^{214}Pb β^- decay 1991Be06

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Shaofei Zhu and E. A. Mccutchan	NDS 175, 1 (2021)	1-May-2021

Parent: ^{214}Pb: E=0.0; $J^\pi=0^+$; $T_{1/2}$=27.06 min *7*; Q(β^-)=1018 *11*; %β^- decay=100.0

^{214}Pb-$T_{1/2}$: From Adopted Levels of ^{214}Pb.

^{214}Pb-Q(β^-): From 2021Wa16.

2004Mo07: ^{226}Ra(α) radioactivity in equilibrium; measured absolute ^{226}Ra α strength; measured absolute Iγ; Ge(Li) and HPGe detectors for γ measurements; ZnS scintillator and α-spectrometer for α measurements.

2002De03: ^{226}Ra(α) radioactivity in equilibrium; measured relative Iγ; one planar p-type HPGe and one coaxial n-type HPGe.

1991Be06: ^{226}Ra radioactivity in equilibrium; Ice measurement using an 1000 μm thick surface-barrier Si detector; $\gamma\gamma(\theta)$ measurement using four 28% efficiency HPGe detectors; $\beta\gamma\gamma$(t) measurement using a BaF_2, a plastic and a HPGe detector; Eγ measurement using a LEPS detector; $\gamma\gamma$ measurement using two HPGe and one LEPS detectors. Determined levels; J^π; $T_{1/2}$; γ-mult. and δ.

Other Eγ and absolute Iγ: 1998Mo14, 1991Li11, 1983Sc13, 1983Ol01.

Other Eγ and relative Iγ: 2002MoZP, 2000Sa32, 1983Bu14, 1983Ol01, 1983Sc13, 1982Fa10, 1981We18, 1979Hn02, 1977Zo01, 1975Ha31, 1972ClZS, 1970Mo28, 1969Li10, 1969Gr33, 1969Wa27, 1967Ma51, 1964Ew04, 1964Hy02, 1954Ml80, 1952Mu45.

$\gamma\gamma$ measurements: 1990Mo08, 1982Ak03.

Ice measurements: 1957Ni11, 1954Ml77, 1954Ml80, 1953Ka40, 1952Be78, 1951Ka32.

Level $T_{1/2}$ measurements: 2011ReZZ, 1984Pe13.

For near-zero energy electrons (e_0) measurements: 2006Va02.

X rays(Bi):

I(Kα1 x ray)=10.13% *8*; I(Kα2 x ray)=6.02% *5* (2004Mo07). Others: I(Kα x ray)=16.3% *4* (1983Sc13); 17.3% *20* (1969Li10).

I(Kβ x ray)=4.23% *10* (2004Mo07). Others: I(Kβ x ray)=4.94% *12* (1983Sc13); 4.3% *8* (1969Li10).

α: Additional information 1.

^{214}Bi Levels

E(level)†	J^π‡	$T_{1/2}$	Comments
0.0	1^-	19.71 min *2*	$T_{1/2}$: from the Adopted Levels.
53.2260 *15*	2^-	≤15 ps	$T_{1/2}$: $\gamma\gamma$(t) fast timing with $LaBr_3$(Ce) (2011ReZZ); Other: <0.1 ns from $\beta\gamma\gamma$(t) (1991Be06); 0.52 ns *15* from $\beta\gamma\gamma$(t) (1984Pe13).
62.68 *5*	$(2^-,3^-)$		
258.869 *24*	$(2)^-$		
295.2236 *19*	1^-	≤0.05 ns	$T_{1/2}$: from $\beta\gamma\gamma$(t) (1991Be06). Other:≤0.10 ns from $\beta\gamma$(t) (1984Pe13).
351.9323 *21*	$0^-,1^-$	≤0.10 ns	$T_{1/2}$: from $\beta\gamma$(t) (1984Pe13).
377.03 *4*	(2^-)		
533.672 *14*	(1^-)		
797.30? *8*			
838.994 *22*	1^+		
888.03? *10*			

† From a least square fit to Eγ's.

‡ From Adopted Levels.

β^- radiations

E(decay)	E(level)	Iβ^-†‡	Log *ft*	Comments
(130 *11*)	888.03?	0.015 *4*	6.26 *17*	av Eβ=34.2 *31*
(179 *11*)	838.994	2.75 *8*	4.43 *9*	av Eβ=48.0 *32*
(484 *11*)	533.672	1.063 *18*	6.23 *4*	av Eβ=142.8 *37*
(666 *11*)	351.9323	44.5 *7*	5.07 *3*	av Eβ=205.1 *39*

Continued on next page (footnotes at end of table)

^{214}Pb β^- decay 1991Be06 (continued)

β^- radiations (continued)

E(decay)	E(level)	Iβ^-[†][‡]	Log *ft*	Comments
				E=670 *20*, %Iβ=25 was measured by 1952Be78 and E=590 *10*, %Iβ=56 by 1953Ka40.
(723 *11*)	295.2236	39.0 *5*	5.250 *24*	av Eβ=225.3 *40*
				E=730, %Iβ=75 was measured by 1952Be78 and E=650 *10*, %Iβ=44 by 1953Ka40.
(759 *11*)	258.869	0.075 *20*	8.04 *12*	av Eβ=238.3 *40*
(1018 *11*)	0.0	12.7 *9*	6.26 *4*	av Eβ=334.5 *42*
				E(decay): 1030 *60* measured by 1956Da28.
				Iβ^-: from intensity balance. %Iβ^-=6.3 *20* from 1956Da28. %Iβ^-<10 was measured by 1957Ni11.

[†] From intensity balance, experimental values are given in comments.
[‡] Absolute intensity per 100 decays.

^{214}Pb β^- decay 1991Be06 (continued)

$\gamma(^{214}Bi)$

Iγ normalization: Deduced from Iγ(609)=45.45 *19* (weighted average of 45.0 *7* (1983Ol01), 44.6 *5* (1983Sc13), 46.1 *5* (1991Li11), 44.8 *6* (1998Mo14), 45.57 *18* (2004Mo07)) per 100 ^{214}Bi β^- decays with ^{226}Ra or ^{222}Rn in equilibrium.

E$_\gamma$	I$_\gamma$[†‡]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.	δ	α	Comments
(9.5)		62.68	(2$^-$,3$^-$)	53.2260	2$^-$				E$_\gamma$: deduced from level energy difference; transition not observed, but expected to be the dominant decay path (1991Be06). Intensity balance at the 62.68-keV level yields I(γ+ce)(62.7γ)+I(γ+ce)(9.5γ)=0.314 *25*.
53.2256 *16*	2.362 *22*	53.2260	2$^-$	0.0	1$^-$	M1+E2	0.038 *+26−18*	12.20 *35*	The transition Eγ=62.7 was not observed; 1991Be06 set a limit for its intensity: Iγ(62.7γ)/Iγ(53.23γ)<0.003. α(L)=9.32 *26*; α(M)=2.20 *7*; α(N)=0.562 *17*; α(O)=0.1146 *32*; α(P)=0.01356 *27* E$_\gamma$: weighted average of 53.2260 *14* (1952Mu45), 53.2230 *21* (1991Be06) and 53.232 *4* (2002MoZP). I$_\gamma$: weighted average of 2.49 *12* (1983Sc13), 2.329 *23* (2002De03) and 2.383 *20* (2002MoZP). Mult.,δ: from the Adopted Gammas with L1:L2:L3=650:124:10.1 (1954Ml77); L1/L2=10 *3*, L1/L3=85 *15* (1957Ni11).
[x]107.22 *9*	0.015 *3*								E$_\gamma$,I$_\gamma$: from 1990Mo08.
[x]137.5 *3*	0.12 *3*								E$_\gamma$: from 1969Li10. I$_\gamma$: weighted average of 0.10 *4* (2000Sa32) and 0.14 *5* (1969Li10).
[x]141.3 *6*	0.06 *3*								E$_\gamma$: from 1969Li10. I$_\gamma$: from 2000Sa32.
[x]170.07 *6*	0.032 *6*								E$_\gamma$,I$_\gamma$: from 1990Mo08.
196.20 *5*	0.15 *2*	258.869	(2)$^-$	62.68	(2$^-$,3$^-$)				
205.68 *9*	0.025 *3*	258.869	(2)$^-$	53.2260	2$^-$				E$_\gamma$,I$_\gamma$: from 1990Mo08.
[x]216.47 *7*	0.022 *5*								E$_\gamma$,I$_\gamma$: from 1990Mo08.
241.995 *4*	15.98 *5*	295.2236	1$^-$	53.2260	2$^-$	M1+E2	0.50 *+8−7*	0.718 *33*	α(K)=0.568 *31*; α(L)=0.1138 *20*; α(M)=0.0272 *4*; α(N)=0.00696 *11*; α(O)=0.001402 *24* α(P)=0.000159 *4* E$_\gamma$: weighted average of 241.924 *30* (1952Mu45), 241.981 *8* (1977Zo01), 241.9983 *30* (1991Be06) and 241.995 *4* (2002MoZP). I$_\gamma$: weighted average of 16.0 *3* (1983Sc13), 16.23 *10* (1990Mo08), 16.1 *3* (1991Li11), 15.7 *3* (1998Mo14), 16.1 *1* (2000Sa32), 15.90 *5* (2002De03) and 15.98 *6* (2002MoZP). Mult.,δ: K:L1:L2=425:78:17.1 (1954Ml77); K/L=5.30 *15* (1957Ni11); α(K)exp=0.73 *16*, α(L)exp=0.104 *26*

$^{214}_{83}Bi_{131}$-3

^{214}Pb β^- decay 1991Be06 (continued)

$\gamma(^{214}Bi)$ (continued)

E_γ	I_γ †‡	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α	Comments
									(1991Be06); (242γ)(53γ)(θ): A_2=+0.194 *24*, A_4=−0.03 *3* (1991Be06).
258.86 *4*	1.169 *9*	258.869	(2)$^-$	0.0	1$^-$	M1		0.696 *10*	α(K)=0.567 *8*; α(L)=0.0983 *14*; α(M)=0.02310 *32*; α(N)=0.00591 *8*; α(O)=0.001207 *17* α(P)=0.0001437 *20* E_γ: weighted average of 258.82 *10* (1969Li10) and 258.87 *4* (1990Mo08). I_γ: weighted average of 1.23 *6* (1990Mo08), 1.14 *3* (1991Li11), 1.17 *3* (1998Mo14), 1.15 *4* (2000Sa32) and 1.171 *9* (2002De03). Mult.: K/L1=5.7 (1954Ml77), assuming 10% uncertainty by evaluator; α(K)exp≈0.58; deduced δ=0.0 *25* (1954Ml77,1991Be06).
274.80 *5*	0.739 *18*	533.672	(1$^-$)	258.869	(2)$^-$	M1		0.590 *8*	α(K)=0.481 *7*; α(L)=0.0833 *12*; α(M)=0.01957 *27*; α(N)=0.00501 *7*; α(O)=0.001023 *14* α(P)=0.0001218 *17* E_γ: weighted average of 274.8 *1* (1969Li10), 274.78 *24* (1982Ak03) and 274.80 *5* (1990Mo08). I_γ: weighted average of 0.84 *5* (1990Mo08), 0.732 *11* (1998Mo14) and 0.83 *8* (2000Sa32). Mult.,δ: K/L1=6.4 (1954Ml77) assuming 10% uncertainty by evaluator; α(K)exp≈0.52 deduced δ=0.00 *2* (1954Ml77,1991Be06), (275γ)(259γ)(θ): A_2=+0.13 *6*, A_4=−0.04 *9* (1991Be06).
295.224 *2*	40.64 *18*	295.2236	1$^-$	0.0	1$^-$	M1+E2	0.39 *7*	0.438 *16*	α(K)=0.352 *15*; α(L)=0.0650 *14*; α(M)=0.01541 *30*; α(N)=0.00394 *8*; α(O)=0.000800 *17* α(P)=9.30×10^{-5} *26* E_γ: weighted average of 295.217 *39* (1952Mu45), 295.213 *8* (1977Zo01), 295.226 *2* (1991Be06) and 295.219 *5* (2002MoZP). I_γ: weighted average of 41.3 *9* (1983Ol01), 40.8 *8* (1983Sc13), 41.85 *26* (1990Mo08), 41.9 *6* (1991Li11), 40.0 *7* (1998Mo14), 40.8 *12* (2000Sa32), 40.36 *12* (2002De03) and 40.61 *13* (2002MoZP). Mult.,δ: K/L1=6.5, K/L2=39, K/M1=28 (1954Ml77), 5.55 *15* (1957Ni11); α(K)exp=0.418 *38*, α(L)exp=0.082 *10* (1991Be06).
305.26 *3*	0.070 *5*	838.994	1$^+$	533.672	(1$^-$)				E_γ: from 1990Mo08. I_γ: weighted average of 0.075 *16* (1982Ak03), 0.068 *5* (1990Mo08) and 0.080 *15* (2000Sa32).
314.32 *7*	0.164 *20*	377.03	(2$^-$)	62.68	(2$^-$,3$^-$)				E_γ: From 1990Mo08. I_γ: weighted average of 0.17 *2* (1990Mo08) and 0.158 *20* (2000Sa32).
323.83 *4*	0.063 *8*	377.03	(2$^-$)	53.2260	2$^-$				E_γ: From 1990Mo08. I_γ: weighted average of 0.060 *7* (1990Mo08) and 0.084 *20* (2000Sa32).

