^{196}Bi ε decay (308 s) 1987Va09,1984Va11

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Huang Xiaolong	NDS 108, 1093 (2007)	1-Jan-2006

Parent: ^{196}Bi: E=0.0; $J^\pi=(3^+)$; $T_{1/2}$=308 s *12*; Q(ε)=7352 *28*; %ε+%$β^+$ decay=100.0

^{196}Bi-$T_{1/2}$: Additional information 1.

^{196}Bi-J^π: Additional information 2.

1987Va09 present a composite decay scheme for the 308-s and 240-s isomers. The evaluators have attempted to separate the decay schemes on the basis of intensity balance and assuming that the two isomers populate levels with different range of spins. The 308-s isomer populating the low spin levels (J≤4), and 240-s isomer populating the high-spin levels (J≥7). The low-lying levels, however, will be seen in the decay of all activities, assuming (%ε + %$β^+$)=0 for ground state.

Because of some unplaced γ rays the decay scheme is incomplete.

1987Va09: sources produced in reaction ^{16}O on nat Re, E(^{16}O)<210 MeV. Mass separation. Measured Eγ, Iγ, x-rays (Ge detectors, FWHM=2.0 keV at 1332 keV, FWHM=580 eV at 122 keV), E(ce), Ice (Si(Li), FWHM=2.5 keV at 624 keV), γγ coin, ceγ coin, triparameter coin.

1976Ch30: sources from ^{181}Ta(^{22}Ne,7n), E(^{22}Ne)=150 MeV and ^{181}Ta(^{20}Ne,5n), E(^{20}Ne)=110 MeV. The identification of the decaying state in the parent is not clear. Others: 1973KhZY, 1971BrZC, 1971ChYB.

^{196}Pb Levels

E(level)†	J^π‡	$T_{1/2}$#	Comments
0.0	0^+	37 min *3*	
1049.27 *15*	2^+		
1142.92 *19*	0^+		J^π: 1143γ is E0; T, coincidence with Pb K x ray and absence of coincidence with 1049γ.
1450.00 *17*	2^+		J^π: 1450γ to g.s. is E2.
1697.8 *5*	0^+		J^π: 1698γ is E0; T, coincidence with Pb K x ray and absence of coincidence with 1049γ.
1738.59 *20*	4^+		
1825.73 *20*	$3^+,4^+$		
1896.16 *19*	2^+		
1991.67 *25*	$2^-,3^-$		J^π: 942γ to 2^+ is E1, γ-ray to g.s. not observed. E(level): this level was established through the 942γ-1049γ coin.
2060.12 *25*	$(1^-,2^+)$		
2124.54 *24*	$(1^-,2,3)$		
2203.4 *3*	4^+		
2376.31 *25*	$(5)^+,(6)^+$		J^π: 638γ to 4^+ is E2, 550γ to $(3,4)^+$.
2471.1 *3*	$(3,4,5^-)$		
3041.7 *4*	4^+		J^π: $J^\pi=4^+$ if fed from low spin ^{196}Bi $β^+$ decay.

† From a least-squares fit to γ-ray energies of 1987Va09.
‡ From ^{196}Pb Adopted Levels.
# From 1961Sv01, 1957An53.

ε,$β^+$ radiations

E(decay)	E(level)	I$β^+$ †	Iε†	Log *ft*	I(ε+$β^+$)†	Comments
(4.31×10^3 *3*)	3041.7	0.91 *12*	2.2 *3*	6.96 *6*	3.1 *4*	av Eβ=1481 *13*; εK=0.570 *5*; εL=0.1024 *8*; εM+=0.03332 *25*
(4.88×10^3 *3*)	2471.1	0.56 *16*	0.84 *24*	7.48 *13*	1.4 *4*	av Eβ=1739 *13*; εK=0.486 *4*; εL=0.0870 *8*; εM+=0.02830 *24*
(5.15×10^3 *3*)	2203.4	0.6 *3*	0.7 *4*	7.59 *24*	1.3 *7*	av Eβ=1861 *13*; εK=0.449 *4*; εL=0.0802 *7*; εM+=0.02607 *23*
(5.23×10^3 *3*)	2124.54	1.2 *4*	1.5 *5*	7.30 *15*	2.7 *9*	av Eβ=1897 *13*; εK=0.438 *4*; εL=0.0782 *7*; εM+=0.02543 *23*

