Energy levels [03Ak06]. **$^{217}_{90}$Th**

E^* [keV]	$2J^\pi$	$T_{1/2}$ or Γ_{cm}
0.0	$\langle 9^+ \rangle$	0.241(5) ms
673.8	$\langle 15^- \rangle$	141(50) ns

Energy levels and branching ratios [95El08, 06Ja03] **$^{218}_{90}$Th**

E^* [keV]	J^π	$T_{1/2}$ or Γ_{cm}
0.0	0^+	109(13) ns
689.6(6)	2^+	
1194.2(9)	4^+	
1563.9(11)	6^+	
1765.8(12)	8^+	1.2(2) ns
2104.0(14)	10^+	0.25(15) ns

Energy levels and branching ratios [95El08, 06Ja03] Part 2 **$^{218}_{90}$Th**

E^*	J^π	Branching ratios in percentage					
	E_f^*:	0.0	689.6	1194.2	1563.9	1765.8	
[keV]	J_f^π:	0^+	2^+	4^+	6^+	8^+	
689.6(6)	2^+	x					
1194.2(9)	4^+		x				
1563.9(11)	6^+			x			
1765.8(12)	8^+				x		
2104.0(14)	10^+					x	

Energy levels and branching ratios [97Ar04]. **$^{220}_{90}$Th**

E^*	J^π	$T_{1/2}$ or	Branching ratios in percentage						
		E_f^*:	0	373.3	759.8	993.7	1165.8	1328.8	1597.9
[keV]		Γ_{cm}	J_f^π: 0^+	2^+	4^+	5^-	6^+	7^-	8^+
0	0^+	9.7(6) μs							
373.3(3)	2^+		x						
759.8(5)	4^+			x					
993.7(5)	5^-				x				
1165.8(5)	6^+				36	64			

(continued) **$^{220}_{90}$Th**

E^*	J^π	$T_{1/2}$ or	Branching ratios in percentage						
		E_f^*:	0	373.3	759.8	993.7	1165.8	1328.8	1597.9
[keV]		Γ_{cm}	J_f^π: 0^+	2^+	4^+	5^-	6^+	7^-	8^+
1328.8(6)	7^-					21	79		
1597.9(6)	8^+						13	87	
1718.7(6)	9^-							55	45
2012.4(6)	10^+								15
2158.7(6)	11^-								
2434.3									
2441.4(6)	12^+								
2554.8(7)	13^-								
2884.4	$\langle 14^+ \rangle$								
2900									
3004.4(7)	15^-								
3466.6(8)	17^-								
3952.8(8)	19^-								

Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [97Ar04]. Part 2 **$^{220}_{90}$Th**

E^*	J^π		Branching ratios in percentage								
		E_f^*:	1718.7	2012.4	2158.7	2434.3	2441.4	2554.8	2884.4	3004.4	3466.6
[keV]		J_f^π:	9^-	10^+	11^-		12^+	13^-	$\langle 14^+ \rangle$	15^-	17^-
2012.4(6)	10^+		85								
2158.7(6)	11^-		61	39							
2434.3					x						
2441.4(6)	12^+			11	89						
2554.8(7)	13^-				23	31	47				
2884.4	$\langle 14^+ \rangle$						17	83			
2900						x					
3004.4(7)	15^-							93	7		
3466.6(8)	17^-									x	
3952.8(8)	19^-										x

Energy levels [90Ak05]. **$^{221}_{90}$Th**

E^*	$2J^\pi$	$T_{1/2}$ or	Ref.
[keV]		Γ_{cm}	
0.0	$\langle 7^+ \rangle$	1.73(3) ms	
36	$\langle 9^+ \rangle$		00He17
250.9(3)	$\langle 11^+ \rangle$		00He17

(continued) **$^{221}_{90}$Th**

E^* [keV]	$2J^\pi$	$T_{1/2}$ or Γ_{cm}	Ref.
488.0(5)	$\langle 13^- \rangle$		
572.8(5)	$\langle 15^+ \rangle$		
746.9(6)	$\langle 17^- \rangle$		
946.5(6)	$\langle 19^+ \rangle$		
1078.6(7)	$\langle 21^- \rangle$		
1356.0(8)	$\langle 23^+ \rangle$		
1472.0(9)	$\langle 25^- \rangle$		
1776.4(9)	$\langle 27^+ \rangle$		
1935.4(10)	$\langle 29^- \rangle$		
2251.5(11)	$\langle 31^+ \rangle$		
2421.5(11)	$\langle 33^- \rangle$		

Additional data on this isotope can be found in [88Da15, 85Da11].

Energy levels and branching ratios [96El01]. **$^{222}_{90}$Th**

E^* [keV]	J^π	$T_{1/2}$ or Γ_{cm}	Ref.	Branching ratios in percentage						
			E_f^*:	0.0	183.3	439.8	651.0	750.0	923.5	1093.5
			J_f^π:	0^+	2^+	4^+	5^-	6^+	7^-	8^+
0.0	0^+	2.237(13) ms								
183.3	2^+	240(20) ps		x						
236	$\langle 1 \rangle$		00He17							
439.8	4^+	46(6) ps			x					
467.0	3^-				x					
651.0	5^-		97Ju03			x				
750.0	6^+	≤45 ps				x	x			
923.5	7^-		97Ju03				x	x		
1093.5	8^+							x	x	
1255.3	9^-		97Ju03						x	x
1461.1	10^+									x
1622.6	11^-		97Ju03							
1850.7	12^+									
2015.5	13^-									
2259.7	14^+									
2431.9	15^-									
2687.8	16^+									
2873.0	17^-									
3133.5	18^+									
3340.7	19^-									
3596.0	20^+									
3835.5	21^-									
4077.6	22^+									
4349.5	23^-									

(continued) **$^{222}_{90}$Th**

E^*	J^π	$T_{1/2}$ orRef.				Branching ratios in percentage			
			E_f^*:	0.0	183.3	439.8	651.0	750.0	923.5	1093.5
[keV]		Γ_{cm}	J_f^π:	0^+	2^+	4^+	5^-	6^+	7^-	8^+
4577.9	24^+									
4882.5	$\langle 25^- \rangle$									
5097.9	$\langle 26^+ \rangle$									

