Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	T. D. Johnson, Balraj Singh	NDS 142, 1 (2017)	15-Apr-2017

Q(β^-)=−7779 *25*; S(n)=8100 *18*; S(p)=2800 *30*; Q(α)=5915 *4* 2017Wa10
S(2n)=19000 *15*, S(2p)=4304 *20*, Q(εp)=5069 *19* (2017Wa10).

1974Le02 (also 1972Ga27): identification and production of ^{189}Pb in ^{182}W(^{16}O,9n); ^{181}Ta(^{19}F,11n) and ^{155}Gd(^{40}Ar,6n) reactions, measured half-life and %α decay mode. A preliminary report on the production of ^{189}Pb is quoted in 1967Es05 from a priv. comm. in 1966 from A. Siivola, with $T_{1/2}$≈50 s.

2009Se13, 2007De09: U(p,X) E=1.4 GeV; measured electromagnetic moments, and mean square charge radii using the Resonance Ionization Laser Ion Source (RILIS) at the ISOLDE (CERN) online mass separator. Uranium carbonite was used as the target. Mean Square Charge Radii taken from 2007De09; uncertainty is taken from 2009Se13. 2006Se18 is from the same group.

Mass measurement: 2000Ra23 (also 1999Sc46).

^{189}Pb Levels

Cross Reference (XREF) Flags

A	^{189}Pb IT decay (22.2 μs)	D	^{106}Pd(^{86}Kr,3nγ)
B	^{193}Po α decay (388 ms)	E	^{158}Gd(^{36}Ar,5nγ),^{164}Er(^{29}Si,4nγ)
C	^{193}Po α decay (245 ms)		

E(level)[†]	J$^\pi$	$T_{1/2}$	XREF	Comments
0.0	(3/2$^-$)	39 s *8*	B E	%ε+%β^+≈100; %α≤0.40 (2013Sa43) μ=−1.081 *9* (2009Se13,2014StZZ) Q=+0.5 *18* (2009Se13) RMS charge radius <r^2>$^{1/2}$=5.4177 fm *24* (2013An02 evaluation). $\delta\langle r^2\rangle$(^{189}Pb-^{208}Pb)=−0.890 fm^2 *10* (2007De09,2009Se13); uncertainty from isotope shift is 0.008 fm^2. Other %α≈0.2 (1974Le02). $T_{1/2}$: from 2009Sa09. J$^\pi$: 13/2$^+$ and 3/2$^-$ isomers are expected from the systematics of ^{187}Pb and ^{191}Pb. μ,Q: laser resonance ionization spectroscopy (2009Se13).
40[‡] *4*	(13/2$^+$)	50 s *3*	A CDE	%ε+%β^+≈100; %α≈0.4 (1974Ho26) μ=−1.19 *1* (2009Se13,2014StZZ) Q=−1.3 *35* (2009Se13) Additional information 1. E(level): from alpha-decay energy difference (2013Sa43). $\delta\langle r^2\rangle$(^{189m}Pb-^{208}Pb)=−0.918 fm^2 *10* (2007De09,2009Se13); uncertainty from isotope shift is 0.008 fm^2. μ,Q: laser resonance ionization spectroscopy (2009Se13). $T_{1/2}$: from 2009Sa09. Other: 51 s *3* (1974Le02,1972Ga27). J$^\pi$: see *J$^\pi$* comment for g.s.; $i_{13/2}$ state.
549.0 *10*	(3/2$^-$)		B	J$^\pi$: E0+M1+E2 γ to (3/2$^-$).
677.60 *23*	(13/2$^+$)		A CDE	J$^\pi$: E0+M1+E2 γ to (13/2$^+$).
858.80[‡] *10*	(17/2$^+$)		A DE	J$^\pi$: E2 γ to (13/2$^+$); band member.
950.56[@] *17*	(15/2$^+$)		A DE	J$^\pi$: γ to (13/2$^+$); band member.
1181.59[#] *15*	(17/2$^+$)	<6.9 ns	A DE	J$^\pi$: E0+M1+E2 γ to (17/2$^+$).
1327.25[‡] *13*	(21/2$^+$)		A DE	J$^\pi$: E2 γ to (17/2$^+$); band member.
1340.11[@] *17*	(19/2$^+$)		A DE	J$^\pi$: γs to (15/2$^+$) and (17/2$^+$); band member.
1607.45[#] *15*	(21/2$^+$)	<2.8 ns	A DE	J$^\pi$: gammas to (21/2$^+$) and (17/2$^+$); band member.
1813.0[@] *4*	(23/2$^+$)		A D	J$^\pi$: γ to (19/2$^+$); band member.
1865.43[‡] *16*	(25/2$^+$)		A DE	J$^\pi$: γ to (21/2$^+$); band member.

