⁶ *5*
1148.2[a] *2*	0.21 *5*	1667.38	2⁺	519.212	5⁻				
1148.20[a] *14*	0.06 *2*	2022.88	(2)⁺	874.508	2⁺				
1153.6 *3*	0.37 *8*	1153.431	2⁺	0.0	0⁺				
1157.3[b]	≤0.1	1344.09	3⁻	186.849	4⁺				
1164.58 *7*	1.32 *7*	1683.77	(4⁻)	519.212	5⁻	(M1+E2)	1.09	0.015 *8*	α(K)=0.012 *6*; α(L)=0.0023 *11*; α(M)=0.00055 *24*; α(N+..)=0.00019 *9* α(N)=0.00015 *7*; α(O)=3.4×10⁻⁵ *16*; α(P)=7.E−6 *3*; α(Q)=6.E−7 *4*; α(IPF)=2.2×10⁻⁶ *10* Mult.: α(K)exp=0.012 *2* (1973Ku09), 0.014 (1960Ar06); theory: α(K)(E2)=0.00588, α(K)(M1)=0.0193. δ: calculated from experimental conversion coefficient (evaluator).
1175.4 *2*	0.23 *5*	1175.24	2⁺	0.0	0⁺				
1184.71 *9*	0.47 *4*	1580.94	(2⁻)	396.108	3⁻	(M1+E2)	1.29	0.014 *7*	α(K)=0.011 *6*; α(L)=0.0022 *10*; α(M)=0.00052 *23*; α(N+..)=0.00018 *8* α(N)=0.00014 *6*; α(O)=3.3×10⁻⁵ *15*; α(P)=6.E−6 *3*; α(Q)=6.E−7 *3*; α(IPF)=3.8×10⁻⁶ *17* Mult.: α(K)exp=0.0105 *20* (1973Ku09); theory: α(K)(E2)=0.00571, α(K)(M1)=0.0185. δ: calculated from experimental conversion coefficient (evaluator).
1191.09[b]	≤0.1	2022.88	(2)⁺	831.72	0⁺				
1204.1 *3*	0.23 *3*	1261.59	4⁺	57.775	2⁺				
1229.2[b]	≤0.15	1416.09	(3⁻)	186.849	4⁺				
1245.17 *6*	5.6 *3*	1432.036	4⁺	186.849	4⁺	[M1,E2]		0.013 *6*	α(K)=0.010 *5*; α(L)=0.0019 *9*; α(M)=0.00046 *20*; α(N+..)=0.00017 *8*

$^{228}_{90}Th_{138}$-29

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
									α(N)=0.00012 *6*; α(O)=2.9×10^{-5} *13*; α(P)=5.6×10^{-6} *25*; α(Q)=5.E−7 *3*; α(IPF)=1.2×10^{-5} *5*
1247.07 *5*	8.2 *4*	1643.15	(3$^-$)	396.108	3$^-$	(M1)		0.0187	α(K)=0.01505 *21*; α(L)=0.00274 *4*; α(M)=0.000654 *10*; α(N+..)=0.000242 *4* α(N)=0.0001743 *25*; α(O)=4.13×10^{-5} *6*; α(P)=8.02×10^{-6} *12*; α(Q)=7.69×10^{-7} *11*; α(IPF)=1.771×10^{-5} *2* Mult.: for the 1245+1246 doublet: α(K)exp=0.0088 *11* (1973Ku09), 0.021 (1960Ar06); theory: α(K)(M1)=0.0162, α(K)(E2)=0.00521.
1249.7 *2*	0.73 *10*	1645.933	3$^+$	396.108	3$^-$				
1252.98 *10*	0.68 *6*	1580.94	(2$^-$)	328.034	1$^-$	(M1+E2)	1.115	0.012 *6*	α(K)=0.010 *5*; α(L)=0.0019 *9*; α(M)=0.00045 *20*; α(N+..)=0.00017 *8* α(N)=0.00012 *6*; α(O)=2.9×10^{-5} *13*; α(P)=5.5×10^{-6} *25*; α(Q)=5.E−7 *3*; α(IPF)=1.4×10^{-5} *6* Mult.: α(K)exp=0.010 *3* (1971Am05); theory: α(K)(E2)=0.00517, α(K)(M1)=0.0160. δ: calculated from experimental conversion coefficient (evaluator).
1261.7 *4*	≤0.15	1448.87	3,4$^-$	186.849	4$^+$				
[x]1281.7 *2*	0.29 *3*								
1282.6 *4*	0.09 *3*	1678.43	2$^+$	396.108	3$^-$				
1286.0[a] *3*	0.14 *5*	1804.690	4$^+$	519.212	5$^-$				
[x]1286.3[a] *3*	0.39 *9*								E_γ: this γ is placed from the 1682.8 level by 1995Ba42. A 1286.27 *20* γ seen in ^{228}Ac decay is placed from the 1344.08 level. However, the ratio Iγ/Iγ(1496.15γ)=0.14 *3* here does not agree with Iγ/Iγ(1495.91γ)=0.058 *15* in ^{228}Ac decay. The calculated energy of the transition from the 1682.8 level is 1286.73 *3*. From 1344.08 level the ratio Iγ/Iγ(947.98γ)=0.47 *10* in ^{228}Ac decay; in this decay, I(948γ)≈0.2 giving the estimated Iγ≈0.1 for that placement.
1286.3[b]	≤0.2	1344.09	3$^-$	57.775	2$^+$				
1286.3[a] *3*	0.25 *8*	1682.85	(2$^+$,3$^+$,4$^+$)	396.108	3$^-$				E_γ: this γ is placed by 1995Ba42. A 1286.27 *20* γ seen in ^{228}Ac decay is placed from the 1344.08 level. However, the ratio Iγ/Iγ(1496.15γ)=0.14 *3* here does not agree with Iγ/Iγ(1495.91γ)=0.058 *15* in ^{228}Ac decay. The calculated energy of the transition from the 1682.8 level is 1286.73 *3*. From 1344.08 level the ratio Iγ/Iγ(947.98γ)=0.47 *10* in ^{228}Ac decay; in this decay, I(948γ)≈0.2 giving the estimated Iγ≈0.1 for that placement.
1287.79[a] *8*	1.56 *11*	1683.77	(4$^-$)	396.108	3$^-$	(M1+E2)	0.91	0.012 *6*	α(K)=0.009 *5*; α(L)=0.0018 *8*; α(M)=0.00042 *18*; α(N+..)=0.00017 *7* α(N)=0.00011 *5*; α(O)=2.7×10^{-5} *12*; α(P)=5.1×10^{-6} *23*; α(Q)=4.7×10^{-7} *24*; α(IPF)=2.0×10^{-5} *9*

γ(^{228}Th) (continued)

$E_γ$[‡]	$I_γ$[‡d]	E_i(level)	$J^π_i$	E_f	$J^π_f$	Mult.[#]	δ[@]	α[†&]	Comments
									Mult.: α(K)exp=0.0104 *15* (1973Ku09); theory: α(K)(M1)=0.0149, α(K)(E2)=0.00492. δ: calculated from experimental conversion coefficient (evaluator).
1298.3 *2*	0.45 *4*	1817.442	4^-	519.212	5^-	(M1+E2)	0.77	0.011 *6*	α(K)=0.009 *5*; α(L)=0.0017 *8*; α(M)=0.00041 *18*; α(N+..)=0.00016 *7* α(N)=0.00011 *5*; α(O)=2.6×10^{-5} *11*; α(P)=5.0×10^{-6} *22*; α(Q)=4.6×10^{-7} *23*; α(IPF)=2.3×10^{-5} *10* Mult.: α(K)exp=0.011 *4* (1973Ku09); theory: α(K)(M1)=0.0146, α(K)(E2)=0.00486, α(K)(E1)=0.00182, α(K)(M2)=0.0146. δ: calculated from experimental conversion coefficient (evaluator). +0.27≤δ≤+5 from γ(θ,H,T) (1995Ba42).
1304.2 *3*	0.07 *3*	1823.49	(4^+)	519.212	5^-				
1310.26[b]	≤0.02	1638.300	2^+	328.034	1^-				$I_γ$: part of a multiplet, Iγ from ^{228}Ac $β^-$ decay.
[x]1310.8 *1*	0.48 *5*								
1310.8 *1*	0.48 *5*	1497.69	(5^-)	186.849	4^+				
1311.6 *4*	0.08 *3*	1707.30	$(2,3^-)$	396.108	3^-				
1315.2 *2*	0.20 *5*	1643.15	(3^-)	328.034	1^-	[E2]		0.006	α(K)=0.009 *5*; α(L)=0.0017 *7*; α(M)=0.00040 *17*; α(N+..)=0.00016 *7* α(N)=0.00011 *5*; α(O)=2.5×10^{-5} *11*; α(P)=4.9×10^{-6} *21*; α(Q)=4.5×10^{-7} *22*; α(IPF)=2.7×10^{-5} *11*
1344.65[b]	0.013 *4*	1531.51	3^+	186.849	4^+				$I_γ$: from branching ratio in adopted γ′s; Iγ≤0.1 (1998We13).
1347.6 *3*	0.16 *5*	1743.90	4^+	396.108	3^-				
1357.2 *3*	0.15 *5*	1876.46	$(3^-,4,5^-)$	519.212	5^-				
1358.3 *3*	0.34 *5*	1416.09	(3^-)	57.775	2^+				
1359.9 *3*	0.13 *5*	1879.06	(3^-)	519.212	5^-				
1361.4 *5*	0.12 *5*	1758.06	2^+	396.108	3^-				
1365.72 *12*	0.40 *4*	1743.90	4^+	378.214	6^+				
1374.26 *7*	≈1.0	1432.036	4^+	57.775	2^+				
1379.2 *2*	0.31 *15*	1707.30	$(2,3^-)$	328.034	1^-				
1383.2 *2*	0.55 *5*	1901.94	4^+	519.212	5^-				
1405.5 *2*	0.32 *8*	1924.66	$4^+,5^-$	519.212	5^-				
1406.8 *2*	0.32 *8*	1802.90	2^+	396.108	3^-				
1415.5 *2*	0.6 *1*	1811.58	$(1^-,2,3^-)$	396.108	3^-				
1415.8 *2*	0.32 *7*	1743.90	4^+	328.034	1^-	[E3]		0.01141	α(K)=0.00849 *12*; α(L)=0.00217 *3*; α(M)=0.000542 *8*; α(N+..)=0.000202 *3* α(N)=0.0001450 *21*; α(O)=3.39×10^{-5} *5*; α(P)=6.36×10^{-6} *9*; α(Q)=4.71×10^{-7} *7*; α(IPF)=1.605×10^{-5} *23*
1419.8 *2*	0.20 *9*	1939.10	(4^+)	519.212	5^-				
1421.1 *2*	1.25 *9*	1817.442	4^-	396.108	3^-	E2+M1	+2.0 *5*	0.0068 *9*	α=0.0068 *9*; α(K)=0.0054 *8*; α(L)=0.00104 *13*; α(M)=0.00025 *3*; α(N+..)=0.000133 *16* α(N)=6.7×10^{-5} *8*; α(O)=1.57×10^{-5} *19*; α(P)=3.0×10^{-6} *4*; α(Q)=2.7×10^{-7} *4*; α(IPF)=4.7×10^{-5} *6* Mult.: α(K)exp=0.0055 *14* (1973Ku09); theory: α(K)(E2)=0.00414.

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[†&]	Comments
1426.43[b]	≤0.3	1804.690	4^+	378.214	6^+	[E2]	0.00518 8	α=0.00518 8; α(K)=0.00407 6; α(L)=0.000809 12; α(M)=0.000196 3; α(N+..)=0.0001056 15 α(N)=5.21×10^{-5} 8; α(O)=1.224×10^{-5} 18; α(P)=2.33×10^{-6} 4; α(Q)=1.97×10^{-7} 3; α(IPF)=3.87×10^{-5} 6
1426.6 1	0.48 6	1945.74	4^+,5^-	519.212	5^-			
1430.0 3	0.19 7	1758.06	2^+	328.034	1^-			
[x]1432[f] 1	≤1.3[f]							E_γ: This line seems to be a doublet of lines with Eγ≈1431 and 1433 keV, which are both in coin with the 4^+ to 2^+ transition.
1432[f] 1	0.60[f] 14	1618.04?	4^+	186.849	4^+			E_γ: The measured intensity suggests that this line doublet with an unassigned line at Eγ≈1431. I_γ: from Iγ/Iγ(1560γ) in adopted γ's. Iγ(doublet)≤1.8 and. Mult.: for the doublet α(K)exp=0.0032 7 (1973Ku09); α(K)(E2)=0.00409, α(K)(M1)=0.0113.
1451.45[b]	0.039 9	1638.300	2^+	186.849	4^+	[E2]	0.00502 7	α=0.00502 7; α(K)=0.00395 6; α(L)=0.000780 11; α(M)=0.000189 3; α(N+..)=0.0001095 16 α(N)=5.02×10^{-5} 7; α(O)=1.180×10^{-5} 17; α(P)=2.25×10^{-6} 4; α(Q)=1.91×10^{-7} 3; α(IPF)=4.51×10^{-5} 7 I_γ: from branching ratio in adopted γ's; Iγ≤0.05 (1998We13).
1455.0 2	1.16 7	1974.20	(2^+,3^-)	519.212	5^-			
1459.2 2	8.6 5	1645.933	3^+	186.849	4^+	E2	0.00498 7	α=0.00498 7; α(K)=0.00391 6; α(L)=0.000771 11; α(M)=0.000186 3; α(N+..)=0.0001108 16 α(N)=4.97×10^{-5} 7; α(O)=1.167×10^{-5} 17; α(P)=2.23×10^{-6} 4; α(Q)=1.89×10^{-7} 3; α(IPF)=4.71×10^{-5} 7 Mult.: α(K)exp=0.0045 9 (1971Am05), 0.0026 (1960Ar06); theory: α(K)(E2)=0.00395, α(K)(M1)=0.0108.
1468.8 3	0.28 7	1864.95	(2^+)	396.108	3^-			
1474.8 4	0.09 5	1802.90	2^+	328.034	1^-			
[x]1480.4[a] 3	0.77 10							Mult.: α(K)exp=0.009 3 (1973Ku09); theory: α(K)(E2)=0.00385, α(K)(M1)=0.0104.
1480.4[a] 3	0.13 6	1876.46	(3^-,4,5^-)	396.108	3^-			
1480.5[a] 2	0.50 14	1667.38	2^+	186.849	4^+			
1482.9[a] 3	0.20 6	1879.06	(3^-)	396.108	3^-			
[x]1483.2[a] 3	0.52 7							
1483.5[a] 2	0.35 11	1811.58	(1^-,2,3^-)	328.034	1^-			
[x]1486.3[a] 3	0.27 7							
1496.15[a] 6	2.44 20	1682.85	(2^+,3^+,4^+)	186.849	4^+	(E2)	0.00477 7	α=0.00477 7; α(K)=0.00374 6; α(L)=0.000732 11; α(M)=0.0001769 25; α(N+..)=0.0001177 α(N)=4.71×10^{-5} 7; α(O)=1.107×10^{-5} 16; α(P)=2.11×10^{-6} 3; α(Q)=1.81×10^{-7} 3; α(IPF)=5.73×10^{-5} 8 Mult.: α(K)exp=0.0029 9 (1973Ku09); theory: α(K)(E2)=0.00378, α(K)(M1)=0.0101.

γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[†&]	Comments
1497.5[a] *2*	0.30 *2*	2016.76	(4$^+$,5$^-$)	519.212	5$^-$				
1501.5 *2*	0.74 *6*	1688.42	2$^+$,3$^+$	186.849	4$^+$				
1503.7 *2*	0.72 *6*	1899.93	(2$^+$)	396.108	3$^-$				Mult.: α(K)exp=0.0050 *23* (1973Ku09); theory: α(K)(E1)=0.00142, α(K)(E2)=0.00374. γ not reported in ^{228}Ac decay.
1505.9 *2*	0.55 *5*	1901.94	4$^+$	396.108	3$^-$				
1512.9[a] *3*	0.14 *5*	1908.47	(3$^-$)	396.108	3$^-$				
1513.4[a] *5*	0.06 *2*	1842.23	(2,3)	328.034	1$^-$				
1523.4[a] *2*	0.46 *8*	1580.94	(2$^-$)	57.775	2$^+$			0.00139	α=0.00139; α(K)=0.00139
1523.5[a] *2*	0.14 *6*	1901.94	4$^+$	378.214	6$^+$				
1529.02 *6*	2.61 *13*	1925.22	3$^+$,4$^+$	396.108	3$^-$	[E1]		0.00185 *3*	α=0.00185 *3*; α(K)=0.001380 *20*; α(L)=0.000222 *4*; α(M)=5.23×10^{-5} *8*; α(N+..)=0.000193 *3* α(N)=1.388×10^{-5} *20*; α(O)=3.28×10^{-6} *5*; α(P)=6.35×10^{-7} *9*; α(Q)=6.04×10^{-8} *9*; α(IPF)=0.0001749 *25* Mult.: α(K)exp=0.0034 *11* (1973Ku09); theory: α(K)(E1)=0.00138, α(K)(E2)=0.00364, α(K)(M1)=0.0095;
1536.8[a] *3*	0.14 *5*	1864.95	(2$^+$)	328.034	1$^-$				
1537.8[a] *2*	0.73 *10*	1724.301	2$^+$	186.849	4$^+$	[E2]		0.00455 *7*	α=0.00455 *7*; α(K)=0.00356 *5*; α(L)=0.000692 *10*; α(M)=0.0001670 *24*; α(N+..)=0.0001269 α(N)=4.44×10^{-5} *7*; α(O)=1.045×10^{-5} *15*; α(P)=2.00×10^{-6} *3*; α(Q)=1.720×10^{-7} *24*; α(IPF)=6.98×10^{-5} *10* Mult.: α(K)exp=0.0080 *25* (1973Ku09); theory: α(K)(E2)=0.00360.
[x]1542.8 *2*	0.28 *5*								
1547.0 *2*	0.44 *12*	1925.22	3$^+$,4$^+$	378.214	6$^+$				
[x]1547.2[a] *3*	0.54 *11*								
1548.7[a] *4*	0.30 *15*	1735.64	4$^+$	186.849	4$^+$				
1548.8[a] *2*		1944.916	3$^+$	396.108	3$^-$				I_γ: No intensity is given in 1998We13.
1549.3[a] *2*	1.2 *2*	1945.74	4$^+$,5$^-$	396.108	3$^-$				
1557.06 *6*	4.42 *22*	1743.90	4$^+$	186.849	4$^+$	(E2+M1)	+1.2 *2*	0.0070 *6*	α=0.0070 *6*; α(K)=0.0055 *5*; α(L)=0.00102 *8*; α(M)=0.000245 *19*; α(N+..)=0.000198 *15* α(N)=6.5×10^{-5} *5*; α(O)=1.54×10^{-5} *12*; α(P)=2.98×10^{-6} *23*; α(Q)=2.75×10^{-7} *24*; α(IPF)=0.000114 *9* Mult.: α(K)exp=0.0056 *11* (1973Ku09), 0.0061 (1960Ar06); theory: α(K)(E2)=0.00352, α(K)(M1)=0.00908.
1559.7[a] *2*	0.34 *5*	1618.04?	4$^+$	57.775	2$^+$				
1561.7 *4*	0.10 *4*	1958.19	(2$^+$)	396.108	3$^-$				
1567.6 *3*	0.23 *11*	1945.74	4$^+$,5$^-$	378.214	6$^+$				
1572.0[a] *1*	0.4 *1*	1899.93	(2$^+$)	328.034	1$^-$				
1573.3[a] *3*	5.6 *10*	1760.32	2$^{(+)}$,3$^{(+)}$	186.849	4$^+$	(E2)		0.00438 *7*	α=0.00438 *7*; α(K)=0.00342 *5*; α(L)=0.000660 *10*; α(M)=0.0001592 *23*; α(N+..)=0.0001356

From ENSDF

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γ(^{228}Th) (continued)

E$_\gamma$[‡]	I$_\gamma$[‡d]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.[#]	α[†&]	Comments
								α(N)=4.24×10^{-5} *6*; α(O)=9.97×10^{-6} *14*; α(P)=1.91×10^{-6} *3*; α(Q)=1.650×10^{-7} *24*; α(IPF)=8.12×10^{-5} *12* Mult.: α(K)exp=0.011 *4* (1973Ku09); theory: α(K)(M1)=0.00884, α(K)(E2)=0.00346 α(K)(E1)=0.00132.
1578.2 *2*	1.33 *13*	1974.20	(2$^+$,3$^-$)	396.108	3$^-$			
1580.5[a] *3*	2.18 *14*	1638.300	2$^+$	57.775	2$^+$	(M1,E2)	0.007 *3*	α=0.007 *3*; α(K)=0.0057 *24*; α(L)=0.0011 *4*; α(M)=0.00025 *10*; α(N+..)=0.00022 *9* α(N)=7.E−5 *3*; α(O)=1.6×10^{-5} *6*; α(P)=3.1×10^{-6} *12*; α(Q)=2.9×10^{-7} *13*; α(IPF)=0.00013 *5* Mult.: α(K)exp=0.0046 *15* (1973Ku09); theory: α(K)(M1)=0.0087, α(K)(E2)=0.00343.
1585.5 *2*	0.32 *10*	1981.90	(3$^-$)	396.108	3$^-$			
1588.15 *5*	37.2 *19*	1645.933	3$^+$	57.775	2$^+$	E2	0.00431 *6*	α=0.00431 *6*; α(K)=0.00337 *5*; α(L)=0.000647 *9*; α(M)=0.0001561 *22*; α(N+..)=0.0001396 *2* α(N)=4.15×10^{-5} *6*; α(O)=9.77×10^{-6} *14*; α(P)=1.87×10^{-6} *3*; α(Q)=1.622×10^{-7} *23*; α(IPF)=8.62×10^{-5} *12* Mult.: α(K)exp=0.0025 *4* (1971Am05), 0.0031 (1960Ar06); theory: α(K)(E2)=0.0034, α(K)(E1)=0.0013, α(K)(M1)=0.0086. δ: ≤−6 from nuclear orientation (1995Ba42).
1595.8 *3*	0.19 *8*	1974.20	(2$^+$,3$^-$)	378.214	6$^+$			
1609.6 *1*	0.92 *7*	1796.45	4$^+$	186.849	4$^+$	(M1)	0.00974 *14*	α=0.00974 *14*; α(K)=0.00770 *11*; α(L)=0.001392 *20*; α(M)=0.000333 *5*; α(N+..)=0.000319 *5* α(N)=8.86×10^{-5} *13*; α(O)=2.10×10^{-5} *3*; α(P)=4.08×10^{-6} *6*; α(Q)=3.92×10^{-7} *6*; α(IPF)=0.000205 *3* Mult.: α(K)exp=0.014 *3* (1973Ku09); theory: α(K)(M1)=0.0092.
1618.0 *1*	0.90 *6*	1804.690	4$^+$	186.849	4$^+$	(M1,E2)	0.007 *3*	α=0.007 *3*; α(K)=0.0054 *22*; α(L)=0.0010 *4*; α(M)=0.00024 *9*; α(N+..)=0.00024 *9* α(N)=6.4×10^{-5} *24*; α(O)=1.5×10^{-5} *6*; α(P)=2.9×10^{-6} *12*; α(Q)=2.7×10^{-7} *12*; α(IPF)=0.00015 *6* Mult.: α(K)exp=0.012 *4* (1973Ku09); theory: α(K)(M1)=0.0096, α(K)(E2)=0.0042.
1620.67[a] *10*	4.6 *2*	1678.43	2$^+$	57.775	2$^+$			
1620.67[a] *10*	0.29 *8*	2016.76	(4$^+$,5$^-$)	396.108	3$^-$	(M1+E2)		Mult.: α(K)exp=0.0060 *15* (1973Ku09); theory: α(K)(M1)=0.0090, α(K)(E2)=0.0034.
1625.0 *2*	0.70 *14*	1682.85	(2$^+$,3$^+$,4$^+$)	57.775	2$^+$			
1630.63 *6*	2.65 *13*	1688.42	2$^+$,3$^+$	57.775	2$^+$	(M1,E2)	0.007 *3*	α=0.007 *3*; α(K)=0.0053 *22*; α(L)=0.0010 *4*; α(M)=0.00023 *9*; α(N+..)=0.00024 *9* α(N)=6.2×10^{-5} *24*; α(O)=1.5×10^{-5} *6*; α(P)=2.9×10^{-6} *11*; α(Q)=2.7×10^{-7} *12*; α(IPF)=0.00016 *6*
1638.30[a] *7*	1.88 *11*	1638.300	2$^+$	0.0	0$^+$	(E2)	0.00410 *6*	α=0.00410 *6*; α(K)=0.00319 *5*; α(L)=0.000608 *9*; α(M)=0.0001463 *21*; α(N+..)=0.0001539 *2* α(N)=3.89×10^{-5} *6*; α(O)=9.16×10^{-6} *13*; α(P)=1.755×10^{-6} *25*;

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γ(^{228}Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[†&]	Comments
									α(Q)=1.533×10^{-7} *22*; α(IPF)=0.0001039 Mult.: α(K)exp=0.0026 *8* (1973Ku09); theory: α(K)(M1)=0.0087, α(K)(E2)=0.0034.
1638.5[a] *3*	0.09 *4*	2016.76	(4$^+$,5$^-$)	378.214	6$^+$				
1666.53 *6*	3.35 *17*	1724.301	2$^+$	57.775	2$^+$	M1		0.00895 *13*	α=0.00895 *13*; α(K)=0.00702 *10*; α(L)=0.001269 *18*; α(M)=0.000303 *5*; α(N+..)=0.000351 *5* α(N)=8.08×10^{-5} *12*; α(O)=1.91×10^{-5} *3*; α(P)=3.72×10^{-6} *6*; α(Q)=3.58×10^{-7} *5*; α(IPF)=0.000247 *4* Mult.: α(K)exp=0.0081 *21* (1971Am05); theory: α(K)(M1)=0.0084. δ: 0.00 *5* from γ(θ,H,T) (1995Ba42).
1677.9 *1*	0.65 *5*	1735.64	4$^+$	57.775	2$^+$				
1686.15 *7*	2.39 *12*	1743.90	4$^+$	57.775	2$^+$	(E2)		0.00391 *6*	α=0.00391 *6*; α(K)=0.00303 *5*; α(L)=0.000573 *8*; α(M)=0.0001378 *20*; α(N+..)=0.0001689 *2* α(N)=3.67×10^{-5} *6*; α(O)=8.64×10^{-6} *12*; α(P)=1.655×10^{-6} *24*; α(Q)=1.455×10^{-7} *21*; α(IPF)=0.0001217 Mult.: α(K)exp=0.0031 *11* (1973Ku09); theory: α(K)(E2)=0.0032, α(K)(M1)=0.0082.
1702.6[a] *3*	1.15 *11*	1760.32	2$^{(+)}$,3$^{(+)}$	57.775	2$^+$				
1706.16 *7*	2.84 *14*	1893.017	3$^+$	186.849	4$^+$	M1+E2	+0.42 *4*	0.00776 *16*	α=0.00776 *16*; α(K)=0.00605 *13*; α(L)=0.001097 *22*; α(M)=0.000262 *6*; α(N+..)=0.000345 *7* α(N)=6.99×10^{-5} *14*; α(O)=1.65×10^{-5} *4*; α(P)=3.21×10^{-6} *7*; α(Q)=3.07×10^{-7} *7*; α(IPF)=0.000256 *6* Mult.: α(K)exp=0.0071 *16* (1973Ku09), 0.0063 (1960Ar06); theory: α(K)(M1)=0.0079, α(K)(E2)=0.0031.
1713.16[b]	≤0.1	1899.93	(2$^+$)	186.849	4$^+$				
1715.06 *10*	0.50 *3*	1901.94	4$^+$	186.849	4$^+$				
1724.0 *2*	0.50 *5*	1724.301	2$^+$	0.0	0$^+$				
1738.48 *5*	0.96 *5*	1925.22	3$^+$,4$^+$	186.849	4$^+$	M1+E2	0.65 *5*	0.0059 *22*	α=0.0059 *22*; α(K)=0.0046 *17*; α(L)=0.0008 *3*; α(M)=0.00020 *7*; α(N+..)=0.00029 *11* α(N)=5.3×10^{-5} *19*; α(O)=1.3×10^{-5} *5*; α(P)=2.4×10^{-6} *9*; α(Q)=2.3×10^{-7} *10*; α(IPF)=0.00022 *8* δ: calculated from experimental conversion coefficient (evaluator). Mult.: α(K)exp=0.0061 *8* (1971Am05), 0.0057 (1960Ar06); theory: α(K)(M1)=0.0074, α(K)(E2)=0.0030.
1741.6 *2*	0.42 *8*	1928.37	3$^+$	186.849	4$^+$				
[x]1746.2 *2*	0.34 *4*								
1746.84[b]	≤0.3	1804.690	4$^+$	57.775	2$^+$				
1752.1 *2*	0.37 *4*	1939.10	(4$^+$)	186.849	4$^+$				
1758.11 *5*	9.0 *5*	1944.916	3$^+$	186.849	4$^+$	E2+M1	−9 *1*	0.00371 *6*	α=0.00371 *6*; α(K)=0.00285 *5*; α(L)=0.000533 *8*; α(M)=0.0001281 *19*; α(N+..)=0.000195 *3*

