^{211}Pb β^- decay

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. A. Mccutchan, C. M. Baglin, O. Gorbachenko, N. Todorovic	NDS 114, 661 (2013)	28-Feb-2013

Parent: ^{211}Pb: E=0.0; $J^\pi=9/2^+$; $T_{1/2}$=36.1 min *2*; Q(β^-)=1367 *6*; %β^- decay=100.0
^{211}Pb-%β^- decay: 100%.

^{211}Bi Levels

The decay scheme is that proposed by 1965Me07 with modifications from 1967Da10, 1968Ha21, and 1971Da34.

E(level)†	J^π‡	$T_{1/2}$‡	Comments
0.0	$9/2^-$	2.14 min *2*	
404.866 *9*	$7/2^-$	0.317 ns *12*	g=1.27 *20* J^π: $\gamma\gamma(\theta)$, $\gamma\gamma$(pol) establish J=7/2 (1968Da07,1968Go15). $T_{1/2}$: weighted average of 0.318 ns *14* ($\gamma\gamma$(t) 1966Go19) and 0.315 ns *20* ($\beta\gamma$(t) 1963Va05). g: from $\gamma\gamma(\theta$,h) (liquid source, H=18.3 kG and $T_{1/2}$=0.317 ns *11*, 1965Ag03).
766.539 *16*	$(9/2,11/2)^-$		
831.960 *12*	$9/2^-$	<90 ps	J^π: $\gamma\gamma(\theta)$ establishes J=9/2. $T_{1/2}$: from $\beta\gamma$(t) (1963Va05).
951?			
1014.40 *4*	$7/2^-$,$9/2^-$,$11/2^-$		
1080.15 *5*			
1103.5 *2*			
1109.485 *23*	$9/2^-$		
1196.33 *5*			
1234.3 *4*			
1270.72 *6*	(7/2,9/2,11/2)		

† From least-squares fit to Eγ, excluding the 677γ which fits its placement poorly; this results in a reduced χ^2 of 4.2 compared with a critical value of 2.25 and a value of 25.9 when all Eγ data are included.
‡ From Adopted Levels.

β^- radiations

E(decay)	E(level)	Iβ^-†‡	Log *ft*	Comments
(96 *6*)	1270.72	0.0186 *11*	5.91 *9*	av Eβ=25.3 *17*
(133 *6*)	1234.3	0.0013 *3*	7.49 *12*	av Eβ=35.3 *17*
(171 *6*)	1196.33	0.017 *3*	6.71 *9*	av Eβ=45.9 *18*
(258 *6*)	1109.485	0.83 *4*	5.58 *4*	av Eβ=71.3 *18*
(264 *6*)	1103.5	0.0046 *7*	7.87 *8*	av Eβ=73.1 *18*
(287 *6*)	1080.15	0.056 *6*	6.90 *6*	av Eβ=80.2 *19*
(416# *6*)	951?	0.022 *13*	7.8 *3*	av Eβ=120.7 *20*
(535 *6*)	831.960	6.28 *10*	5.7330 *18*	av Eβ=160.2 *21* E(decay),Iβ^-: Eβ=525 *25*, Iβ=5.5 *8* from F-K analysis of $\beta(830\gamma)$ (1963Va05).
(962 *6*)	404.866	1.63 *9*	7.19 *3*	av Eβ=313.7 *23* E(decay),Iβ^-: Eβ=951 *25*, Iβ=1.4 *5* from F-K analysis of $\beta(404\gamma+427\gamma)$ (1963Va05).
(1367 *6*)	0.0	91.32 *12*	5.990 *8*	av Eβ=475.3 *24* E(decay): Eβ=1378 *8*, from F-K analysis (1965Co06). Other: 1355 *25* (1963Va05). Iβ^-: from I(γ+ce) imbalance at ^{211}Bi g.s. Others (from F-K analysis): 93 *2* (1965Co06), 92.4 *15* (1963Va05).

Continued on next page (footnotes at end of table)

^{211}Pb β^- decay (continued)

β^- radiations (continued)

† Calculated from I(γ+ce) imbalance at each level.
‡ Absolute intensity per 100 decays.
# Existence of this branch is questionable.

