^{211}Rn ε decay (14.6 h) 1972As11,1972As12

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	B. Singh, S. Singh, H. X. Nguyen and M. Patial	NDS 114, 661 (2013)	28-Feb-2013

Parent: ^{211}Rn: E=0.0; J$^\pi$=1/2$^-$; $T_{1/2}$=14.6 h *2*; Q(ε)=2892 *7*; %ε+%β^+ decay=72.6 *17*
^{211}Rn-J$^\pi$,$T_{1/2}$: From Adopted Levels of ^{211}Rn.
^{211}Rn-Q(ε): From 2012Wa38.
^{211}Rn-%ε+%β^+ decay: %ε=72.6 *17* deduced from Iγ in α and ε decays (1972As11) and the level schemes.
The decay scheme proposed is that of 1972As11 and is based on energy fit and extensive coincidence data.
Others: 1990Ve05 and 1985BuZT ($\gamma\gamma(\theta)$); 1970Be37 (Eγ,Iγ); 1956St60 (ce).

^{211}At Levels

Spin assignments are taken from Adopted Levels where specific arguments for these assignments, based on experimental results, are listed. 1972As11, 1972As12 also consider shell-model calculations and propose the spin sequence 7/2$^-$,7/2$^-$,5/2$^-$,3/2$^-$ and 1/2$^+$ for the levels at 674.1, 866.0, 947.4, 1116.2 and 2479.2 keV. The $\gamma\gamma(\theta)$ results reported in 1985BuZT, however, rule out the 1/2(D)3/2(D+Q)5/2 sequence for the (1362.9γ)(168.7γ) cascade if δ(168.7γ)=2.7 *4* (the δ measured in ce data).

1990Ve05 report $\gamma\gamma(\theta)$ results for ten cascades in this decay. Their conclusions, in general, agree with those of 1972As11, 1972As12, but do not agree with the results of 1985BuZT for the (1362.9γ)(168.7γ) cascade.

E(level)	J$^\pi$ †	$T_{1/2}$	Comments
0.0	9/2$^-$		
674.1	(7/2)$^-$		J$^\pi$: $\gamma\gamma(\theta)$ favors 7/2 over 9/2.
866.0	(7/2)$^-$		J$^\pi$: $\gamma\gamma(\theta)$ favors 7/2 over 5/2 or 9/2.
947.4	(5/2)$^-$		J$^\pi$: $\gamma\gamma(\theta)$ favors 5/2 over 7/2.
1116.2	(3/2)$^-$	0.57 ns *4*	J$^\pi$: $\gamma\gamma(\theta)$ favors 3/2 over 5/2. $T_{1/2}$: from (ce(K))γ(t) (1972As12).
1800.8	(3/2)$^-$		J$^\pi$: $\gamma\gamma(\theta)$ favors 3/2 over 5/2.
1992.5	(5/2)$^-$		
2062.9	1/2$^-$,3/2$^-$		
2108.7	(3/2)$^-$		
2128.7	(5/2$^-$)		
2479.2	(1/2)$^+$		J$^\pi$: $\gamma\gamma(\theta)$ favors 1/2 over 3/2.
2655.0	1/2,3/2		

† From Adopted Levels.

ε,β^+ radiations

The electron capture branches have been deduced from I(γ+ce) balances on the adopted decay scheme.
Intensity balance is negative (−4.3 *21*) for 947 level.

E(decay)	E(level)	Iε †	Log *ft*	I($\varepsilon+\beta^+$) †	Comments
(237 *7*)	2655.0	5.1 *6*	6.08 *7*	5.1 *6*	εK=0.626 *9*; εL=0.272 *7*; εM+=0.101 *3*
(413 *7*)	2479.2	68 *4*	5.59 *4*	68 *4*	εK=0.7253 *19*; εL=0.2030 *13*; εM+=0.0717 *6*
(763 *7*)	2128.7	0.79 *12*	8.15 *7*	0.79 *12*	εK=0.7682 *5*; εL=0.1726 *3*; εM+=0.05917 *12* Log *ft*: too low for ΔJ=2, no transition.
(783‡ *7*)	2108.7	≤2	≥7.8	≤2	εK=0.7693 *4*; εL=0.1718 *3*; εM+=0.05884 *12* I($\varepsilon+\beta^+$): 0.5 *15*, assuming Iγ=1.5 *1.5* for 992.5γ.
(829‡ *7*)	2062.9	1.8 *15*	7.9 *4*	1.8 *15*	εK=0.7717 *4*; εL=0.17016 *25*; εM+=0.05816 *10*
(1091‡ *7*)	1800.8	<3.6	>7.8	<3.6	εK=0.7810 *2*; εL=0.1636 *2*; εM+=0.05547 *6*