$^{228}_{90}$Th$_{138}$-35

^{228}Pa ε decay 1998We13,1995Ba42 (continued)

γ(^{228}Th) (continued)

E_γ ‡	I_γ ‡d	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	δ@	α†&	Comments
									α(N)=3.41×10^{-5} *5*; α(O)=8.03×10^{-6} *12*; α(P)=1.542×10^{-6} *23*; α(Q)=1.369×10^{-7} *20*; α(IPF)=0.0001515 Mult.: α(K)exp=0.0038 *8* (1971Am05), 0.0015 (1960Ar06); theory: α(K)(E2)=0.0029, α(K)(M1)=0.0072.
1778.0 *6*	0.06 *2*	1965.05	(2$^+$)	186.849	4$^+$				
1784.4 *2*	0.62 *5*	1842.23	(2,3)	57.775	2$^+$				
1787.2 *2*	0.37 *4*	1974.20	(2$^+$,3$^-$)	186.849	4$^+$				
1795.15 *6*	1.19 *7*	1981.90	(3$^-$)	186.849	4$^+$				
1807.2 *1*	0.60 *5*	1864.95	(2$^+$)	57.775	2$^+$				Mult.: α(K)exp=0.006 *3* (1973Ku09); theory: α(K)(M1)=0.0068, α(K)(E2)=0.0028.
1823.19 *10*	0.47 *3*	2010.10	(2$^+$)	186.849	4$^+$				
1835.26 *5*	9.8 *5*	1893.017	3$^+$	57.775	2$^+$	E2+M1	+2.9 *3*	0.00382 *10*	α=0.00382 *10*; α(K)=0.00291 *8*; α(L)=0.000536 *14*; α(M)=0.000128 *4*; α(N+..)=0.000246 *7* α(N)=3.42×10^{-5} *9*; α(O)=8.06×10^{-6} *21*; α(P)=1.55×10^{-6} *4*; α(Q)=1.41×10^{-7} *4*; α(IPF)=0.000202 *6* Mult.: α(K)exp=0.0036 *6* (1971Am05), 0.0055 (1960Ar06); theory: α(K)(E2)=0.00275, α(K)(M1)=0.0065.
1842.15 *8*	2.29 *12*	1899.93	(2$^+$)	57.775	2$^+$	M1+E2	−0.86 *14*	0.0055 *4*	α=0.0055 *4*; α(K)=0.00420 *25*; α(L)=0.00076 *5*; α(M)=0.000182 *11*; α(N+..)=0.000363 *21* α(N)=4.9×10^{-5} *3*; α(O)=1.15×10^{-5} *7*; α(P)=2.23×10^{-6} *13*; α(Q)=2.10×10^{-7} *13*; α(IPF)=0.000301 *18* Mult.: α(K)exp=0.0059 *20* (1971Am05); theory: α(K)(M1)=0.0064, α(K)(E2)=0.0027.
1865.1 *1*	0.80 *4*	1864.95	(2$^+$)	0.0	0$^+$				
1870.80 *9*	0.73 *4*	1928.37	3$^+$	57.775	2$^+$	(M1+E2)		0.0051 *18*	α=0.0051 *18*; α(K)=0.0038 *14*; α(L)=0.00070 *24*; α(M)=0.00017 *6*; α(N+..)=0.00036 *13* α(N)=4.4×10^{-5} *15*; α(O)=1.1×10^{-5} *4*; α(P)=2.0×10^{-6} *7*; α(Q)=1.9×10^{-7} *8*; α(IPF)=0.00030 *11* Mult.: α(K)exp=0.0028 *14* (1973Ku09); theory: α(K)(E2)=0.0026, α(K)(M1)=0.0071 α(K)(E1)=0.00100, α(K)(M2)=0.0138. δ: −0.32 *9* or −1.7 *3* from γ(θ,H,T) (1995Ba42).
1887.13 *5*	24.0 *12*	1944.916	3$^+$	57.775	2$^+$	E2+M1	−9.1 *9*	0.00333 *5*	α=0.00333 *5*; α(K)=0.00251 *4*; α(L)=0.000462 *7*; α(M)=0.0001107 *16*; α(N+..)=0.000243 *4* α(N)=2.95×10^{-5} *5*; α(O)=6.95×10^{-6} *10*; α(P)=1.336×10^{-6} *19*; α(Q)=1.201×10^{-7} *18*; α(IPF)=0.000205 *3* Mult.: α(K)exp=0.0028 *5* (1971Am05), 0.0023 (1960Ar06); theory: α(K)(E2)=0.0026, α(K)(M1)=0.0059.
1900.3 *3*	0.34 *5*	1899.93	(2$^+$)	0.0	0$^+$				
1907.13 *11*	0.99 *5*	1965.05	(2$^+$)	57.775	2$^+$				
1916.6 *3*	0.15 *3*	1974.20	(2$^+$,3$^-$)	57.775	2$^+$				
^{x}1919.4 *2*	0.26 *3*								
1924.2 *2*	0.18 *2*	1981.90	(3$^-$)	57.775	2$^+$				
^{x}1936.0 *2*	0.20 *3*								

$\gamma(^{228}$Th) (continued)

E_γ[‡]	I_γ[‡d]	E_i(level)	J_i^π	E_f	J_f^π
1952.39 *10*	0.76 *5*	2010.10	(2^+)	57.775	2^+
1958.1 *2*	0.29 *3*	1958.19	(2^+)	0.0	0^+
1965.22[ea] *12*	0.43[e] *4*	1965.05	(2^+)	0.0	0^+
1965.22[ea] *12*	0.43[e] *4*	2022.88	$(2)^+$	57.775	2^+

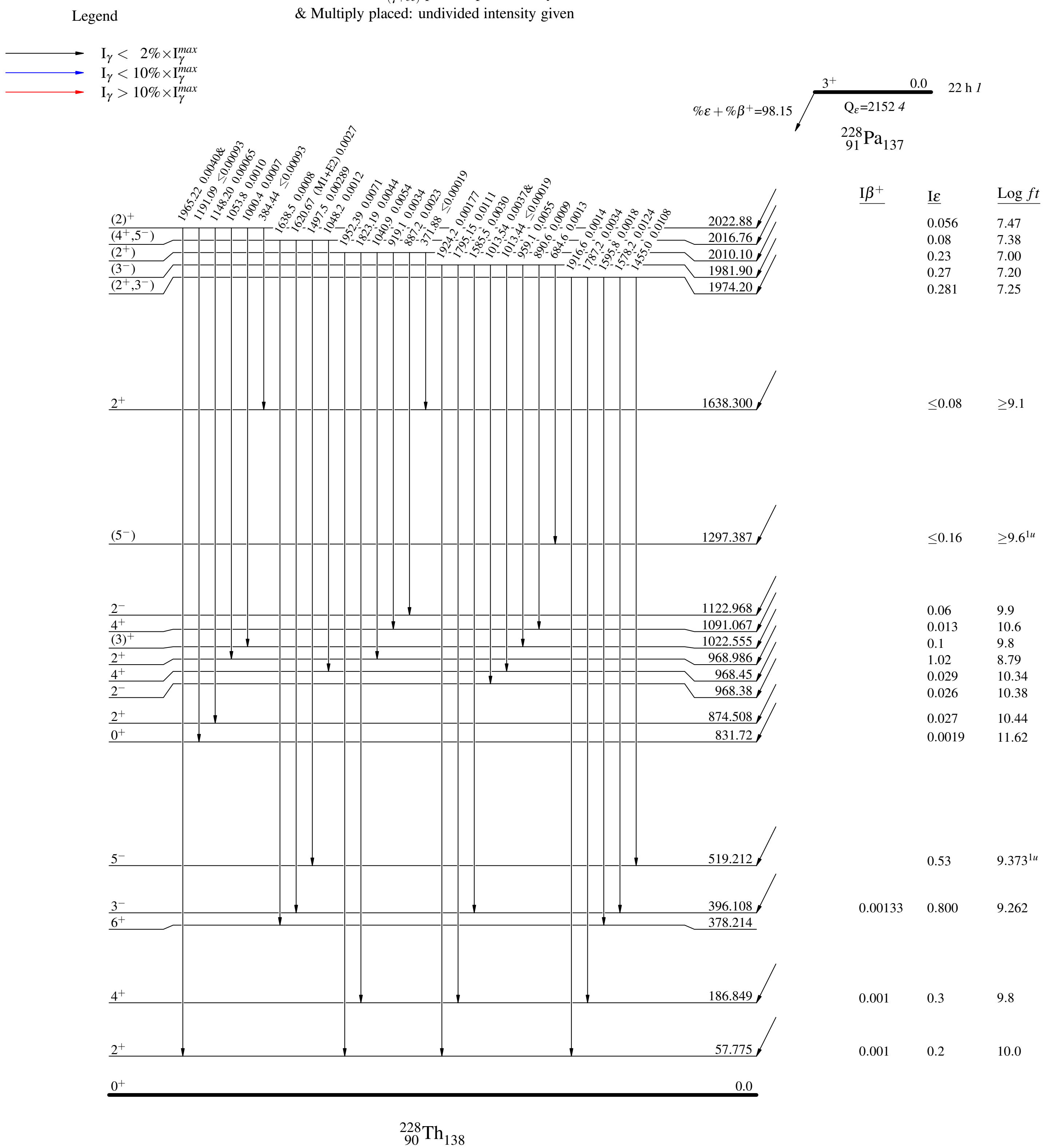
† Additional information 1.
‡ From 1998We13 and 1995Ba42, unless otherwise noted.
# Based on $\gamma(\theta$,H,T) of 1995Ba42 and on α′s and Ice ratios. α′s deduced from I(ce(K)) of 1973Ku09, 1971Am05 and/or 1960Ar06 as noted and Iγ of 1995Ba42. The I(ce(K)) are normalized to Iγ at 911.204γ (α(K)(E2)=0.0091).
@ From $\gamma(\theta$,H,T) in 1995Ba42, unless otherwise noted.
& Calculated using BrIcc v2.2s, 2008Ki07, "Frozen Orbitals".
a γ is seen as unresolved doublet in γ-ray singles spectrum.
b Energy calculated from E(level), existence of γ suggested by ^{228}Ac decay.
c From α data of 1995Ba42 (data not given).
d For absolute intensity per 100 decays, multiply by 0.0093 *5*.
e Multiply placed with undivided intensity.
f Multiply placed with intensity suitably divided.
g Placement of transition in the level scheme is uncertain.
x γ ray not placed in level scheme.