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Adopted Levels, Gammas (continued)

^{189}Pb Levels (continued)

E(level)[†]	J^π	$T_{1/2}$	XREF	Comments
2137.83[#] *16*	$(25/2^+)$	<2.1 ns	A DE	J^π: E0+M1+E2 γ to $(25/2^+)$ level.
2280.36 *23*	$(27/2^+)$		A DE	J^π: M2 γ from $(31/2^-)$; γ to $(25/2^+)$.
2474.53[&] *18*	$(31/2^-)$	22.2 μs *+69−14*	A D	%IT=100 J^π: E3 γ to $(25/2^+)$. E(level): this isomer is interpreted as bandhead of a shears structure with neutrons (in i13/2 orbital) coupled to protons at ≈60° (2009Dr03). $T_{1/2}$: deduced from fitting of single exponential decay functions to the decay curves of both the 468 and 819 transitions in IT decay (2005Ba51).
2476.4 *5*			E	J^π: γ to $(25/2^+)$ suggests (25/2,27/2,29/2$^+$).
2654.3? *4*	(33/2)		D	J^π: $\Delta J=1$, dipole γ to $(31/2^-)$.
2680.93[&] *20*	$(33/2^-)$		D	J^π: M1 γ to $(31/2^-)$; band member.
3069.7[&] *3*	$(35/2^-)$		D	J^π: (M1) γ to $(33/2^-)$; band member.
3142.4 *7*			E	
3229.0? *11*	$(33/2^-)$		D	J^π: $\Delta J=1$, dipole γ to $(31/2^-)$.
3488.4?[&] *5*	$(37/2^-)$		D	J^π: (M1) γ to $(35/2^-)$; band member.
3923.4?[&] *6*	$(39/2^-)$		D	J^π: (M1) γ to $(37/2^-)$; band member.
4336.6?[&] *6*	$(41/2^-)$		D	J^π: (M1) γ to $(39/2^-)$; band member.
4671.7?[&] *9*	$(43/2^-)$		D	J^π: (M1) γ to $(41/2^-)$; band member.

[†] From least-squares fit to Eγ data, keeping the energy of the 40-keV level as fixed, its uncertainty of 4 keV is not carried over in the energies of the higher levels.
[‡] Band(A): $\nu(i_{13/2})^{-3}$ band.
[#] Band(B): band based on $(17/2^+)$,α=+1/2.
[@] Band(b): band based on $(15/2^+)$,α=−1/2.
[&] Band(C): Magnetic-rotational (shears) dipole band. In comparison to structure of neighboring nuclides, this band is proposed as based on $\pi[s^{-2}_{1/2}h_{9/2}i_{13/2}]_{11-}\otimes \nu i^{-1}_{13/2}$ configuration.