^{214}Pb β^- decay 1991Be06 (continued)

$\gamma(^{214}Bi)$ (continued)

E_γ	I_γ[†‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α	Comments
351.9320 *21*	78.6 *4*	351.9323	$0^-,1^-$	0.0	1^-	M1+E2	0.49 *10*	0.257 *15*	α(K)=0.207 *13*; α(L)=0.0384 *14*; α(M)=0.00911 *30*; α(N)=0.00233 *8*; α(O)=0.000472 *17* α(P)=5.47×10^{-5} *25* E_γ: weighted average of 351.992 *62* (1952Mu45), 351.921 *8* (1977Zo01), 351.9319 *19* (1991Be06) and 351.939 *6* (2002MoZP). I_γ: weighted average of 79.6 *17* (1983Ol01), 78.7 *13* (1983Sc13), 81.48 *48* (1990Mo08), 81.6 *12* (1991Li11), 77.5 *14* (1998Mo14), 78.5 *24* (2000Sa32), 78.16 *23* (2002De03) and 78.34 *23* (2002MoZP). Mult.,δ: K/L1=5.9, K/L2=33, K/M1=26 (1954Ml77), K/L=5.65 *15* (1957Ni11); α(K)exp=0.280 *23*, α(L)exp=0.049 *5* (1991Be06). 56.84- and 298.76-keV γ decays not observed, tentatively placed by 1969Li10. A ce line observed by 1954Ml77 at 40.30 keV was interpreted by 1969Li10 as the L1 of 56.84γ.
462.01 *7*	0.467 *14*	838.994	1^+	377.03	(2^-)				E_γ: weighted average of 462.1 *2* (1969Li10) and 462.00 *7* (1990Mo08). I_γ: weighted average of 0.40 *4* (1990Mo08), 0.479 *20* (1991Li11) and 0.470 *14* (2000Sa32).
[x]470.6 *8*	0.024 *6*								E_γ: from 1969Li10. I_γ: weighted average of 0.024 *7* (2000Sa32) and 0.023 *9* (1969Li10).
480.43 *2*	0.741 *10*	533.672	(1^-)	53.2260	2^-	M1		0.1303 *18*	α(K)=0.1066 *15*; α(L)=0.01818 *25*; α(M)=0.00427 *6*; α(N)=0.001091 *15* α(O)=0.0002230 *31*; α(P)=2.66×10^{-5} *4* E_γ: weighted average of 480.5 *2* (1969Li10), 480.54 *16* (1982Ak03) and 480.43 *2* (1990Mo08). I_γ: weighted average of 0.71 *5* (1990Mo08), 0.694 *25* (1991Li11), 0.75 *4* (1998Mo14), 0.74 *3* (2000Sa32) and 0.749 *10* (2002De03). Mult.,δ: from (480γ)(53γ)(θ): A_2=+0.16 *6*, A_4=+0.03 *9* deduced δ=0.00 *+19−17* (1991Be06).
487.11 *7*	0.952 *12*	838.994	1^+	351.9323	$0^-,1^-$	(E1)		0.01046 *15*	α(K)=0.00863 *12*; α(L)=0.001406 *20*; α(M)=0.000328 *5*; α(N)=8.33×10^{-5} *12* α(O)=1.676×10^{-5} *23*; α(P)=1.909×10^{-6} *27* E_γ: weighted average of 487.25 *20* (1969Li10) and 487.90 *7* (1990Mo08). I_γ: weighted average of 0.83 *7* (1990Mo08), 0.92 *4* (1991Li11), 0.96 *4* (1998Mo14), 0.90 *5* (2000Sa32) and 0.961 *12* (2002De03). Mult.: α(K)exp<0.024 (1954Ml77,1991Be06); (487γ)(352γ)(θ): A_2=−0.01 *3*, A_4=−0.01 *4* (1991Be06).