Continued on next page (footnotes at end of table)

^{196}Bi ε decay (308 s) 1987Va09,1984Va11 (continued)

ε,β+ radiations (continued)

E(decay)	E(level)	Iβ+ †	Iε†	Log *ft*	I(ε+β+)†	Comments
(5.29×10^3 *3*)	2060.12	1.4 *3*	1.5 *3*	7.29 *10*	2.9 *6*	av Eβ=1926 *13*; εK=0.429 *4*; εL=0.0767 *7*; εM+=0.02492 *23*
(5.36×10^3 *3*)	1991.67	3.1 *3*	3.3 *3*	6.97 *5*	6.4 *6*	av Eβ=1958 *13*; εK=0.420 *4*; εL=0.0750 *7*; εM+=0.02438 *22*
(5.46×10^3 *3*)	1896.16	3.8 *7*	3.8 *7*	6.92 *9*	7.6 *14*	av Eβ=2001 *13*; εK=0.408 *4*; εL=0.0728 *7*; εM+=0.02365 *22*
(5.53×10^3 *3*)	1825.73	4.9 *4*	4.8 *4*	6.84 *4*	9.7 *8*	av Eβ=2034 *13*; εK=0.399 *4*; εL=0.0711 *7*; εM+=0.02312 *21*
(5.61×10^3 *3*)	1738.59	16.9 *10*	15.5 *9*	6.34 *4*	32.4 *19*	av Eβ=2074 *13*; εK=0.388 *4*; εL=0.0692 *7*; εM+=0.02247 *21*
(5.65×10^3 *3*)	1697.8	0.17 *8*	0.15 *8*	8.36 *22*	0.32 *16*	av Eβ=2092 *13*; εK=0.383 *4*; εL=0.0682 *7*; εM+=0.02218 *21*
(5.90×10^3 *3*)	1450.00	6.1 *7*	4.8 *6*	6.90 *6*	10.9 *13*	av Eβ=2206 *13*; εK=0.354 *4*; εL=0.0629 *6*; εM+=0.02045 *19*
(6.30×10^3 *3*)	1049.27	14 *2*	8.4 *15*	6.71 *9*	22 *4*	av Eβ=2391 *13*; εK=0.310 *3*; εL=0.0552 *6*; εM+=0.01791 *17*

† Absolute intensity per 100 decays.

^{196}Bi ε decay (308 s) 1987Va09,1984Va11 (continued)

γ(^{196}Pb)

Iγ normalization: From this decay scheme if no ε feeding to ^{196}Pb g.s. from ^{196}Bi(308 s).

