^{240}Np β^- decay (7.22 min) 1970Sc12,1981Hs02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, E. Browne	NDS 109, 2439 (2008)	31-Jul-2008

Parent: ^{240}Np: E=0+x; J^π=(1$^+$); $T_{1/2}$=7.22 min *2*; Q(β^-)=2188 *15*; %β^- decay=99.88 *1*
^{240}Np-E: X=20 *15* (see ^{240}Np 'Adopted Levels').
^{240}Np-%β^- decay: %β^-=99.88 *1* based on %IT=0.12 *1* (1981Hs02).
β^-, ce data from 1959Bu20, 1964As11. Other β^- intensities from intensity balance.
1970Sc12, 1970Sc39: $\gamma\gamma(\theta)$ measurements.
Eβ measurement: 1959Bu20.

^{240}Pu Levels

E(level)	J^π †	E(level)	J^π †	E(level)	J^π †	E(level)	J^π †
0	0$^+$	958.84 *6*	(2$^-$)	1488.17 *7*	(1$^-$)	1796.16 *11*	(1)$^-$
42.824 *8*	2$^+$	1089.45? *10*	0$^+$	1525.86 *8*	(0$^+$)	1808.02 *13*	(1$^-$,2$^+$)
141.688 *21*	4$^+$	1130.95 *9*	(2$^+$)	1539.67 *6*	(1$^-$)	1917.8 *3*	(1$^-$)
294.3 *10*	6$^+$	1136.97 *13*	(2$^+$)	1558.87 *5*	(2$^+$)	1954.51 *8*	(2$^+$)
597.35 *3*	1$^-$	1222.89 *13*	(2$^+$)	1607.72 *13*	(1$^-$)	1996.42 *17*	(1$^-$,2$^+$)
648.86 *4*	3$^-$	1240.8? *3*	(2$^-$)	1626.77 *15*	(1$^-$)	2117.63 *20*	(1,2$^+$)
860.71 *6*	0$^+$	1321.11? *10*	(1,2$^+$)	1633.37 *7*	(1$^-$)		
900.32 *4*	2$^+$	1410.76 *11*	0$^{(-)}$ ‡	1710.43 *8*	(2$^+$)		
938.05 *3*	(1$^-$)	1438.45 *8*	2$^{(-)}$ #	1775.27 *15*	(1)$^-$		

† From 'Adopted Levels'.
‡ $\gamma\gamma(\theta)$ consistent with J=0 (1970Sc12).
# $\gamma\gamma(\theta)$ data are consistent only with J=2 (1970Sc12).

β^- radiations

E(decay)	E(level)	Iβ^- †	Log *ft*	Comments
(70 *15*)	2117.63	0.0038 *7*	6.1 *4*	av Eβ=23.4 *58*
(192 *15*)	1996.42	0.008 *2*	6.9 *2*	av Eβ=57.1 *62*
(233 *15*)	1954.51	0.055 *8*	6.3 *2*	av Eβ=69.3 *63*
(270 *15*)	1917.8	0.013 *1*	7.1 *1*	av Eβ=80.1 *64*
(380 *15*)	1808.02	0.030 *5*	7.2 *1*	av Eβ=113.9 *67*
(392 *15*)	1796.16	0.041 *5*	7.1 *1*	av Eβ=117.6 *68*
(413 *15*)	1775.27	0.005 *2*	8.1 *2*	av Eβ=124.2 *68*
(478 *15*)	1710.43	0.084 *9*	7.1 *1*	av Eβ=145.1 *70*
(555 *15*)	1633.37	0.26 *1*	6.8 *1*	av Eβ=170.5 *71*
(580 *15*)	1607.72	0.07 *1*	7.4 *1*	av Eβ=179.1 *72*
(629 *15*)	1558.87	0.31 *3*	6.9 *1*	av Eβ=195.6 *73*
(648 *15*)	1539.67	2.3 *1*	6.07 *5*	av Eβ=202.2 *73*
(662 *15*)	1525.86	0.16 *2*	7.3 *1*	av Eβ=206.9 *73*
(700 *15*)	1488.17	0.58 *2*	6.78 *5*	av Eβ=220.0 *74*
(750 *15*)	1438.45	0.36 *4*	7.1 *1*	av Eβ=237.3 *75*
(777 *15*)	1410.76	0.20 *3*	7.4 *1*	av Eβ=247.0 *75*
(867 *15*)	1321.11?	0.034 *5*	8.3 *1*	av Eβ=278.9 *77*
(947 *15*)	1240.8?	0.010 *2*	9.0 *1*	av Eβ=308.0 *78*
(965 *15*)	1222.89	0.028 *7*	8.6 *1*	av Eβ=314.5 *78*
(1051 *15*)	1136.97	0.014 *5*	9.0 *2*	av Eβ=346.1 *79*
(1057 *15*)	1130.95	0.18 *1*	7.89 *4*	av Eβ=348.3 *79*
(1099 *15*)	1089.45?	0.10 *2*	8.2 *1*	av Eβ=363.8 *80*
(1229 *15*)	958.84	1.26 *5*	7.27 *4*	av Eβ=412.8 *81*