$\gamma(^{189}Pb)$

E_i(level)	J^π_i	E_γ[†]	I_γ[†]	E_f	J^π_f	Mult.[†]	α[#]	Comments
549.0	$(3/2^-)$	549 *1*	100	0.0	$(3/2^-)$	E0+M1+E2[‡]	0.40 *19*	α: From α(K)exp=0.34 *16* (2002Va13) and multiplied by 1.2 to include higher shells.
677.60	$(13/2^+)$	637.4 *3*	100	40	$(13/2^+)$	E0+M1+E2[‡]	0.49 *19*	α: From α(K)exp=0.41 *16* (2009Dr03) and multiplied by 1.2 to include higher shells.
858.80	$(17/2^+)$	818.8 *1*	100	40	$(13/2^+)$	E2		
950.56	$(15/2^+)$	910.6 *3*	100	40	$(13/2^+)$			
1181.59	$(17/2^+)$	230.9 *2*	56 *22*	950.56	$(15/2^+)$			
		323.5 *3*	33 *11*	858.80	$(17/2^+)$	E0+M1+E2	1.5 *5*	
		503.8 *3*	91 *20*	677.60	$(13/2^+)$			
		1142.1 *6*	100 *18*	40	$(13/2^+)$			
1327.25	$(21/2^+)$	468.4 *1*	100	858.80	$(17/2^+)$	E2	0.0344	α(K)=0.0239 *4*; α(L)=0.00797 *12*; α(M)=0.00199 *3*; α(N+..)=0.000606 *9* α(N)=0.000504 *7*; α(O)=9.49×10^{-5} *14*; α(P)=7.20×10^{-6} *10*
1340.11	$(19/2^+)$	389.7 *2*	88 *25*	950.56	$(15/2^+)$			
		481.2 *2*	100 *38*	858.80	$(17/2^+)$			

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Adopted Levels, Gammas (continued)

γ(^{189}Pb) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[†]	α[#]	Comments
1607.45	(21/2$^+$)	267.4 *3*	25 *5*	1340.11	(19/2$^+$)			
		279.7 *2*	9 *2*	1327.25	(21/2$^+$)			
		425.9 *1*	100 *20*	1181.59	(17/2$^+$)	[E2]	0.0438	α(K)=0.0293 *5*; α(L)=0.01086 *16*; α(M)=0.00273 *4*; α(N+..)=0.000829 *12* α(N)=0.000691 *10*; α(O)=0.0001294 *19*; α(P)=9.40×10^{-6} *14* B(E2)(W.u.)>0.16
1813.0	(23/2$^+$)	473.0 *5*	100	1340.11	(19/2$^+$)			
1865.43	(25/2$^+$)	538.2 *1*	100	1327.25	(21/2$^+$)			
2137.83	(25/2$^+$)	272.4 *2*	17 *2*	1865.43	(25/2$^+$)	E0+M1+E2	1.50 *20*	
		325.0 *5*	6 *3*	1813.0	(23/2$^+$)			
		530.3 *1*	100 *21*	1607.45	(21/2$^+$)	E2	0.0255	α(K)=0.0184 *3*; α(L)=0.00543 *8*; α(M)=0.001343 *19* α(N)=0.000340 *5*; α(O)=6.45×10^{-5} *9*; α(P)=5.16×10^{-6} *8* B(E2)(W.u.)>0.052
		810.8 *2*	61 *4*	1327.25	(21/2$^+$)	E2	0.01012	α(K)=0.00788 *11*; α(L)=0.001701 *24*; α(M)=0.000409 *6* α(N)=0.0001037 *15*; α(O)=2.01×10^{-5} *3*; α(P)=1.85×10^{-6} *3* B(E2)(W.u.)>0.0038
2280.36	(27/2$^+$)	142.4 *2*	100	2137.83	(25/2$^+$)			
2474.53	(31/2$^-$)	193.9 *3*	7 *2*	2280.36	(27/2$^+$)	M2	7.04	α(K)=5.08 *8*; α(L)=1.477 *23*; α(M)=0.371 *6* α(N)=0.0953 *15*; α(O)=0.0187 *3*; α(P)=0.00180 *3* B(M2)(W.u.)=0.0050 *+16−22*
		336.7 *1*	100 *10*	2137.83	(25/2$^+$)	E3	0.395	α(K)=0.1324 *19*; α(L)=0.195 *3*; α(M)=0.0521 *8* α(N)=0.01325 *19*; α(O)=0.00242 *4*; α(P)=0.0001439 *21* B(E3)(W.u.)=24 *+4−9*
		609.3 *3*	19 *3*	1865.43	(25/2$^+$)	(E3)	0.0542	α(K)=0.0331 *5*; α(L)=0.01582 *23*; α(M)=0.00406 *6* α(N)=0.001031 *15*; α(O)=0.000194 *3*; α(P)=1.478×10^{-5} *21* B(E3)(W.u.)=0.073 *+15−27*
2476.4		611.0 *4*	100	1865.43	(25/2$^+$)			
2654.3?	(33/2)	179.8[@] *3*	100	2474.53	(31/2$^-$)	D		
2680.93	(33/2$^-$)	206.4 *1*	100	2474.53	(31/2$^-$)	M1	1.199	α(K)=0.979 *14*; α(L)=0.1683 *24*; α(M)=0.0394 *6* α(N)=0.01002 *14*; α(O)=0.00200 *3*; α(P)=0.000214 *3* Mult.: from α(K)exp deduced from K-x ray and γ intensities.
3069.7	(35/2$^-$)	388.8 *2*	100	2680.93	(33/2$^-$)	(M1)	0.211	α(K)=0.1729 *25*; α(L)=0.0293 *5*; α(M)=0.00686 *10* α(N)=0.001744 *25*; α(O)=0.000348 *5*; α(P)=3.72×10^{-5} *6*
3142.4		666.0 *5*	100	2476.4				
3229.0?	(33/2$^-$)	754.5[@] *10*	100	2474.53	(31/2$^-$)	D		
3488.4?	(37/2$^-$)	418.7 *3*	100	3069.7	(35/2$^-$)	(M1)	0.1731	α(K)=0.1418 *20*; α(L)=0.0240 *4*; α(M)=0.00561 *8* α(N)=0.001427 *21*; α(O)=0.000284 *4*; α(P)=3.05×10^{-5} *5*

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Adopted Levels, Gammas (continued)

$\gamma(^{189}Pb)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[†]	α[#]	Comments
3923.4?	(39/2$^-$)	435.0 *3*	100	3488.4?	(37/2$^-$)	(M1)	0.1563	α(K)=0.1280 *18*; α(L)=0.0217 *3*; α(M)=0.00506 *8* α(N)=0.001287 *19*; α(O)=0.000257 *4*; α(P)=2.75×10^{-5} *4*
4336.6?	(41/2$^-$)	413.2 *3*	100	3923.4?	(39/2$^-$)	(M1)	0.179	α(K)=0.1469 *21*; α(L)=0.0249 *4*; α(M)=0.00582 *9* α(N)=0.001479 *21*; α(O)=0.000295 *5*; α(P)=3.16×10^{-5} *5*
4671.7?	(43/2$^-$)	335.1 *6*	100	4336.6?	(41/2$^-$)	(M1)	0.316	α(K)=0.258 *4*; α(L)=0.0440 *7*; α(M)=0.01029 *16* α(N)=0.00261 *4*; α(O)=0.000521 *8*; α(P)=5.58×10^{-5} *9* Due to poor statistics, firm coincidence evidence of the placement of the 335.1-keV γ ray from recoil-isomer-tagged prompt $\gamma\gamma$ spectra is lacking. Present placement is based on systematic arguments.

[†] From IT decay and ^{158}Gd(^{36}Ar,5nγ) for levels up to 2476 keV, and for 3142 level. Other levels above 2476 keV are only from ^{106}Pd(^{86}Kr,3nγ).

[‡] From ce data in ^{193}Po α decay.

[#] Theoretical values from BrIcc code with "Frozen Orbitals" approximation.