^{211}Pb β^- decay (continued)

$\gamma(^{211}Bi)$

Iγ normalization: from (0.99724 *4*)×(0.1295 *11*)=0.1291 *11*; where ^{211}Bi α decay branching=99.724% *4* and I(351.06γ,^{207}Tl)=12.95% *11* of ^{211}Bi α decay. All Iγ(^{211}Pb) have been measured relative to I(351.06γ in ^{207}Tl)=100 in sources where ^{211}Pb is in equilibrium with its daughter, ^{211}Bi.

Others: 1967CaZY, 1962Gi03.

All ce intensities have been measured relative to I(ce(K) 351.06γ). The evaluator has renormalized all Ice to give α(K)(351.06γ, ^{207}Tl)=0.199. The α(exp) quoted are the weighted averages of all measured and renormalized Ice divided by adopted Iγ.

The data presented include information from the following references:
Eγ,Iγ: 1988Hi14, 1976Bl13, 1971Da34, 1968Br17, 1968Go15, 1968Ha21, 1967Da10, 1967Da20, 1965Me07
α: 1971Ra30, 1968Go15, 1965Br35, 1965Co06, 1965Me07, 1963Va05, 1938Ch04
γγ,sum γγ: 1971Da34, 1968Go15, 1968Ha21, 1967Da10, 1965Me07, 1963Va05
γγ(θ),γγ(θ,pol): 1968Da07, 1968Go15, 1965Ag03, 1965Co06, 19 1964Uh01, 1963Va05
γγ(t): 1966Go19
β⁻: 1967Sc39, 1965Co06, 1963Va05
βγ: 1967Sc39
βγ(t): 1963Va05
βγ(θ): 1971Ra30

Kα$_1$ x ray(Tl)/Kα$_1$ x ray(Bi)=3.12 *4* (1971Da34).
Kα$_1$ x ray(Tl)/I(65.420γ)=15.5 *2* (1971Da34).
I(65.402γ)/x-ray(Tl)=0.029 *10* (1965Me07).

E_γ [†]	I_γ [‡b]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ [#]	α [c]	Comments
65.420 *14*	0.60 [@] *4*	831.960	9/2⁻	766.539	(9/2,11/2)⁻	M1		6.58	α(L)=5.02 *7*; α(M)=1.182 *17*; α(N+..)=0.372 *6* α(N)=0.302 *5*; α(O)=0.0618 *9*; α(P)=0.00735 *11* Mult.: from L1/L2=6.8 (1965Br35), 10 (1938Ch04); α(L)exp=7.2 (Ice(L)(1938Ch04)/Iγ). (theory: L1/L2=9.39 *20*).
[x]81.0 [@] *2*	0.35 [@] *9*								
[x]83.8 [@] *1*	0.45 [@] *7*								
[x]88.2 [@] *2*	0.13 [@] *3*								
[x]94.3 [@] *3*	0.09 [@] *2*								
95.0 [@] *2*	0.14 [@] *2*	1109.485	9/2⁻	1014.40	7/2⁻,9/2⁻,11/2⁻	M1+E2	1.6 *+5−3*	9.4 *4*	α(K)=3.0 *9*; α(L)=4.8 *5*; α(M)=1.25 *12*; α(N+..)=0.38 *4* α(N)=0.32 *3*; α(O)=0.059 *6*; α(P)=0.0048 *4* Mult.,δ: from α(K)exp=2.8 *9* (K x ray/γ in γγ, 1965Me07).
[x]97.3 [@] *2*	0.09 [@] *1*								
[x]244 [a]	0.3 [a] *1*								
313.59 *9*	0.24 [@] *3*	1080.15		766.539	(9/2,11/2)⁻				

$^{211}_{83}Bi_{128}$-3

^{211}Pb β^- decay (continued)

$\gamma(^{211}Bi)$ (continued)