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^{211}Rn ε decay (14.6 h) 1972As11,1972As12 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I($\varepsilon+\beta^+$)†	Comments
						I($\varepsilon+\beta^+$): 1.6 *20* from intensity balance.
(1776‡ *7*)	1116.2	<0.008	<3	>8.4	<3	av Eβ=361.9 *31*; εK=0.7894; εL=0.15566 *6*; εM+=0.05229 *3* I($\varepsilon+\beta^+$): 1 *3* from intensity balance.

† Absolute intensity per 100 decays.
‡ Existence of this branch is questionable.

γ(^{211}At)

Iγ normalization: from ΣI(γ+ce to g.s.)=100.
Unless noted otherwise, all data are from 1972As11.
The ce spectra measured by 1972As11, 1972As12 were normalized to the γ spectra through α(K)(442.2γ)=0.02955, the theoretical value for an E2 transition.

E_γ	I_γ[a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ[@]	α[#&]	Comments
116.0 *1*	0.20 *2*	2108.7	(3/2)$^-$	1992.5	(5/2)$^-$	M1(+E2)	<0.65	7.4 *6*	α(K)=5.5 *9*; α(L)=1.39 *24*; α(M)=0.34 *7* α(N)=0.089 *18*; α(O)=0.018 *4*; α(P)=0.0023 *3* Ice(K)=0.20 *2*. Mult.,δ: from α(K)exp=6.1 *15*.
168.7 *1*	14.9 *8*	1116.2	(3/2)$^-$	947.4	(5/2)$^-$	E2+M1	−2.9 *4*	1.12 *6*	α(K)=0.44 *7*; α(L)=0.499 *8*; α(M)=0.1318 *23* α(N)=0.0341 *6*; α(O)=0.00676 *12*; α(P)=0.000720 *11* Ice(K)=7.2 *7*. Mult.: from α(K)exp=0.47 *5*, K:L2:M+N=7.2 *7*:4.6 *4*:1.4 *4*; α(L12)exp=0.31 *2* (1972As12); K/L=0.6 (1956St60).
176.0 *1*	0.14 *3*	2655.0	1/2,3/2	2479.2	(1/2)$^+$	[D,E2]		1.3 *12*	
191.8 *1*	2.0 *1*	866.0	(7/2)$^-$	674.1	(7/2)$^-$	M1(+E2)	−0.06 *18*	1.90 *8*	α(K)=1.54 *8*; α(L)=0.275 *4*; α(M)=0.0652 *12* α(N)=0.0169 *3*; α(O)=0.00361 *6*; α(P)=0.000499 *9* Ice(K)=2.8 *7*. Mult.: from α(K)exp=1.4 *4*, K/L=7 *4*; α(L1)exp=0.22 *6* (1972As12).
250.2 *1*	13.3 *7*	1116.2	(3/2)$^-$	866.0	(7/2)$^-$	E2		0.232	α(K)=0.1017 *15*; α(L)=0.0969 *14*; α(M)=0.0255 *4* α(N)=0.00660 *10*; α(O)=0.001316 *19*; α(P)=0.0001419 *20* Ice(K)=1.0 *4*. Mult.: from α(K)exp=0.08 *3*; α(L)exp=0.104 *24*, L12/L3=3.5 *19* (1972As12); and from γγ(θ) (1985BuZT). δ(M3/E2)=−0.12 *7* (1990Ve05). (250γ)(192γ)(θ): A_2=+0.18 *6*, A_4=−0.15 *11* (1990Ve05). (250γ)(866γ)(θ): A_2=−0.179 *20*, A_4=−0.02 *4*(1990Ve05).
262.1 *1*	0.49 *5*	2062.9	1/2$^-$,3/2$^-$	1800.8	(3/2)$^-$	M1		0.798	α(K)=0.647 *9*; α(L)=0.1148 *17*; α(M)=0.0272 *4* α(N)=0.00703 *10*; α(O)=0.001506 *22*; α(P)=0.000208 *3* Ice(K)=0.5 *2*. Mult.: from α(K)exp=1.0 *4*; K/L=5.0 *14* (1956St60).
350.5 *1*	0.88 *6*	2479.2	(1/2)$^+$	2128.7	(5/2$^-$)	(M2)		1.200	α(K)=0.903 *13*; α(L)=0.224 *4*; α(M)=0.0555 *8* α(N)=0.01449 *21*; α(O)=0.00308 *5*; α(P)=0.000416 *6* Ice(K)=0.6 *2*. Mult.: α(K)exp=0.7 *2*; K/L=6.3 *18* (1956St60).
370.5 *1*	3.0 *2*	2479.2	(1/2)$^+$	2108.7	(3/2)$^-$	E1		0.0201	α(K)=0.01642 *23*; α(L)=0.00282 *4*; α(M)=0.000663 *10* α(N)=0.0001703 *24*; α(O)=3.58×10^{-5} *5*; α(P)=4.70×10^{-6} *7* Ice(K)=0.06 *3*. Mult.: from α(K)exp=0.02 *1*.
416.4 *1*	7.7 *4*	2479.2	(1/2)$^+$	2062.9	1/2$^-$,3/2$^-$	E1		0.01561	α(K)=0.01278 *18*; α(L)=0.00216 *3*; α(M)=0.000508 *8*

From ENSDF

γ(^{211}At) (continued)

E_γ	I_γ[a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ[@]	α[#&]	Comments
									α(N)=0.0001308 *19*; α(O)=2.75×10^{-5} *4*; α(P)=3.64×10^{-6} *5* Ice(K)<0.15. Mult.: from α(K)exp<0.02.
442.2 *1*	51 *3*	1116.2	(3/2)$^-$	674.1	(7/2)$^-$	E2		0.0454	α(K)=0.0295 *5*; α(L)=0.01192 *17*; α(M)=0.00304 *5* α(N)=0.000786 *11*; α(O)=0.0001601 *23*; α(P)=1.88×10^{-5} *3* Mult.: from K/L=1.9 *5* (1956St60) and $\gamma\gamma(\theta)$ (1985BuZT) (theory: K/L(E2)=2.45, K/L(M1)=5.70, K/L(M4)=1.82). (442γ)(674γ)(θ): A_2=+0.230 *8*, A_4=−0.025 *15* (1990Ve05).
592.3 *1*	0.58 *5*	2655.0	1/2,3/2	2062.9	1/2$^-$,3/2$^-$				
674.1 *1*	100	674.1	(7/2)$^-$	0.0	9/2$^-$	M1+E2	−0.65 *6*	0.0493 *19*	α(K)=0.0398 *16*; α(L)=0.00724 *24*; α(M)=0.00172 *6* α(N)=0.000445 *15*; α(O)=9.5×10^{-5} *3*; α(P)=1.29×10^{-5} *5* Ice(K)=4.6 *3*. Mult.: from α(K)exp=0.046 *3*.
678.4 *1*	64 *3*	2479.2	(1/2)$^+$	1800.8	(3/2)$^-$	(E1+M2)	0.23 *5*	0.014 *4*	α(K)=0.011 *3*; α(L)=0.0020 *6*; α(M)=0.00049 *14* α(N)=0.00013 *4*; α(O)=2.7×10^{-5} *8*; α(P)=3.7×10^{-6} *11* Ice(K)=0.7 *2*. Mult.,δ: from α(K)exp=0.011 *3*. (M1+E2 also allowed by α(K)exp, but ruled out by the decay scheme). (678γ)(853γ)(θ): A_2=−0.10 *4*, A_4=−0.02 *8* (1990Ve05). (678γ)(1127γ)(θ)+(1127γ)(674γ)(θ): A_2=+0.066 *9*, A_4=+0.006 *15* (1990Ve05).
684.7 *1*	1.3 *1*	1800.8	(3/2)$^-$	1116.2	(3/2)$^-$				
853.4 *1*	10.2 *5*	1800.8	(3/2)$^-$	947.4	(5/2)$^-$	(M1+E2)	−0.38 *11*	0.0310 *17*	α(K)=0.0252 *14*; α(L)=0.00440 *21*; α(M)=0.00104 *5* α(N)=0.000269 *13*; α(O)=5.7×10^{-5} *3*; α(P)=7.9×10^{-6} *4* Ice(K)=0.21 *3*. Mult.,δ: from α(K)exp=0.021 *3*. Also δ=−0.01 *17* from $\gamma\gamma(\theta)$. (853γ)(947γ)(θ): A_2=+0.04 *3*, A_4=−0.06 *6* (1990Ve05).
866.0 *1*	17.5 *9*	866.0	(7/2)$^-$	0.0	9/2$^-$	(E2)		0.01025	α(K)=0.00792 *11*; α(L)=0.001769 *25*; α(M)=0.000430 *6* α(N)=0.0001113 *16*; α(O)=2.33×10^{-5} *4*; α(P)=3.01×10^{-6} *5* Ice(K)=0.13 *3*. Mult.: from α(K)exp=0.0073 *15*. δ: >+12 or -∞.
934.7 *1*	8.1 *4*	1800.8	(3/2)$^-$	866.0	(7/2)$^-$	(E2)		0.00882	α(K)=0.00688 *10*; α(L)=0.001473 *21*; α(M)=0.000357 *5* α(N)=9.22×10^{-5} *13*; α(O)=1.94×10^{-5} *3*; α(P)=2.52×10^{-6} *4* Ice(K)=0.08 *3*. Mult.: from α(K)exp=0.010 *3*. δ(M3/E2)=+0.03 *7*, >+32 or <−7 (1990Ve05); the latter two values are unrealistic, as 934.7 transition is not expected to be pure M3. (935γ)(866γ)(θ): A_2=−0.09 *5*, A_4=−0.04 *9* (1990Ve05).
946.7 *1*	11 *3*	2062.9	1/2$^-$,3/2$^-$	1116.2	(3/2)$^-$	(M1)[‡]		0.0259	α(K)=0.0212 *3*; α(L)=0.00363 *5*; α(M)=0.000855 *12* α(N)=0.000221 *4*; α(O)=4.75×10^{-5} *7*; α(P)=6.57×10^{-6} *10*

$^{211}_{85}$At$_{126}$-4

γ(^{211}At) (continued)