Additional data on this isotope can be found in [04Ga03, 03SmZZ, 97Ju03, 97Jo15].
Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [96El01]. Part 2 **$^{222}_{90}$Th**

E^*	J^π					Branching ratios in percentage						
		E_f^*:	1255.3	1461.1	1622.6	1850.7	2015.5	2259.7	2431.9	2687.8	2873.0	3133.5
[keV]		J_f^π:	9^-	10^+	11^-	12^+	13^-	14^+	15^-	16^+	17^-	18^+
1461.1	10^+		x									
1622.6	11^-		x	x								
1850.7	12^+			x	x							
2015.5	13^-				x	x						
2259.7	14^+					x	x					
2431.9	15^-						x	x				
2687.8	16^+							x	x			
2873.0	17^-								x	x		
3133.5	18^+									x	x	
3340.7	19^-										x	x
3596.0	20^+											x

Energy levels and branching ratios [96El01]. Part 3 **$^{222}_{90}$Th**

E^*	J^π				Branching ratios in percentage				
		E_f^*:	3340.7	3596.0	3835.5	4077.6	4349.5	4577.9	4882.5
[keV]		J_f^π:	19^-	20^+	21^-	22^+	23^-	24^+	$\langle 25^- \rangle$
3596.0	20^+		x						
3835.5	21^-		x	x					
4077.6	22^+			x	x				
4349.5	23^-				x	x			
4577.9	24^+					x	x		
4882.5	$\langle 25^- \rangle$						x	x	
5097.9	$\langle 26^+ \rangle$							x	x

Energy levels and branching ratios [01Br31]. **$^{223}_{90}$Th**

E^*	$2J^\pi$	$T_{1/2}$ or		Branching ratios in percentage						
			E_f^*:	0.0	51.3	118.9	180.5	212.3	243.0	320.0
[keV]		Γ_{cm}	$2J_f^\pi$:	$\langle 5\rangle^+$	$\langle 7\rangle^+$	$\langle 9\rangle^+$	$\langle 9^-\rangle$	$\langle 11\rangle^+$	$\langle 11^-\rangle$	$\langle 13^+\rangle$
0.0	$\langle 5\rangle^+$	0.60(2) s								
51.3(5)	$\langle 7\rangle^+$			100						
118.9(6)	$\langle 9\rangle^+$			31(17)	69					
180.5(5)	$\langle 9^-\rangle$				100					
209(1)	$\langle 7\rangle^+$			50(18)	50(18)					
212.3(6)	$\langle 11\rangle^+$				33(11)	24(7)	42(20)			
243.0(6)	$\langle 11^-\rangle$					100				
247(1)	$\langle 3\rangle^+$			100						
310(1)	$\langle 5\rangle^+$			55(18)	45(18)					
320.0(6)	$\langle 13^+\rangle$					39(2)		22(2)	39(7)	
324.1(6)	$\langle 13\rangle^-$							100		
412.4(6)	$\langle 15^-\rangle$								9(5)	91(12)
428.7(6)	$\langle 15\rangle^+$							x		x
547.3(6)	$\langle 17\rangle^-$									
569.6(6)	$\langle 17\rangle^+$									23(4)
657.0(6)	$\langle 19^-\rangle$									
706.0(6)	$\langle 19\rangle^+$									
838.1(6)	$\langle 21\rangle^-$									
858.1(6)	$\langle 21\rangle^+$									
962.1(6)	$\langle 23^-\rangle$									
1021.6(6)	$\langle 23\rangle^+$									
1179.4(6)	$\langle 25\rangle^-$									
1185.4(6)	$\langle 25\rangle^+$									
1313.8(6)	$\langle 27\rangle^-$									
1370.6(6)	$\langle 27\rangle^+$									
1551.7(6)	$\langle 29\rangle^+$									
1558.4(6)	$\langle 29\rangle^-$									
1702.5(7)	$\langle 31\rangle^-$									

Additional data on this isotope can be found in [91Ho05, 88Da15].
Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [01Br31]. Part 2 **$^{223}_{90}$Th**

E^*	$2J^\pi$		Branching ratios in percentage									
		E_f^*:	324.1	412.4	428.7	547.3	569.6	657.0	706.0	838.1	858.1	962.1
[keV]		$2J_f^\pi$:	$\langle 13\rangle^-$	$\langle 15^-\rangle$	$\langle 15\rangle^+$	$\langle 17\rangle^-$	$\langle 17\rangle^+$	$\langle 19^-\rangle$	$\langle 19\rangle^+$	$\langle 21\rangle^-$	$\langle 21\rangle^+$	$\langle 23^-\rangle$
412.4(6)	$\langle 15^-\rangle$		x									
428.7(6)	$\langle 15\rangle^+$		x									
547.3(6)	$\langle 17\rangle^-$		53(3)	12(5)	35(8)							
569.6(6)	$\langle 17\rangle^+$			77(3)	<3							
657.0(6)	$\langle 19^-\rangle$			25(11)		x	75(7)					
706.0(6)	$\langle 19\rangle^+$				12(2)	74(4)	14(6)					

(continued) **$^{223}_{90}$Th**

E^*	$2J^\pi$	Branching ratios in percentage									
	E_f^*:	324.1	412.4	428.7	547.3	569.6	657.0	706.0	838.1	858.1	962.1
[keV]	$2J_f^\pi$:	$\langle 13\rangle^-$	$\langle 15^-\rangle$	$\langle 15\rangle^+$	$\langle 17\rangle^-$	$\langle 17\rangle^+$	$\langle 19^-\rangle$	$\langle 19\rangle^+$	$\langle 21\rangle^-$	$\langle 21\rangle^+$	$\langle 23^-\rangle$
838.1(6)	$\langle 21\rangle^-$				29(4)			71(9)			
858.1(6)	$\langle 21\rangle^+$					6(1)	94(5)				
962.1(6)	$\langle 23^-\rangle$						12(1)			88(9)	
1021.6(6)	$\langle 23\rangle^+$							12(2)	88(21)		
1179.4(6)	$\langle 25\rangle^-$								7(3)		
1185.4(6)	$\langle 25\rangle^+$									13(3)	87(5)
1313.8(6)	$\langle 27\rangle^-$										59(15)

