Adopted Levels, Gammas

History

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

Q(β^-)=−6990 *70*; S(n)=7930 *50*; S(p)=2770 *50*; Q(α)=7143.0 *27* 2012Wa38

^{209}Ra Levels

Cross Reference (XREF) Flags

A ^{213}Th α decay
B ^{174}Yb(^{40}Ar,5nγ)
C ^{184}W(^{30}Si,5nγ)

E(level)†	J$^\pi$#	T$_{1/2}$	XREF	Comments
0.0	5/2$^-$	4.8 s *2*	ABC	%α≈100 μ=+0.852 *16*; Q=+0.39 *4* J$^\pi$: from collinear LASER spectroscopy (1988Ah02). π from μ. T$_{1/2}$: weighted average of 4.7 s *2* (α(t),1967Va22), 4.5 s *3* (α(t), 1968Lo15) and 5.1 s *2* (238-KLMα(t)+644.0$\gamma\alpha$(t), 2008Ha12). Since ^{209}Ra and ^{210}Ra have similar Eα, different beam energies were used to differentiate production of ^{209}Ra and ^{210}Ra in 1967Va22 and 1968Lo15. μ,Q: measured using Collinear Fast Beam Laser Spectroscopy. μ is weighted average of +0.865 *13* (1988Ah02,1987Ar20) and +0.832 *16* (1987We03); Q is weighted average of +0.38 *4* (1988Ah02,1987We03) and +0.40 *4* (1989Ne03). configuration=ν(f$_{5/2}$)$^{-1}$. $\delta\langle r^2\rangle$(^{209}Ra,^{214}Ra)=−0.253 fm^2 *25* (1988Ah02). Eα=7008 keV *5* (1967Va22), 7003 keV *10* (2003He06), and 7005 keV *4* (2008Ha12).
644.0 *5*	9/2$^-$		BC	configuration: ν(f$_{5/2}$)$^{-1}\otimes$2$^+$. J$^\pi$: 644.0γ E2 to 5/2$^-$.
882.4 *7*	13/2$^+$	117 μs *5*	BC	J$^\pi$: 238.4γ M2 to 9/2$^-$; systematics of known J^π=13/2$^+$ isomeric states in neighboring N=121 isotones. T$_{1/2}$: weighted average of 115 μs *7* from 644.0γ(t) and 118 μs *6* from from 238-KLM(t) in ^{174}Yb(^{40}Ar,5nγ) (2008Ha12). Other: 88 μs *31* from 238.4γ(t) in ^{174}Yb(^{40}Ar,5nγ) (2008Ha12). configuration: ν(i$_{13/2}$)$^{-1}$.
1014.8‡ *7*	(11/2$^-$)		C	
1409.3‡ *7*	(13/2$^-$)		C	
1450.9 *9*	(17/2$^+$)		C	configuration: possible ν(i$_{13/2}$)$^{-1}\otimes$2$^+$.
1888.1 *10*	(21/2$^+$)		C	
2223.7 *12*	(25/2$^+$)		C	
2452.8? *13*	(27/2$^+$)		C	
2760? *15*	(29/2$^+$)		C	

† From a least-squares fit to Eγ.
‡ Fed from a long-lived (a few μs or longer) isomeric state, since 378.8γ, 643.6γ and 765.3γ were observed at the mass separator focal plane in ^{184}W(^{30}Si,5nγ) (2004Re04).
# From 2004Re04 in ^{184}W(^{30}Si,5nγ), based on the deduced γ-ray transition multipolarities and systematics arguments, unless otherwise stated.

Adopted Levels, Gammas (continued)