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

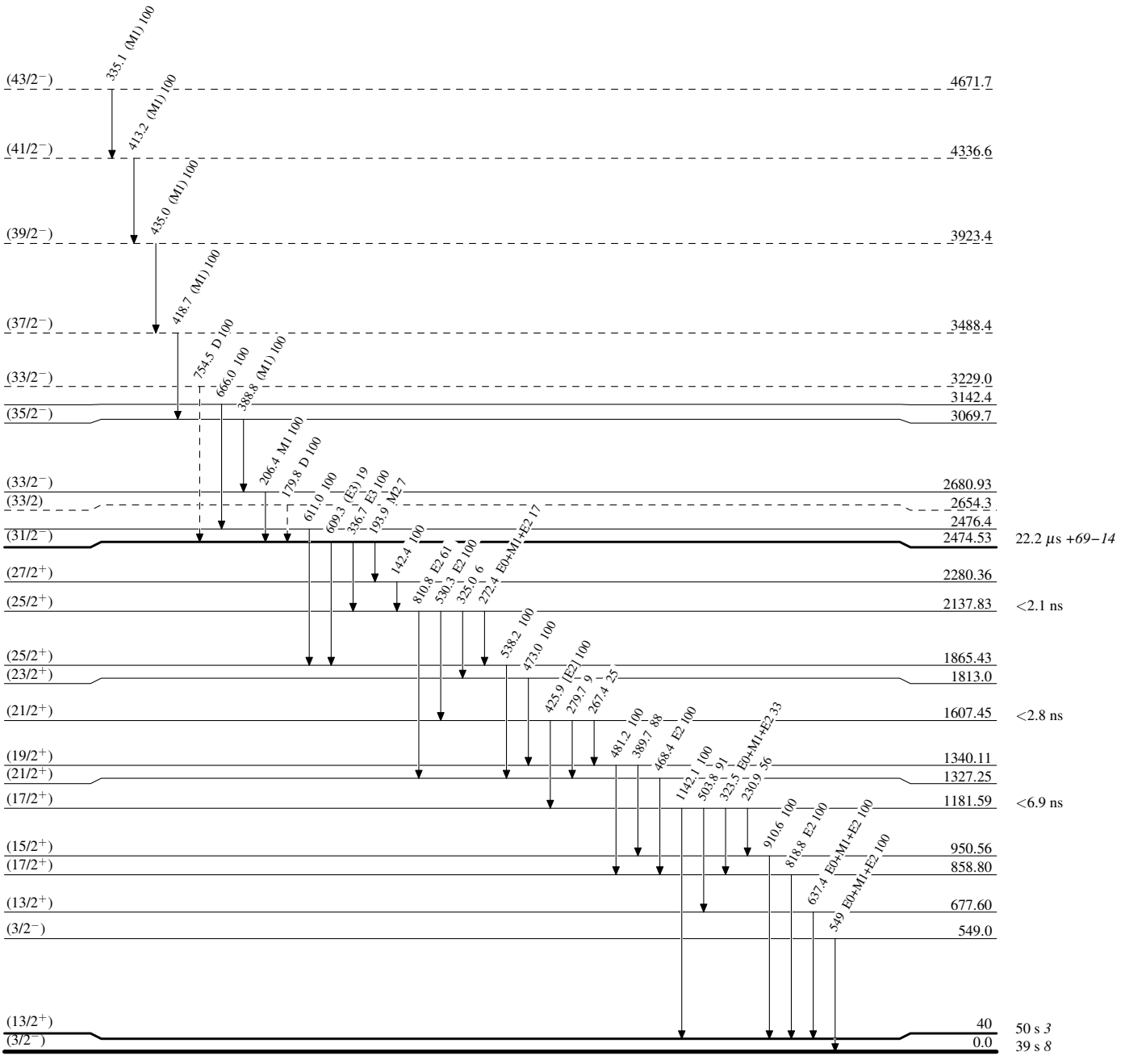
Adopted Levels, Gammas

Legend

Level Scheme