E_γ[†]	I_γ[‡@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α[&]	Comments
288.7 *2*	0.3 *1*	1738.59	4^+	1450.00	2^+	[E2]	0.1298	α(K)=0.0712 *10*; α(L)=0.0439 *7*; α(M)=0.01130 *17*; α(N+..)=0.00341 *5* placed In ^{196}Bi low spin ε decay also. Iγ deduced from intensity balance and branching ratios At 1739-keV level.
306.9 *3*	0.7 *1*	1450.00	2^+	1142.92	0^+	[E2]	0.1081	α(K)=0.0617 *9*; α(L)=0.0348 *5*; α(M)=0.00892 *13*; α(N+..)=0.00270 *4* α(K)exp=0.18 *3*; α(L)exp=0.020 *3* B(E2;307γ)/B(E2;1450γ)=377 (1984Va11,1984Va19). Mult.: this transition has a doublet structure.
375.5 *2*	0.5 *1*	1825.73	$3^+,4^+$	1450.00	2^+			
400.9 *2*	3.9 *2*	1450.00	2^+	1049.27	2^+	E0+M1+E2	0.12 *8*	α(K)exp=0.29 *2*; α(L)exp=0.068 *9*; α(M)exp=0.012 *3* α(K)=0.10 *7*; α(L)=0.020 *7*; α(M)=0.0049 *15*; α(N+..)=0.0015 *5* the conversion coefficient of the 401γ shows the presence of a strong E0 component.
[x]471.5 *2*	1.8 *2*							
[x]473.7 *2*	2.3 *2*							α(K)exp=0.030 *5*
[x]519.1 *2*	1.3 *3*					M1	0.0986	α(K)=0.0809 *12*; α(L)=0.01361 *20*; α(M)=0.00318 *5*; α(N+..)=0.000987 *14* α(K)exp=0.095 *10* (1987Va09)
550.4 *3*	0.2 *1*	2376.31	$(5)^+,(6)^+$	1825.73	$3^+,4^+$			E_γ,I_γ: placed in ^{196}Bi high-spin ε decay also, intensity not divided.
[x]620.8 *2*	1.3 *2*							
637.8 *2*	1.7 *3*	2376.31	$(5)^+,(6)^+$	1738.59	4^+	E2	0.01682	α(K)=0.01261 *18*; α(L)=0.00319 *5*; α(M)=0.000780 *11*; α(N+..)=0.000239 *4* α(K)exp=0.014 *3* Mult.: From α(K)exp. E_γ,I_γ: placed in ^{196}Bi high-spin ε decay also, intensity not divided.
665.4 *2*	1.9 *2*	3041.7	4^+	2376.31	$(5)^+,(6)^+$	E2	0.01534	α(K)=0.01159 *17*; α(L)=0.00284 *4*; α(M)=0.000693 *10*; α(N+..)=0.000212 *3* α(K)exp=0.011 *2* E_γ,I_γ: placed in ^{196}Bi high-spin ε decay also, intensity not divided. Mult.: From α(K)exp.
674.6 *2*	1.0 *2*	2124.54	$(1^-,2,3)$	1450.00	2^+			
689.3 *2*	22.2 *8*	1738.59	4^+	1049.27	2^+	E2	0.01422	α(K)=0.01081 *16*; α(L)=0.00259 *4*; α(M)=0.000629 *9*; α(N+..)=0.000193 *3* α(L)exp=0.0026 *4*; α(M)exp=0.0009 *2*
732.5 *2*	0.9 *2*	2471.1	$(3,4,5^-)$	1738.59	4^+			
753.4[a] *2*	1.4[a] *7*	1896.16	2^+	1142.92	0^+	E2	0.01179	α(K)=0.00909 *13*; α(L)=0.00205 *3*; α(M)=0.000496 *7*; α(N+..)=0.0001520 *22* α(K)exp=0.011 *2* I_γ: Iγ=2.2 *8* was divided. Mult.: α=0.01189 for E2, α=0.03876 for M1.

$^{196}_{82}Pb_{114}$-3

^{196}Bi ε decay (308 s) 1987Va09,1984Va11 (continued)

γ(^{196}Pb) (continued)