Energy levels and branching ratios [01Br31]. Part 3 **$^{223}_{90}$Th**

E^*	$2J^\pi$	Branching ratios in percentage						
	E_f^*:	1021.6	1179.4	1185.4	1313.8	1370.6	1551.7
[keV]	$2J_f^\pi$:	$\langle 23\rangle^+$	$\langle 25\rangle^-$	$\langle 25\rangle^+$	$\langle 27\rangle^-$	$\langle 27\rangle^+$	$\langle 29\rangle^+$
1179.4(6)	$\langle 25\rangle^-$	93(4)					
1313.8(6)	$\langle 27\rangle^-$			41(6)			
1370.6(6)	$\langle 27\rangle^+$	22(9)	78(6)				
1551.7(6)	$\langle 29\rangle^+$			23(8)	77(8)		
1558.4(6)	$\langle 29\rangle^-$		19(5)			81(5)	
1702.5(7)	$\langle 31\rangle^-$				38(11)		62(14)

Energy levels and branching ratios [97Ar05, 04Ga03]. **$^{224}_{90}$Th**

E^*	J^π	$T_{1/2}$ or	Branching ratios in percentage						
			E_f^*:	0.0	98.1	284.1	464.5	534.7	699.5	833.9
[keV]		Γ_{cm}	J_f^π:	0^+	2^+	4^+	5^-	6^+	7^-	8^+
0.0	0^+	0.81(10) s								
98.1(3)	2^+	0.59(4) ns		x						
251.0(3)	1^-			67(17)	33(9)					
284.1(5)	4^+				x					
305.3(5)	3^-				x					
464.5(5)	5^-					x				
534.7(5)	6^+					54	46(14)			
699.5(5)	7^-						x	x		
833.9(6)	8^+							33(7)	67	
997.7(6)	9^-								x	x
1173.8(6)	10^+									26(3)
1347.3(6)	11^-									
1549.8(6)	12^+									
1738.7(6)	13^-									

(continued) **$^{224}_{90}$Th**

E^*	J^π	$T_{1/2}$ or	Branching ratios in percentage							
			E_f^*:	0.0	98.1	284.1	464.5	534.7	699.5	833.9
[keV]		Γ_{cm}	J_f^π:	0^+	2^+	4^+	5^-	6^+	7^-	8^+
1958.9(7)	14^+									
2164.7(7)	15^-									
2398.0(7)	16^+									
2620.2(7)	17^-									
2864	18^+									

Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [97Ar05, 04Ga03]. Part 2 **$^{224}_{90}$Th**

E^*	J^π		Branching ratios in percentage							
		E_f^*:	997.7	1173.8	1347.3	1549.8	1738.7	1958.9	2164.7	2398.0
[keV]		J_f^π:	9^-	10^+	11^-	12^+	13^-	14^+	15^-	16^+
1173.8(6)	10^+		74							
1347.3(6)	11^-		23(3)	77						
1549.8(6)	12^+			22(2)	78					
1738.7(6)	13^-				33(3)	67				
1958.9(7)	14^+					22(2)	78			
2164.7(7)	15^-						31(4)	69		
2398.0(7)	16^+							x	x	
2620.2(7)	17^-								30(8)	70
2864	18^+									x

Energy levels [90Ak03]. **$^{225}_{90}$Th**

E^*	$2J^\pi$	$T_{1/2}$ or
[keV]		Γ_{cm}
0.0[a]	$\langle 3 \rangle^+$	8.72(4) m
28(5)[a]	$\langle 5^+ \rangle$	
64(5)[a]	$\langle 7^+ \rangle$	
102(5)		
139(5)[a]	$\langle 9^+ \rangle$	
178(5)[a]	$\langle 11^+ \rangle$	

Levels of K=3/2 band are marked by "a" [90Ak03].

Energy levels and branching ratios [96Ak02]. **$^{226}_{90}$Th**

E^*	J^π	$T_{1/2}$ or	Ref.	Branching ratios in percentage							
				E_f^*:	0.0	72.20	226.43	230.37	307.5	447.3	450.5
[keV]		Γ_{cm}		J_f^π:	0^+	2^+	4^+	1^-	3^-	6^+	5^-
0.0	0^+	30.57(10) m									
72.20(4)	2^+	0.395(20) ns	98Li05		x						
226.43(5)	4^+	145(20) ps	98Li05			x					
230.37(5)	1^-	3.5(12) ps	98Li05		62(3)	38(3)					
307.5(2)	3^-					96(7)	3.9(10)				
351(2)											
362(3)											
447.3(2)	6^+						x				
450.5(2)	5^-						x				
657.9(2)	7^-									x	x
721.9(2)	8^+									88.5	
805.2(4)	$\langle 0^+ \rangle$							x			
847.8(4)	$\langle 2^+ \rangle$							47(11)	53(11)		
923.1(3)	9^-										
1040.3(3)	10^+										
1238.4(4)	11^-										
1395.2(4)	12^+										
1596.0(5)	13^-										
1781.5(5)	14^+										
1989.4(5)	15^-										
2195.8(6)	16^+										
2412.8(6)	17^-										
2635.1(7)	18^+										
2861.1(7)	19^-										
3097.1(8)	20^+										

Additional data on this isotope can be found in [04Ga03, 98Li05, 72Va20].

Two bands built on the ground state (up to J^π=20^+) and on the 1^- state (up to J^π=19^-) are shown in [99Co02].

Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [96Ak02]. Part 2 **$^{226}_{90}$Th**

E^*	J^π					Branching ratios in percentage						
		E_f^*:	657.9	721.9	923.1	1040.3	1238.4	1395.2	1596.0	1781.5	1989.4	2195.8
[keV]		J_f^π:	7^-	8^+	9^-	10^+	11^-	12^+	13^-	14^+	15^-	16^+
721.9(2)	8^+		11.50(442)									
923.1(3)	9^-		20	80(8)								
1040.3(3)	10^+			78	21.6(16)							
1238.4(4)	11^-				38	62(5)						
1395.2(4)	12^+					70	30(2)					
1596.0(5)	13^-						x	x				
1781.5(5)	14^+							71	29(3)			

(continued) **$^{226}_{90}$Th**

E^*	J^π	Branching ratios in percentage									
	E_f^*:	657.9	721.9	923.1	1040.3	1238.4	1395.2	1596.0	1781.5	1989.4	2195.8
[keV]	J_f^π:	7^-	8^+	9^-	10^+	11^-	12^+	13^-	14^+	15^-	16^+
1989.4(5)	15^-							62	38(6)		
2195.8(6)	16^+								x	x	
2412.8(6)	17^-									70	30(5)
2635.1(7)	18^+										x

Energy levels and branching ratios [96Ak02]. Part 3 **$^{226}_{90}$Th**

E^*	J^π	Branching ratios in percentage		
		E_f^*:	2412.8	2635.1
[keV]		J_f^π:	17^-	18^+
2861.1(7)	19^-		70	30(7)
3097.1(8)	20^+			x

Energy levels and branching ratios [01Br31]. **$^{227}_{90}$Th**

E^*	$2J^\pi$	$T_{1/2}$ or	Branching ratios in percentage							
			E_f^*:	0.0	9.29	24.38	37.864	73.67	76.23	77.62
[keV]		Γ_{cm}	$2J_f^\pi$:	1^+	$\langle 5^+ \rangle$	3^+	3^-			$3^+,5^+$
0.0	1^+	18.68(9) d								
9.29(3)	$\langle 5^+ \rangle$			100						
24.38(3)	3^+			98(20)	2.2					
37.864(25)	3^-			51(10)	49(10)					
73.67(4)	$\langle 3^-,5^-,7^- \rangle$				100					
76.23(4)					80(8)	20(4)				
77.62(3)	$3^+,5^+$				52(3)	43(4)	4(1)			
86.78	$\langle 9^+ \rangle$				100					
99.19(3)	$1^+,3^+,5^+$			10(2)	39(9)	19(3)	31(3)			
127.30(5)	$3^+,5^+$				31(6)	69(7)				
183.71(5)	$1^-,3^-,5^-$					17(4)	3.5(19)			
200.02(7)	$X^{\langle - \rangle}$				38(9)					
207.1(2)	$X^{\langle - \rangle}$									100
228.48(12)	$3^-,5^-$				22(8)	34(8)	2.7(8)			33(17)
231.46(9)	$X^{\langle - \rangle}$							100		
289.04(4)	$1^+,3^+,5^+$			20(3)	24(3)	45(4)				6(1)
318.96(7)	$\langle 3^+,5^+,7^+ \rangle$				69(12)	17(6)			10(3)	4(2)
400.14(21)										
448.19(20)							≈11			≈8
0.0+X										
503.4(3)										

(continued) **$^{227}_{90}$Th**

E^*	$2J^\pi$	$T_{1/2}$ or	Branching ratios in percentage						
		E_f^*:	0.0	9.29	24.38	37.864	73.67	76.23	77.62
[keV]		Γ_{cm}	$2J_f^\pi$: 1^+	$\langle 5^+ \rangle$	3^+	3^-			3^+,5^+
51.7+X									
547.02(19)				11(5)	33(11)				
106.0+X									
170.8+X									
688.73(16)									
698.4(4)									
268.0+X									
284.7+X									
296.6+X									
340.2+X									
477.4+X									
483.7+X									
509.4+X									
518.4+X									
563.9+X									
701.9+X									
747.4+X									
772.0+X									
775.1+X									
838.9+X									
970.4+X									
1025.5+X									
1053.4+X									
1069.5+X									
1078.7+X									
1159.8+X									
1281.7+X									
1339.3+X									
1396.1+X									
1404.0+X									
1417.4+X									
1520.4+X									
1683.9+X									
1768.0+X									
1769.6+X									
1915.9+X									
2166.3+X									

Additional data on this isotope can be found in [97Mu08, 95Li04, 94Li12].
Six bands of levels with different K-numbers ($1/2^+$, $1/2^-$, $3/2^-$) are suggested in [02Ha30].
Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [01Br31]. Part 2 **$^{227}_{90}$Th**

E^*	$2J^\pi$		Branching ratios in percentage									
		E_f^*:	99.19	127.30	183.71	228.48	289.04	0.0+X	503.4	51.7+X	547.02	106.0+X
[keV]		$2J_f^\pi$:		$3^+,5^+$		$3^-,5^-$						
183.71(5)	$1^-,3^-,5^-$		4.1(19)	75(6)								
200.02(7)	$X^{\langle-\rangle}$			62(12)								
228.48(12)	$3^-,5^-$		8(1)									
289.04(4)	$1^+,3^+,5^+$		2.7(9)			1.6(5)						
400.14(21)							100					
448.19(20)					81(20)							
503.4(3)			18(9)		82(22)							
547.02(19)				36(8)	19(8)							
106.0+X								x		x		
170.8+X										x		x
688.73(16)			13(4)	36(6)		17(5)			22(6)		12(3)	
698.4(4)						100						
268.0+X												x
284.7+X												x
296.6+X												x

Energy levels and branching ratios [01Br31]. Part 3 **$^{227}_{90}$Th**

E^*	$2J^\pi$		Branching ratios in percentage									
		E_f^*:	170.8+X	268.0+X	284.7+X	296.6+X	340.2+X	477.4+X	483.7+X	509.4+X	518.4+X	563.9+X
[keV]		$2J_f^\pi$:										
284.7+X			x									
340.2+X			x	x	x							
477.4+X				x		x						
483.7+X				x								
509.4+X					x		x					
518.4+X					x							
563.9+X							x			x		
701.9+X								x	x			
747.4+X									x			
772.0+X										x	x	
775.1+X										x		x
838.9+X												x

Energy levels and branching ratios [01Br31]. Part 4 **$^{227}_{90}$Th**

E^*	$2J^\pi$		Branching ratios in percentage									
		E_f^*:	701.9+X	747.4+X	772.0+X	775.1+X	838.9+X	970.4+X	1026+X	1053+X	1070+X	1079+X
[keV]		$2J_f^\pi$:										
838.9+X						x						
970.4+X			x	x								
1025.5+X					x							
1053.4+X				x								
1069.5+X					x	x						
1078.7+X						x	x					
1159.8+X							x					x
1281.7+X								x		x		
1339.3+X									x		x	
1396.1+X										x		
1404.0+X											x	x
1417.4+X												x

Energy levels and branching ratios [01Br31]. Part 5 **$^{227}_{90}$Th**

E^*	$2J^\pi$		Branching ratios in percentage						
		E_f^*:	1160+X	1339+X	1396+X	1404+X	1417+X	1520+X	1770+X
[keV]		$2J_f^\pi$:							
1417.4+X			x						
1520.4+X			x				x		
1683.9+X				x		x			
1768.0+X							x		
1769.6+X					x				
1915.9+X								x	
2166.3+X									x

Energy levels and branching ratios [97Ar08]. **$^{228}_{90}$Th**

E^*	J^π	L	σ (p,t)	σ (p,t)	S_N	R	$T_{1/2}$ or	Ref.	Branching ratios in percentage				
									E_f^*: 0.0	57.7	186.8	328	378
[keV]		(p,t)	μb/sr	μb/sr	(p,t)	(p,t)	Γ_{cm}		J_f^π: 0^+	2^+	4^+	1^-	6^+
0.0	0^+	0	210	247	100		1.9116(16) yr	72Ma15					
57.759(4)	2^+		97				0.405(7) ns	72Ma15	100				
186.823(4)	4^+		28				0.164(4) ns	72Ma15		100			
328.003(4)	1^-								47.2(11)	52.8(8)			
378.179(10)	6^+										100		
396.078(5)	3^-									74.3(13)	25.7(4)		
519.192(6)	5^-										91(5)		9.2(5)
622.5(3)	8^+												x

(continued)

$^{228}_{90}$Th

E^* [keV]	J^π	L (p,t)	σ (p,t) μb/sr	σ (p,t) μb/sr	S_N (p,t)	R (p,t)	$T_{1/2}$ or Γ_{cm}	Ref.	Branching ratios in percentage E_f^*: 0.0 J_f^π: 0^+	57.7 2^+	186.8 4^+	328 1^-	378 6^+
695.6(3)	7^-												x
831.823(10)	0^+	0	42	89.4	28.9	0.18		72Ma15	x	≈25		75(5)	
874.473(18)	2^+		12			[0.2]		72Ma15	9(1)	4.8(8)	12(1)	35(2)	
911.8(4)	10^+												
920.8(3)	9^-												
938.58(7)	0^+		11	25.0	7.8			04Wi06		21(6)		79(17)	
944.196(13)	$1,2^+$								52(4)			48(6)	
968.369(17)	3^-											17(2)	
968.968(5)	2^+								37.5(7)	61.4(10)	1.16(4)		
979.499(14)	2^+		21			[0.3]		72Ma15	9(1)	≤5.5	≈26	29(3)	
1016.41(2)	2^+–4^+								4.3(7)	63(8)		15.1(9)	
1022.527(6)	$\langle 3\rangle^+$									75.5(14)	24.5(8)		
1059.93(3)	4^-										41(4)		
1091.017(8)	4^+									20.2(7)	76(3)		1.4(3)
1120.1(3)				1.1	0.3			04Wi06					
1122.951(6)	2^-									2.23(9)		73.7(12)	
1153.467(10)	2^+						0.29(2) ns		18(1)	16(1)			
1160(5)			10					72Ma15					
1168.375(5)	3^-									8.5(9)	1.4(2)	28.2(10)	
1174.508(18)	$\langle 5^+\rangle$										x		
1175.39(5)	2^+								13(2)	30(4)	43(7)		
1189.8(4)	11^-												
1200.54(4)	$\langle 3\rangle^+$									7(2)	27(3)		
1226.565(7)	$\langle 4\rangle^-$										6.1(4)		
1239.4(4)	12^+												
1297.423(10)	$\langle 5\rangle^-$										32(3)		
1344.078(11)	3^-									21(4)	2.9(5)	8(1)	
1416.11(6)	$2^+,3^-$										11(3)	9(2)	
1431.979(6)	4^+									0.20(6)	1.56(8)		
1450.394(10)	4^-												
1497.1(5)	13^-												
1511.2(3)				3.6	1.0			04Wi06					
1531.474(6)	3^+										0.31(6)		
1539.21(9)	2,3,4												
1580.91(6)	$\langle 2^-\rangle$									26(3)		29(3)	
1588.335(14)	4^-												
1599.5(5)	14^+												
1617.78(7)	$2^+,3,4^+$									21(4)	37(7)		
1627.9(3)				18.6	4.9			04Wi06					
1638.284(9)	2^+								42(3)	50(3)	0.9(2)	1.6(5)	
1643.125(15)	$\langle 2^-,3^-\rangle$											2.1(3)	
1645.954(12)	3^+									72.7(18)	17.2(9)		
1682.81(3)	2^+–4^+									22.4(15)	77(4)		
1683.82(5)	$\langle 4^-\rangle$												
1688.394(11)	$2^+,3^+$									76(2)	22.2(11)		

(continued) **$^{228}_{90}$Th**

E^*	J^π	L	σ (p,t)	σ (p,t)	S_N	R	$T_{1/2}$ or	Ref.	Branching ratios in percentage				
									E_f^*: 0.0	57.7	186.8	328	378
[keV]		(p,t)	μb/sr	μb/sr	(p,t)	(p,t)	Γ_{cm}		J_f^π: 0^+	2^+	4^+	1^-	6^+
1691.4(4)				1.7	0.4			04Wi06					
1724.283(6)	2^+								1.7(2)	10.7(5)	2.6(3)		
1735.450(25)	$\langle 4^+ \rangle$									41(4)	28(3)		15(3)
1743.89(3)	4^+									27.1(12)	50(3)		4.4(4)
1758.24(12)	$2^+,3,4^+$									21(5)	11(3)		
1760.218(24)	$2^+,3^{\langle + \rangle}$									37(3)	24(1)		
1795.90(10)	$3^-,4^+$									56(12)			
1797.65(8)	2^+								5(2)	24(7)		44(9)	
1804.689(23)	4^+										16(1)		9(1)
1817.432(23)	4^-												
1838.3(5)	15^-												
1892.996(17)	3^+									26(3)	7.2(3)		
1899.95(4)	2^+								4(1)	40(2)			
1901.93(8)	$3^-,4$										23(2)		27(3)
1906.64(10)	$\langle 2^+ \rangle$								36(3)				
1925.22(4)	$3^+,4^+$										58(3)		
1928.57(6)	3^+									44(3)	19(5)		
1937.16(9)	$2^+,3,4^+$									2.8(10)	17(2)		
1944.895(11)	3^+									32(2)	11.9(6)		
1958.72(22)	2^+								45(15)		55(15)		
1964.98(7)	$2^+,3,4^+$								29(3)	67(6)	4(1)		
1974.20(11)	$3^-,4^+$									5.0(10)	12(1)		
1981.97(6)	$2^+,3,4^+$									10.3(12)	68(4)		
1987.46(10)	4^+									53(6)	12(2)		21(4)
1988.1(6)	16^+												
2010.11(5)	$2^+,3$									25(2)	17(2)		
2013.6(3)	$2^+,3,4^+$									28(10)	72(28)		
2016.76(10)	$\langle 2^- – 4^- \rangle$												
2022.84(8)										31(3)			
2029.84(16)	$1,2^+$								9(3)	19(4)			
2036.99(17)	$2^+,3,4^+$									29(8)	71(13)		
2044.7(5)	$[0^+]$			1.7	0.4			04Wi06					
2079.9(5)	$[0^+]$			8.9	2.1			04Wi06					
2123.1(3)	$\langle 2^+ \rangle$										50(12)	50(19)	
2131.3(6)	$[0^+]$			50.7	11.8			04Wi06					
2159.4(5)	$[0^+]$			3.0	0.7			04Wi06					
2209.7(6)	17^-												
2290.0(7)	$[0^+]$			26.3	5.9			04Wi06					

(continued) **$^{228}_{90}$Th**

E^*	J^π	L	σ (p,t)	σ (p,t)	S_N	R	$T_{1/2}$ or	Ref.	Branching ratios in percentage					
									E_f^*:	0.0	57.7	186.8	328	378
[keV]		(p,t)	μb/sr	μb/sr	(p,t)	(p,t)	Γ_{cm}		J_f^π:	0^+	2^+	4^+	1^-	6^+
2407.9(7)	18^+													
			72Ma15	04Wi06	04Wi06	70Ma29		Ref.						

Additional data on this isotope can be found in [04Ga03, 99Am04, 97We05, 96Ba67, 95Ba42, 72Va20].

L and the first value σ (p,t) were obtained in measurements at 60° with E_p=17 MeV [72Ma15].

The second cross section σ (p,t) and relative S_N (in %) were measured at 7.5° [04Wi06].

Two bands built on the ground state (up to J^π=22^+) and on the 1^- state (up to J^π=19^-) are shown in [99Am04]; 8 vibrational bands are discussed in [97We05].

The ratio R of the (p,t) reaction cross section of the excited state to that of the ground state was found [70Ma29] strong in many actinide nuclei indicating pair correlations in 0^+ states.

Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [97Ar08]. Part 2 **$^{228}_{90}$Th**

E^*	J^π		Branching ratios in percentage									
		E_f^*:	396.078	519.192	622.5	695.6	831.823	874.473	911.8	920.8	944.196	968.369
[keV]		J_f^π:	3^-	5^-	8^+	7^-	0^+	2^+	10^+	9^-	$1,2^+$	3^-
874.473(18)	2^+		39(2)									
911.8(4)	10^+				x							
920.8(3)	9^-				80	19.7(12)						
968.369(17)	3^-		60(3)	23(3)								
979.499(14)	2^+		36(3)									
1016.41(2)	2^+–4^+		17.8(9)									
1059.93(3)	4^-		36(3)	24(4)								
1091.017(8)	4^+		2.2(3)									
1122.951(6)	2^-		10.1(10)									
1153.467(10)	2^+						30(1)	21(3)				
1168.375(5)	3^-		45.6(9)	1.2(1)								
1175.39(5)	2^+										14(2)	
1189.8(4)	11^-								60	40(3)		
1226.565(7)	$\langle 4\rangle^-$		62(2)	17.0(4)								
1239.4(4)	12^+								x			
1297.423(10)	$\langle 5\rangle^-$		27(4)	36(4)		4.0(7)						
1344.078(11)	3^-		44(4)	21(2)								
1416.11(6)	2^+,3^-		31(6)								49(5)	
1450.394(10)	4^-		4.3(4)									2.3(2)
1531.474(6)	3^+		0.35(5)									
1539.21(9)	2,3,4		44(9)									
1580.91(6)	$\langle 2^-\rangle$		20(2)									
1643.125(15)	$\langle 2^-,3^-\rangle$		77(4)								5.7(8)	≤23
1645.954(12)	3^+		1.41(10)									
1683.82(5)	$\langle 4^-\rangle$		49(3)	41(2)								

(continued) **$^{228}_{90}$Th**

E^*	J^π	Branching ratios in percentage									
	E_f^*:	396.078	519.192	622.5	695.6	831.823	874.473	911.8	920.8	944.196	968.369
[keV]	J_f^π:	3^-	5^-	8^+	7^-	0^+	2^+	10^+	9^-	$1,2^+$	3^-
1688.394(11)	$2^+,3^+$						0.35(8)				
1735.450(25)	$\langle 4^+\rangle$		16(2)								
1795.90(10)	$3^-,4^+$		44(10)								
1797.65(8)	2^+	27(7)									
1817.432(23)	4^-	32(2)	10.5(9)								
1899.95(4)	2^+	13(1)									
1901.93(8)	$3^-,4$	25(2)	25(2)								
1906.64(10)	$\langle 2^+\rangle$					30(9)					
1925.22(4)	$3^+,4^+$	15.7(8)									15(3)
1937.16(9)	$2^+,3,4^+$						22(6)				
1944.895(11)	3^+	1.6(3)					1.6(1)				
1974.20(11)	$3^-,4^+$	44(4)	38(2)								
1981.97(6)	$2^+,3,4^+$										22(3)
2016.76(10)	$\langle 2^-\text{–}4^-\rangle$	100									
2022.84(8)							22(4)				