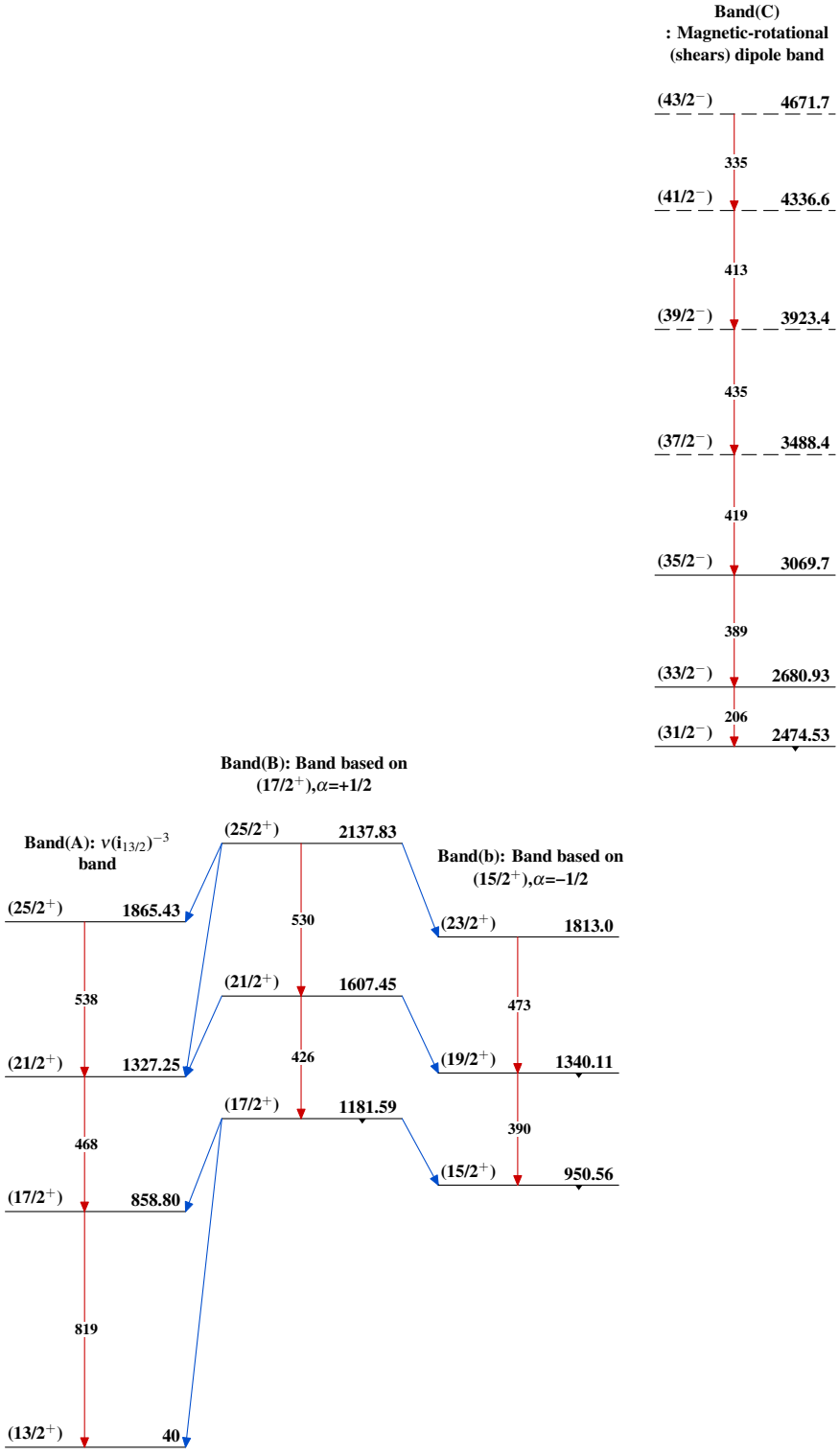
Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{189}_{82}Pb_{107}$

Adopted Levels, Gammas



$^{189}_{82}Pb_{107}$