E_γ	I_γ[a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ[@]	α[#&]	Comments
947.4 *1*	36 *4*	947.4	(5/2)$^-$	0.0	9/2$^-$	(E2)[‡]		0.00859	α(K)=0.00671 *10*; α(L)=0.001427 *20*; α(M)=0.000345 *5* α(N)=8.93×10^{-5} *13*; α(O)=1.88×10^{-5} *3*; α(P)=2.44×10^{-6} *4*
992.5[b]	≈3	2108.7	(3/2)$^-$	1116.2	(3/2)$^-$				I_γ: tentative evidence for this γ ray from (370γ)(169γ) and (370γ)(250γ) coincidences.
1012.5 *1*	0.47 *4*	2128.7	(5/2$^-$)	1116.2	(3/2)$^-$				
[x]1038.2[†] *5*	0.08 *3*								
1044.7 *4*	0.13 *4*	1992.5	(5/2)$^-$	947.4	(5/2)$^-$				
1115.5[†b] *3*	0.2 *1*	2062.9	1/2$^-$,3/2$^-$	947.4	(5/2)$^-$				E_γ: an 1115.2γ is known in ^{207}Po from ^{207}At ε decay.
1126.7 *1*	49 *3*	1800.8	(3/2)$^-$	674.1	(7/2)$^-$	(E2)		0.00616	α(K)=0.00489 *7*; α(L)=0.000962 *14*; α(M)=0.000231 *4* α(N)=5.96×10^{-5} *9*; α(O)=1.258×10^{-5} *18*; α(P)=1.666×10^{-6} *24*; α(IPF)=3.94×10^{-7} *6* Ice(K)=0.26 *5*. Mult.: from α(K)exp=0.0053 *10*.
1181.3 *1*	3.2 *2*	2128.7	(5/2$^-$)	947.4	(5/2)$^-$				
1242.9 *2*	0.15 *3*	2108.7	(3/2)$^-$	866.0	(7/2)$^-$				
1318.3 *1*	0.28 *3*	1992.5	(5/2)$^-$	674.1	(7/2)$^-$				
1362.9 *1*	72 *4*	2479.2	(1/2)$^+$	1116.2	(3/2)$^-$	E1+M2	−0.12 *3*	0.00204 *18*	α(K)=0.00162 *14*; α(L)=0.00026 *3*; α(M)=6.0×10^{-5} *7* α(N)=1.56×10^{-5} *17*; α(O)=3.3×10^{-6} *4*; α(P)=4.6×10^{-7} *5*; α(IPF)=7.95×10^{-5} *13* Ice(K)=0.10 *3*. Mult.: from α(K)exp=0.0014 *4*. (1363γ)(442γ)(θ): A_2=−0.040 *9*, A_4=+0.009 *17* (1990Ve05). Additional information 1. (1363γ)(250γ)(θ): A_2=−0.038 *18*, A_4=−0.03 *4* (1990Ve05). (1363γ)(169γ)(θ): A_2=−0.001 *17*, A_4=+0.01 *4* (1990Ve05). The corresponding values from 1985BuZT disagree.
