^{222}Ra α decay (33.6 s) 1995Ko54,1976Ku08,1956As38

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, M. S. Basunia, Murray Martin et al. ,	NDS 160, 405 (2019)	30-Oct-2019

Parent: ^{222}Ra: E=0.0; $J^\pi=0^+$; $T_{1/2}$=33.6 s *4*; Q(α)=6678 *4*; %α decay=100.0

^{222}Ra-$T_{1/2}$: From 2012Po13 (from α activity measurement, decay curve and uncertainty details given). Others: 36.17 s *10* (1995Ko54, from γ activity measured for 32 samples, value is from authors′ text, also quoted as 36.0 s *1* in their abstract and 36.07 in Fig. 4, but decay curve and details of uncertainties not given); 43 s *4* (1982Bo04, from α activity in a complex α spectrum with contribution from many isotopes); 39 s *4* (1958To25); 37.5 s *20* and 36 s *2* (1956As38, from α activity); 38.0 s (1948St42).

^{222}Ra-Q(α): From 2017Wa10.

1995Ko54: measured $T_{1/2}$, Eγ, Iγ.

1991Ga28: $\alpha\alpha$ correlations from successive α decays.

1976Ku08: measured Eγ, Iγ.

1956As38: measured $T_{1/2}$, Eα, Iα, $\alpha\gamma$ coin.

$\alpha\gamma$: 1963Le17, 1969Pe17.

$\gamma\gamma$: 1960St20.

$\alpha\gamma(\theta)$: 1956Sm88.

$\alpha\gamma$(t): 1960Be25.

α(K)exp: 1974Va28, 1963Le17.

Analysis and syst of ^{222}Ra α decay data: 1987Po06.

Additional information 1.

^{218}Rn Levels

E(level)†	J^π‡	$T_{1/2}$‡	Comments
0.0	0^+	33.75 ms *15*	
324.320 *18*	2^+	<80 ps	$T_{1/2}$: from $\alpha\gamma$(t) (1960Be25). J^π: $\alpha\gamma(\theta)$ (1956Sm88) establishes 0-2-0 ($\alpha\gamma$) cascade.
653.12 *19*	(4^+)		
796.911 *21*	(3^-)		
840.172 *18*	(3^-)		

† From a least-squares fit to Eγ, by evaluators.

‡ From the Adopted Levels. 1995Ko54 assigned (2^+) to the 653 level and $(1^-,2^+)$ to the 797 and 840 levels based on g.s. transitions, but in the opinion of the evaluators, γ rays to g.s. are probably contributed by summing effects.

α radiations

Eα†	E(level)	Iα@	HF#	Comments
5733 *5*	840.172	0.0043‡ *1*	4.37 *16*	Iα: other: 0.006% from $\alpha\gamma$ coin (1963Le17).
5775 *5*	796.911	0.0043‡ *2*	7.1 *4*	Iα: other: 0.007% (1963Le17) from $\gamma\alpha$ coin.
5916 *5*	653.12	0.0043‡ *2*	34.4 *19*	α was not observed due to presence of interfering transitions (1963Le17).
6239 *5*	324.320	3.05 *5*	1.44 *6*	Eα: other: energy was measured by 1961Ru06 relative to Eα(g.s.) and ΔQ(α)=326 *4* was given. Iα: from 1969Pe17. Others: 3.2% (1961Ru06), 4.1% *12* (1963Le17), 3.2% *2* (1975VaZD). Iα=3.09% *9* is deduced from level scheme.
6558 *5*	0.0	96.9 *1*	1.00	Eα: recommended by 1991Ry01 from measurement of 1956As38. The original energy has been increased by 4 keV because of change in calibration energy. Iα: weighted average of 96.95 *5* (1969Pe17) and 96.8 *2* (1975VaZD).

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α radiations (continued)

† Deduced by evaluators from level energies and Q(α)=6678 *4* (2017Wa10).
‡ Derived by evaluators using γ-ray intensity balance.
# HF(6558α)=1.0 yields $r_0(^{218}Rn)$=1.5492 *22*.
@ Absolute intensity per 100 decays.

$\gamma(^{218}Rn)$

Iγ normalization: From absolute gamma-ray intensity (per 100 decays of the parent) of 324γ=2.77% *8* (1969Pe17).
A γ-ray with Eγ=653.14 keV *9* and Iγ(653γ)=0.00024 *4* was observed in 1995Ko54 and placed from the 653-keV level. 1995Ko54 note that random summing cannot be excluded from this observed transition. Adopted J^π assignments give an M4 multipolarity for the 653γ transition and considering Iγ(516γ)=0.00142 *8* for the competing E1 depopulating transition, the transition strength for 653γ would be more than 10^6 W.u. larger than the E1 transition. Thus, the evaluators consider the 653γ to have resulted from summing and do not include it in this decay dataset.