E_γ[†]	I_γ[‡@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ	α[&]	$I_{(\gamma+ce)}$[@]	Comments
753.4[a] 2	0.8[a] 4	2203.4	4+	1450.00	2+	E2		0.01179		α(K)=0.00909 13; α(L)=0.00205 3; α(M)=0.000496 7; α(N+..)=0.0001520 22 α(K)exp=0.011 2 Iγ: Iγ=2.2 8 was divided. Mult.: from α(K)exp and the lack of a competitive transition to other levels (an enhanced stretched E2).
776.6 2	5.7 4	1825.73	3+,4+	1049.27	2+	E2(+M1)	2.0	0.01574		α(K)=0.01252 18; α(L)=0.00246 4; α(M)=0.000586 9; α(N+..)=0.000181 3 α(K)exp=0.011 2; α(L)exp=0.0032 6 δ: from α(K)exp and α(L)exp. Mult.: From α(K)exp.
846.7 2	2.4 2	1896.16	2+	1049.27	2+	E2+(M1)	1.83	0.01348		α(K)=0.01080 16; α(L)=0.00204 3; α(M)=0.000485 7; α(N+..)=0.0001495 21 α(K)exp=0.011 2 δ: from α(K)exp and α(L)exp. Mult.: From α(K)exp.
[x]868.8 2	1.2 2									
916.8 3	0.4 3	2060.12	(1−,2+)	1142.92	0+					
942.4 2	4.0 3	1991.67	2−,3−	1049.27	2+	E1		0.00279		α(K)exp=0.0027 6 α(K)=0.00232 4; α(L)=0.000356 5; α(M)=8.21×10^{-5} 12; α(N+..)=2.53×10^{-5} 4 Mult.: From α(K)exp.
[x]947.6 2	0.5 2									
1011.1 3	1.2 2	2060.12	(1−,2+)	1049.27	2+					
[x]1030.9 3	0.7 3									
1049.4 2	54.3 19	1049.27	2+	0.0	0+	E2		0.00608		α(K)=0.00486 7; α(L)=0.000927 13; α(M)=0.000220 3; α(N+..)=6.78×10^{-5} 10 α(L)exp=0.00093 9; α(M)exp=0.0004 1 ΔIγ: From 665.4γ of 3042 level (evaluators).
1075.0 4	0.7 5	2124.54	(1−,2,3)	1049.27	2+					
1142.7 3		1142.92	0+	0.0	0+	E0			2.6 8	K/L=5.95 21 (1990TrZZ) K/L=5.91 for calculation (1990TrZZ). $I_{(\gamma+ce)}$: from intensities balance, I(γ+ce)=2.0 3 (1987Va09). Mult.: from comparison of γ and ce spectra. E_γ: 1143.4 2 keV from 1984Va11 and 1984Va19. $I_{(\gamma+ce)}$: Ti(out)≤Ti(In) At 1142.9 level, intensity balance is consistent with uncertainty.
1449.7 3	4.3 4	1450.00	2+	0.0	0+	E2		0.00333		α=0.00333; α(K)=0.00271; α(L)=0.00047 α(K)exp=0.0026 4 α(K)=0.00269 4; α(L)=0.000464 7; α(M)=0.0001089 16; α(N+..)=8.26×10^{-5} 12
1697.8 5		1697.8	0+	0.0	0+	E0			0.2 1	K/L=6.23 36 (1990TrZZ) K/L=6.00 from calculation (1990TrZZ). Mult.: from comparison of γ and ce spectra.

$^{196}_{82}Pb_{114}$-4

^{196}Bi ε decay (308 s) 1987Va09,1984Va11 (continued)

γ(^{196}Pb) (continued)

E_γ †	I_γ ‡@	E_i(level)	J_i^π	E_f	J_f^π
1896.3 *5*	0.9 *4*	1896.16	2^+	0.0	0^+
2060.9 *7*	0.2 *1*	2060.12	$(1^-,2^+)$	0.0	0^+

† Measurements of 1987Va09.
‡ Intensities are relative to 100 for 1049.4γ with ^{196}Bi ε decay (high-spin + low-spin).
# From ^{196}Pb adopted gammas,except as noted.
@ For absolute intensity per 100 decays, multiply by 1.60 *6*.
& 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.
a Multiply placed with intensity suitably divided.
x γ ray not placed in level scheme.