Continued on next page (footnotes at end of table)

^{240}Np β^- decay (7.22 min) 1970Sc12,1981Hs02 (continued)

β^- radiations (continued)

E(decay)	E(level)	Iβ^- †	Log *ft*	Comments
(1250 *15*)	938.05	1.4 *1*	7.25 *4*	av Eβ=420.7 *81*
(1288 *15*)	900.32	3.8 *2*	6.86 *4*	av Eβ=435.1 *81*
(1327 *15*)	860.71	2.5 *2*	7.09 *5*	av Eβ=450.2 *82*
(1539‡ *15*)	648.86	<0.1	>9.5[1u]	av Eβ=505.8 *78*
(1591 *15*)	597.35	31 *2*	6.27 *4*	av Eβ=552.2 *84* Iβ^-: from 1959Bu20. E(decay): 1600 *30* (1959Bu20).
(2046‡ *15*)	141.688	<1.5	>8.0	av Eβ=733.2 *86*
(2145 *15*)	42.824	≈42	≈6.6	av Eβ=772.9 *86* Iβ^-: Iβ(2180)+Iβ(2140)=52% *3* (1959Bu20).
2180 *20*	0	≈10	≈7.3	av Eβ=790.2 *86* E(decay): 2180 *20* (1959Bu20).

† For absolute intensity per 100 decays, multiply by 0.9988 *1*.

‡ Existence of this branch is questionable.

γ(^{240}Pu)

Iγ normalization: Based on absolute intensity I(554.60γ)=20.9 *5* per 100 ^{244}Pu α decays (22.4 *11* (1970Sc12), 20.6 *5* (1981Hs02)). β^- measurements (1959Bu20) result in a similar normalization.

E_γ[#]	I_γ[#@]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[‡]	α[&]	Comments
42.824[†] *8*	0.074 *16*	42.824	2$^+$	0	0$^+$	E2	906	α(L)=658 *10*; α(M)=183 *3*; α(N+..)=64.1 *9* α(N)=50.4 *7*; α(O)=11.84 *17*; α(P)=1.85 *3*; α(Q)=0.00390 *6*
98.860[†] *20*	0.17 *3*	141.688	4$^+$	42.824	2$^+$	E2	16.65	α(L)=12.08 *17*; α(M)=3.38 *5*; α(N+..)=1.185 *17* α(N)=0.930 *13*; α(O)=0.219 *3*; α(P)=0.0349 *5*; α(Q)=0.0001222 *18*
(152.630[†])	<0.02	294.3	6$^+$	141.688	4$^+$	E2	2.49	α(K)=0.196 *3*; α(L)=1.665 *24*; α(M)=0.465 *7*; α(N+..)=0.1629 *23* α(N)=0.1278 *18*; α(O)=0.0302 *5*; α(P)=0.00488 *7*; α(Q)=2.76×10^{-5} *4*
251.47 *7*	0.86 *3*	900.32	2$^+$	648.86	3$^-$	[E1]	0.0610	α(K)=0.0480 *7*; α(L)=0.00983 *14*; α(M)=0.00239 *4*; α(N+..)=0.000832 *12* α(N)=0.000645 *9*; α(O)=0.0001571 *22*; α(P)=2.81×10^{-5} *4*; α(Q)=1.406×10^{-6} *20*
263.37 *7*	1.14 *2*	860.71	0$^+$	597.35	1$^-$	(E1)	0.0550	α(K)=0.0433 *6*; α(L)=0.00881 *13*; α(M)=0.00214 *3*; α(N+..)=0.000745 *11* α(N)=0.000578 *9*; α(O)=0.0001409 *20*; α(P)=2.52×10^{-5} *4*; α(Q)=1.277×10^{-6} *18*
289.21 *10*	0.017 *4*	938.05	(1$^-$)	648.86	3$^-$	[E2]	0.237	α(K)=0.0824 *12*; α(L)=0.1131 *16*; α(M)=0.0310 *5*; α(N+..)=0.01088 *16* α(N)=0.00851 *12*; α(O)=0.00203 *3*; α(P)=0.000339 *5*; α(Q)=4.83×10^{-6} *7*
302.98 *7*	1.00 *4*	900.32	2$^+$	597.35	1$^-$	[E1]	0.0405	α(K)=0.0320 *5*; α(L)=0.00637 *9*; α(M)=0.001543 *22*; α(N+..)=0.000538 *8* α(N)=0.000417 *6*; α(O)=0.0001018 *15*; α(P)=1.84×10^{-5} *3*; α(Q)=9.59×10^{-7} *14*
309.99 *9*	0.044 *4*	958.84	(2$^-$)	648.86	3$^-$	[M1]	1.093	α(K)=0.865 *13*; α(L)=0.1715 *24*; α(M)=0.0417 *6*; α(N+..)=0.01472 *21* α(N)=0.01133 *16*; α(O)=0.00282 *4*; α(P)=0.000536 *8*; α(Q)=3.50×10^{-5} *5*
340.70 *1*	0.060 *6*	938.05	(1$^-$)	597.35	1$^-$	[M1]	0.842	α(K)=0.667 *10*; α(L)=0.1320 *19*; α(M)=0.0321 *5*; α(N+..)=0.01133 *16* α(N)=0.00872 *13*; α(O)=0.00217 *3*; α(P)=0.000413 *6*; α(Q)=2.69×10^{-5} *4*
361.55 *10*	0.036 *6*	958.84	(2$^-$)	597.35	1$^-$	[M1]	0.716	α(K)=0.567 *8*; α(L)=0.1121 *16*; α(M)=0.0272 *4*; α(N+..)=0.00962 *14* α(N)=0.00740 *11*; α(O)=0.00184 *3*; α(P)=0.000350 *5*; α(Q)=2.28×10^{-5} *4*
475.0 *3*	0.011 *3*	1796.16	(1)$^-$	1321.11?	(1,2$^+$)			
496.7 *3*	0.010 *2*	1633.37	(1$^-$)	1136.97	(2$^+$)			
507.2 *1*	0.70 *9*	648.86	3$^-$	141.688	4$^+$	[E1]	0.01401	α(K)=0.01126 *16*; α(L)=0.00208 *3*; α(M)=0.000500 *7*; α(N+..)=0.0001749 *25* α(N)=0.0001352 *19*; α(O)=3.33×10^{-5} *5*; α(P)=6.13×10^{-6} *9*; α(Q)=3.53×10^{-7} *5*
518.2 *3*	0.006 *2*	1607.72	(1$^-$)	1089.45?	0$^+$			
554.60 *7*	20.9 *5*	597.35	1$^-$	42.824	2$^+$	E1	0.01179	α(K)=0.00949 *14*; α(L)=0.001734 *25*; α(M)=0.000417 *6*; α(N+..)=0.0001458 *21* α(N)=0.0001126 *16*; α(O)=2.77×10^{-5} *4*; α(P)=5.13×10^{-6} *8*; α(Q)=2.99×10^{-7} *5* Mult.: from α(K)exp=0.0092 *9*, K:L1=5.2 *10* (1959Bu20).
573.4[a] *2*	0.008[a] *2*	1710.43	(2$^+$)	1136.97	(2$^+$)			

From ENSDF

$\gamma(^{240}Pu)$ (continued)

E_γ[#]	I_γ[#@]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[‡]	α[&]	$I_{(\gamma+ce)}$[@]	Comments
573.4[a] *2*	0.008[a] *2*	1796.16	(1)$^-$	1222.89	(2$^+$)				
580.7 *2*	0.007 *2*	1539.67	(1$^-$)	958.84	(2$^-$)				
597.40 *7*	11.7 *3*	597.35	1$^-$	0	0$^+$	E1	0.01024		α(K)=0.00826 *12*; α(L)=0.001495 *21*; α(M)=0.000359 *5*; α(N+..)=0.0001256 *18* α(N)=9.70×10^{-5} *14*; α(O)=2.39×10^{-5} *4*; α(P)=4.43×10^{-6} *7*; α(Q)=2.62×10^{-7} *4* Mult.: from α(K)exp=0.0078 *12*, K:L1=4.9 *20* (1959Bu20).
606.10 *7*	0.67 *7*	648.86	3$^-$	42.824	2$^+$	[E1]	0.00996		α(K)=0.00804 *12*; α(L)=0.001453 *21*; α(M)=0.000349 *5*; α(N+..)=0.0001221 *17* α(N)=9.43×10^{-5} *14*; α(O)=2.32×10^{-5} *4*; α(P)=4.31×10^{-6} *6*; α(Q)=2.55×10^{-7} *4*
658.5[b]	<0.018	1558.87	(2$^+$)	900.32	2$^+$				E_γ: assigned as probable sum peak by 1981Hs02.
758.61 *8*	1.18 *3*	900.32	2$^+$	141.688	4$^+$	E2	0.0212		α(K)=0.01484 *21*; α(L)=0.00474 *7*; α(M)=0.001212 *17*; α(N+..)=0.000427 *6* α(N)=0.000331 *5*; α(O)=8.06×10^{-5} *12*; α(P)=1.453×10^{-5} *21*; α(Q)=6.09×10^{-7} *9* Mult.: from α(K)exp=0.014 *5* (1959Bu20).
789.59 *10*	0.18 *3*	1438.45	2$^{(-)}$	648.86	3$^-$				(789.6γ)(507.1γ)(θ): A_2=+0.11 *5*, (789.6γ)(606.1γ)(θ): A_2=+0.26 *13*,
(796.2)	<0.001	938.05	(1$^-$)	141.688	4$^+$				
813.41 *10*	0.18 *3*	1410.76	0$^{(-)}$	597.35	1$^-$				(813.4γ)(554.6γ)(θ): A_2=+0.062 *15*, (813.4γ)(597.4γ)(θ): A_2=+0.62 *15* (1970Sc12).
(817.2)	<0.1	958.84	(2$^-$)	141.688	4$^+$				
817.89 *10*	1.28 *3*	860.71	0$^+$	42.824	2$^+$	E2	0.0183		α(K)=0.01302 *19*; α(L)=0.00389 *6*; α(M)=0.000990 *14*; α(N+..)=0.000348 *5* α(N)=0.000270 *4*; α(O)=6.59×10^{-5} *10*; α(P)=1.194×10^{-5} *17*; α(Q)=5.27×10^{-7} *8* Mult.: from α(K)exp=0.014 *5* (1959Bu20).
837.6 *2*	0.008 *3*	1796.16	(1)$^-$	958.84	(2$^-$)				
841.11 *10*	0.150 *17*	1438.45	2$^{(-)}$	597.35	1$^-$				(841.1γ)(554.6γ)(θ): A_2=−0.014 *24*, (841.1γ)(597.4γ)(θ): A_2=−0.14 *24* (1970Sc12).
857.48 *10*	0.49 *2*	900.32	2$^+$	42.824	2$^+$				
860.	<0.005	860.71	0$^+$	0	0$^+$	E0		0.14 *1*	ce(K)/(γ+ce)=0.839 Mult.: from α(K)exp>0.8 (1959Bu20). $I_{(\gamma+ce)}$: from 1959Bu20, relative to Iγ(554γ)=21.4.
[x]867.2 *2*	0.009 *2*								
890.6 *2*	0.017 *2*	1539.67	(1$^-$)	648.86	3$^-$				
895.3 *1*	0.061 *10*	938.05	(1$^-$)	42.824	2$^+$				
900.37 *10*	0.16 *2*	900.32	2$^+$	0	0$^+$				
910.1 *1*	0.14 *2*	1558.87	(2$^+$)	648.86	3$^-$				
915.98 *9*	1.02 *3*	958.84	(2$^-$)	42.824	2$^+$				
928.55 *10*	0.15 *2*	1525.86	(0$^+$)	597.35	1$^-$				

$^{240}_{94}Pu_{146}$-4

γ(^{240}Pu) (continued)

E_γ#	I_γ#@	E_i(level)	J^π_i	E_f	J^π_f
938.02 10	1.21 5	938.05	(1$^-$)	0	0$^+$
942.39 10	0.096 9	1539.67	(1$^-$)	597.35	1$^-$
959.0 2	0.0073 20	1607.72	(1$^-$)	648.86	3$^-$
961.62 10	0.130 7	1558.87	(2$^+$)	597.35	1$^-$
^{x}985.7 5	0.015 3				
989.2 1	0.081 5	1130.95	(2$^+$)	141.688	4$^+$
^{x}1028.3 5	0.007 1				
1036.5 3	0.003 2	1633.37	(1$^-$)	597.35	1$^-$
1046.62 10	0.097 18	1089.45?	0$^+$	42.824	2$^+$
1061.6 2	0.029 7	1710.43	(2$^+$)	648.86	3$^-$
^{x}1072.2 1	0.017 3				
1088.3 2	0.032 3	1130.95	(2$^+$)	42.824	2$^+$
1094.2 2	0.020 3	1136.97	(2$^+$)	42.824	2$^+$
1113.2 2	0.018 3	1710.43	(2$^+$)	597.35	1$^-$
1131.0 2	0.062 5	1130.95	(2$^+$)	0	0$^+$
1137.0 4	0.014 2	1136.97	(2$^+$)	0	0$^+$
1159.2 2	0.006 2	1808.02	(1$^-$,2$^+$)	648.86	3$^-$
^{x}1167.4 2	0.007 2				
1180.1 2	0.020 5	1222.89	(2$^+$)	42.824	2$^+$
^{x}1182.1 5	0.007 2				
1198.0 3	0.009 2	1240.8?	(2$^-$)	42.824	2$^+$
1210.5 5	0.015 4	1808.02	(1$^-$,2$^+$)	597.35	1$^-$
1223.0 2	0.018 3	1222.89	(2$^+$)	0	0$^+$
1305.8 2	0.023 6	1954.51	(2$^+$)	648.86	3$^-$
1321.1 1	0.034 3	1321.11?	(1,2$^+$)	0	0$^+$
^{x}1328.9 2	0.009 2				
^{x}1340.0 10	0.006 2				
1357.2 2	0.013 3	1954.51	(2$^+$)	597.35	1$^-$
1398.5 5	0.005 2	1996.42	(1$^-$,2$^+$)	597.35	1$^-$
1417.2 1	0.023 5	1558.87	(2$^+$)	141.688	4$^+$
^{x}1428.3 1	0.028 4				
(1438.5)	<0.001	1438.45	2$^{(-)}$	0	0$^+$
1445.3 1	0.38 1	1488.17	(1$^-$)	42.824	2$^+$
^{x}1455.1 5	0.004 1				
1483.0 1	0.027 4	1525.86	(0$^+$)	42.824	2$^+$
1488.2 1	0.20 1	1488.17	(1$^-$)	0	0$^+$
1496.9 1	1.33 3	1539.67	(1$^-$)	42.824	2$^+$
1515.9 1	0.015 5	1558.87	(2$^+$)	42.824	2$^+$
1539.62 9	0.84 2	1539.67	(1$^-$)	0	0$^+$
1558.8 1	0.006 2	1558.87	(2$^+$)	0	0$^+$
1568.6 2	0.006 1	1710.43	(2$^+$)	141.688	4$^+$
1584.1 2	0.017 2	1626.77	(1$^-$)	42.824	2$^+$
1590.5 1	0.097 4	1633.37	(1$^-$)	42.824	2$^+$
^{x}1604.8 3	0.037 5				
1607.6 2	0.055 5	1607.72	(1$^-$)	0	0$^+$
1626.6 2	0.005 1	1626.77	(1$^-$)	0	0$^+$
1633.33 10	0.154 5	1633.37	(1$^-$)	0	0$^+$
1667.6 1	0.019 3	1710.43	(2$^+$)	42.824	2$^+$
1711.0 10	0.002 1	1710.43	(2$^+$)	0	0$^+$
1732.4 2	0.002 1	1775.27	(1)$^-$	42.824	2$^+$
^{x}1737.2 3	0.004 1				
1752.9 2	0.0054 12	1796.16	(1)$^-$	42.824	2$^+$
1765.2 2	0.0070 11	1808.02	(1$^-$,2$^+$)	42.824	2$^+$
1775.3 2	0.003 1	1775.27	(1)$^-$	0	0$^+$
1796.2 3	0.003 1	1796.16	(1)$^-$	0	0$^+$
1807.9 4	0.002 1	1808.02	(1$^-$,2$^+$)	0	0$^+$
1812.8 1	0.005 2	1954.51	(2$^+$)	141.688	4$^+$
^{x}1844.5 5	0.002 1				
^{x}1861.1 3	0.004 1				
1874.9 3	0.012 1	1917.8	(1$^-$)	42.824	2$^+$
1911.4 3	0.014 1	1954.51	(2$^+$)	42.824	2$^+$
1918.0 10	0.0008 4	1917.8	(1$^-$)	0	0$^+$
1953.6 2	0.0023 5	1996.42	(1$^-$,2$^+$)	42.824	2$^+$
^{x}1978.0 10	0.0004 2				
1996.7 4	0.0010 4	1996.42	(1$^-$,2$^+$)	0	0$^+$
^{x}2041.7 2	0.006 1				
2074.8 2	0.0031 5	2117.63	(1,2$^+$)	42.824	2$^+$
^{x}2086.7 2	0.0008 4				
2117.5 10	0.0007 4	2117.63	(1,2$^+$)	0	0$^+$

† From ^{244}Cm α decay (1972Sc01).

‡ From adopted γ's, unless otherwise noted.

Weighted average of 1970Sc12, 1981Hs02, unless otherwise noted.

@ For absolute intensity per 100 decays, multiply by 0.9988 1.