1435.1 *2*	0.15 *2*	2108.7	(3/2)$^-$	674.1	(7/2)$^-$				
[x]1482.9[†] *2*	0.09 *2*								
1531.8 *3*	0.10 *5*	2479.2	(1/2)$^+$	947.4	(5/2)$^-$				
1538.8 *2*	10.4 *11*	2655.0	1/2,3/2	1116.2	(3/2)$^-$				
[x]1654.5[†] *2*	0.06 *1*								
[x]1686.0[†] *4*	0.028 *14*								
[x]1747.0[†] *4*	0.011 *4*								
1805.0 *2*	0.26 *5*	2479.2	(1/2)$^+$	674.1	(7/2)$^-$	[E3]		0.00528	α(K)=0.00410 *6*; α(L)=0.000825 *12*; α(M)=0.000198 *3* α(N)=5.14×10^{-5} *8*; α(O)=1.088×10^{-5} *16*; α(P)=1.455×10^{-6} *21*; α(IPF)=9.61×10^{-5} *14*
[x]1947.9[†] *4*	0.023 *6*								
[x]1953.4[†] *4*	0.016 *5*								
1992.7 *2*	1.11 *6*	1992.5	(5/2)$^-$	0.0	9/2$^-$				
[x]2113.4[†] *4*	0.012 *4*								

$^{211}_{85}$At$_{126}$-5

γ(^{211}At) (continued)

E_γ	I_γ[a]	E_i(level)	J_i^π	E_f	J_f^π
2129.0[†b] *3*	0.010 *4*	2128.7	(5/2⁻)	0.0	9/2⁻
[x]2212.9[†] *3*	0.022 *4*				
[x]2405.1[†] *5*	0.009 *3*				
[x]2486.0[†] *4*	0.009 *2*				
[x]2696.3[†] *5*	0.0036 *12*				

[†] γ ray tentatively assigned to decay of ^{211}Rn or ^{207}Po.
[‡] The 946.7γ and 947.4γ ce(K) are not resolved; the measured α(K)exp(sum)=0.010 *1* is consistent with M1 for 946.7γ and E2 for 947.4γ.
[#] Additional information 2.
[@] From 1990Ve05, obtained from combined analysis of their γγ(θ) and previous ce data, unless otherwise stated.
[&] Additional information 3.
[a] For absolute intensity per 100 decays, multiply by 0.454 *18*.
[b] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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