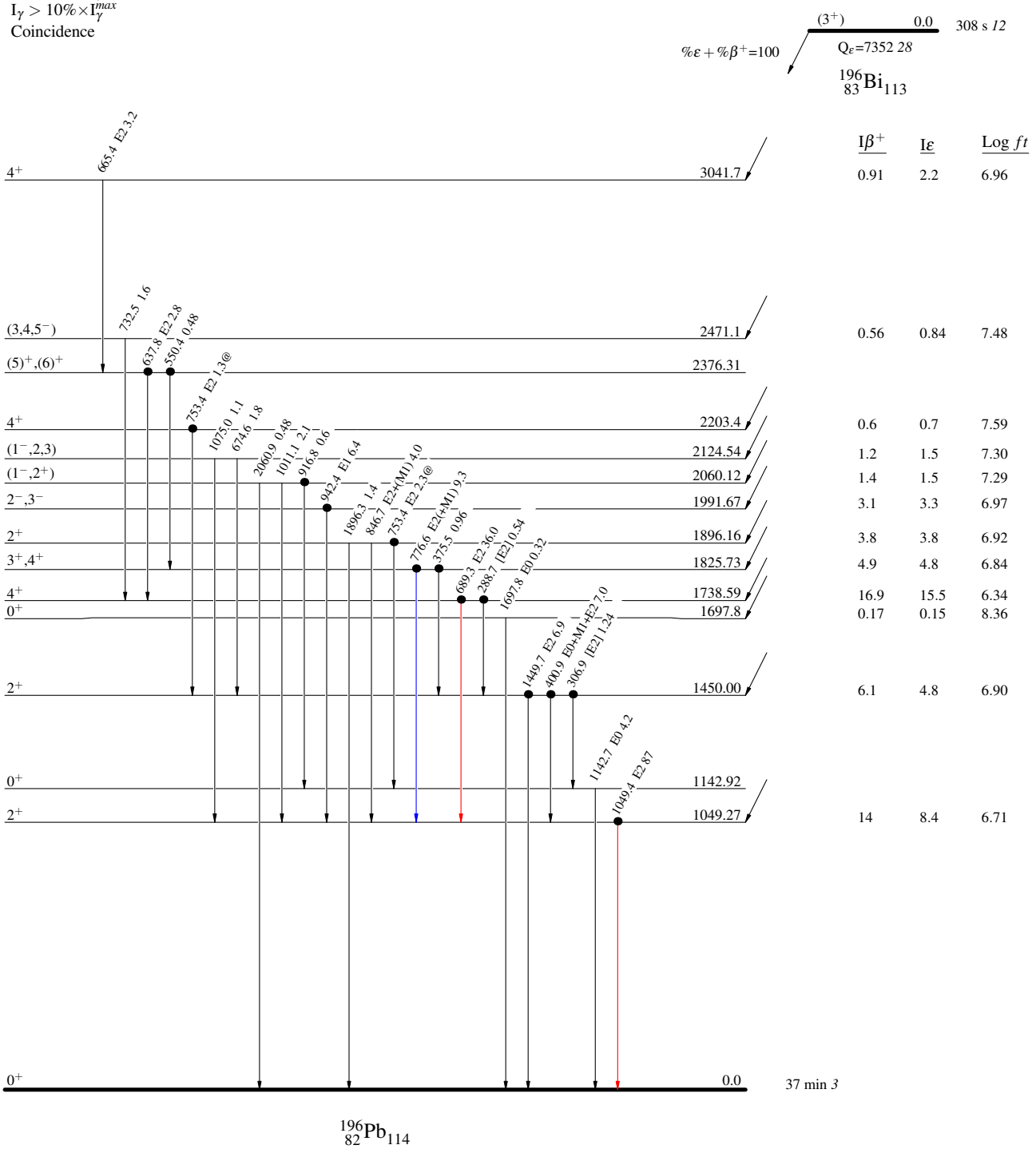
$^{196}_{82}Pb_{114}$-5

^{196}Bi ε decay (308 s) 1987Va09,1984Va11

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays
@ Multiply placed: intensity suitably divided

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
Coincidence



$^{196}_{82}Pb_{114}$