$\gamma(^{209}Ra)$

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[#]	α[@]	Comments
644.0	$9/2^-$	644.0 *5*	100	0.0	$5/2^-$	E2	0.0218	α(K)=0.01553 *22*; α(L)=0.00471 *7*; α(M)=0.001187 *17*; α(N+..)=0.000394 *6* α(N)=0.000313 *5*; α(O)=6.94×10^{-5} *10*; α(P)=1.130×10^{-5} *16*; α(Q)=5.51×10^{-7} *8* E_γ: weighted average of 643.6 keV *5* from ^{184}W(^{30}Si,5nγ) and 644.4 keV *5* from ^{174}Yb(^{40}Ar,5nγ). Mult.: ^{209}Ra cg Mα(K)exp<0.034 and K/L>3 in ^{174}Yb(^{40}Ar,5nγ) (2008Ha12) are consistent with E1 or E2, but E1 is ruled out, since the placement in the level scheme requires Mult.=E2; γ-ray anisotropy measurements in ^{184}W(^{30}Si,5nγ) (2004Re04) suggest also Mult.=E2.
882.4	$13/2^+$	238.4 *5*	100	644.0	$9/2^-$	M2	5.38	α(K)=3.81 *6*; α(L)=1.164 *17*; α(M)=0.298 *5*; α(N+..)=0.1010 *15* α(N)=0.0796 *12*; α(O)=0.0181 *3*; α(P)=0.00308 *5*; α(Q)=0.000221 *3* B(M2)(W.u.)=0.00153 *7* E_γ,I_γ: from ^{174}Yb(^{40}Ar,5nγ) 2008Ha12. Mult.: from α(K)exp=4.0 *5* in ^{174}Yb(^{40}Ar,5nγ) (2008Ha12).
1014.8	$(11/2^-)$	370.8[‡] *5*	100	644.0	$9/2^-$	(M1)	0.397	α(K)=0.320 *5*; α(L)=0.0585 *9*; α(M)=0.01395 *21*; α(N+..)=0.00467 *7* α(N)=0.00368 *6*; α(O)=0.000839 *13*; α(P)=0.0001463 *22*; α(Q)=1.147×10^{-5} *17*
1409.3	$(13/2^-)$	765.3[‡] *5*	100	644.0	$9/2^-$	(E2)	0.01525	α(K)=0.01130 *16*; α(L)=0.00297 *5*; α(M)=0.000739 *11*; α(N+..)=0.000246 *4* α(N)=0.000195 *3*; α(O)=4.34×10^{-5} *7*; α(P)=7.17×10^{-6} *11*; α(Q)=3.93×10^{-7} *6*
1450.9	$(17/2^+)$	568.5 *5*	100	882.4	$13/2^+$	(E2)	0.0288	α(K)=0.0197 *3*; α(L)=0.00677 *10*; α(M)=0.001722 *25*; α(N+..)=0.000571 *9* α(N)=0.000454 *7*; α(O)=0.0001003 *15*; α(P)=1.615×10^{-5} *23*; α(Q)=7.10×10^{-7} *10*
1888.1	$(21/2^+)$	437.2 *5*	100	1450.9	$(17/2^+)$	(E2)	0.0537	α(K)=0.0329 *5*; α(L)=0.01549 *23*; α(M)=0.00402 *6*; α(N+..)=0.001331 *20* α(N)=0.001061 *16*; α(O)=0.000232 *4*; α(P)=3.65×10^{-5} *6*; α(Q)=1.226×10^{-6} *18*
2223.7	$(25/2^+)$	335.6 *5*	100	1888.1	$(21/2^+)$	(E2)	0.1093	α(K)=0.0562 *8*; α(L)=0.0393 *6*; α(M)=0.01038 *16*; α(N+..)=0.00343 *6* α(N)=0.00274 *5*; α(O)=0.000594 *9*; α(P)=9.13×10^{-5} *14*; α(Q)=2.19×10^{-6} *4*
2452.8?	$(27/2^+)$	229.1 *5*	100	2223.7	$(25/2^+)$	(M1)	1.496 *23*	α(K)=1.203 *19*; α(L)=0.222 *4*; α(M)=0.0530 *9*; α(N+..)=0.0178 *3* α(N)=0.01398 *22*; α(O)=0.00319 *5*; α(P)=0.000556 *9*; α(Q)=4.36×10^{-5} *7*
2760?	$(29/2^+)$	306[&]		2452.8?	$(27/2^+)$	(M1)	0.671	α(K)=0.541 *8*; α(L)=0.0992 *14*; α(M)=0.0237 *4*; α(N+..)=0.00793 *12* α(N)=0.00624 *9*; α(O)=0.001424 *20*; α(P)=0.000248 *4*; α(Q)=1.95×10^{-5} *3*

[†] From ^{184}W(^{30}Si,5nγ) (2004Re04), unless otherwise stated.

[‡] Observed at the focal plane and, therefore, fed from an isomeric state with a half-life of a few μs or longer in ^{184}W(^{30}Si,5nγ)

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

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

(2004Re04) (not placed in the level scheme).

From 2004Re04 in $^{184}W(^{30}Si,5n\gamma)$, based on the measured γ-ray anisotropies (D=M1 and Q=E2 were assumed), unless otherwise stated.

@ 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.

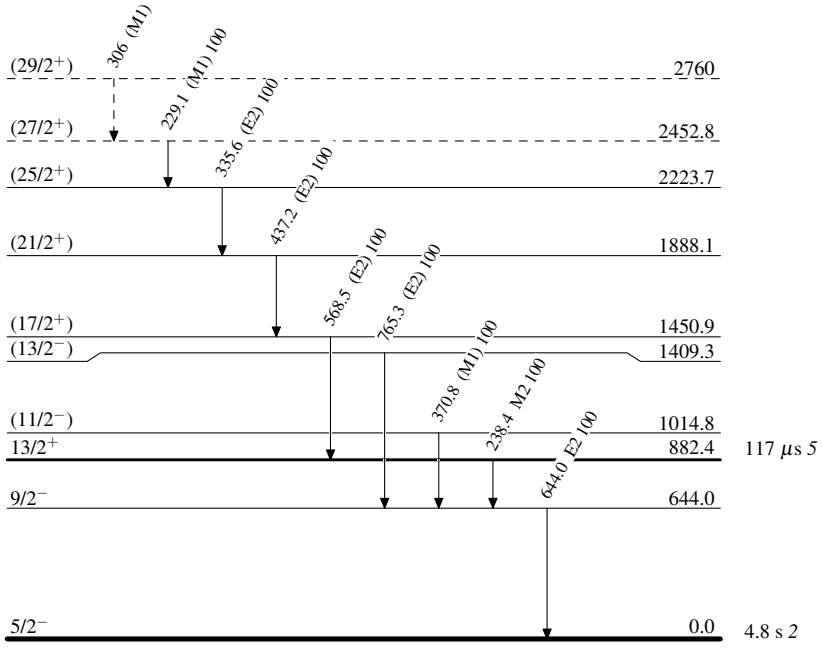
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{209}_{88}Ra_{121}$