From ENSDF

^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme

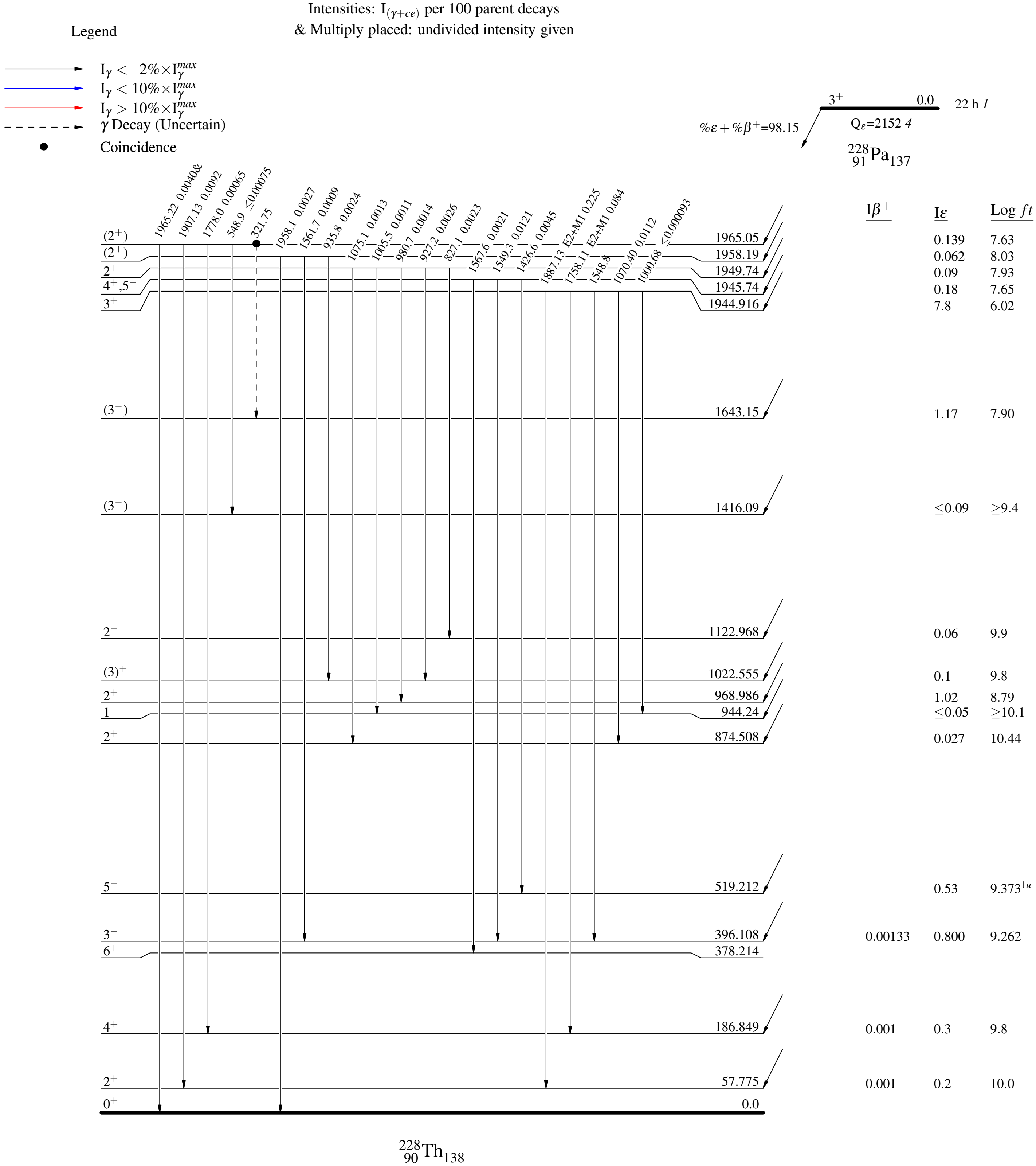
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

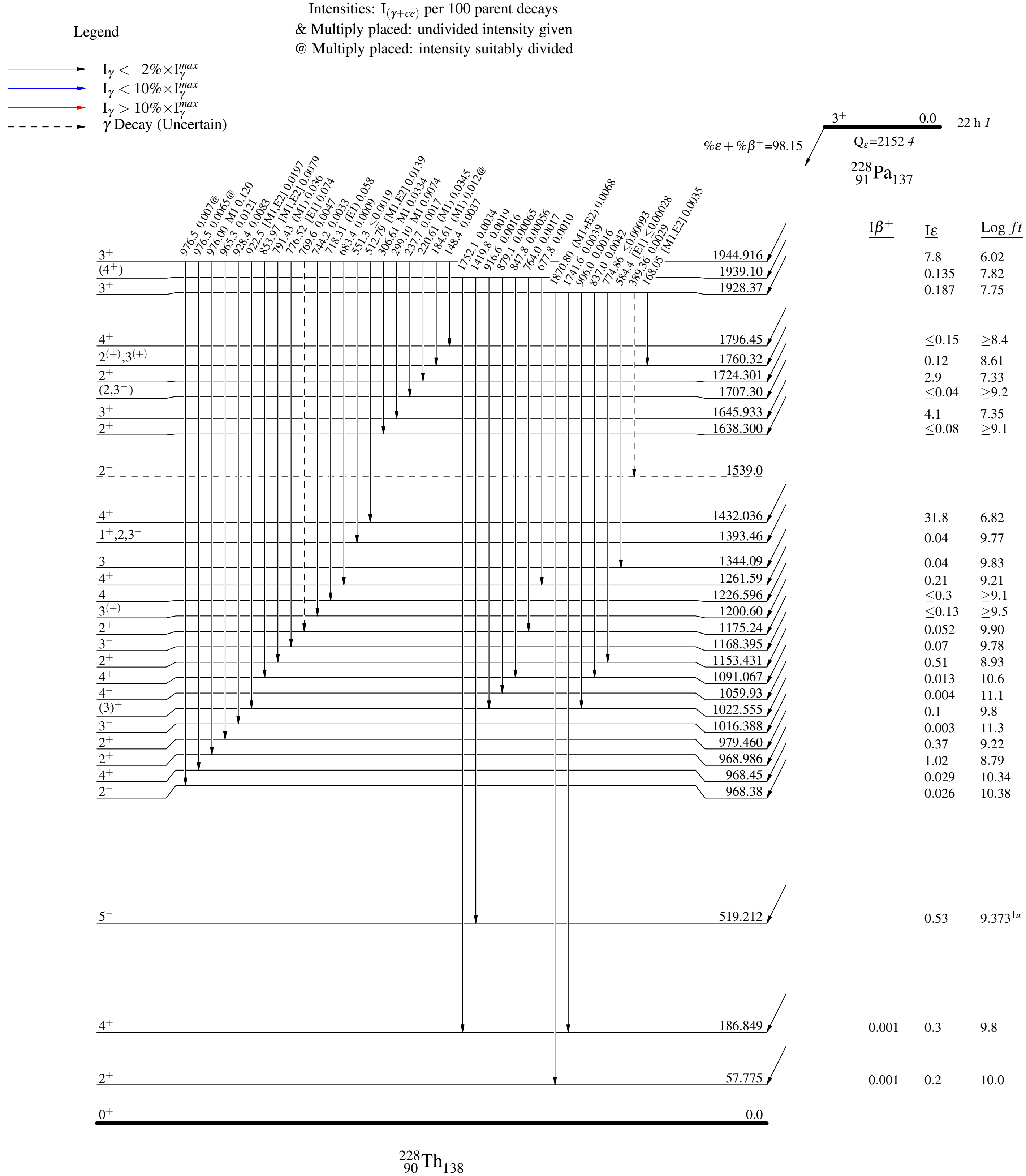
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

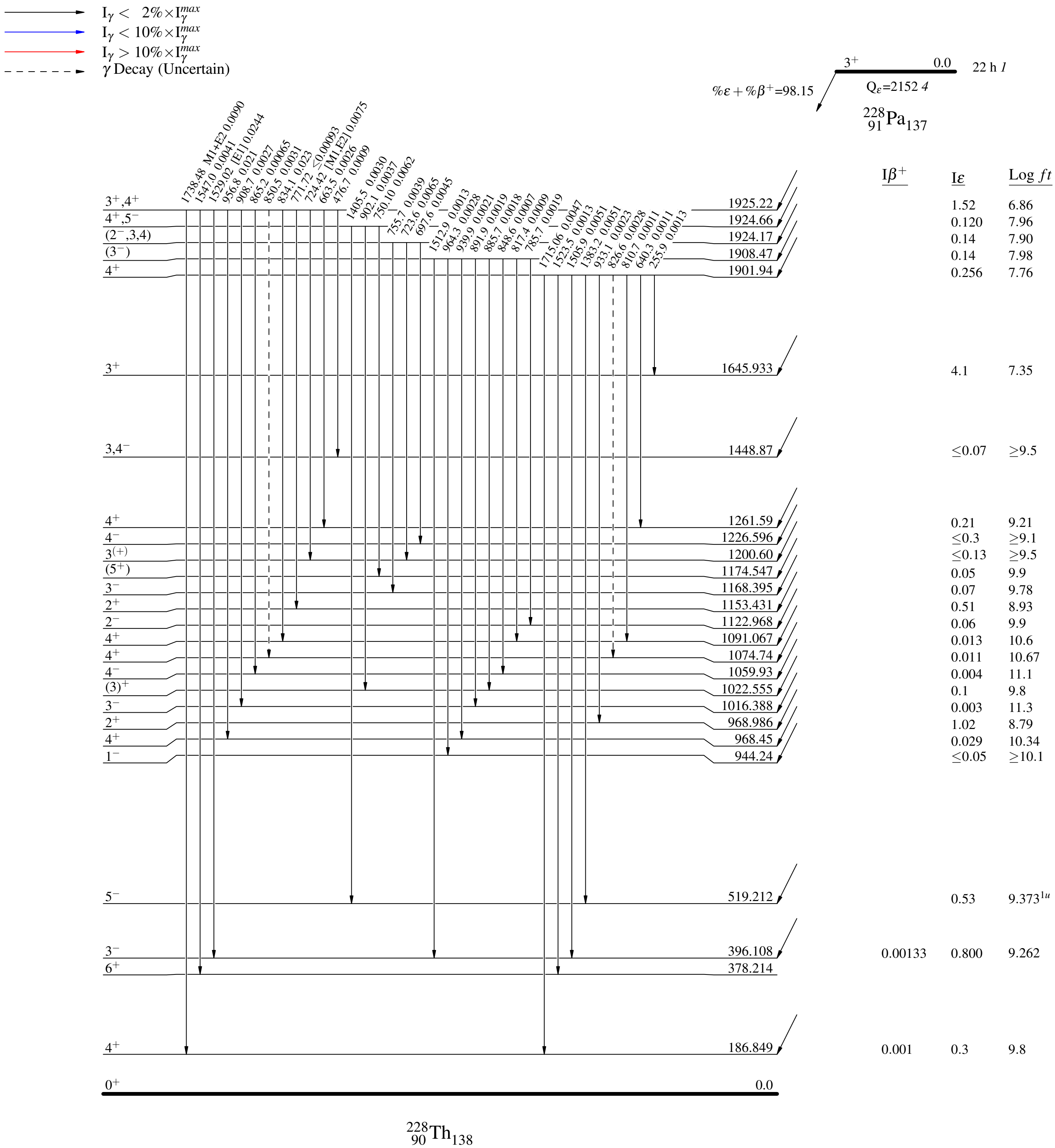
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

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

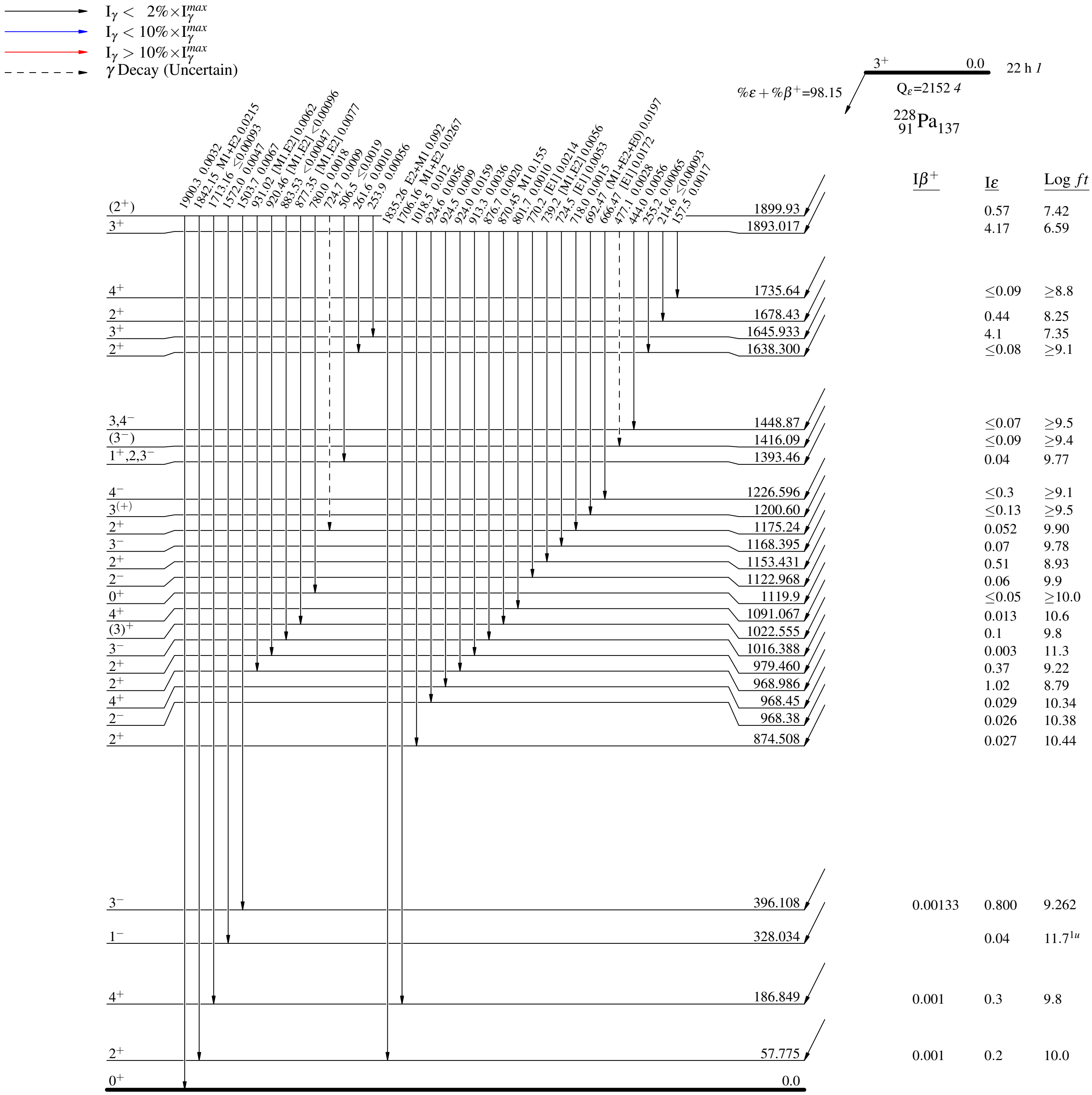


^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

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

Legend

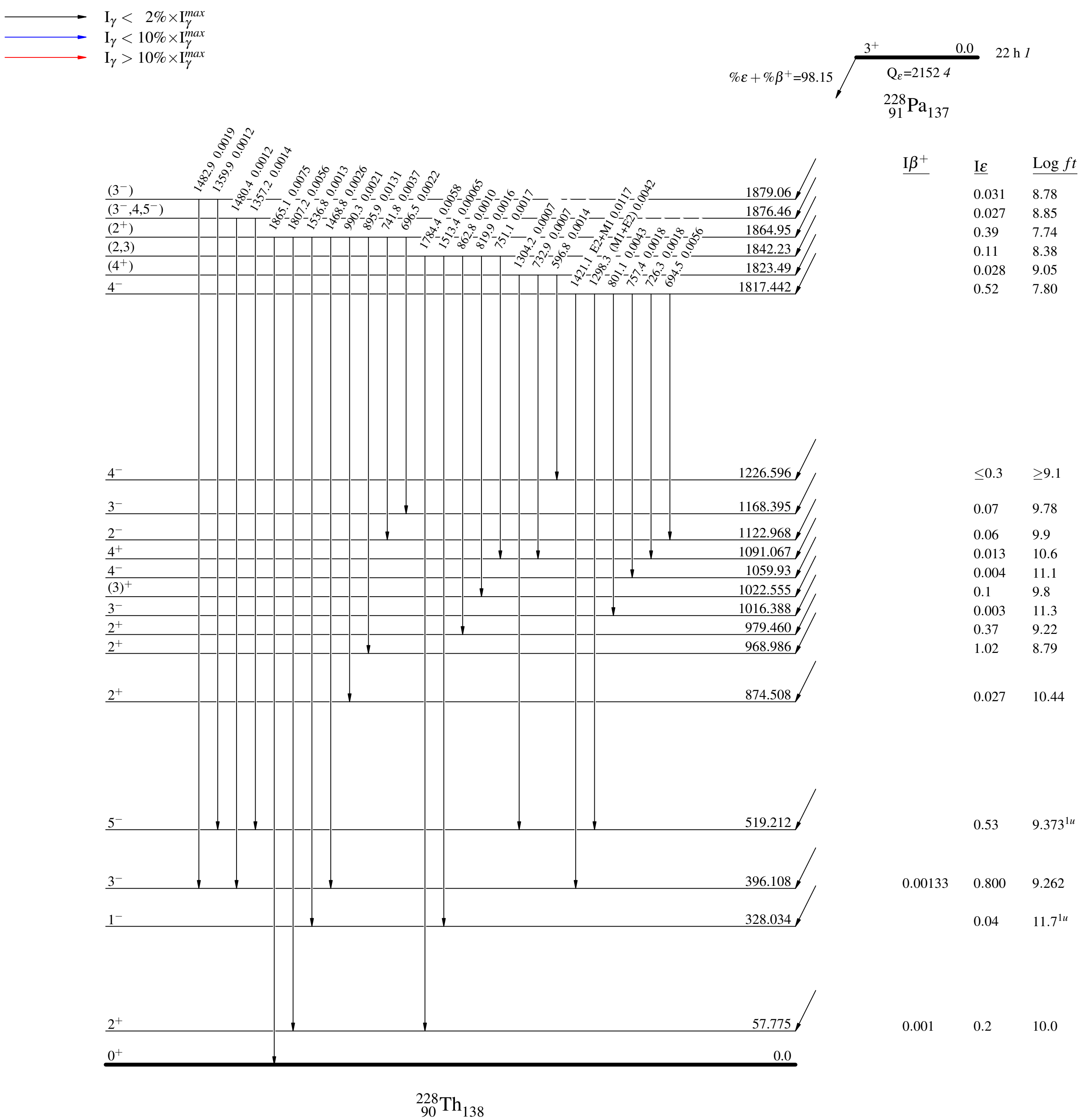


$^{228}_{90}Th_{138}$

^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

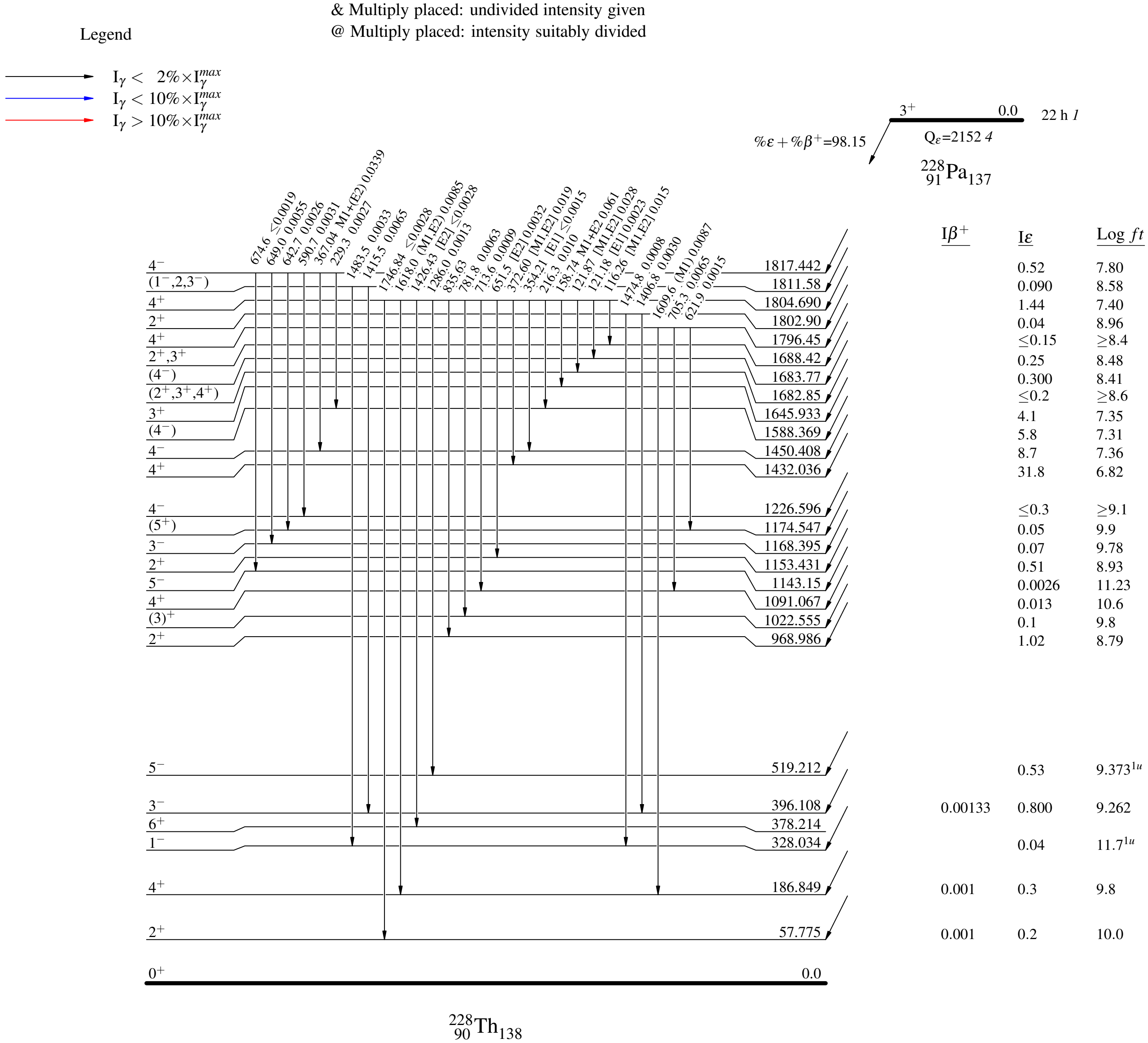
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

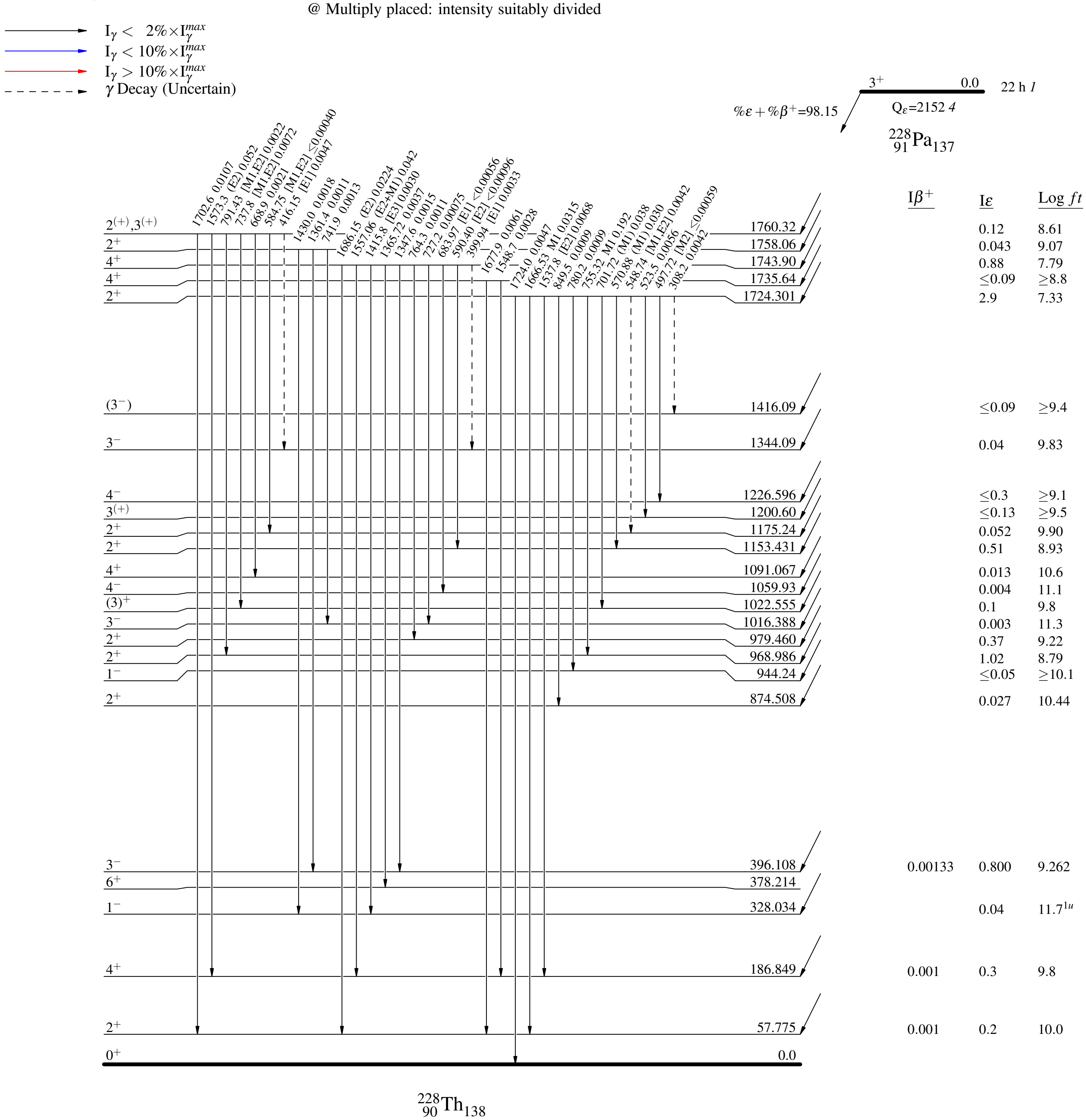
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

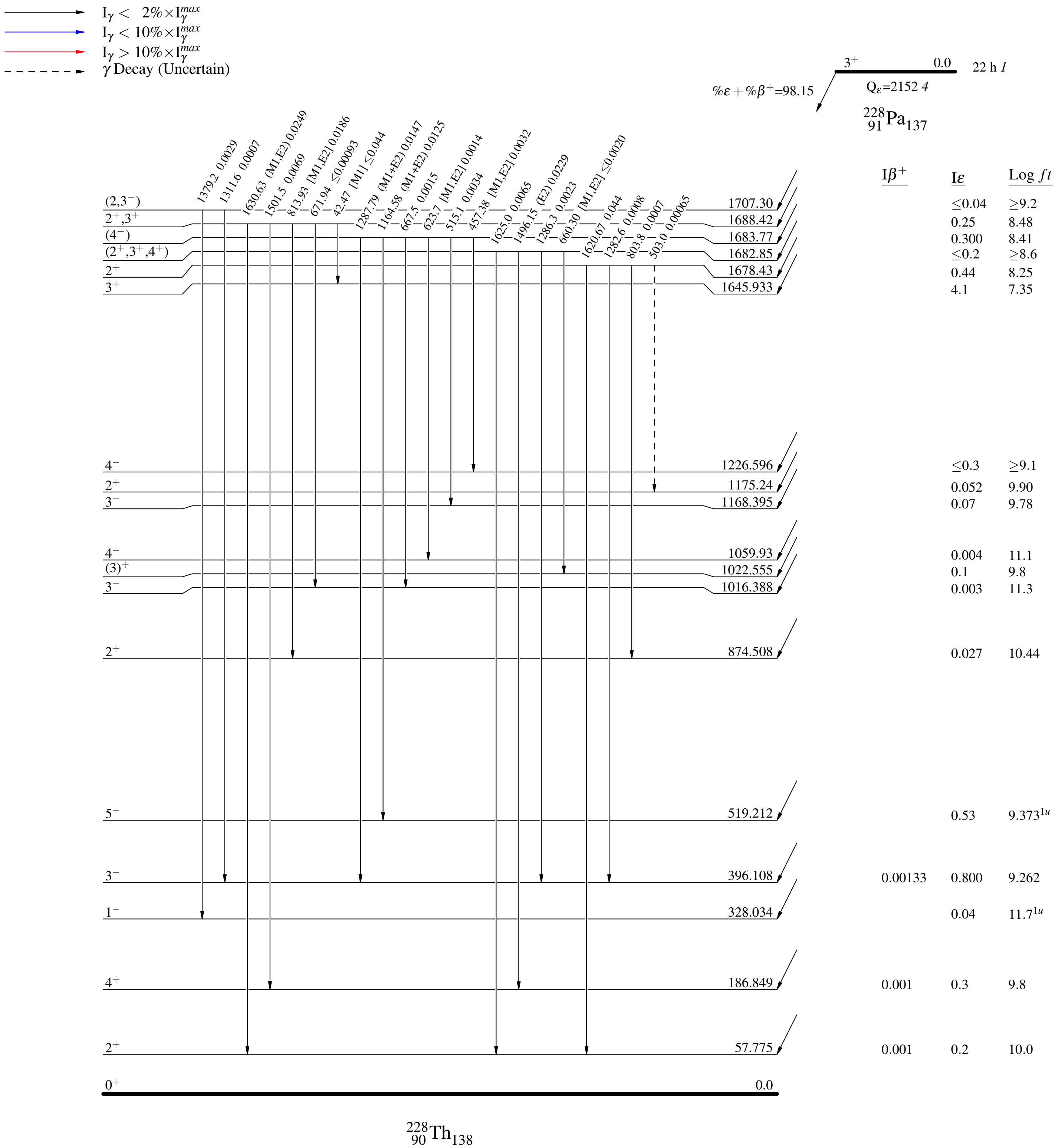
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

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

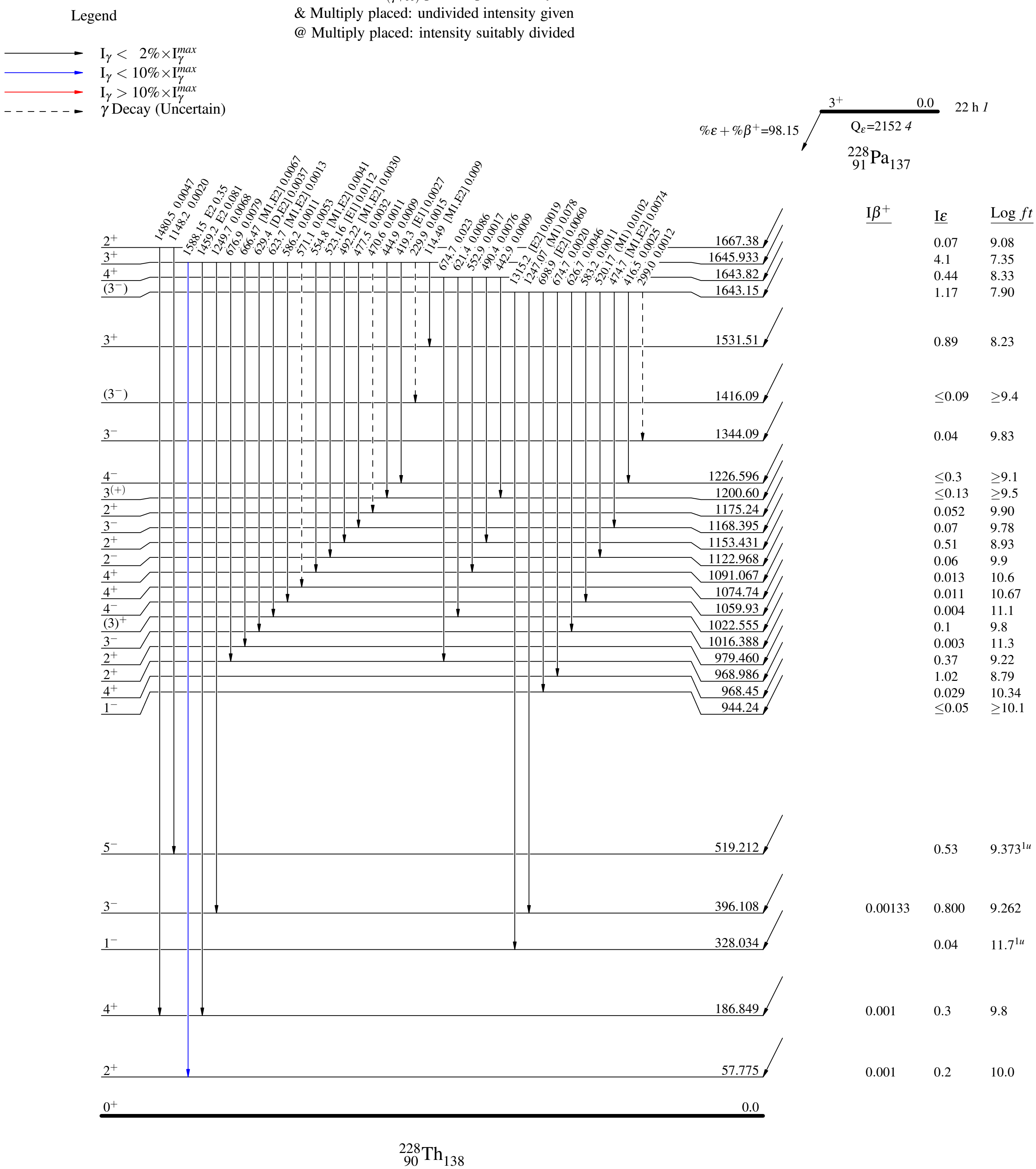


		Iβ+	Iε	Log ft
(2,3−)	1707.30		≤0.04	≥9.2
2+,3+	1688.42		0.25	8.48
(4−)	1683.77		0.300	8.41
(2+,3+,4+)	1682.85		≤0.2	≥8.6
2+	1678.43		0.44	8.25
3+	1645.933		4.1	7.35
4−	1226.596		≤0.3	≥9.1
2+	1175.24		0.052	9.90
3−	1168.395		0.07	9.78
4−	1059.93		0.004	11.1
(3)+	1022.555		0.1	9.8
3−	1016.388		0.003	11.3
2+	874.508		0.027	10.44
5−	519.212		0.53	9.373[1u]
3−	396.108	0.00133	0.800	9.262
1−	328.034		0.04	11.7[1u]
4+	186.849	0.001	0.3	9.8
2+	57.775	0.001	0.2	10.0
0+	0.0			

^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

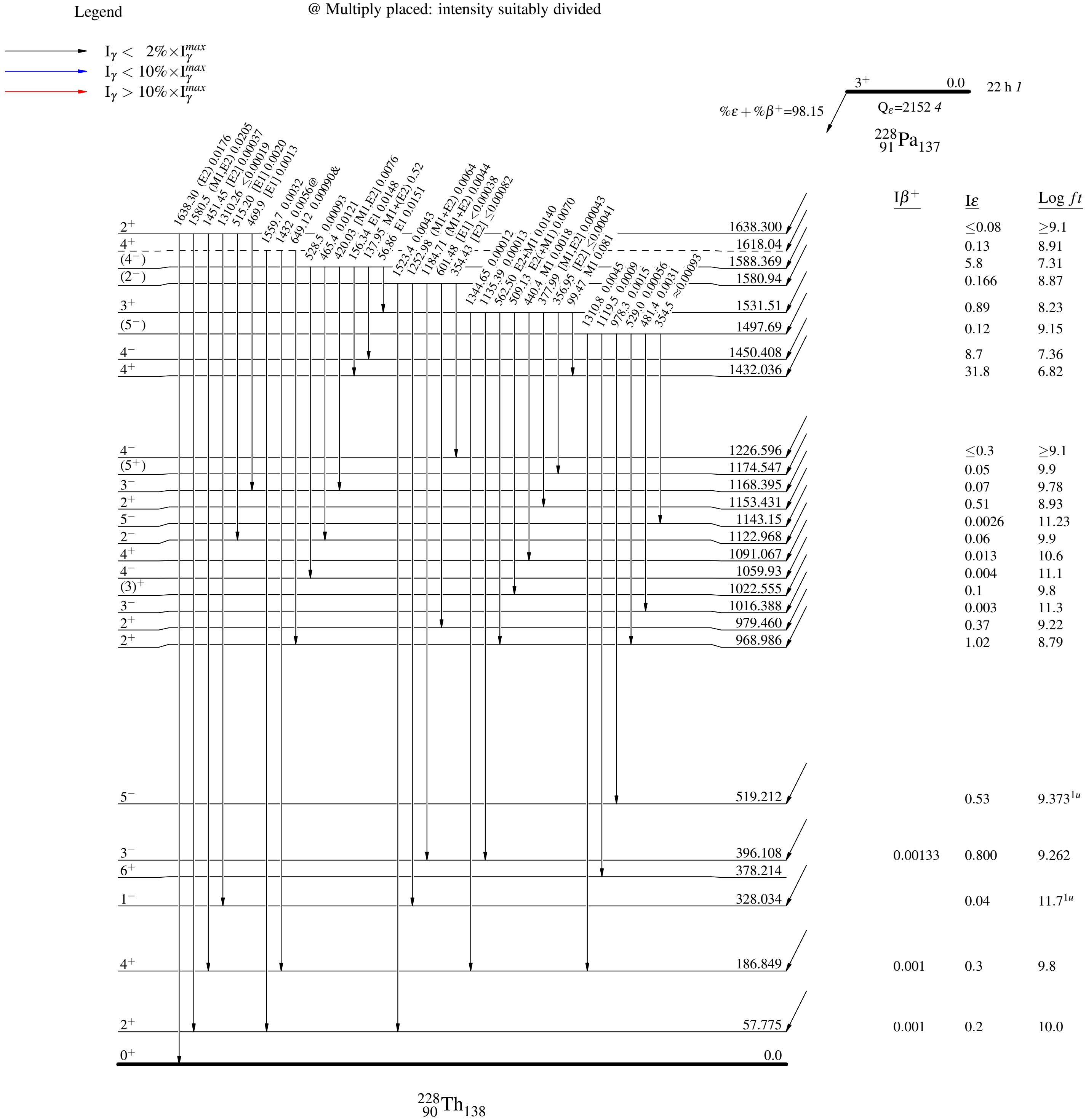
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

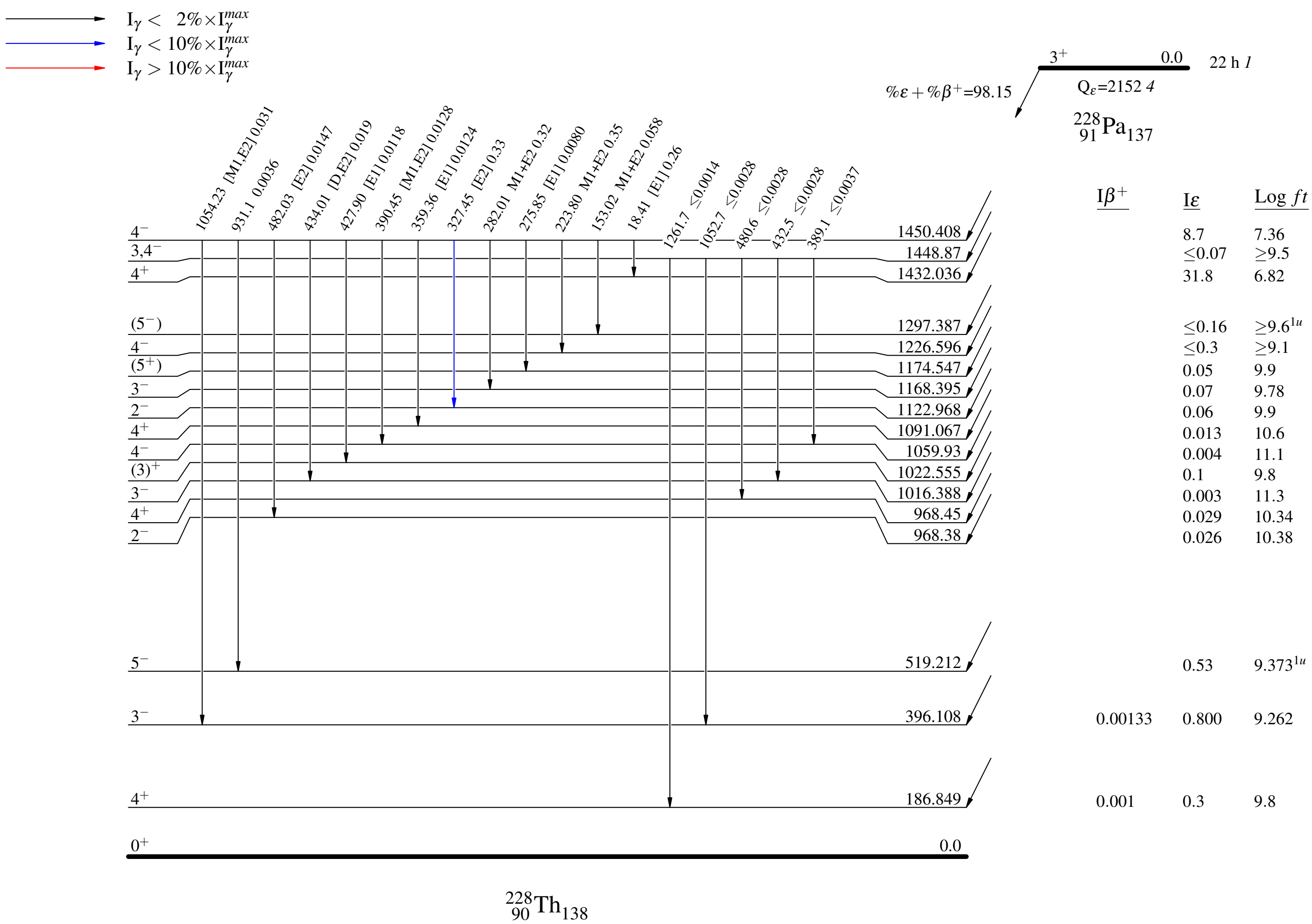
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

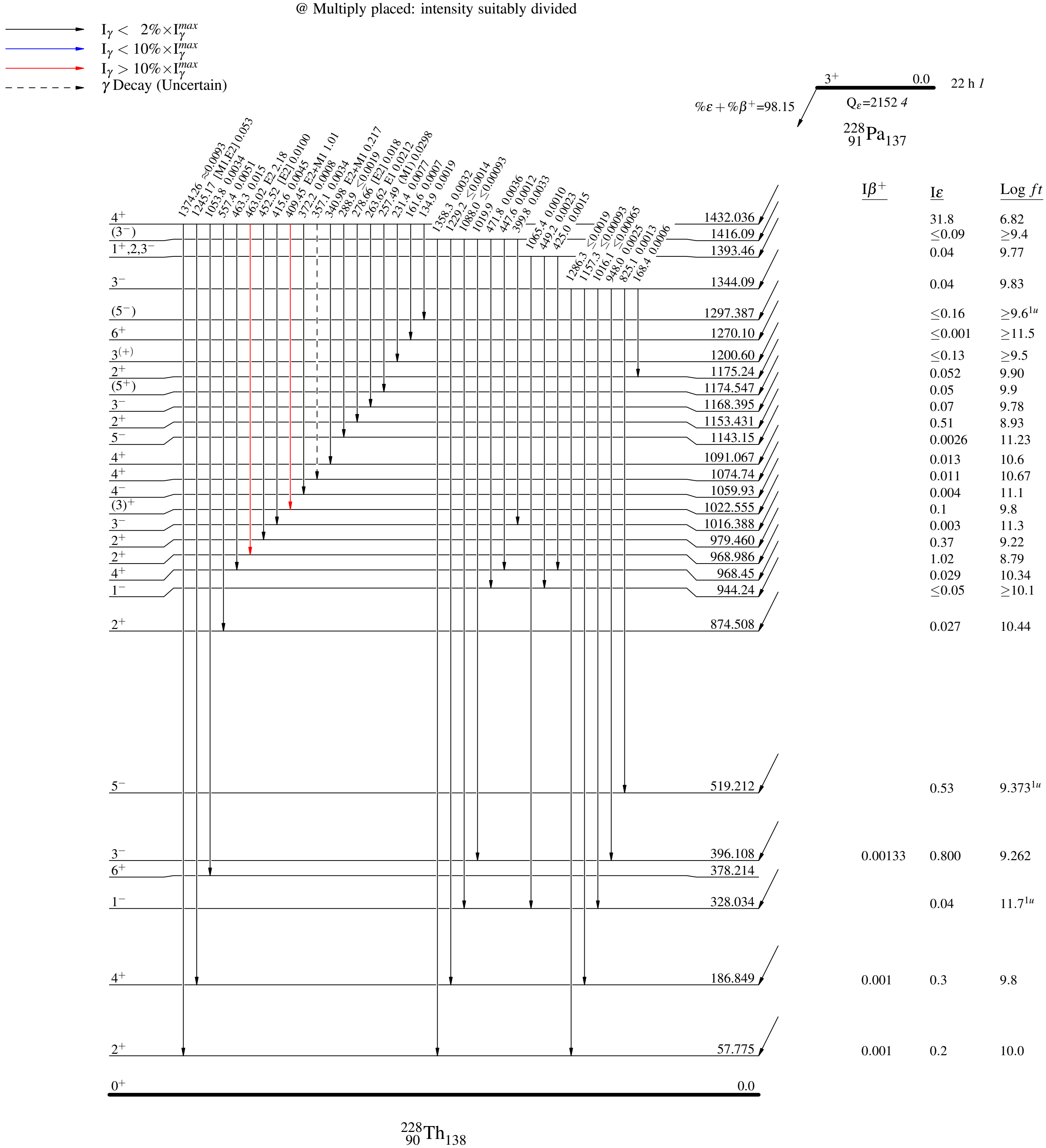
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

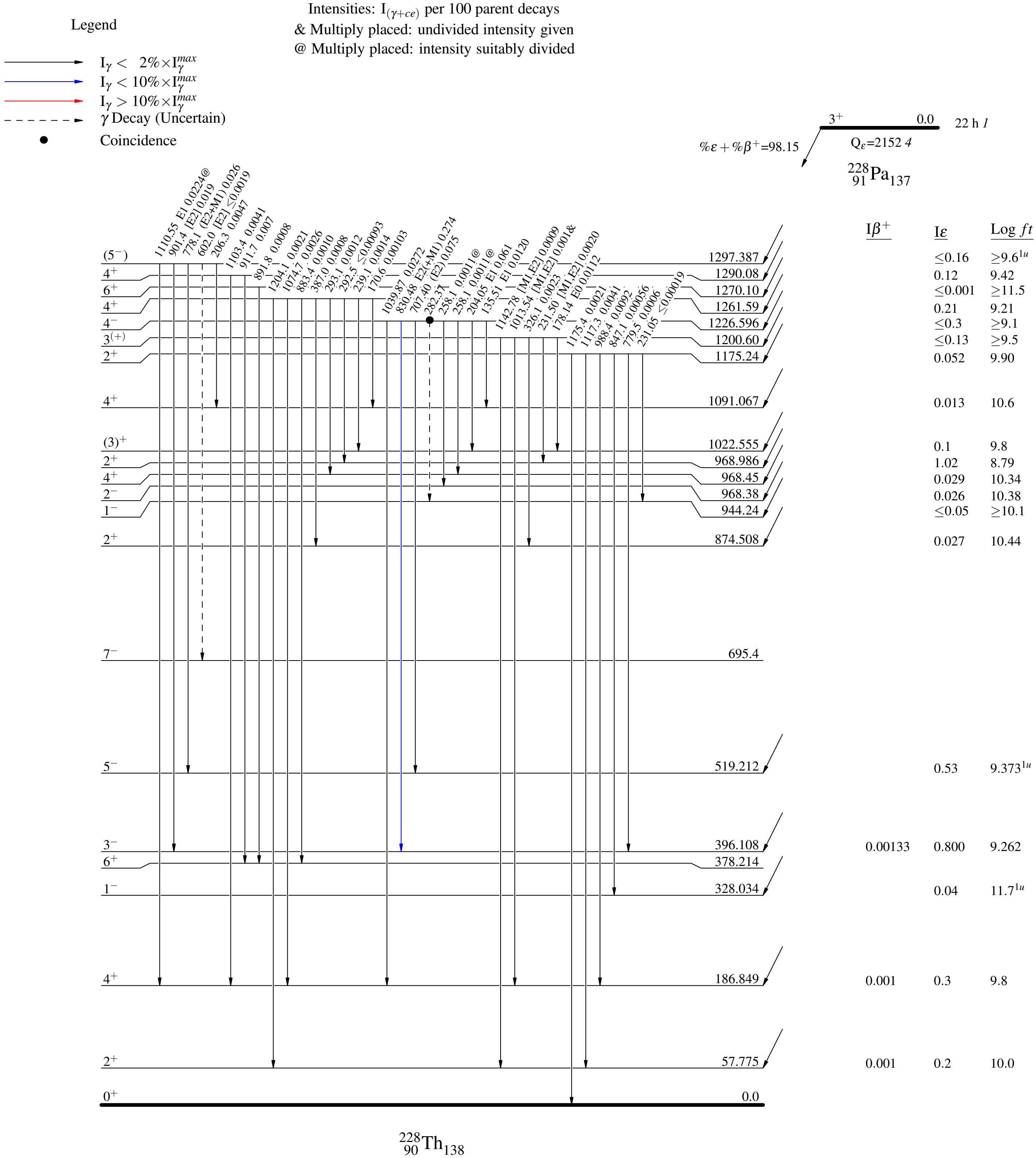
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

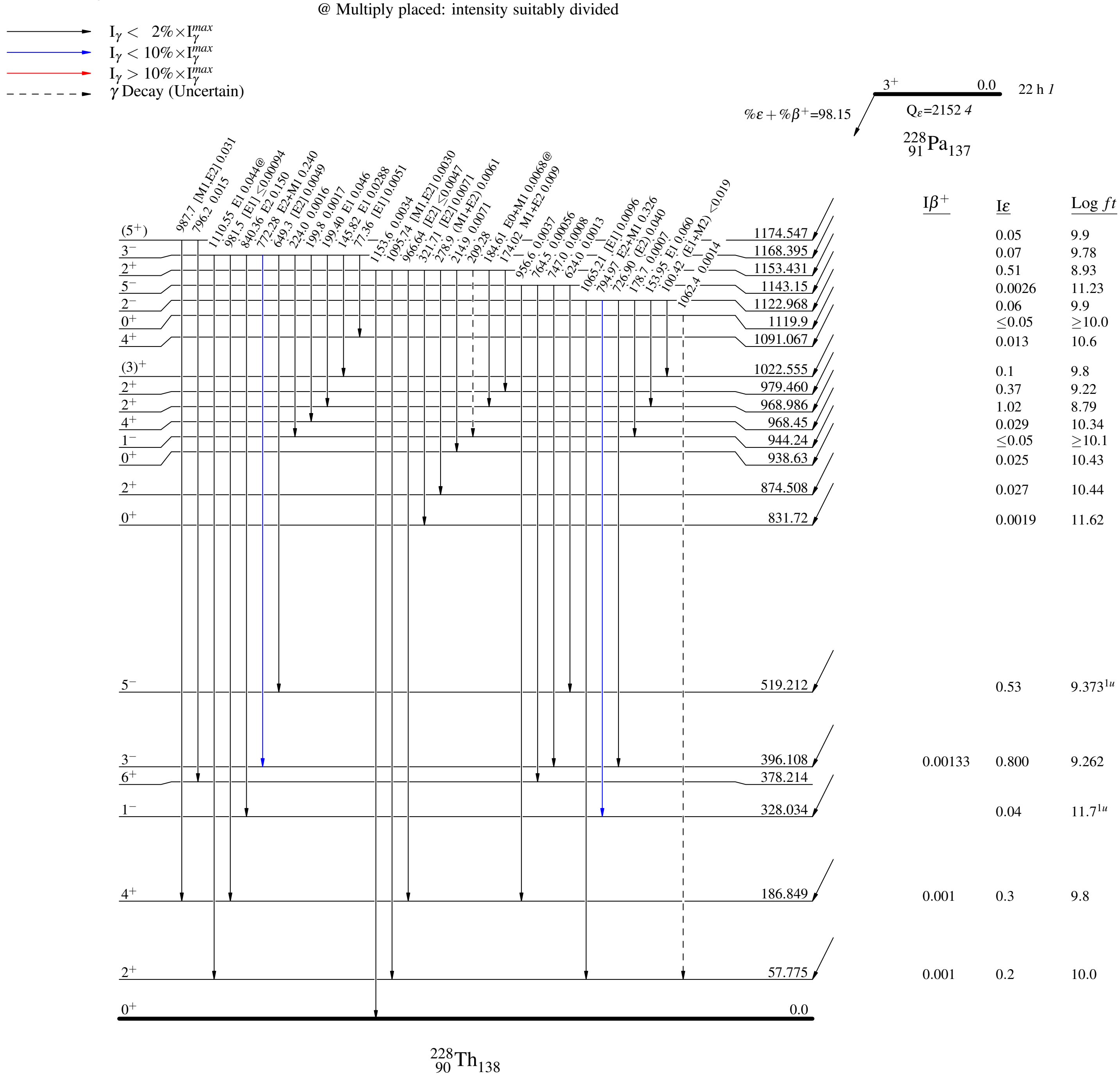
Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided



^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

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

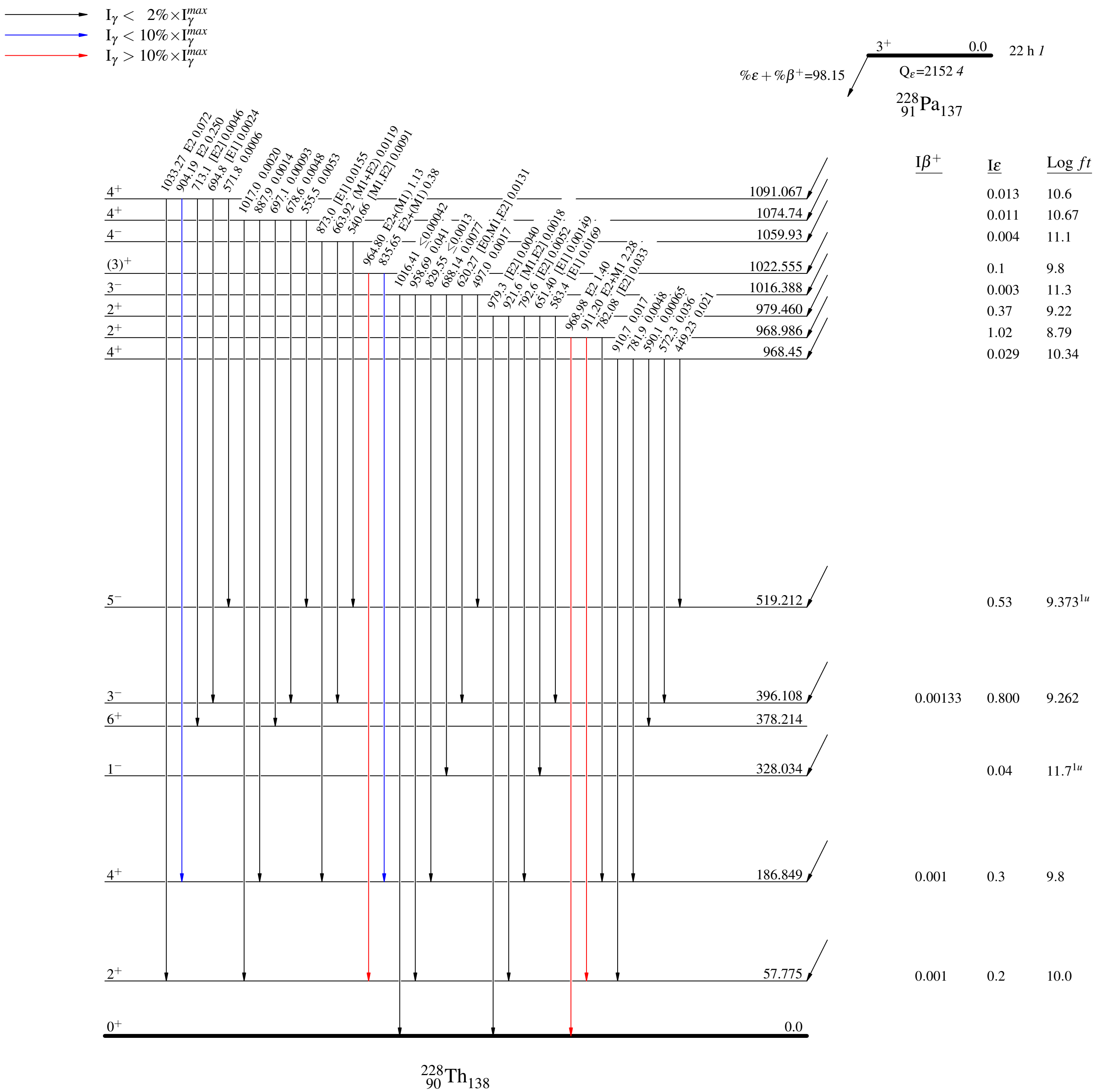


^{228}Pa ε decay 1998We13,1995Ba42

Decay Scheme (continued)

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

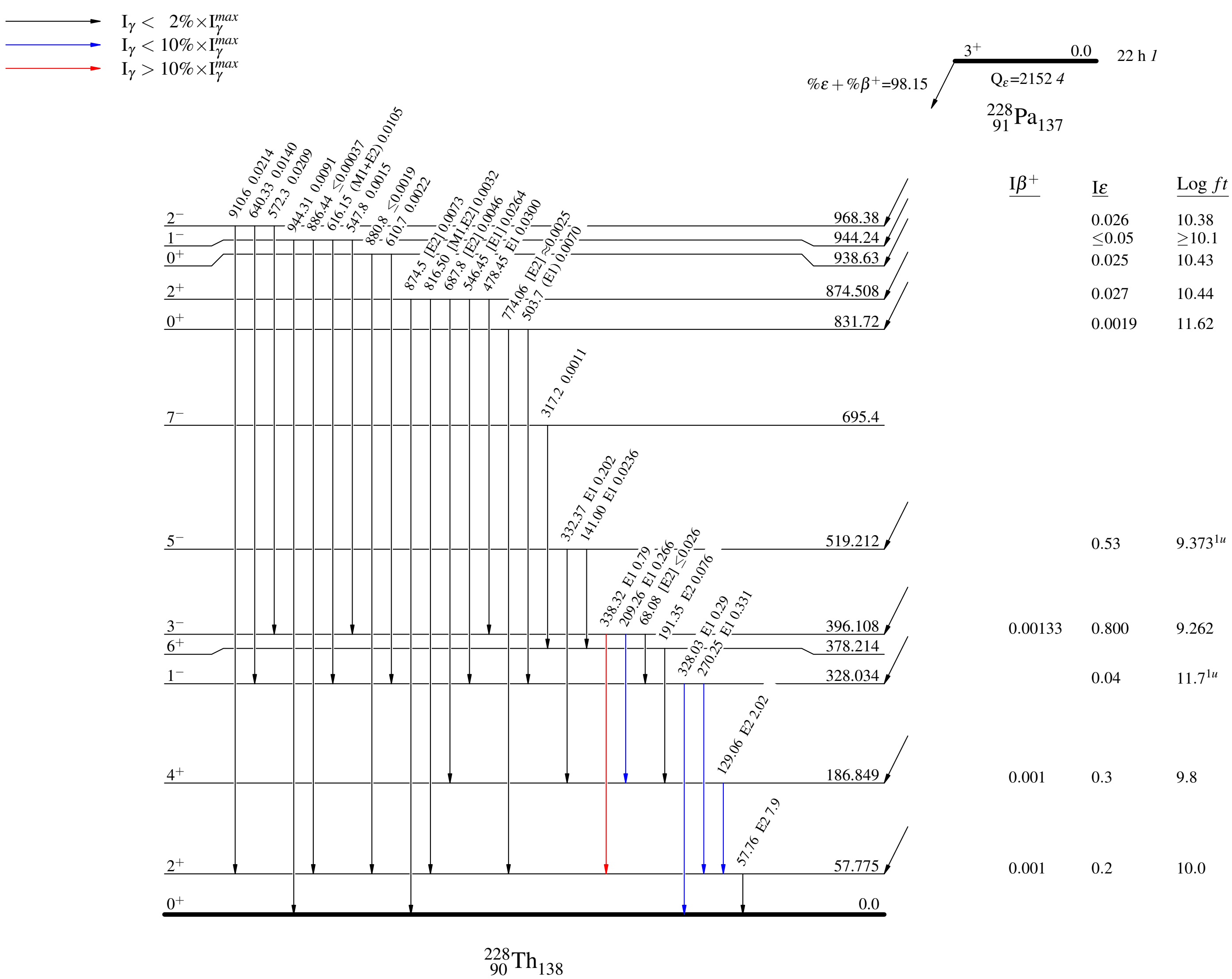
Legend

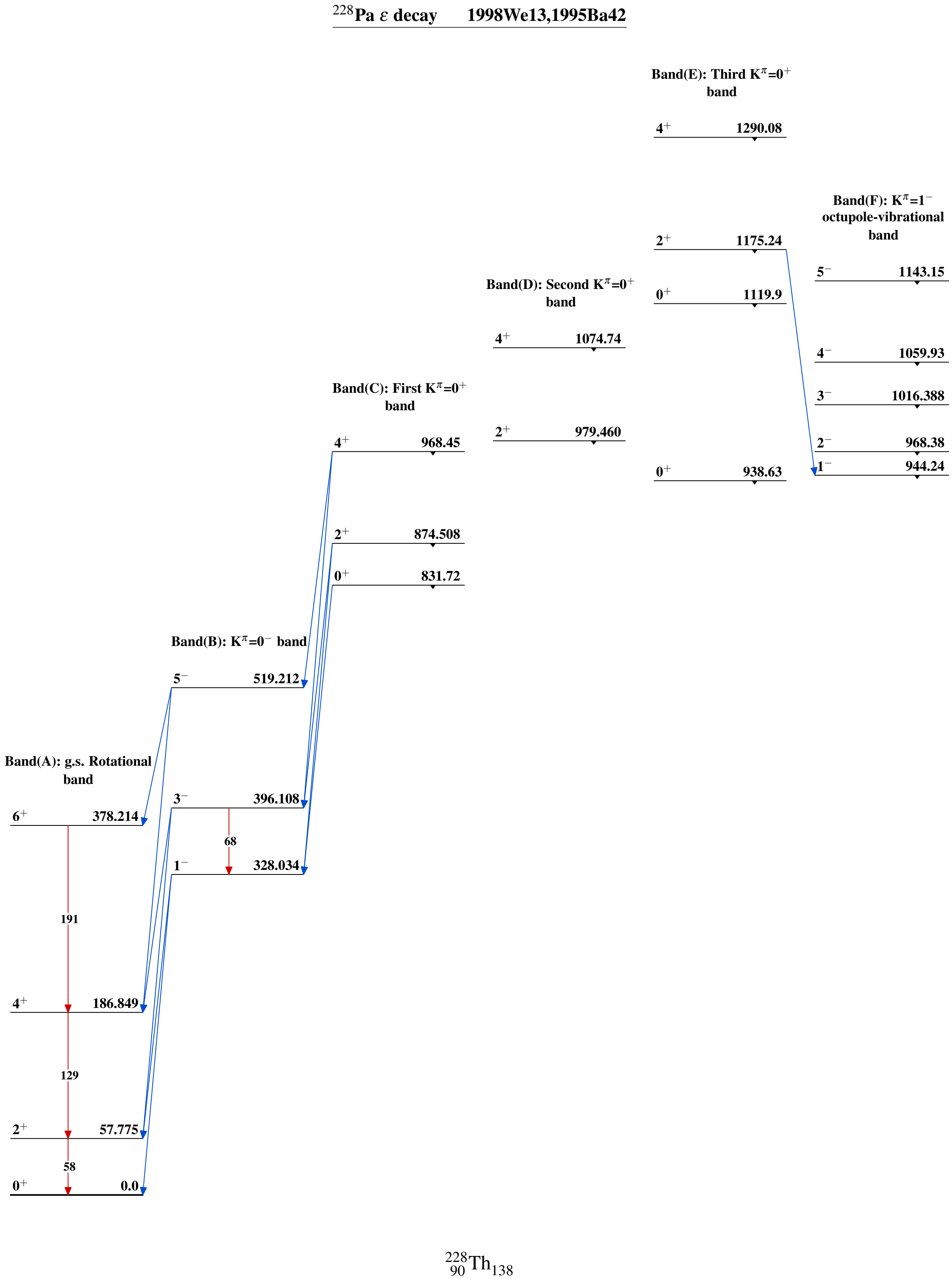


^{228}Pa ε decay 1998We13,1995Ba42

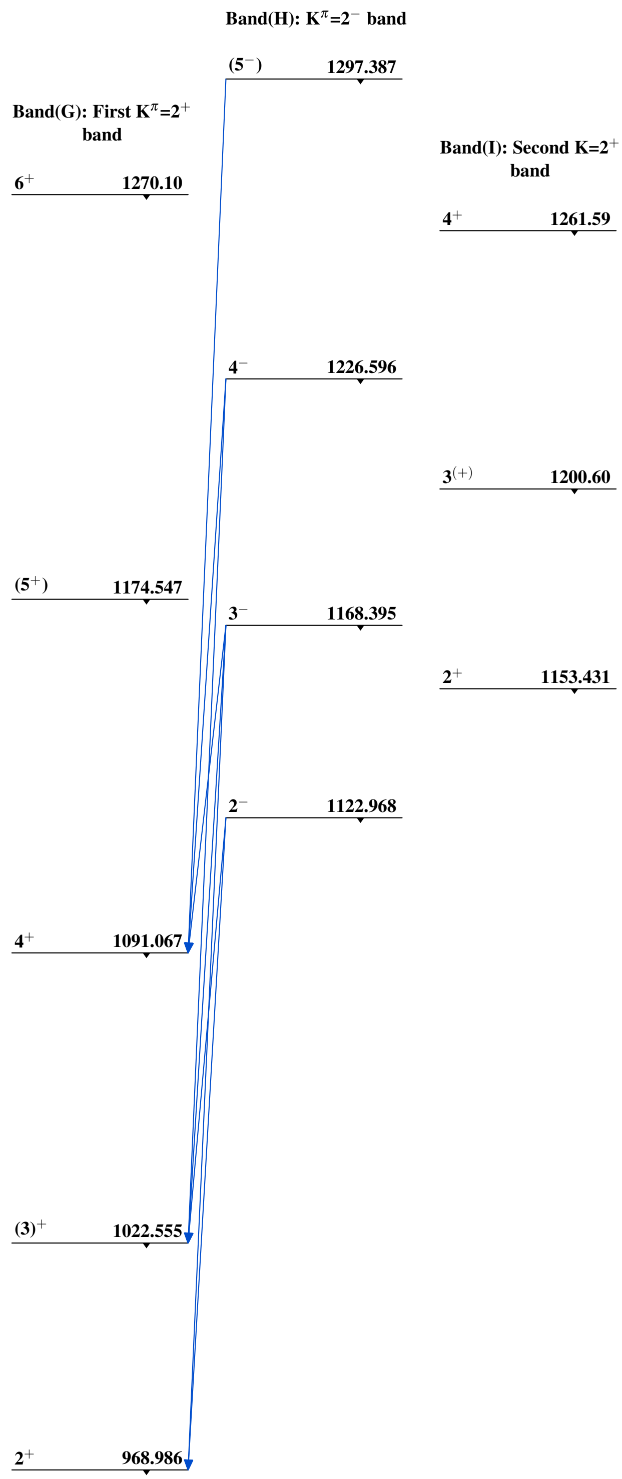
Decay Scheme (continued)

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




^{228}Pa ε decay 1998We13,1995Ba42
Band(E): Third $K^\pi=0^+$ band
4^+ 1290.08
Band(F): $K^\pi=1^-$ octupole-vibrational band
2^+ 1175.24
5^- 1143.15
Band(D): Second $K^\pi=0^+$ band
0^+ 1119.9
4^+ 1074.74
4^- 1059.93
Band(C): First $K^\pi=0^+$ band
3^- 1016.388
2^+ 979.460
4^+ 968.45
2^- 968.38
0^+ 938.63
1^- 944.24
2^+ 874.508
0^+ 831.72
Band(B): $K^\pi=0^-$ band
5^- 519.212
Band(A): g.s. Rotational band
3^- 396.108
6^+ 378.214
68
1^- 328.034
191
4^+ 186.849
129
2^+ 57.775
58
0^+ 0.0
$^{228}_{90}Th_{138}$

^{228}Pa ε decay 1998We13,1995Ba42 (continued)



$^{228}_{90}Th_{138}$