Energy levels and branching ratios [97Ar08]. Part 3 **$^{228}_{90}$Th**

E^*	J^π	Branching ratios in percentage									
	E_f^*:	968.968	979.499	1016.41	1022.53	1059.93	1091.02	1122.95	1153.47	1168.38	1174.51
[keV]	J_f^π:	2^+	2^+		$\langle 3\rangle^+$	4^-	4^+	2^-	2^+	3^-	$\langle 5^+\rangle$
1122.951(6)	2^-	12.3(4)			1.6(2)						
1153.467(10)	2^+	9(1)	4.6(7)								
1168.375(5)	3^-	9.5(4)			4.7(2)		0.8(1)				
1200.54(4)	$\langle 3\rangle^+$	66(3)			≤14						
1226.565(7)	$\langle 4\rangle^-$				12.8(6)		2.26(12)				
1431.979(6)	4^+	63.2(10)	0.28(3)		27.7(5)		5.6(3)		0.44(7)	0.60(3)	0.40(2)
1450.394(10)	4^-			2.2(1)	1.6(1)	1.40(7)	1.64(9)	39.1(4)		23(1)	1.04(9)
1531.474(6)	3^+	31(2)			18(4)		4.3(3)		0.88(11)		0.60(6)
1539.21(9)	2,3,4							56(9)			
1580.91(6)	$\langle 2^-\rangle$		13(2)								
1588.335(14)	4^-									7.0(5)	
1617.78(7)	$2^+,3,4^+$	42(4)									
1638.284(9)	2^+							4.1(4)		1.1(3)	
1643.125(15)	$\langle 2^-,3^-\rangle$	≤23		2.2(5)				9.1(8)		3.6(5)	
1645.954(12)	3^+	1.45(12)	1.3(1)	0.87(15)	0.25(7)		1.02(10)	2.5(2)	0.54(4)		
1682.81(3)	$2^+\text{–}4^+$				≈0.5						
1683.82(5)	$\langle 4^-\rangle$					≤13					
1688.394(11)	$2^+,3^+$			1.3(4)							
1724.283(6)	2^+	62(2)			11.2(6)				10.6(6)		
1743.89(3)	4^+					5.2(12)			4.7(6)		
1760.218(24)	$2^+,3^{\langle+\rangle}$	8(2)			27(3)						

(continued) **$^{228}_{90}$Th**

E^*	J^π	Branching ratios in percentage									
	E_f^*:	968.968	979.499	1016.41	1022.53	1059.93	1091.02	1122.95	1153.47	1168.38	1174.51
[keV]	J_f^π:	2^+	2^+		$\langle 3\rangle^+$	4^-	4^+	2^-	2^+	3^-	$\langle 5^+\rangle$
1804.689(23)	4^+								6(1)		
1892.996(17)	3^+	6.8(5)			40(2)			5.7(4)	1.4(2)	1.9(2)	
1899.95(4)	2^+	17(2)	7(2)	2.7(7)	17(2)						
1925.22(4)	$3^+,4^+$					3.0(4)					
1944.895(11)	3^+	18(1)		1.2(1)	3.0(2)		1.1(1)		5(1)	10(1)	
1987.46(10)	4^+	15(4)									
2010.11(5)	$2^+,3$	19(4)					12(2)	12(1)			
2022.84(8)		48(15)									
2029.84(16)	$1,2^+$			24(7)			48(17)				

Energy levels and branching ratios [97Ar08]. Part 4 **$^{228}_{90}$Th**

E^*	J^π	Branching ratios in percentage									
	E_f^*:	1175.39	1189.8	1200.54	1226.57	1239.4	1297.42	1344.08	1416.11	1431.98	1450.39
[keV]	J_f^π:	2^+	11^-	$\langle 3\rangle^+$	$\langle 4\rangle^-$	12^+	$\langle 5\rangle^-$	3^-	$2^+,3^-$	4^+	4^-
1344.078(11)	3^-	4(1)									
1450.394(10)	4^-				17.0(8)		1.40(7)			4.7(6)	
1497.1(5)	13^-		66			34(3)					
1531.474(6)	3^+									44(3)	
1580.91(6)	$\langle 2^-\rangle$				12(2)						
1588.335(14)	4^-									14.0(7)	68(2)
1599.5(5)	14^+					x					
1645.954(12)	3^+				0.47(7)						
1683.82(5)	$\langle 4^-\rangle$				9.5(9)						
1724.283(6)	2^+	1.4(2)									
1743.89(3)	4^+							8.2(9)			
1758.24(12)	$2^+,3,4^+$									68(10)	
1760.218(24)	$2^+,3^{\langle+\rangle}$	4(1)									
1804.689(23)	4^+									29(1)	5(1)
1817.432(23)	4^-										57(3)
1892.996(17)	3^+			5.0(4)	4(1)				1.8(5)		
1906.64(10)	$\langle 2^+\rangle$								34(7)		
1925.22(4)	$3^+,4^+$	4.0(5)		4.6(5)							
1928.57(6)	3^+							13(4)			
1944.895(11)	3^+				8.3(5)					1.7(2)	
1964.98(7)	$2^+,3,4^+$								<31		

Energy levels and branching ratios [97Ar08]. Part 5 **$^{228}_{90}$Th**

E^*	J^π	Branching ratios in percentage									
	E_f^*:	1497.1	1531.47	1539.21	1599.5	1638.28	1645.95	1682.81	1683.82	1688.39	1724.28
[keV]	J_f^π:	13^-	3^+	2,3,4	14^+	2^+	3^+		$\langle 4^- \rangle$	2^+,3^+	2^+
1588.335(14)	4^-		11.0(5)								
1645.954(12)	3^+		0.20(3)								
1688.394(11)	2^+,3^+						0.45(15)				
1804.689(23)	4^+						23(1)	6.0(5)	3.5(5)	2.9(4)	
1838.3(5)	15^-	x									
1928.57(6)	3^+			19(3)							
1937.16(9)	2^+,3,4^+			58(6)							
1944.895(11)	3^+					2.6(1)	0.57(7)				1.6(1)
1988.1(6)	16^+				x						
2010.11(5)	2^+,3					3(1)					