E_γ †	I_γ ‡#	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α @	Comments
144.4 *5*	1.1×10^{-4} *2*	796.911	(3$^-$)	653.12	(4$^+$)	[E1]	0.190 *4*	α(K)=0.1508 *25*; α(L)=0.0299 *5*; α(M)=0.00714 *12*; α(N)=0.00184 *3* α(O)=0.000387 *7*; α(P)=5.09×10^{-5} *9* Eγ: weighted average of 144.0 *5* (1976Ku08) and 144.8 *5* (1995Ko54). Iγ: from 1976Ku08. Other: <0.00025 *7* (1995Ko54).
324.31 *2*	2.77 *8*	324.320	2$^+$	0.0	0$^+$	E2	0.1097	α(K)=0.0582; α(L)=0.0382; α(M)=0.0100; α(N)=0.00260; α(O)=0.000537; α(P)=6.51×10^{-5} Eγ: weighted average of 324.22 *5* (1976Ku08) and 324.31 *1* (1995Ko54). Iγ: from 1969Pe17. Mult.: from α(K)exp=0.059 (1974Va28).
328.9 *2*	0.0040 *1*	653.12	(4$^+$)	324.320	2$^+$	[E2]	0.1053	α(K)=0.0565; α(L)=0.0363; α(M)=0.00948; α(N)=0.00247; α(O)=0.000510; α(P)=6.19×10^{-5} Eγ: other: 328.9 *2* (1976Ku08). Iγ: other: 0.0043 *5* (1976Ku08).
472.59 *1*	0.0039 *1*	796.911	(3$^-$)	324.320	2$^+$	[E1]	0.0124	α(K)=0.0101; α(L)=0.00171; α(M)=0.00040; α(N)=0.000104; α(O)=2.25×10^{-5}; α(P)=3.17×10^{-6} Eγ: other: 472.5 *1* (1976Ku08). Iγ: other: 0.0040 *3* (1976Ku08). Mult.: possibly E1 from α(K)exp≈0.01 (α(ce) and $\alpha\gamma$ coin data of 1963Le17); but a definitive assignment could not be made from the available data (according to private communication from author of 1963Le17 to 1987El12).
515.83 *3*	0.00142 *8*	840.172	(3$^-$)	324.320	2$^+$	(E1)	0.0103	α(K)=0.00847; α(L)=0.00142; α(M)=0.00033; α(N)=8.64×10^{-5}; α(O)=1.87×10^{-5}; α(P)=2.64×10^{-6} α(K)exp≈0.025 (1963Le17). Eγ: other: 515.6 *1* (1976Ku08). Iγ: other: 0.0015 *1* (1976Ku08). Mult.: from α(K)exp.
796.8& *2*	0.00017 *5*	796.911	(3$^-$)	0.0	0$^+$	[E3]	0.0333	α(K)=0.0219; α(L)=0.00849; α(M)=0.00217;

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$\gamma(^{218}Rn)$ (continued)

E_γ [†]	I_γ [‡#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α [@]	Comments
								α(N)=0.000569; α(O)=0.0001202; α(P)=1.579×10^{-5}
								E_γ,I_γ: from 1995Ko54 only, probably contributed by coincidental summing of 472γ and 324γ.
840.18 *2*	0.0028 *1*	840.172	(3$^-$)	0.0	0$^+$	[E3]	0.0292	α(K)=0.0197; α(L)=0.00714; α(M)=0.00182;
								α(N)=0.000476; α(O)=0.0001008; α(P)=1.333×10^{-5}
								E_γ: other: 840.2 *2* (1976Ku08).
								I_γ: other: 0.0025 *2* (1976Ku08).

† From 1995Ko54, unless otherwise stated. Values from 1976Ku08 are consistent and provided in the comments. Others: 1974Va28, 1963Le17, 1956As38, 1956Sm88, 1960St20.

‡ From 1995Ko54, unless otherwise stated. Intensities are normalized to Iγ(324γ)=2.77% *8* (1969Pe17). Values from 1976Ku08 are consistent and provided in the comments. Others: 1963Le17, 1961Ru06, 1960St20, 1956As38.

Absolute intensity per 100 decays.

@ 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.

& Placement of transition in the level scheme is uncertain.

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Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 decays through this branch