E_γ[†]	I_γ[‡b]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ[#]	α[c]	Comments
342.91 *4*	0.27[@] *4*	1109.485	9/2$^-$	766.539	(9/2,11/2)$^-$	[M1,E2]		0.20 *12*	α(K)=0.16 *11*; α(L)=0.035 *11*; α(M)=0.0085 *22*; α(N+..)=0.0027 *7* α(N)=0.0022 *6*; α(O)=0.00043 *13*; α(P)=4.7×10^{-5} *20*
362.072[d] *17*	0.33 *2*	766.539	(9/2,11/2)$^-$	404.866	7/2$^-$				E_γ: a 361-keV γ was deduced from $\gamma\gamma$ data (1968Ha21). I_γ: from 1976Bl13.
404.853 *10*	29.3 *4*	404.866	7/2$^-$	0.0	9/2$^-$	M1+E2	−1.1 *1*	0.122 *8*	α(K)=0.095 *7*; α(L)=0.0206 *8*; α(M)=0.00498 *17*; α(N+..)=0.00156 *6* α(N)=0.00127 *5*; α(O)=0.000254 *10*; α(P)=2.79×10^{-5} *13* Mult.: from ce data. α(K)exp=0.099 *5* (average of renormalized measurements of 1971Ra30,1968Go15,1965Co06,1965Me07,1963Va05); L1/L2=2.1 (1965Br35); K/L=4 *1* (1965Co06) (theory: L1/L2=3.12 *27*,K/L=4.6 *4*). δ: from −1.15 ($\gamma\gamma(\theta$,pol) 1968Go15) and 0.98 *+8−7* (from α(K)exp).
427.088 *10*	13.6 *3*	831.960	9/2$^-$	404.866	7/2$^-$	M1+E2	−0.022 *9*	0.1784	α(K)=0.1457 *21*; α(L)=0.0250 *4*; α(M)=0.00586 *9*; α(N+..)=0.00184 *3* α(N)=0.001497 *21*; α(O)=0.000306 *5*; α(P)=3.65×10^{-5} *6* Mult.: from α(K)exp=0.143 *17* (weighted average of renormalized values of 1968Go15,1965Co06,1965Me07,1963Va05); K/L=7 *2* (1965Co06); L1/L2=5.0 (1965Br35). (theory: K/L=5.84 *12*, L1/L2=9.78 *23*). δ: from $\gamma\gamma(\theta)$: 9/2(427γ)7/2(405γ)9/2 cascade with δ(405γ)=−1.1 *1* and A_2=−0.094 *6* (weighted average of measurements by 1968Da07,1968Go15,1965Co06,1964Uh01,1963Va05). Other: 0.17 *15* $\gamma\gamma(\theta$,pol) (1968Go15).
430[@] *1*	0.05[@] *2*	1196.33		766.539	(9/2,11/2)$^-$				
[x]478.0[@] *4*	0.10[@] *2*								
[x]479.62[&] *20*	0.04[&] *1*								
[x]481.1[@] *4*	0.20[@] *4*								
[x]481.92[&] *12*	0.08[&] *1*								
[x]491.82[&] *12*	0.032[&] *6*								
[x]494.2[&] *3*	0.013[&] *5*								
[x]500.4[@] *5*	0.09[@] *2*								
[x]502.0[&] *2*	0.028[&] *6*								

$^{211}_{83}Bi_{128}$-4

^{211}Pb β^- decay (continued)

$\gamma(^{211}Bi)$ (continued)