$^{214}_{83}Bi_{131}$-5

^{214}Pb β^- decay 1991Be06 (continued)

$\gamma(^{214}Bi)$ (continued)

E_γ	I_γ[†‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α	Comments
511.00[#] *9*	0.033 *9*	888.03?		377.03	(2^-)			The 511.0γ was observed to be in direct coincidence with the 324- and 314-keV γ transitions, and placed by 1990Mo08 between a level at 888 keV and the 377-keV level. The authors of 1990Mo08 consider this placement, and therefore existence of the proposed level at 888 keV, to be questionable.
533.66 *2*	0.397 *20*	533.672	(1^-)	0.0	1^-			E_γ: weighted average of 533.8 *2* (1969Li10), 533.71 *16* (1982Ak03) and 533.66 *2* (1990Mo08). I_γ: weighted average of 0.39 *3* (1990Mo08), 0.403 *20* (1991Li11) and 0.39 *3* (2000Sa32). 181.5- and 238.4-keV γ decays tentatively assigned by 1969Li10. Not observed by others. A ce line observed by 1954Ml77 at 90.96 was interpreted by 1969Li10 as being the K of a 181.5γ.
538.43[#] *8*	0.042 *6*	797.30?		258.869	$(2)^-$			E_γ: weighted average of 538.7 *4* (1969Li10), 538.47 *24* (1982Ak03) and 538.41 *8* (1990Mo08). I_γ: weighted average of 0.038 *9* (1982Ak03), 0.044 *6* (1990Mo08) and 0.037 *20* (2000Sa32).
543.82 *7*	0.11 *2*	838.994	1^+	295.2236	1^-			E_γ: weighted average of 544.0 *3* (1969Li10) and 543.81 *7* (1990Mo08). I_γ: weighted average of 0.15 *2* (1990Mo08) and 0.10 *1* (2000Sa32).
580.13 *3*	0.811 *12*	838.994	1^+	258.869	$(2)^-$	(E1)	0.00732 *10*	α(K)=0.00605 *8*; α(L)=0.000970 *14*; α(M)=0.0002257 *32*; α(N)=5.74×10^{-5} *8* α(O)=1.158×10^{-5} *16*; α(P)=1.331×10^{-6} *19* E_γ: weighted average of 580.3 *2* (1969Li10), 580.11 *16* (1982Ak03) and 580.13 *3* (1990Mo08). I_γ: weighted average of 0.79 *11* (1982Ak03), 0.76 *6* (1990Mo08), 0.76 *3* (1991Li11), 0.84 *4* (1998Mo14), 0.74 *4* (2000Sa32) and 0.823 *11* (2002De03). Mult.: α(K)exp<0.024 (1954Ml77,1991Be06); (580γ)(259γ)(θ): A_2=+0.16 *4*, A_4=−0.06 *6* (1991Be06).
[x]766.0 *2*	0.12 *2*							E_γ: weighted average of 766.0 *4* (1969Li10), 766.1 *4* (1982Ak03) and 765.96 *21* (1990Mo08). I_γ: weighted average of 0.27 *9* (1982Ak03), 0.17 *3* (1990Mo08) and 0.11 *1* (2000Sa32).
785.96 *9*	2.33 *17*	838.994	1^+	53.2260	2^-	E1	0.00406 *6*	α(K)=0.00337 *5*; α(L)=0.000527 *7*; α(M)=0.0001222 *17*; α(N)=3.11×10^{-5} *4*; α(O)=6.30×10^{-6} *9* α(P)=7.35×10^{-7} *10* E_γ,I_γ: from 1990Mo08. Mult.: α(K)exp<0.009 (1954Ml77,1991Be06), (786γ)(53γ)(θ): A_2=+0.21 *8* (1991Be06).
839.06 *9*	1.278 *23*	838.994	1^+	0.0	1^-	(E1)	0.00359 *5*	α(K)=0.00299 *4*; α(L)=0.000465 *7*; α(M)=0.0001077 *15*; α(N)=2.74×10^{-5} *4*; α(O)=5.56×10^{-6} *8* α(P)=6.49×10^{-7} *9* E_γ: weighted average of 839.2 *2* (1969Li10), 839.03 *16* (1982Ak03) and 839.04 *9* (1990Mo08). I_γ: weighted average of 1.29 *10* (1990Mo08), 1.27 *3* (1991Li11) and 1.29 *4* (2000Sa32). Mult.: from its ce lines not observed.

$^{214}_{83}Bi_{131}$-6

γ(^{214}Bi) (continued)

† Relative intensities are normalized to Iγ(609)=100 with ^{226}Ra or ^{222}Rn in equilibrium.
‡ For absolute intensity per 100 decays, multiply by 0.4545 *19*.
# Placement of transition in the level scheme is uncertain.
^{x} γ ray not placed in level scheme.

$^{214}_{83}Bi_{131}$-7

^{214}Pb β^- decay 1991Be06

Decay Scheme

Intensities: I_γ per 100 parent decays