$\gamma(^{240}$Pu) (continued)

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

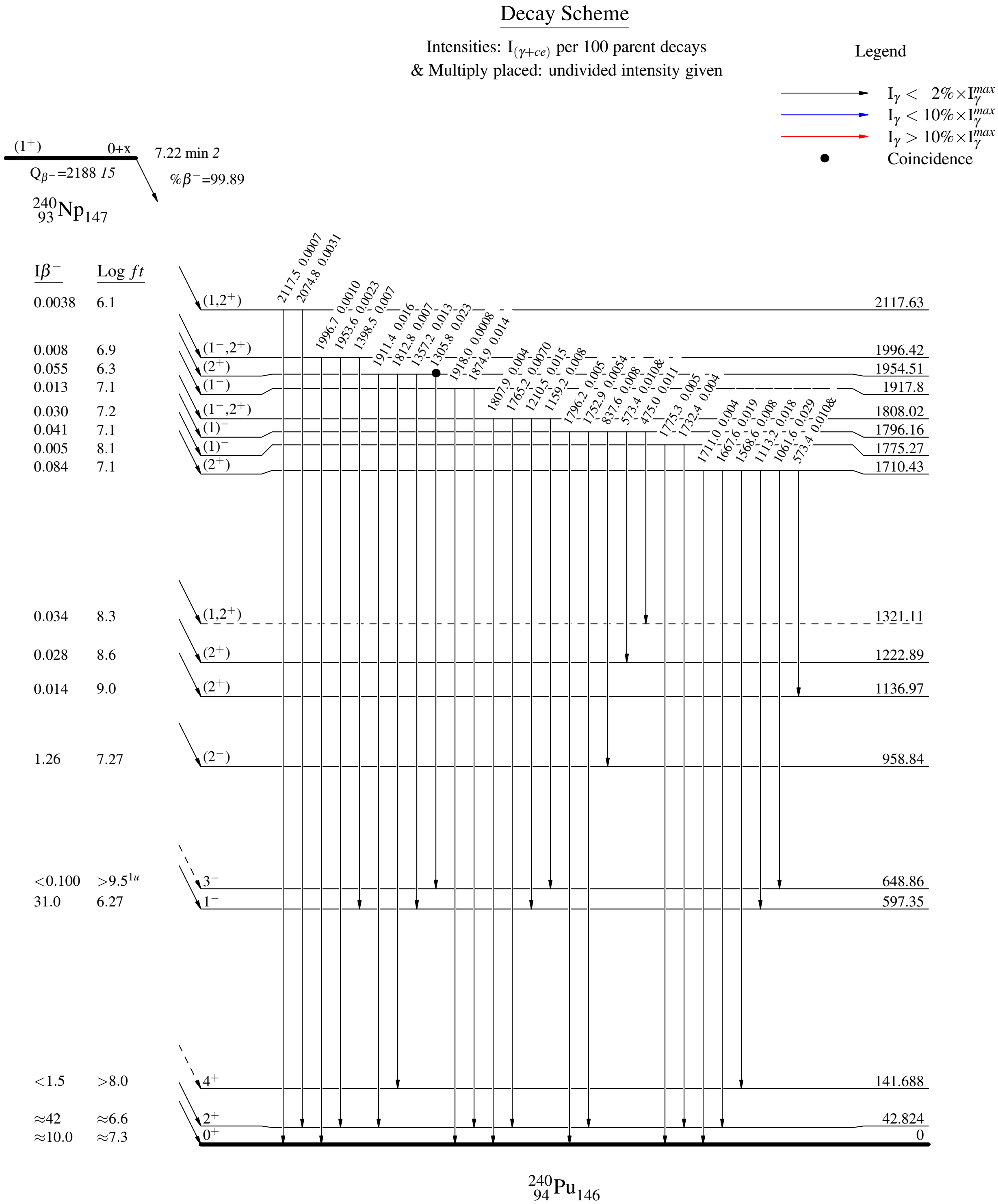
[a] Multiply placed with undivided intensity.

[b] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

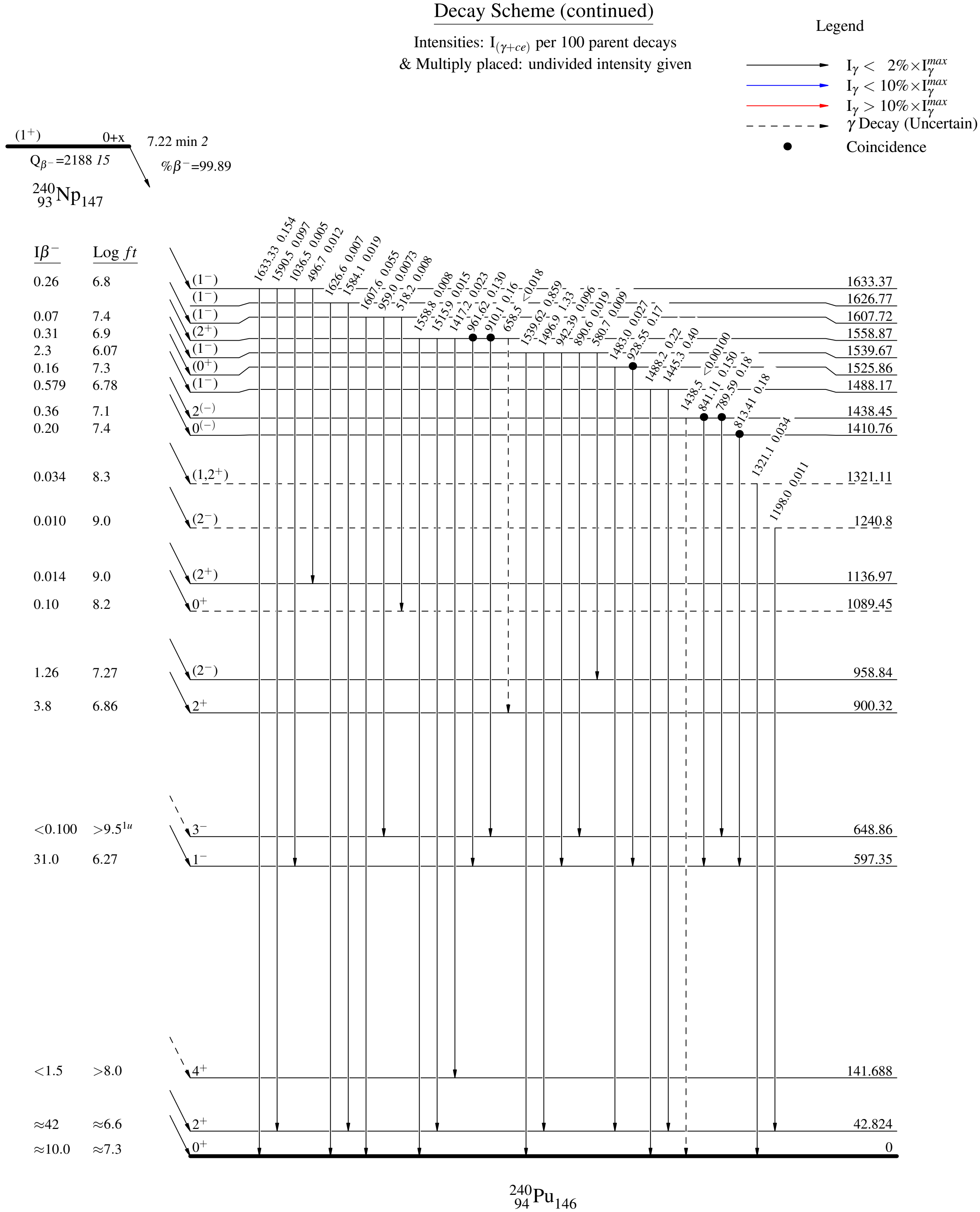
$^{240}_{94}$Pu$_{146}$-6

^{240}Np β^- decay (7.22 min) 1970Sc12,1981Hs02



^{240}Np β^- decay (7.22 min) 1970Sc12,1981Hs02

Decay Scheme (continued)



^{240}Np β^- decay (7.22 min) 1970Sc12,1981Hs02

Decay Scheme (continued)

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