^{209}Rn ε decay 1974Vy01,1973Jo14

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. Chen # and F. G. Kondev	NDS 126, 373 (2015)	30-Sep-2013

Parent: ^{209}Rn: E=0.0; J^π=5/2$^-$; $T_{1/2}$=28.8 min *10*; Q(ε)=3954 *21*; %ε+%β^+ decay=83 *2*
^{209}Rn-J^π,$T_{1/2}$: From Adopted Levels of ^{209}Rn.
^{209}Rn-Q(ε): From 2012Wa38.
^{209}Rn-Additional information 1.
1974Vy01: ^{209}Rn isotopes were produced by bombarding a Th target with proton beams produced from the JINR synchrocyclotron. γ-rays were detected with three Ge(Li) detectors with volumes 0.5, 8.2 and 3.7 cm^3 (FWHM=1.5, 2.5 and 2.3 keV at Eγ=1332 keV) and conversion electrons were detected with surface-barrier Si(Li) detectors (FWHM= 2-4 keV). Measured Eγ, Iγ, I(ce), $\gamma\gamma$-coin. Deduced levels, J^π, α, log *ft*, γ-ray branching ratios, γ-ray transition multipolarities.
1973Jo14: ^{209}Rn isotopes were produced by bombarding a Th target with proton beams produced from the synchrocyclotron at the ISOLDE facility at CERN. γ-rays were detected with two Ge(Li) detectors (FWHM=1.9-2.2 keV) and electrons were detected with a 2 mm thick Si(Li) (FWHM= 2.7 keV at 500 keV). Measured Eγ, Iγ, I(ce), $\gamma\gamma$-coin. Deduced levels, J^π, γ-ray branching ratios, γ-ray transition multipolarities, conversion coefficients.
Others: 1971KhZU, 1973KeZP, 1985BuZT, 1988Ki03, 2007Ta17, 2008Ta11.

^{209}At Levels

The decay scheme is that of 1974Vy01 except that the 577γ is placed by evaluators from a 577 level, rather than from the 2712 level and the 722γ is placed from an 1131 level, rather than from the 3544 level. Both of these alternate placements are suggested by the in-beam studies. If J^π(577) is 11/2$^-$, no direct ε feeding is expected. The evaluators propose a level at 934 keV to partially account for the feeding of the 577 level. The introduction of this level accommodates seven previously unplaced transitions, and provides an alternate placement for the 1778γ and 2453γ.

E(level)†	J^π‡	Comments
0.0	9/2$^-$	Additional information 2.
408.34 *3*	7/2$^-$	Additional information 3.
577.15 *8*	11/2$^-$	
745.79 *4*	7/2$^-$	Additional information 4.
794.61 *5*	5/2$^-$	
934.55? *14*	(7/2)$^-$	
1081.19 *5*	(5/2,7/2)$^-$	
1093.10 *16*	(7/2)$^-$	
1097.72 *5*	(7/2)$^-$	
1131.11 *11*	(5/2,7/2)$^-$	
1394.45 *6*	(7/2)$^-$	
1953.51 *6*	7/2$^+$	
2135.78 *6*	(5/2,7/2)$^+$	
2414.99 *9*	5/2$^+$,7/2$^+$	
2516.68 *11*	(5/2 to 9/2)$^+$	
2522.37 *19*	(5/2$^+$,7/2$^+$)	
2569.2 *3*	(3/2$^-$,5/2,7/2)	
2581.37 *15*	(3/2,5/2,7/2)	
2689.90 *24*	(3/2$^-$,5/2,7/2)	
2712.9 *5*	(3/2$^-$,5/2,7/2)	
2821.9 *5*	(5/2,7/2)	
3140.48 *13*	(5/2,7/2)	
3172.3 *3*	(3/2$^-$,5/2,7/2)	
3388.43 *20*	(3/2$^-$,5/2,7/2)	
3544.38 *17*	(5/2,7/2)	
3551.3 *3*	(5/2,7/2,9/2)	

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^{209}Rn ε decay 1974Vy01,1973Jo14 (continued)

^{209}At Levels (continued)

E(level)[†]	Jπ[‡]
3627.0 *4*	(3/2⁻,5/2,7/2)
3753.7 *3*	(5/2,7/2)⁻

† From a least-squares fit to γ-ray energies.
‡ From Adopted Levels.

ε,β⁺ radiations

The log *ft* values are given as approximate since the unplaced γ-ray transition intensity is about 14%.

E(decay)	E(level)	Iβ⁺ [‡]	Iε[‡]	Log *ft*	I(ε+β⁺)[†‡]	Comments
(200 *21*)	3753.7		≈0.4	≈5.5	≈0.4	εK=0.57 *6*; εL=0.31 *4*; εM+=0.119 *16*
(327 *21*)	3627.0		≈0.3	≈6.2	≈0.3	εK=0.695 *11*; εL=0.224 *8*; εM+=0.081 *4*
(403 *21*)	3551.3		≈0.2	≈6.6	≈0.2	εK=0.723 *7*; εL=0.205 *5*; εM+=0.0725 *19*
(410 *21*)	3544.38		≈1.0	≈5.9	≈1.0	εK=0.724 *6*; εL=0.204 *5*; εM+=0.0720 *18*
(566 *21*)	3388.43		≈0.5	≈6.6	≈0.5	εK=0.752 *3*; εL=0.1842 *19*; εM+=0.0639 *8*
(782 *21*)	3172.3		≈0.2	≈7.3	≈0.2	εK=0.7692 *12*; εL=0.1719 *9*; εM+=0.0589 *4*
(814 *21*)	3140.48		≈0.9	≈6.7	≈0.9	εK=0.7709 *11*; εL=0.1707 *8*; εM+=0.0584 *4*
(1132 *21*)	2821.9		≈0.5	≈7.2	≈0.5	εK=0.7820 *6*; εL=0.1628 *4*; εM+=0.05517 *15*
(1241 *21*)	2712.9		≈0.2	≈7.7	≈0.2	εK=0.7843 *5*; εL=0.1612 *3*; εM+=0.05449 *13*
(1264 *21*)	2689.90		≈0.4	≈7.4	≈0.4	εK=0.7848 *4*; εL=0.1608 *3*; εM+=0.05436 *12*
(1373 *21*)	2581.37		≈0.7	≈7.3	≈0.7	εK=0.7866 *4*; εL=0.15949 *25*; εM+=0.05382 *10*
(1385 *21*)	2569.2		≈0.5	≈7.4	≈0.5	εK=0.7868 *3*; εL=0.15936 *24*; εM+=0.05376 *10*
(1432 *21*)	2522.37		≈3.2	≈6.6	≈3.2	εK=0.7874 *3*; εL=0.15884 *23*; εM+=0.05355 *10*
(1437 *21*)	2516.68		≈0.7	≈7.3	≈0.7	εK=0.7875 *3*; εL=0.15878 *23*; εM+=0.05353 *9*
(1539 *21*)	2414.99	≈0.0020	≈3.4	≈6.7	≈3.4	av Eβ=256.5 *95*; εK=0.7885 *2*; εL=0.15777 *21*; εM+=0.05312 *8*
(1818 *21*)	2135.78	≈0.0065	≈2.0	≈7.1	≈2.0	av Eβ=380.6 *93*; εK=0.78930 *9*; εL=0.15530 *18*; εM+=0.05215 *7*
(2000 *21*)	1953.51	≈0.025	≈3.6	≈6.9	≈3.6	av Eβ=460.6 *92*; εK=0.7878 *3*; εL=0.15372 *19*; εM+=0.05155 *7*
(2560 *21*)	1394.45	≈0.057	≈1.7	≈7.4	≈1.8	av Eβ=704.8 *92*; εK=0.7713 *10*; εL=0.1478 *3*; εM+=0.04943 *10*
(2823 *21*)	1131.11	≈0.03	≈0.5	≈8.1	≈0.5	av Eβ=819.9 *93*; εK=0.7565 *14*; εL=0.1441 *4*; εM+=0.04815 *12*
(2856 *21*)	1097.72	≈0.054	≈0.95	≈7.8	≈1.0	av Eβ=834.6 *92*; εK=0.7543 *15*; εL=0.1436 *4*; εM+=0.04797 *12*
(2861 *21*)	1093.10	≈0.071	≈1.2	≈7.7	≈1.3	av Eβ=836.7 *92*; εK=0.7540 *15*; εL=0.1435 *4*; εM+=0.04795 *12*
(2873 *21*)	1081.19	≈0.089	≈1.5	≈7.6	≈1.6	av Eβ=841.9 *92*; εK=0.7532 *15*; εL=0.1433 *4*; εM+=0.04788 *12*
(3019 *21*)	934.55?	≈0.03	≈0.4	≈8.3	≈0.4	av Eβ=906.2 *93*; εK=0.7425 *17*; εL=0.1409 *4*; εM+=0.04705 *13*
(3159 *21*)	794.61	≈0.19	≈2.0	≈7.6	≈2.2	av Eβ=967.6 *93*; εK=0.7311 *19*; εL=0.1384 *4*; εM+=0.04620 *14*
(3208 *21*)	745.79	≈4.0	≈40	≈6.3	≈44	av Eβ=989.1 *93*; εK=0.7268 *19*; εL=0.1375 *4*; εM+=0.04589 *14* measured E(β⁺)=2160 *40*, I(β⁺)=2.35% 50 from I(511γ) (1974Vy01).
(3546 *21*)	408.34	≈3.0	≈20	≈6.7	≈23	av Eβ=1138.1 *93*; εK=0.6937 *23*; εL=0.1306 *5*; εM+=0.04355 *16*

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^{209}Rn ε decay 1974Vy01,1973Jo14 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Comments
		measured E(β^+)=2620 *120*, I(β^+)=0.85% 27 from I(511γ) (1974Vy01).

† From I(γ+ce) imbalance at each level, given as approximate due to a large amount of unplaced transitions.
‡ Absolute intensity per 100 decays.

γ(^{209}At)

Iγ normalization: From Σ (I(γ+ce) to g.s.))=100% by assuming no direct feedings to the ground state.

Additional information 5.

Measured relative x-ray intensities: %(Kα_2 x ray)=21.7 *15*, %(Kα_1 x ray)=38.8 *19*, %(Kβ_1' x ray)=14.0 *10*, %(Kβ_2' x ray)=4.1 *5* (1974Vy01). From the decay scheme, one obtains %(Kα_2 x ray)=20.7 *3*, %(Kα_1 x ray)=34.4 *5*, %(Kβ x ray)=15.7 *2* using the RadList program.

Total intensity of unplaced γ-ray transitions≈14%.

E_γ[†]	I_γ[†c]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	δ[&b]	α[a]	Comments
≈147[@]	<1.0[@]	1081.19	(5/2,7/2)$^-$	934.55?	(7/2)$^-$			≈2.8	α(K)≈1.8; α(L)≈0.76; α(M)≈0.20; α(N+..)≈0.062 α(N)≈0.050; α(O)≈0.010; α(P)≈0.00119
[x]≈152[@]	<1.0[@]								
182.23[#] *12*	2.3 *5*	2135.78	(5/2,7/2)$^+$	1953.51	7/2$^+$	[M1]		2.20	α(K)=1.78 *3*; α(L)=0.318 *5*; α(M)=0.0753 *11* α(N)=0.0195 *3*; α(O)=0.00417 *6*; α(P)=0.000577 *9*
188.4 *3*	1.1 *3*	934.55?	(7/2)$^-$	745.79	7/2$^-$	[M1]		2.00	α(K)=1.623 *24*; α(L)=0.289 *5*; α(M)=0.0685 *10* α(N)=0.0177 *3*; α(O)=0.00380 *6*; α(P)=0.000525 *8*
202.3[@] *4*	<1.0[@]	3753.7	(5/2,7/2)$^-$	3551.3	(5/2,7/2,9/2)			0.9 *8*	α(K)=0.7 *6*
[x]206.2[@] *4*	<1.0[@]								
[x]211.7[@] *4*	<1.0[@]								
[x]224.8[@] *6*	<1.0[@]								
[x]230.4[@] *8*	<1.0[@]								
[x]249.3[@] *4*	<1.0[@]								
[x]256.3[@] *4*	<1.0[@]								
[x]263.1[@] *4*	<1.0[@]								
[x]265.2[@] *6*	<1.0[@]								
[x]275.90 *25*	3.3 *7*								
279.20[#] *10*	10.3 *11*	2414.99	5/2$^+$,7/2$^+$	2135.78	(5/2,7/2)$^+$	M1(+E2)	<0.4	0.64 *4*	α(K)=0.51 *4*; α(L)=0.094 *3*; α(M)=0.0224 *6* α(N)=0.00579 *14*; α(O)=0.00124 *4*; α(P)=0.000169 *7*
286.59[#] *10*	2.8 *9*	1081.19	(5/2,7/2)$^-$	794.61	5/2$^-$	[M1]		0.624	α(K)=0.506 *8*; α(L)=0.0896 *13*; α(M)=0.0212 *3* α(N)=0.00549 *8*; α(O)=0.001176 *17*; α(P)=0.0001624 *23*
296.6 *4*	3.0 *4*	1394.45	(7/2)$^-$	1097.72	(7/2)$^-$	M1+E2	1.6 *+7−4*	0.26 *6*	α(K)=0.18 *5*; α(L)=0.059 *5*; α(M)=0.0147 *9* α(N)=0.00382 *22*; α(O)=0.00078 *6*; α(P)=9.5×10^{-5} *10*
302.98[#] *13*	5.2 *13*	1097.72	(7/2)$^-$	794.61	5/2$^-$	M1(+E2)	<0.6	0.48 *6*	α(K)=0.39 *5*; α(L)=0.073 *5*; α(M)=0.0174 *9* α(N)=0.00449 *23*; α(O)=0.00096 *6*; α(P)=0.000130 *10*
[x]324.9[@] *4*	<1.0[@]								

γ(^{209}At) (continued)

E_γ[†]	I_γ[†c]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	δ[&b]	α[a]	Comments
337.46[#] *4*	135 *4*	745.79	7/2$^-$	408.34	7/2$^-$	M1(+E2)	<0.4	0.378 *22*	α(K)=0.305 *20*; α(L)=0.0553 *20*; α(M)=0.0131 *5* α(N)=0.00340 *11*; α(O)=0.00073 *3*; α(P)=0.000100 *5* anisotropy R=0.903 *14* (1988Ki03).
357.38 *15*	3.0 *9*	934.55?	(7/2)$^-$	577.15	11/2$^-$	[E2]		0.0796	α(K)=0.0463 *7*; α(L)=0.0248 *4*; α(M)=0.00642 *9* α(N)=0.001661 *24*; α(O)=0.000335 *5*; α(P)=3.80×10^{-5} *6*
380.83[#] *10*	5.2 *16*	2516.68	(5/2 to 9/2)$^+$	2135.78	(5/2,7/2)$^+$	M1(+E2)	≈0.6	≈0.229	α(K)≈0.182; α(L)≈0.0355; α(M)≈0.00849 α(N)≈0.00220; α(O)≈0.000467; α(P)≈6.28×10^{-5}
386.43[d] *7*	19.2[d] *12*	794.61	5/2$^-$	408.34	7/2$^-$	(M1)		0.276	α(K)=0.225 *4*; α(L)=0.0395 *6*; α(M)=0.00933 *13* α(N)=0.00242 *4*; α(O)=0.000517 *8*; α(P)=7.15×10^{-5} *10* E_γ: for the doublet.
386.43[d] *7*	19.2[d] *12*	2522.37	(5/2$^+$,7/2$^+$)	2135.78	(5/2,7/2)$^+$	(M1)		0.276	α(K)=0.225 *4*; α(L)=0.0395 *6*; α(M)=0.00933 *13* α(N)=0.00242 *4*; α(O)=0.000517 *8*; α(P)=7.15×10^{-5} *10* E_γ: for the doublet.
408.32[#] *4*	468 *14*	408.34	7/2$^-$	0.0	9/2$^-$	E2(+M1)		0.238	α(K)=0.194 *3*; α(L)=0.0340 *5*; α(M)=0.00803 *12* α(N)=0.00208 *3*; α(O)=0.000445 *7*; α(P)=6.16×10^{-5} *9* anisotropy R=1.009 *7* (1988Ki03).
461.47[#] *9*	13.4 *7*	2414.99	5/2$^+$,7/2$^+$	1953.51	7/2$^+$	M1(+E2)	≤0.6	0.154 *18*	α(K)=0.125 *15*; α(L)=0.0226 *19*; α(M)=0.0054 *5* α(N)=0.00139 *11*; α(O)=0.000296 *25*; α(P)=4.1×10^{-5} *4*
^{x}497.2[@] *4*	≈1.0[@]								
526.8 *5*	1.9 *6*	934.55?	(7/2)$^-$	408.34	7/2$^-$	M1+E2	≈0.7	≈0.0907	α(K)≈0.0726; α(L)≈0.01373; α(M)≈0.00328 α(N)≈0.000848; α(O)≈0.000180; α(P)≈2.44×10^{-5}
577.14[#] *8*	9.1 *6*	577.15	11/2$^-$	0.0	9/2$^-$	M1+E2	0.8 *1*	0.067 *5*	α(K)=0.054 *4*; α(L)=0.0102 *6*; α(M)=0.00244 *12* α(N)=0.00063 *3*; α(O)=0.000134 *7*; α(P)=1.81×10^{-5} *10* E_γ: transition is placed from the 2712 level by 1974Vy01; however, this placement is not consistent with the $\gamma\gamma$ data of 1973Jo14 where the 577γ is not seen in coincidence with the 1038γ. The 577γ is placed as a ground-state transition in the in-beam studies.
599.87[#] *12*	5.4 *5*	1394.45	(7/2)$^-$	794.61	5/2$^-$	M1(+E2)	<0.3	0.083 *3*	α(K)=0.0674 *24*; α(L)=0.0118 *4*; α(M)=0.00278 *8* α(N)=0.000721 *21*; α(O)=0.000154 *5*; α(P)=2.13×10^{-5} *7*
^{x}605.4 *5*	1.59 *16*					M1(+E2)	≈0.3	≈0.0783	α(K)≈0.0636; α(L)≈0.01120; α(M)≈0.00265 α(N)≈0.000686; α(O)≈0.0001467; α(P)≈2.02×10^{-5} Mult.: α(K)exp≈0.063 (1974Vy01).

γ(^{209}At) (continued)

E_γ[†]	I_γ[†c]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	δ[&b]	α[a]	Comments
^{x}625.2[@] *7*	<1.0[@]								
^{x}635.3[@] *4*	<1.0[@]								
^{x}642.0[@] *6*	<1.0[@]								
^{x}656.8[@] *5*	<1.0[@]								
672.83[#] *4*	30.4 *10*	1081.19	(5/2,7/2)$^-$	408.34	7/2$^-$	E2(+M1)		0.0632	α(K)=0.0515 *8*; α(L)=0.00892 *13*; α(M)=0.00210 *3* α(N)=0.000545 *8*; α(O)=0.0001166 *17*; α(P)=1.614×10^{-5} *23*
684.75[#] *15*	10.8 *13*	1093.10	(7/2)$^-$	408.34	7/2$^-$	(E0+M1+E2)		0.121 *21*	α(K)=0.0492 *7*; α(L)=0.00851 *12*; α(M)=0.00201 *3* α(N)=0.000520 *8*; α(O)=0.0001113 *16*; α(P)=1.541×10^{-5} *22* α: From Adopted Gammas.
689.29[#] *6*	90 *3*	1097.72	(7/2)$^-$	408.34	7/2$^-$	M1(+E2)	<0.4	0.056 *3*	α(K)=0.046 *3*; α(L)=0.0080 *4*; α(M)=0.00189 *9* α(N)=0.000489 *23*; α(O)=0.000105 *5*; α(P)=1.45×10^{-5} *7* anisotropy R=1.079 *22* (1988Ki03).
^{x}695.9 *3*	2.20 *22*					M1(+E2)	≈0.8	≈0.0415	α(K)≈0.0334; α(L)≈0.00618; α(M)≈0.001470 α(N)≈0.000381; α(O)≈8.10×10^{-5}; α(P)≈1.101×10^{-5} Mult.: α(K)exp≈0.034 (1974Vy01).
^{x}705.50 *20*	2.46 *25*					(E1,E2)			Mult.: α(K)exp<0.028 (1974Vy01).
722.77[#] *10*	3.84 *22*	1131.11	(5/2,7/2)$^-$	408.34	7/2$^-$	M1(+E2)	<0.4	0.050 *3*	α(K)=0.0405 *23*; α(L)=0.0071 *4*; α(M)=0.00167 *8* α(N)=0.000432 *20*; α(O)=9.2×10^{-5} *5*; α(P)=1.28×10^{-5} *7* E_γ: placed by 1974Vy01 from the 3544 level. In (^{3}He,3nγ), the 722γ is placed from the 1131 level. The agreement in energy in the measured α(K)exp suggests that the same transition is being observed in the two experiments.
^{x}731.0 *3*	2.38 *14*								
745.78[#] *4*	212 *6*	745.79	7/2$^-$	0.0	9/2$^-$	M1(+E2)	<0.4	0.0459 *25*	α(K)=0.0374 *21*; α(L)=0.0065 *3*; α(M)=0.00153 *7* α(N)=0.000397 *19*; α(O)=8.5×10^{-5} *4*; α(P)=1.17×10^{-5} *6* anisotropy R=1.129 *14* (1988Ki03).
^{x}761.59 *8*	5.2 *4*					M1(+E2)	<0.5	0.042 *4*	α(K)=0.035 *3*; α(L)=0.0060 *4*; α(M)=0.00142 *10* α(N)=0.000369 *25*; α(O)=7.9×10^{-5} *6*; α(P)=1.09×10^{-5} *8* Mult.: α(K)exp=0.058 *16* (1974Vy01).
794.68[#] *7*	31.3 *21*	794.61	5/2$^-$	0.0	9/2$^-$	E2		0.01219	α(K)=0.00929 *13*; α(L)=0.00219 *3*; α(M)=0.000535 *8* α(N)=0.0001384 *20*; α(O)=2.89×10^{-5} *4*; α(P)=3.69×10^{-6} *6*
^{x}806.3[@] *4*	≈1.0[@]								
^{x}819.1[@] *5*	≈1.0[@]								
855.77[#] *5*	45.3 *24*	1953.51	7/2$^+$	1097.72	(7/2)$^-$	E1		0.00375	α(K)=0.00311 *5*; α(L)=0.000492 *7*; α(M)=0.0001148 *16* α(N)=2.96×10^{-5} *5*; α(O)=6.29×10^{-6} *9*; α(P)=8.55×10^{-7} *12*

γ(^{209}At) (continued)

E_γ[†]	I_γ[†c]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	δ[&b]	α[a]	Comments
868.43	≈3.1	2821.9	(5/2,7/2)	1953.51	7/2$^+$				I_γ: transition shown on the level scheme in 1974Vy01, but not in table of gammas. Intensity deduced by evaluators based on intensity balance at the 2822 level.
872.40 *15*	6.5 *23*	1953.51	7/2$^+$	1081.19	(5/2,7/2)$^-$	[E1]		0.00362	α(K)=0.00300 *5*; α(L)=0.000475 *7*; α(M)=0.0001107 *16* α(N)=2.85×10^{-5} *4*; α(O)=6.07×10^{-6} *9*; α(P)=8.25×10^{-7} *12*
^{x}921.6[@] *4*	≈1.0[@]								
^{x}948.7 *10*	2.3[‡] *5*					(M1+E2)		0.0258	α(K)=0.0211 *3*; α(L)=0.00361 *6*; α(M)=0.000851 *13* α(N)=0.000220 *4*; α(O)=4.72×10^{-5} *7*; α(P)=6.54×10^{-6} *10* Mult.: α(K)exp=0.025 *8* (1974Vy01) for (948.7+951.5) doublet.
^{x}951.5 *8*	2.3[‡] *5*					(M1+E2)		0.0256	α(K)=0.0209 *3*; α(L)=0.00358 *5*; α(M)=0.000844 *12* α(N)=0.000219 *3*; α(O)=4.68×10^{-5} *7*; α(P)=6.49×10^{-6} *10* Mult.: α(K)exp=0.025 *8* (1974Vy01) for (948.7+951.5) doublet.
986.06[#] *10*	5.0 *5*	1394.45	(7/2)$^-$	408.34	7/2$^-$	E2(+M1)	>2	0.0095 *16*	α(K)=0.0075 *13*; α(L)=0.00150 *20*; α(M)=0.00036 *5* α(N)=9.3×10^{-5} *12*; α(O)=2.0×10^{-5} *3*; α(P)=2.6×10^{-6} *4*
^{x}1021.5 *5*	1.7 *3*					M1+E2	1.1 *+19−6*	0.014 *5*	α(K)=0.011 *4*; α(L)=0.0020 *7*; α(M)=0.00048 *15* α(N)=0.00012 *4*; α(O)=2.6×10^{-5} *9*; α(P)=3.6×10^{-6} *12* Mult.: α(K)exp=0.011 *4* (1974Vy01).
1027.55 *20*	1.7 *4*	3544.38	(5/2,7/2)	2516.68	(5/2 to 9/2)$^+$	[E1]		0.00270	α(K)=0.00224 *4*; α(L)=0.000350 *5*; α(M)=8.15×10^{-5} *12* α(N)=2.10×10^{-5} *3*; α(O)=4.48×10^{-6} *7*; α(P)=6.12×10^{-7} *9*
1037.95[#] *6*	38.7 *20*	2135.78	(5/2,7/2)$^+$	1097.72	(7/2)$^-$	E1(+M2)	<0.09	0.00283 *19*	α(K)=0.00235 *16*; α(L)=0.00037 *3*; α(M)=8.7×10^{-5} *7* α(N)=2.24×10^{-5} *19*; α(O)=4.8×10^{-6} *4*; α(P)=6.5×10^{-7} *6*
1054.52[#] *7*	15.2 *8*	2135.78	(5/2,7/2)$^+$	1081.19	(5/2,7/2)$^-$	E1(+M2)	≤0.23	0.0037 *12*	α(K)=0.0030 *9*; α(L)=0.00051 *18*; α(M)=0.00012 *5*

γ(^{209}At) (continued)

E_γ[†]	I_γ[†c]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	δ[&b]	α[a]	Comments
									α(N)=3.1×10^{-5} *11*; α(O)=6.6×10^{-6} *23*; α(P)=9.E−7 *4*
^{x}1059.35[#] *10*	5.2 *4*					E2		0.00692	α(K)=0.00547 *8*; α(L)=0.001104 *16*; α(M)=0.000265 *4* α(N)=6.86×10^{-5} *10*; α(O)=1.446×10^{-5} *21*; α(P)=1.90×10^{-6} *3* Mult.: α(K)exp=0.0054 *18* (1974Vy01).
^{x}1065.57[#] *7*	15.8 *8*					M1+E2	0.7 *2*	0.0151 *16*	α(K)=0.0123 *14*; α(L)=0.00215 *21*; α(M)=0.00051 *5* α(N)=0.000131 *13*; α(O)=2.8×10^{-5} *3*; α(P)=3.9×10^{-6} *4* Mult.: α(K)exp=0.0123 *14* (1974Vy01).
1082 *1*	1.0 *5*	1081.19	(5/2,7/2)$^-$	0.0	9/2$^-$	[M1,E2]		0.0184	α(K)=0.01500 *22*; α(L)=0.00256 *4*; α(M)=0.000603 *9* α(N)=0.0001561 *23*; α(O)=3.35×10^{-5} *5*; α(P)=4.64×10^{-6} *7*
^{x}1085 *1*	1.4 *5*								
1097.55 *25*	2.20 *20*	1097.72	(7/2)$^-$	0.0	9/2$^-$	[M1]		0.01770	α(K)=0.01446 *21*; α(L)=0.00247 *4*; α(M)=0.000581 *9* α(N)=0.0001504 *21*; α(O)=3.22×10^{-5} *5*; α(P)=4.47×10^{-6} *7*
1110.2 *4*	1.2 *5*	3627.0	(3/2$^-$,5/2,7/2)	2516.68	(5/2 to 9/2)$^+$				
^{x}1119 *1*	0.47 *20*								
1129 *1*	1.59 *21*	3544.38	(5/2,7/2)	2414.99	5/2$^+$,7/2$^+$	[E1]		0.00228	α(K)=0.00190 *3*; α(L)=0.000295 *5*; α(M)=6.87×10^{-5} *10* α(N)=1.770×10^{-5} *25*; α(O)=3.77×10^{-6} *6*; α(P)=5.17×10^{-7} *8*; α(IPF)=2.00×10^{-6} *8*
^{x}1135.2 *3*	1.92 *25*								
^{x}1143.5[@] *8*	<1.0[@]								
1158.86[#] *10*	7.8 *5*	1953.51	7/2$^+$	794.61	5/2$^-$	[E1]		0.00219	α(K)=0.00181 *3*; α(L)=0.000282 *4*; α(M)=6.55×10^{-5} *10* α(N)=1.689×10^{-5} *24*; α(O)=3.60×10^{-6} *5*; α(P)=4.93×10^{-7} *7*; α(IPF)=5.26×10^{-6} *8*
1186.91[d#] *15*	3.9[d] *3*	2581.37	(3/2,5/2,7/2)	1394.45	(7/2)$^-$				
1186.91[d#] *15*	3.9[d] *3*	3140.48	(5/2,7/2)	1953.51	7/2$^+$				
^{x}1192.0[@] *10*	<1.0[@]								
1207.4 *4*	2.26 *21*	1953.51	7/2$^+$	745.79	7/2$^-$	[E1]		0.00205	α(K)=0.001688 *24*; α(L)=0.000262 *4*; α(M)=6.09×10^{-5} *9* α(N)=1.569×10^{-5} *22*; α(O)=3.35×10^{-6} *5*; α(P)=4.59×10^{-7} *7*; α(IPF)=1.64×10^{-5} *3*

From ENSDF

$^{209}_{85}$At$_{124}$-8

$\gamma(^{209}At)$ (continued)

E_γ[†]	I_γ[†c]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	δ[&b]	α[a]	Comments
[x]≈1252[@]	<1.0[@]								
[x]≈1258[@]	<1.0[@]								
[x]≈1265[@]	≈1.0[@]								
[x]≈1272[@]	<1.0[@]								
[x]1278.8 *5*	0.83 *11*								
[x]1291.2 *7*	0.43 *11*								
[x]1298.2 *4*	2.02 *20*								
1317.8[@] *8*	<1.0[@]	2414.99	$5/2^+,7/2^+$	1097.72	$(7/2)^-$				
[x]1323.0 *6*	0.38 *18*								
1338.0 *8*	1.44 *19*	3753.7	$(5/2,7/2)^-$	2414.99	$5/2^+,7/2^+$	[E1]		1.77×10^{-3}	α(K)=0.001415 *20*; α(L)=0.000218 *3*; α(M)=5.07×10^{-5} *8* α(N)=1.308×10^{-5} *19*; α(O)=2.79×10^{-6} *4*; α(P)=3.84×10^{-7} *6*; α(IPF)=6.73×10^{-5} *11*
1341.86[#] *13*	4.6 *4*	2135.78	$(5/2,7/2)^+$	794.61	$5/2^-$	[E1]		1.76×10^{-3}	α(K)=0.001408 *20*; α(L)=0.000217 *3*; α(M)=5.05×10^{-5} *7* α(N)=1.301×10^{-5} *19*; α(O)=2.78×10^{-6} *4*; α(P)=3.82×10^{-7} *6*; α(IPF)=6.92×10^{-5} *10*
[x]1349.1[@] *8*	<1.0[@]								
[x]1377.0 *6*	0.88 *8*								
1394.50[#] *9*	9.1 *4*	1394.45	$(7/2)^-$	0.0	$9/2^-$	E2(+M1)	<1.1	0.0081 *15*	α(K)=0.0066 *13*; α(L)=0.00113 *20*; α(M)=0.00027 *5* α(N)=6.9×10^{-5} *12*; α(O)=1.5×10^{-5} *3*; α(P)=2.0×10^{-6} *4*; α(IPF)=5.5×10^{-5} *9*
1415.5[@] *10*	≈1.0[@]	3551.3	(5/2,7/2,9/2)	2135.78	$(5/2,7/2)^+$				
[x]1420.5[@] *10*	<1.0[@]								
1429[@] *1*	<1.0[@]	2522.37	$(5/2^+,7/2^+)$	1093.10	$(7/2)^-$				
[x]≈1439[@]	<1.0[@]								
1471.8 *5*	1.33 *16*	2569.2	$(3/2^-,5/2,7/2)$	1097.72	$(7/2)^-$				
[x]1497.8 *8*	0.88 *14*								
1500.2 *4*	0.80 *10*	2581.37	(3/2,5/2,7/2)	1081.19	$(5/2,7/2)^-$				
[x]1512.6[@] *7*	<1.0[@]								
[x]1516.8[@] *10*	<1.0[@]								
[x]1543.18[#] *13*	7.5 *5*								
[x]1555.5[@] *10*	<1.0[@]								
[x]≈1559[@]	<1.0[@]								
[x]1568[@] *1*	≈1.0[@]								
1592.1 *3*	1.75 *11*	2689.90	$(3/2^-,5/2,7/2)$	1097.72	$(7/2)^-$				
[x]1594[@] *1*	<1.0[@]								

From ENSDF

$^{209}_{85}At_{124}$-9

γ(^{209}At) (continued)

E_γ [†]	I_γ [†c]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [&]	α [a]	Comments
1597.4 *6*	0.91 *11*	3551.3	(5/2,7/2,9/2)	1953.51	7/2$^+$			
[x]1603.0 *10*	0.47 *12*							
1608.5 *10*	0.60 *8*	2689.90	(3/2$^-$,5/2,7/2)	1081.19	(5/2,7/2)$^-$			
1616.0 *10*	0.58 *12*	2712.9	(3/2$^-$,5/2,7/2)	1097.72	(7/2)$^-$			
1631.5 *10*	0.51 *15*	2712.9	(3/2$^-$,5/2,7/2)	1081.19	(5/2,7/2)$^-$			
1635.0 *10*	0.50 *15*	2569.2	(3/2$^-$,5/2,7/2)	934.55?	(7/2)$^-$			
[x]1665.5 *10*	0.65 *13*							
1669.5 *10*	1.10 *15*	2414.99	5/2$^+$,7/2$^+$	745.79	7/2$^-$	[E1]	1.45×10^{-3}	α(K)=0.000977 *14*; α(L)=0.0001493 *21*; α(M)=3.46×10^{-5} *5* α(N)=8.93×10^{-6} *13*; α(O)=1.91×10^{-6} *3*; α(P)=2.63×10^{-7} *4*; α(IPF)=0.000283 *4*
[x]1692.8 *6*	0.45 *12*							
[x]1700.2 *6*	0.41 *11*							
[x]1709.3[#] *3*	6.2 *5*							
1722.5 *10*	1.30 *15*	2516.68	(5/2 to 9/2)$^+$	794.61	5/2$^-$	[E1]	1.43×10^{-3}	α(K)=0.000927 *13*; α(L)=0.0001415 *20*; α(M)=3.28×10^{-5} *5* α(N)=8.46×10^{-6} *12*; α(O)=1.81×10^{-6} *3*; α(P)=2.50×10^{-7} *4*; α(IPF)=0.000321 *5*
1727.5[d@] *7*	<1.0[d@]	2135.78	(5/2,7/2)$^+$	408.34	7/2$^-$			
1727.5[d@] *7*	<1.0[d@]	2522.37	(5/2$^+$,7/2$^+$)	794.61	5/2$^-$			
1741.0 *10*	0.33 *12*	2821.9	(5/2,7/2)	1081.19	(5/2,7/2)$^-$			
1746.1 *3*	1.36 *11*	3140.48	(5/2,7/2)	1394.45	(7/2)$^-$			
[x]1761.0[@] *7*	<1.0[@]							
1771.2 *5*	1.78 *11*	2516.68	(5/2 to 9/2)$^+$	745.79	7/2$^-$	[E1]	1.42×10^{-3}	α(K)=0.000885 *13*; α(L)=0.0001350 *19*; α(M)=3.13×10^{-5} *5* α(N)=8.07×10^{-6} *12*; α(O)=1.727×10^{-6} *25*; α(P)=2.38×10^{-7} *4*; α(IPF)=0.000357 *5*
1774.3 *5*	0.91 *10*	2569.2	(3/2$^-$,5/2,7/2)	794.61	5/2$^-$			
1778.2[d] *5*	≈0.7[d]	2712.9	(3/2$^-$,5/2,7/2)	934.55?	(7/2)$^-$			
1778.2[d] *5*	≈0.7[d]	3172.3	(3/2$^-$,5/2,7/2)	1394.45	(7/2)$^-$			
1786.6[@] *5*	≈1.0[@]	2581.37	(3/2,5/2,7/2)	794.61	5/2$^-$			
[x]1796.5 *3*	1.53 *10*							
[x]1812.5[@] *10*	≈1.0[@]							
1823[@] *1*	<1.0[@]	2569.2	(3/2$^-$,5/2,7/2)	745.79	7/2$^-$			
1836[@] *1*	<1.0[@]	2581.37	(3/2,5/2,7/2)	745.79	7/2$^-$			
[x]≈1848[@]	<1.0[@]							
[x]≈1858[@]	<1.0[@]							
[x]≈1865[@]	<1.0[@]							
[x]1875.0 *10*	0.43 *17*							
[x]≈1883[@]	<1.0[@]							
1887.0 *10*	0.60 *23*	2821.9	(5/2,7/2)	934.55?	(7/2)$^-$			
[x]1912.0 *7*	0.57 *23*							
[x]1925.7 *3*	2.52 *16*							

$^{209}_{85}At_{124}$-10

γ(^{209}At) (continued)

Eγ[†]	Iγ[†c]	Ei(level)	J_i^π	Ef	J_f^π	Mult.[&]	α[a]	Comments
[x]1950.0 *10*	0.46 *10*							
1954.3 *10*	1.21 *12*	1953.51	7/2$^+$	0.0	9/2$^-$	[E1]	1.39×10^{-3}	α(K)=0.000753 *11*; α(L)=0.0001145 *16*; α(M)=2.65×10^{-5} *4* α(N)=6.84×10^{-6} *10*; α(O)=1.464×10^{-6} *21*; α(P)=2.02×10^{-7} *3*; α(IPF)=0.000489 *7*
2043.5[@] *10*	<1.0[@]	3140.48	(5/2,7/2)	1097.72	(7/2)$^-$			
2074.5 *3*	0.87 *10*	3172.3	(3/2$^-$,5/2,7/2)	1097.72	(7/2)$^-$			
2114.05 *20*	3.07 *11*	2522.37	(5/2$^+$,7/2$^+$)	408.34	7/2$^-$			
[x]2121.2 *5*	0.70 *14*							
[x]2130.5 *10*	0.61 *12*							
[x]2133.8 *10*	0.52 *8*							
[x]2145.0 *10*	0.56 *17*							
2150.0 *10*	1.41 *14*	3544.38	(5/2,7/2)	1394.45	(7/2)$^-$	[M1]	0.00370	α(K)=0.00256 *4*; α(L)=0.000430 *6*; α(M)=0.0001010 *15* α(N)=2.61×10^{-5} *4*; α(O)=5.60×10^{-6} *8*; α(P)=7.78×10^{-7} *11*; α(IPF)=0.000575 *8*
2160.7 *6*	0.80 *10*	2569.2	(3/2$^-$,5/2,7/2)	408.34	7/2$^-$			
[x]2176.5 *4*	0.67 *11*							
[x]2195.5 *4*	1.02 *10*							
2205.2 *10*	0.58 *11*	3140.48	(5/2,7/2)	934.55?	(7/2)$^-$			
2233[@] *1*	<1.0[@]	3627.0	(3/2$^-$,5/2,7/2)	1394.45	(7/2)$^-$			
[x]2251[@]	<1.0[@]							
2281.7 *4*	1.03 *10*	2689.90	(3/2$^-$,5/2,7/2)	408.34	7/2$^-$			
2290.5 *3*	0.68 *11*	3388.43	(3/2$^-$,5/2,7/2)	1097.72	(7/2)$^-$			
2306.0 *15*	≈0.25	3388.43	(3/2$^-$,5/2,7/2)	1081.19	(5/2,7/2)$^-$			
[x]2317.2 *4*	0.78 *11*							
[x]2335.7[@] *8*	<1.0[@]							
2346.0 *3*	1.08 *11*	3140.48	(5/2,7/2)	794.61	5/2$^-$			
[x]2369.5[@] *10*	<1.0[@]							
2394.7 *6*	0.79 *9*	3140.48	(5/2,7/2)	745.79	7/2$^-$			
[x]≈2404[@]	<1.0[@]							
2413.5 *6*	0.63 *7*	2821.9	(5/2,7/2)	408.34	7/2$^-$			
2426.0 *10*	≈0.3	3172.3	(3/2$^-$,5/2,7/2)	745.79	7/2$^-$			
[x]≈2437[@]	<1.0[@]							
2446.9 *4*	0.61 *10*	3544.38	(5/2,7/2)	1097.72	(7/2)$^-$	[M1]	0.00303	α(K)=0.00183 *3*; α(L)=0.000307 *5*; α(M)=7.21×10^{-5} *10* α(N)=1.86×10^{-5} *3*; α(O)=4.00×10^{-6} *6*; α(P)=5.56×10^{-7} *8*; α(IPF)=0.000795 *12*
2453.5[d] *5*	0.56[d] *11*	3388.43	(3/2$^-$,5/2,7/2)	934.55?	(7/2)$^-$			
2453.5[d] *5*	0.56[d] *11*	3551.3	(5/2,7/2,9/2)	1097.72	(7/2)$^-$			
[x]2460.8 *6*	1.61 *11*							
2463.7 *6*	0.93 *11*	3544.38	(5/2,7/2)	1081.19	(5/2,7/2)$^-$	[M1]	0.00300	α(K)=0.00180 *3*; α(L)=0.000301 *5*; α(M)=7.08×10^{-5} *10*