E_γ [†]	I_γ [‡] [b]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ [#]	α [c]	Comments
504.12 [&] *12*	0.045 [&] *6*	1270.72	(7/2,9/2,11/2)	766.539	(9/2,11/2)$^-$				
546 [d]		951?		404.866	7/2$^-$				E_γ: γ not observed; existence deduced from $\gamma\gamma$ data (1968Ha21).
609.38 *4*	0.33 *5*	1014.40	7/2$^-$,9/2$^-$,11/2$^-$	404.866	7/2$^-$				
676.69 *7*	0.10 *3*	1080.15		404.866	7/2$^-$				E_γ: fits poorly; Eγ excluded from least-squares fit.
704.64 *3*	3.58 *8*	1109.485	9/2$^-$	404.866	7/2$^-$	M1+E2	−0.022 *7*	0.0476	α(K)=0.0390 *6*; α(L)=0.00657 *10*; α(M)=0.001540 *22*; α(N+..)=0.000484 *7* α(N)=0.000394 *6*; α(O)=8.05×10^{-5} *12*; α(P)=9.61×10^{-6} *14* Mult.: from α(K)exp=0.036 *5* (weighted average of renormalized values of 1968Go15 and 1963Va05); $\gamma\gamma(\theta)$. δ: from $\gamma\gamma(\theta)$: 9/2(705γ)7/2(405γ)9/2 cascade with δ(405γ)=−1.1 *1* and A_2=−0.094 *4* (weighted average of measurements by 1968Da07,1968Go15,1965Ag03,1965Co06, 1963Va05); δ=0.4 *+3−4* from α(K)exp.
766.51 *3*	4.78 *12*	766.539	(9/2,11/2)$^-$	0.0	9/2$^-$	M1		0.0382	α(K)=0.0313 *5*; α(L)=0.00527 *8*; α(M)=0.001234 *18*; α(N+..)=0.000388 *6* α(N)=0.000316 *5*; α(O)=6.45×10^{-5} *9*; α(P)=7.71×10^{-6} *11* Mult.: from α(K)exp=0.041 *5* (weighted average of renormalized values of 1968Go15 and 1965Me07).
832.01 *3*	27.3 *4*	831.960	9/2$^-$	0.0	9/2$^-$	M1+E2	0.39 *+18−25*	0.0281 *24*	α(K)=0.0230 *20*; α(L)=0.0039 *3*; α(M)=0.00092 *7*; α(N+..)=0.000288 *22* α(N)=0.000235 *18*; α(O)=4.8×10^{-5} *4*; α(P)=5.7×10^{-6} *5* Mult.,δ: from α(K)exp=0.023 *2* (weighted average of renormalized values of 1968Go15,1965Me07,1963Va05).
865.93 *14*	0.046 *3*	1270.72	(7/2,9/2,11/2)	404.866	7/2$^-$				
951 [d]	0.17 *10*	951?		0.0	9/2$^-$				E_γ,I_γ: from 1968Ha21, not observed by other investigators.
1014.64 *5*	0.134 *4*	1014.40	7/2$^-$,9/2$^-$,11/2$^-$	0.0	9/2$^-$				
1080.16 *6*	0.095 *5*	1080.15		0.0	9/2$^-$				
[x]1090.5 [@] *5*	0.020 [@] *5*								
1103.52 [&] *20*	0.036 *5*	1103.5		0.0	9/2$^-$				
1109.48 *5*	0.89 *3*	1109.485	9/2$^-$	0.0	9/2$^-$				
1196.33 *5*	0.079 *3*	1196.33		0.0	9/2$^-$				

$^{211}_{83}Bi_{128}$-5

^{211}Pb β^- decay (continued)

$\gamma(^{211}Bi)$ (continued)

E_γ [†]	I_γ [‡ b]	E_i(level)	J_i^π	E_f	J_f^π
1234.3[@] *4*	0.010[@] *2*	1234.3		0.0	$9/2^-$
1270.71 *8*	0.053 *4*	1270.72	(7/2,9/2,11/2)	0.0	$9/2^-$

[†] From 1976Bl13, unless otherwise noted. The energies quoted by 1976Bl13 have been adjusted by the evaluator for a change in calibration energies (compare 1979He19). The change is +10 eV for 300 <Eγ<500 keV and +50 eV for Eγ>600 keV.

[‡] Weighted average of measurements by 1988Hi14, 1976Bl13, 1971Da34, 1968Br17, 1968Go15, 1968Ha21, 1967Da10, 1967Da20, and 1965Me07, unless otherwise noted.

[#] If δ is given without a sign, then the sign of δ is not known.

[@] From 1971Da34.

[&] From 1988Hi14.

[a] From 1968Ha21.

[b] For absolute intensity per 100 decays, multiply by 0.1291 *11*.

[c] 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.

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

[x] γ ray not placed in level scheme.

$^{211}_{83}Bi_{128}$-6

^{211}Pb β^- decay

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays