^{190}Pb ε decay (71 s) 1981El03,2015Es07

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, [1] and Jun Chen[2]	NDS 169, 1 (2020)	15-Oct-2020

Parent: ^{190}Pb: E=0.0; J^π=0^+; $T_{1/2}$=71 s *1*; Q(ε)=3955 *15*; %ε+%β^+ decay=99.60 *4*
^{190}Pb-$T_{1/2}$: From ^{190}Pb Adopted Levels.
^{190}Pb-Q(ε): From 2017Wa10.
^{190}Pb-%ε+%β^+ decay: %α decay=0.40 *4* for ^{190}Pb decay (1992Wa14).
1981El03: Measured Eγ, Iγ, γγ-coin, ce, α decay. Mass separated sources from the reaction ^{180}W(^{16}O,6n).
Due to lack of knowledge about the intensities and multipolarities of some of the transitions, the decay scheme cannot be used to extract reliable ε+β^+ feedings.
2015Es07: measured total absorption spectrum (TAS) at the ISOLDE (CERN) facility using *Lucrecia* TAS detector, a cylindrically shaped NaI(Tl) monocrystal and other detectors for measurement of x rays, γ rays, and β particles in coincidence with the TAS detector. Source of ^{190}Pb produced. Spherical shape for ^{190}Pb nucleus deduced from the shape of the TAGS spectrum.

^{190}Tl Levels

E(level)†	J^π‡	Comments
0.0	2^-	J^π: 2^- (1981El03).
151.31 *9*	(1^-)	J^π: 1^- (1981El03).
158.15 *15*	(0 to 3)$^{(-)}$	J^π: 1^-,0^- (1981El03).
210.55 *13*	(1^-,2^-,3^-)	J^π: 1^- (1981El03).
274.17 *9*	(1^-,2^-,3^-)	J^π: 1^-,2^- (1981El03).
372.75? *24*	(0 to 4)$^{(-)}$	J^π: 0^-,1^- (1981El03).
376.26 *9*	(1^-,2^-)	J^π: 1^- (1981El03).
416.68 *22*	(0,1,2^-)	J^π: none in 1981El03.
495.07 *22*	(0^-,1^-,2^-)	J^π: (1^-) (1981El03).
539.81 *22*	(0,1,2^-)	J^π: none in 1981El03.
598.33 *18*	(1^-,2^-,3^-)	J^π: $(1)^-$ (1981El03).
738.99 *16*	(0^- to 4^-)	J^π: (1^+) (1981El03).
890.72 *18*	(1^+)	J^π: 0^-,1 (1981El03).
942.21 *9*	1^+	J^π: 1^+ (1981El03).
120×10^1 *68*		E(level): 520 to 1880 group of levels.
1235.50 *15*	(1^+)	J^π: 1 (1981El03).
1854.5 *3*	(1^+)	J^π: 1 (1981El03).
279×10^1 *91*		E(level): 1880 to 3700 keV is group of levels from TAGS data, not included in the Adopted Levels.

† From least-squares fit to Eγ data.
‡ From the Adopted Levels.

ε,β^+ radiations

The decay scheme is from 1981El03. Based on TAGS data in 2015Es07, the decay scheme is considered as incomplete. The quoted values of ε+β^+ feedings and log *ft* are approximate.

E(decay)	E(level)	Iβ^+ #	Iε#	Log *ft*	I(ε+β^+)†#	Comments
(1.2×10^3 *9*)	2790				18 *1*	B(GT)=0.14 *3* (2015Es07). Other: B(GT)=0.32 *4* for %ε+%β^+=98 *1* in the excitation range 520-3700 keV (2015Es07).
(2101 *15*)	1854.5	0.079 *16*	5.9 *12*	5.2	6.0 *12*	av Eβ=501.8 *66*; εK=0.7936 *5*; εL=0.14585 *16*; εM+=0.04741 *6* B(GT)=0.022 *2* (2015Es07).

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^{190}Pb ε decay (71 s) 1981El03,2015Es07 (continued)

ε,$β^+$ radiations (continued)

E(decay)	E(level)	$Iβ^+$ [#]	Iε[#]	Log *ft*	I(ε+$β^+$)[†#]	Comments
(2720 *15*)	1235.50	0.64 *3*	10.7 *4*	5.2	11.3 *4*	av Eβ=773.0 *66*; εK=0.7607 *12*; εL=0.1376 *3*; εM+=0.04461 *9* B(GT)=0.024 *2* (2015Es07).
(2.8×10^3 *7*)	1200				13 *2*	I(ε+$β^+$): deduced by evaluators from subtraction of all the ε+$β^+$ feedings for levels above 520 keV from measured %ε+%$β^+$=98 *1* for 520-3700 keV region, and assigning it as ε+$β^+$ feeding in the energy range of 520-1880 keV.
(3013 *15*)	942.21	≈4.0	≈40	≈4.7	≈44.1[‡]	av Eβ=902.1 *67*; εK=0.7342 *16*; εL=0.1321 *3*; εM+=0.04280 *11* I(ε+$β^+$): total feeding for 942.2 and 890.72 levels is 48.5% *11* (2015Es07), most of it feeding the 942.2 level. Separate feedings deduced by evaluators based on γ-intensities from the two levels, assuming there are no other γ transitions associated with these levels. B(GT)=0.081 *4* (2015Es07).
(3064 *15*)	890.72	≈0.43	≈4.0	≈5.7	≈4.4[‡]	av Eβ=924.9 *67*; εK=0.7288 *16*; εL=0.1310 *4*; εM+=0.04244 *11* I(ε+$β^+$): see comment for $β^+$+ε feeding to the 942.2 level.
(3216[@] *15*)	738.99				≈0	av Eβ=937 *62*; εK=0.726 *16*; εL=0.130 *3*; εM+=0.0423 *11*
(3357[@] *15*)	598.33				≈0	av Eβ=999 *63*; εK=0.710 *17*; εL=0.127 *4*; εM+=0.0412 *11*
(3415 *15*)	539.81	0.19 *7*	1.1 *4*		1.3[‡] *5*	av Eβ=1080.4 *67*; εK=0.6875 *20*; εL=0.1230 *4*; εM+=0.03982 *12* I(ε+$β^+$): combined feeding for 539.81 and 495.07 levels. B(GT)=0.002 *1* (2015Es07).
(3460 *15*)	495.07				[‡]	av Eβ=1045 *63*; εK=0.698 *18*; εL=0.125 *4*; εM+=0.0404 *12* I(ε+$β^+$): see comment for $β^+$+ε feeding for 539.8 level.
(3538 *15*)	416.68	0.1 *1*	0.6 *3*	6.7	0.7 *4*	av Eβ=1135.2 *67*; εK=0.6713 *21*; εL=0.1199 *4*; εM+=0.03881 *13* B(GT)=0.0008 *4* (2015Es07).
(3579[@] *15*)	376.26				≈0[‡]	av Eβ=1098 *63*; εK=0.683 *19*; εL=0.122 *4*; εM+=0.0395 *12*
(3582[@] *15*)	372.75?				≈0[‡]	av Eβ=1099 *63*; εK=0.682 *19*; εL=0.122 *4*; εM+=0.0395 *12*
(3681[@] *15*)	274.17				≈0	
(3744[@] *15*)	210.55				≈0	av Eβ=1171 *63*; εK=0.660 *20*; εL=0.118 *4*; εM+=0.0381 *12*
(3797[@] *15*)	158.15				≈0[‡]	av Eβ=1195 *63*; εK=0.653 *20*; εL=0.116 *4*; εM+=0.0377 *13*
(3804[@] *15*)	151.31				≈0[‡]	av Eβ=1198 *63*; εK=0.652 *20*; εL=0.116 *4*; εM+=0.0376 *13*
(3955[@] *15*)	0.0	<0.1	<0.9	>8.5^{1u}	<1	av Eβ=1293.5 *65*; εK=0.7219 *12*; εL=0.1333 *3*; εM+=0.04338 *9* I(ε+$β^+$): from log I($f^{1u}t$)>8.5 for ΔJ=2, Δπ=no (first-forbidden unique) β transition. 2015Es07 do not provide a value for feeding to the g.s.

† From TAGS spectrum analysis in singles and coincidence (2015Es07).

‡ Combined feedings are given by 2015Es07 for the following pairs of levels which were not resolved in their TAGS data: 151.31 and 158.15; 372.75 and 376.26; 495.07 and 539.81; and 890.72 and 942.21.

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^{190}Pb ε decay (71 s) 1981El03,2015Es07 (continued)

ε,β^+ radiations (continued)

Absolute intensity per 100 decays.
@ Existence of this branch is questionable.

$\gamma(^{190}Tl)$

Tl K x ray: E≈73 I(x ray)=1030 *130*. From decay scheme in 1981El03, authors calculated I(K x ray)=1070 *125*. But note that the decay scheme is incomplete.

The γ-ray normalization factor (Iγ/100 decays of ^{190}Pb) was given as 0.090 *8* by 1981El03 based on the decay scheme proposed by these authors, and assuming summed I(γ+ce) to g.s.=100. From deduced β feeding of 48.5% *11* for the 890.7 and 942.2 levels, evaluators deduce γ-normalization factor of 0.094 *6*, provided no additional γ-feedings to these levels exist. Since the TAGS data indicate that the decay scheme from γ-ray data by itself is incomplete, no meaningful γ-normalization factor can be deduced.

E_γ[†]	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	α[&]	Comments
59.4[@a]		210.55	$(1^-,2^-,3^-)$	151.31	(1^-)			
78.6[@a]		495.07	$(0^-,1^-,2^-)$	416.68	$(0,1,2^-)$			
101.8 *2*	7.3 *10*	376.26	$(1^-,2^-)$	274.17	$(1^-,2^-,3^-)$	[M1,E2]	6.8 *14*	α(K)=3.6 *31*; α(L)=2.4 *13*; α(M)=0.62 *35* α(N)=0.155 *87*; α(O)=0.027 *15*; α(P)=0.00128 *4*
118.8 *2*	4.1 *10*	495.07	$(0^-,1^-,2^-)$	376.26	$(1^-,2^-)$	(M1+E2)	4.1 *12*	α(K)=2.4 *19*; α(L)=1.27 *53*; α(M)=0.32 *15* α(N)=0.081 *38*; α(O)=0.0144 *60*; α(P)=0.00074 *7*
122.25 *20*	7.4 *9*	274.17	$(1^-,2^-,3^-)$	151.31	(1^-)	(M1+E2)	3.7 *12*	α(K)=2.2 *18*; α(L)=1.13 *45*; α(M)=0.29 *13* α(N)=0.072 *32*; α(O)=0.0128 *51*; α(P)=0.00067 *7*
140.6 *3*	≈47[#]	738.99	$(0^-$ to $4^-)$	598.33	$(1^-,2^-,3^-)$	[D,E2]	1.7 *15*	
142.2 *3*	≈83[#]	416.68	$(0,1,2^-)$	274.17	$(1^-,2^-,3^-)$	[M1,E2]	2.3 *9*	α(K)=1.5 *11*; α(L)=0.62 *18*; α(M)=0.16 *6*; α(N)=0.039 *13*; α(O)=0.0070 *20*
151.19 *10*	100 *2*	151.31	(1^-)	0.0	2^-	(M1+E2)	1.88 *76*	α(K)=1.24 *93*; α(L)=0.49 *12*; α(M)=0.122 *36* α(N)=0.0307 *89*; α(O)=0.0055 *14*; α(P)=0.00032 *8*
158.15 *15*	19.1 *17*	158.15	$(0$ to $3)^{(-)}$	0.0	2^-	(M1,E2)	1.64 *69*	α(K)=1.10 *81*; α(L)=0.41 *9*; α(M)=0.103 *27* α(N)=0.0258 *66*; α(O)=0.0047 *10*; α(P)=2.80×10^{-4} *72*
162.2 *2*	5.5 *19*	372.75?	$(0$ to $4)^{(-)}$	210.55	$(1^-,2^-,3^-)$	(M1(+E2))	2.17	α(K)=1.77 *3*; α(L)=0.303 *5*; α(M)=0.0707 *11* α(N)=0.0178 *3*; α(O)=0.00347 *5*; α(P)=0.000327 *5* α: for M1.
[x]193.16 *15*	14.5 *20*							
210.55 *13*	40 *10*	210.55	$(1^-,2^-,3^-)$	0.0	2^-	(M1)	1.042	α(K)=0.853 *12*; α(L)=0.1449 *21*; α(M)=0.0338 *5* α(N)=0.00855 *12*; α(O)=0.001660 *24*; α(P)=0.0001569 *23*
265.7[a] *3*	≈1.9	416.68	$(0,1,2^-)$	151.31	(1^-)	[M1,E2]	0.35 *20*	α(K)=0.27 *19*; α(L)=0.066 *10*; α(M)=0.0161 *17*; α(N)=0.0040 *5*
274.21 *10*	34 *6*	274.17	$(1^-,2^-,3^-)$	0.0	2^-	(M1)	0.502	α(K)=0.411 *6*; α(L)=0.0695 *10*;

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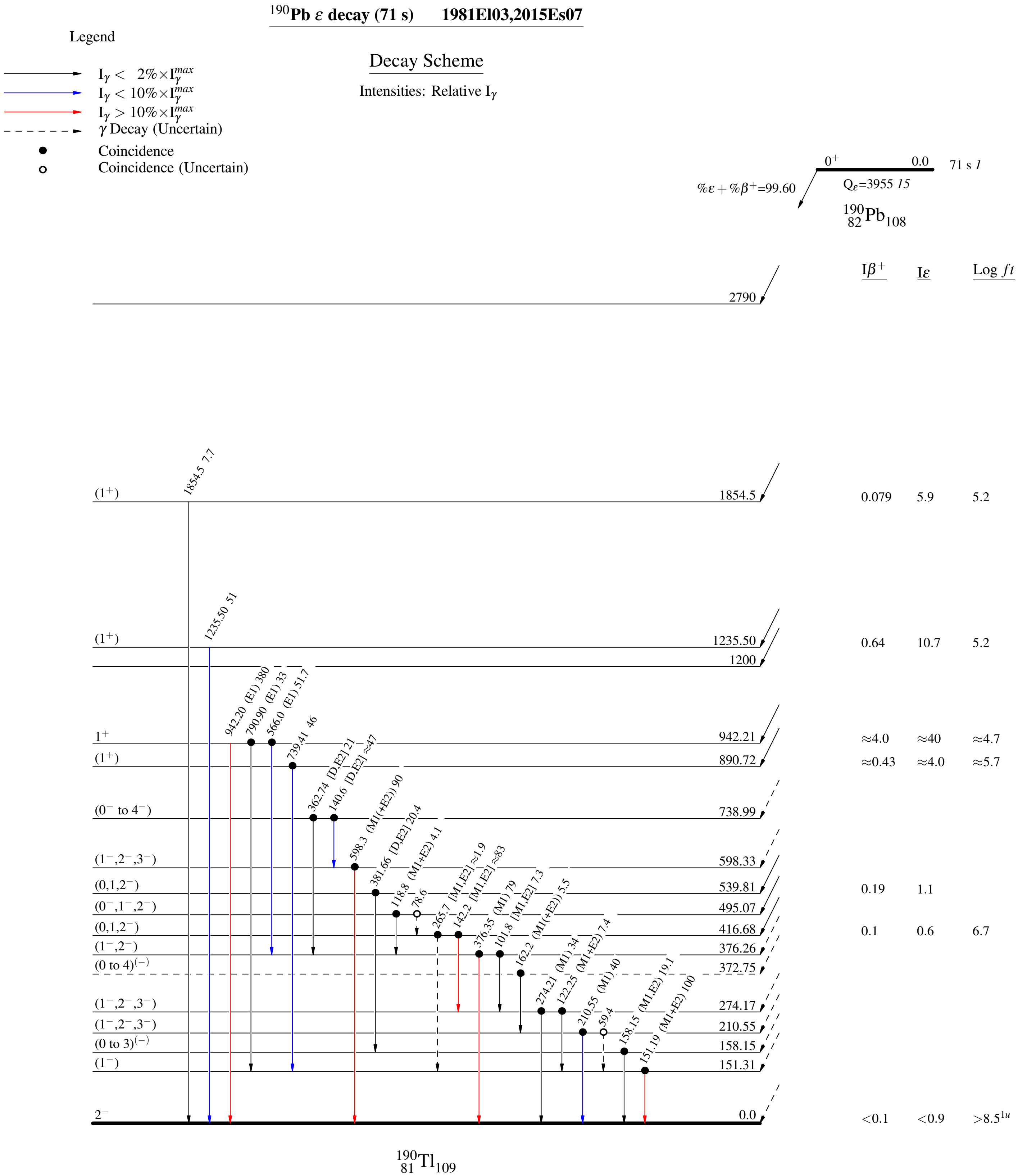
^{190}Pb ε decay (71 s) 1981El03,2015Es07 (continued)

γ(^{190}Tl) (continued)

E_γ [†]	I_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [‡]	α [&]	Comments
								α(M)=0.01622 *23* α(N)=0.00409 *6*; α(O)=0.000795 *12*; α(P)=7.52×10^{-5} *11*
362.74 *15*	21 *3*	738.99	(0$^-$ to 4$^-$)	376.26	(1$^-$,2$^-$)	[D,E2]	0.12 *10*	
376.35 *10*	79 *10*	376.26	(1$^-$,2$^-$)	0.0	2$^-$	(M1)	0.212	α(K)=0.1740 *25*; α(L)=0.0292 *4*; α(M)=0.00681 *10* α(N)=0.001720 *25*; α(O)=0.000334 *5*; α(P)=3.16×10^{-5} *5*
381.66 *15*	20.4 *20*	539.81	(0,1,2$^-$)	158.15	(0 to 3)$^{(-)}$	[D,E2]	0.11 *9*	
566.0 *2*	51.7 *26*	942.21	1$^+$	376.26	(1$^-$,2$^-$)	(E1)	0.00714	α(K)=0.00593 *9*; α(L)=0.000933 *13*; α(M)=0.000216 *3* α(N)=5.41×10^{-5} *8*; α(O)=1.037×10^{-5} *15*; α(P)=9.11×10^{-7} *13*
598.3 *2*	90 *7*	598.33	(1$^-$,2$^-$,3$^-$)	0.0	2$^-$	(M1(+E2))	0.0621	α(K)=0.0510 *8*; α(L)=0.00845 *12*; α(M)=0.00197 *3* α(N)=0.000497 *7*; α(O)=9.65×10^{-5} *14*; α(P)=9.16×10^{-6} *13* α: for M1.
739.41 *15*	46 *5*	890.72	(1$^+$)	151.31	(1$^-$)			
790.90 *20*	33 *3*	942.21	1$^+$	151.31	(1$^-$)	(E1)	0.00370	α(K)=0.00309 *5*; α(L)=0.000473 *7*; α(M)=0.0001091 *16* α(N)=2.74×10^{-5} *4*; α(O)=5.28×10^{-6} *8*; α(P)=4.76×10^{-7} *7*
942.20 *10*	380 *30*	942.21	1$^+$	0.0	2$^-$	(E1)	0.00268	α(K)=0.00223 *4*; α(L)=0.000339 *5*; α(M)=7.79×10^{-5} *11* α(N)=1.96×10^{-5} *3*; α(O)=3.78×10^{-6} *6*; α(P)=3.45×10^{-7} *5*
1235.50 *15*	51 *5*	1235.50	(1$^+$)	0.0	2$^-$			
1854.5 *3*	7.7 *20*	1854.5	(1$^+$)	0.0	2$^-$			

[†] From 1981El03.
[‡] From ce data in 1981El03, normalized to known E2 transitions in ^{190}Hg (416γ and 731γ) and in ^{190}Pt (296γ). Since no numerical data for conversion electron lines and deduced conversion coefficients are given in 1981El03, evaluators list all the multipolarities, proposed by 1981El03, in parentheses. The same assignments are recommended in the Adopted Gammas.
[#] Iγ(140.6γ+142.2γ)=130 *50*.
[@] Tentative transition from γγ-coin only.
[&] 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] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.



190Pb ε decay (71 s) 1981El03,2015Es07
Decay Scheme
Intensities: Relative Iγ
Legend
Iγ < 2%×Iγmax
Iγ < 10%×Iγmax
Iγ > 10%×Iγmax
γ Decay (Uncertain)
Coincidence
Coincidence (Uncertain)
0+ 0.0 71 s 1
Qε=3955 15
%ε+%β+=99.60
190 82 Pb 108
Iβ+ Iε Log ft
2790
(1+) 1854.5 0.079 5.9 5.2
1854.5 7.7
(1+) 1235.50 0.64 10.7 5.2
1235.50 51
1200
1+ 942.21 ≈4.0 ≈40 ≈4.7
942.20 (E1) 380
790.90 (E1) 33
566.0 (E1) 51.7
(1+) 890.72 ≈0.43 ≈4.0 ≈5.7
739.41 46
(0− to 4−) 738.99
362.74 [D,E2] 21
140.6 [D,E2] ≈47
(1−,2−,3−) 598.33
598.3 (M1(+E2)) 90
(0,1,2−) 539.81 0.19 1.1
381.66 [D,E2] 20.4
(0−,1−,2−) 495.07
118.8 (M1+E2) 4.1
78.6
(0,1,2−) 416.68 0.1 0.6 6.7
265.7 [M1,E2] ≈1.9
142.2 [M1,E2] ≈83
(1−,2−) 376.26
376.35 (M1) 79
101.8 [M1,E2] 7.3
(0 to 4)(−) 372.75
162.2 (M1(+E2)) 5.5
(1−,2−,3−) 274.17
274.21 (M1) 34
122.25 (M1+E2) 7.4
(1−,2−,3−) 210.55
210.55 (M1) 40
59.4
(0 to 3)(−) 158.15
158.15 (M1,E2) 19.1
(1−) 151.31
151.19 (M1+E2) 100
2− 0.0 <0.1 <0.9 >8.5[1u]
190 81 Tl 109