$^{209}_{85}$At$_{124}$-11

γ(^{209}At) (continued)

Eγ[†]	Iγ[†c]	Ei(level)	J^π_i	Ef	J^π_f	Mult.[&]	α[a]	Comments
								α(N)=1.83×10^{-5} *3*; α(O)=3.93×10^{-6} *6*; α(P)=5.46×10^{-7} *8*; α(IPF)=0.000807 *12*
[x]2475.5 *4*	0.93 *14*							
[x]2485.7 *4*	0.89 *23*							
[x]≈2496[@]	<1.0[@]							
[x]2536.7 *7*	0.38 *10*							
[x]2555.7 *3*	1.06 *8*							
[x]2638.8 *6*	0.66 *13*							
2642.9 *3*	2.9 *3*	3388.43	(3/2⁻,5/2,7/2)	745.79	7/2⁻			
[x]2646.4 *8*	0.75 *15*							
2656.4 *4*	0.56 *12*	3753.7	(5/2,7/2)⁻	1097.72	(7/2)⁻	[M1,E2]	0.00275	α(K)=0.001480 *21*; α(L)=0.000248 *4*; α(M)=5.81×10^{-5} *9* α(N)=1.505×10^{-5} *21*; α(O)=3.23×10^{-6} *5*; α(P)=4.49×10^{-7} *7*; α(IPF)=0.000944 *14*
[x]2667.0 *10*	0.28 *10*							
[x]2694.9 *6*	0.42 *10*							
2750.3 *6*	0.46 *10*	3544.38	(5/2,7/2)	794.61	5/2⁻	[M1]	0.00265	α(K)=0.001353 *19*; α(L)=0.000226 *4*; α(M)=5.31×10^{-5} *8* α(N)=1.374×10^{-5} *20*; α(O)=2.95×10^{-6} *5*; α(P)=4.10×10^{-7} *6*; α(IPF)=0.001006 *14*
[x]2762.5 *7*	0.55 *9*							
2798.1 *10*	0.62 *7*	3544.38	(5/2,7/2)	745.79	7/2⁻	[M1]	0.00261	α(K)=0.001294 *19*; α(L)=0.000216 *3*; α(M)=5.08×10^{-5} *8* α(N)=1.314×10^{-5} *19*; α(O)=2.82×10^{-6} *4*; α(P)=3.92×10^{-7} *6*; α(IPF)=0.001037 *15*
[x]≈2810[@]	<1.0[@]							
[x]2824.3 *10*	≈0.25							
2833.5 *10*	≈0.25	3627.0	(3/2⁻,5/2,7/2)	794.61	5/2⁻			
2881.0 *10*	0.42 *10*	3627.0	(3/2⁻,5/2,7/2)	745.79	7/2⁻			
[x]≈2932[@]	<1.0[@]							
[x]2937.0 *10*	0.28 *10*							
[x]2942.0 *3*	1.22 *19*							
2981.0 *10*	0.18 *6*	3388.43	(3/2⁻,5/2,7/2)	408.34	7/2⁻			
3007.5 *6*	0.51 *6*	3753.7	(5/2,7/2)⁻	745.79	7/2⁻	[M1,E2]	0.00248	α(K)=0.001073 *15*; α(L)=0.000179 *3*; α(M)=4.20×10^{-5} *6* α(N)=1.088×10^{-5} *16*; α(O)=2.33×10^{-6} *4*; α(P)=3.25×10^{-7} *5*; α(IPF)=0.001172 *17*
[x]3088.5 *10*	0.38 *12*							
[x]3118.0 *15*	≈0.15							
[x]3123.5 *15*	≈0.15							
3136.0 *8*	1.20 *12*	3544.38	(5/2,7/2)	408.34	7/2⁻	[M1,E2]	0.00242	α(K)=0.000963 *14*; α(L)=0.0001606 *23*; α(M)=3.77×10^{-5} *6* α(N)=9.76×10^{-6} *14*; α(O)=2.09×10^{-6} *3*; α(P)=2.91×10^{-7} *4*; α(IPF)=0.001248 *18*
3143.7 *8*	0.59 *7*	3551.3	(5/2,7/2,9/2)	408.34	7/2⁻			
[x]3169.5 *15*	0.18 *5*							
[x]3183.0 *15*	0.20 *5*							
3218.0 *15*	0.23 *5*	3627.0	(3/2⁻,5/2,7/2)	408.34	7/2⁻			

$^{209}_{85}At_{124}$-12

γ(^{209}At) (continued)

† From 1974Vy01, unless otherwise noted.

‡ 1974Vy01 report Iγ=2.3 *5* for the 948.7γ+951.5γ doublet.

\# Weighted average of values from 1974Vy01 and 1973Jo14.

@ Assignment to decay of ^{209}Rn by 1974Vy01, not definitely established.

& From Adopted Gammas. Those for unplaced γ transitions are from ce data in 1974Vy01.

[a] Additional information 6.

[b] Additional information 7.

[c] For absolute intensity per 100 decays, multiply by 0.108 *4*.

[d] Multiply placed with undivided intensity.

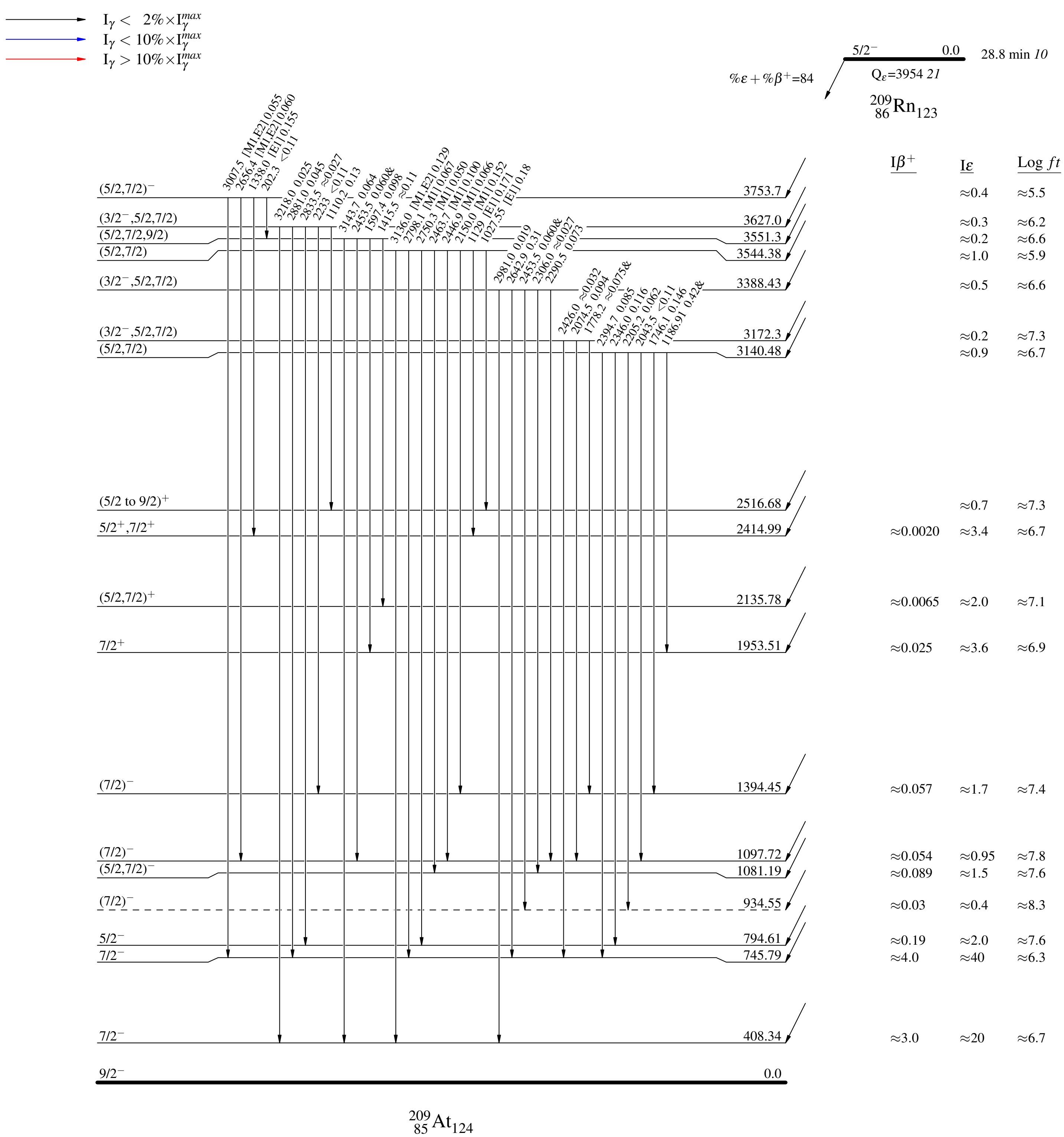
[x] γ ray not placed in level scheme.

$^{209}_{85}$At$_{124}$-13

^{209}Rn ε decay 1974Vy01,1973Jo14

Decay Scheme

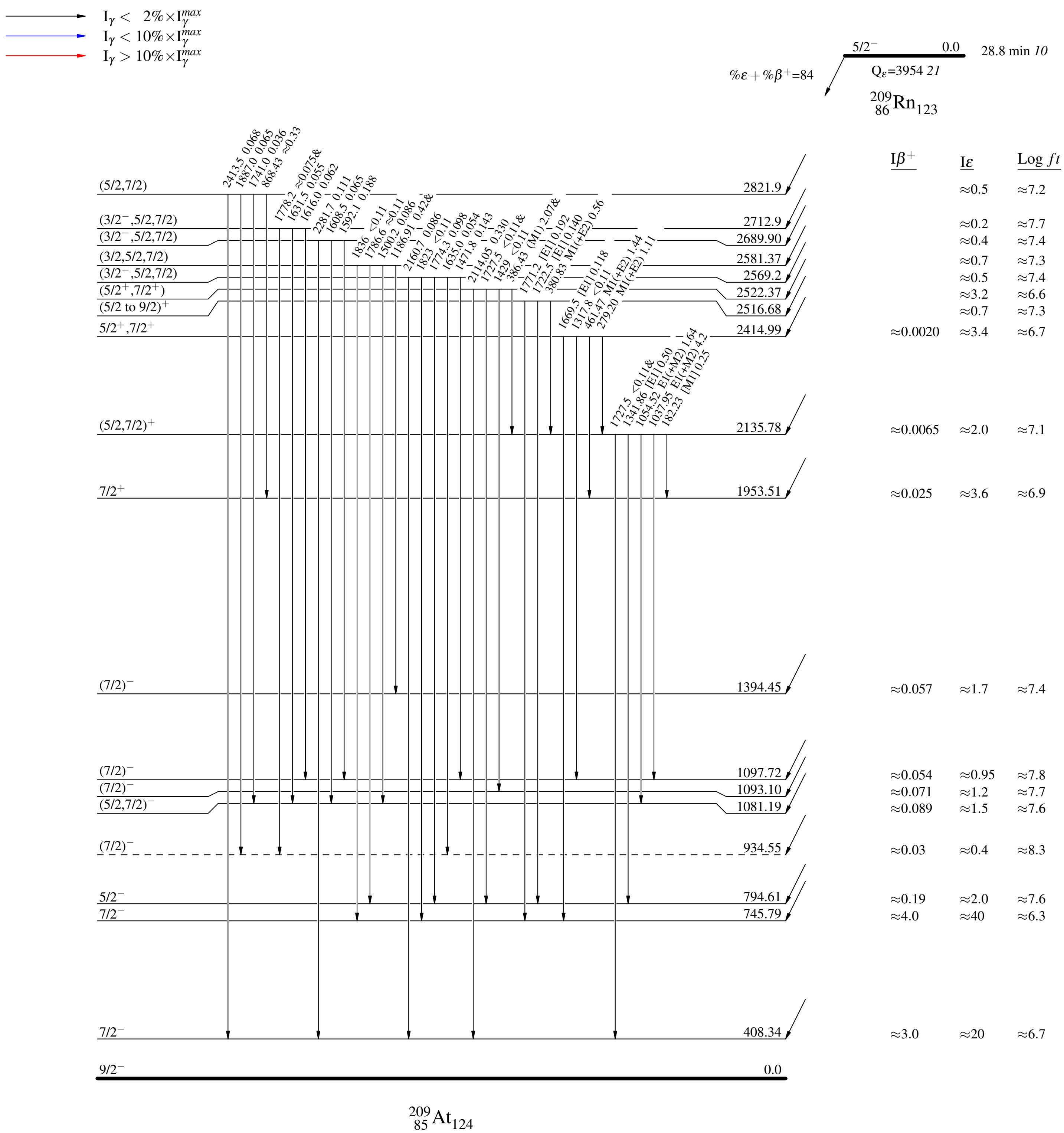
Intensities: I_γ per 100 parent decays
& Multiply placed: undivided intensity given



^{209}Rn ε decay 1974Vy01,1973Jo14

Decay Scheme (continued)

Intensities: I_γ per 100 parent decays
& Multiply placed: undivided intensity given



^{209}Rn ε decay 1974Vy01,1973Jo14

Decay Scheme (continued)

Intensities: I_γ per 100 parent decays
& Multiply placed: undivided intensity given