Energy levels and branching ratios [97Ar08]. Part 6 **$^{228}_{90}$Th**

E^*	J^π	Branching ratios in percentage			
	E_f^*:	1760.22	1795.90	1838.3	1988.1
[keV]	J_f^π:	2^+,$3^{\langle + \rangle}$	3^-,4^+	15^-	16^+
1928.57(6)	3^+	5(1)			
1944.895(11)	3^+	0.5(1)			
2010.11(5)	2^+,3		12(2)		
2209.7(6)	17^-			x	
2407.9(7)	18^+				x

Energy levels and branching ratios [89Ak03]. **$^{229}_{90}$Th**

E^*	$2J^\pi$	C^2V^2	$T_{1/2}$ or	Ref.	Branching ratios in percentage				
					E_f^*:	0.0	≤0.010	29.19	42.44	71.82
[keV]		(d,t)	Γ_{cm}		$2J_f^\pi$:	5^+	$\langle 3^+ \rangle$	$\langle 5^+ \rangle$	7^+	$\langle 7^+ \rangle$
0.0	5^+	≤0.009	7340(160) yr	90Bu17						
0.0035(10)*	3^+			02Gu15						
21										
29.188(3)*	5^+			02Gu15		x				
42.449(1)*	7^+	≈0.06	0.172(6) ns	90Bu17		x				
68										
71.819(2)*	$\langle 7^+ \rangle$			02Gu15		x				
75										
97.136(3)*	9^+	0.024	0.147(12) ns	90Bu17		51(8)		0.7(1)	46(1)	2.8(5)
125.442(3)*	9^+			02Gu15		1.1(2)		23(4)	2.9(4)	73(6)
140										
146.353(1)*	5^-		336(10) ps	02Gu15			63(1)	22(4)		15(3)

(continued) **$^{229}_{90}$Th**

E^* [keV]	$2J^\pi$	C^2V^2 (d,t)	$T_{1/2}$ or Γ_{cm}	Ref.	E^*_f: $2J^\pi_f$:	Branching ratios in percentage 0.0 5^+	≤0.010 $\langle 3^+\rangle$	29.19 $\langle 5^+\rangle$	42.44 7^+	71.82 $\langle 7^+\rangle$
148.165(3)*	$\langle 7^-\rangle$			02Gu15		6.9(11)		85(1)		7.6(12)
162.92(10)**	11^+	≈0.46		90Bu17					75(1)	
164.527(1)*	$\langle 3^-\rangle$	incl	53(4) ps	02Gu15			72.9(6)	27.1(3)		
173.60(8)	$\langle 9^-\rangle$								27(3)	73(12)
187										
195.71(3)	$\langle 11^+\rangle$								3.5(6)	41(7)
202										
212.34(5)	$\langle 5^+–9^+\rangle$					43(9)				
217.155(1)*	$\langle 5\rangle^-$			02Gu15		46(7)		27(5)		22(5)
236.35(10)**				02Gu15						
237.368(3)*	$\langle 7^-\rangle$			02Gu15				57.8(8)		9(2)
241.6(2)	13^+									
255.94(5)						81(13)		19(5)		
261.958(4)*	$\langle 1^+\rangle$		<35 ps	02Gu15			x			
287.92(7)	$\langle 7\rangle$									65(10)
288.52(5)	$\langle 3^+\rangle$							x		
302.89(10)	$\langle 7\rangle$					18(3)			27(4)	
317.17(2)	$\langle 5^+\rangle$						59.6(6)	7.4(12)	3.1(5)	28(2)
320.544(1)*	$\langle 5^+\rangle$			02Gu15		23.9(3)		44(4)	9(2)	12(2)
327.0(3)	$\langle 15^+\rangle$									
348										
360.3(10)										
365.814(2)*	$\langle 7^+\rangle$			02Gu15			20(3)	15(2)	21(3)	4(1)
374										
381.9(10)										
423.92(3)**										
425.50(5)**	$\langle 9\rangle^+$			02Gu15				3	30(4)	18(3)
428										
436.6(3)	$\langle 5^+,7^-\rangle$					4.6(8)			7(3)	
449.4(2)**	X^+			02Gu15						
465.5(2)										x
478.64(2)**	$\langle 5,7\rangle^-$			02Gu15		36(6)		34(5)	13(3)	13(3)
480.7(10)										
517(2)										
526.75(10)**				02Gu15					3.1(8)	
534.97(10)**	1^-			02Gu15						
569.27(2)**	$\langle 3–7\rangle^+$			02Gu15		58(8)		13(2)	4.0(8)	
576.2(3)**				02Gu15						
589.4(20)										
605.0(2)	$\langle 3^+–7\rangle$					56(7)		13(3)	16(3)	
638.60(3)**				02Gu15						
653.74(4)**				02Gu15						
661.68(3)**				02Gu15						
689.02(6)**				02Gu15						
781.3(10)										

(continued) **$^{229}_{90}$Th**

E^*	$2J^\pi$	C^2V^2	$T_{1/2}$ or	Ref.	Branching ratios in percentage					
					E_f^*:	0.0	≤0.010	29.19	42.44	71.82
[keV]		(d,t)	Γ_{cm}		$2J_f^\pi$:	5^+	$\langle 3^+ \rangle$	$\langle 5^+ \rangle$	7^+	$\langle 7^+ \rangle$
779.35(4)**				02Gu15						
817.2(10)										
897.1(10)										
932(3)										
984.4(10)										
1096(2)										
1125(2)										
1336(2)										

Additional data on this isotope can be found in [05Gu15, 96Ko29, 71Er09, 01SaZK, 72Va20].
* Evaluated and given in [02Gu15].
** Previously not observed in β^- decay [02Gu15].
7 bands based on states with E^*=0.0, 0.004, 146.4, 164.5, 261, 320 and 535 keV are discussed in [02Gu15].
Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [89Ak03]. Part 2 **$^{229}_{90}$Th**

E^*	$2J^\pi$					Branching ratios in percentage							
		E_f^*:	97.13	125.41	146.35	148.16	164.53	173.60	195.71	217.16	234.8	237.36
[keV]		$2J_f^\pi$:	9^+	$\langle 9^+ \rangle$	$\langle 5^- \rangle$	$\langle 7^- \rangle$	$\langle 3^- \rangle$	$\langle 9^- \rangle$	$\langle 11^+ \rangle$	$\langle 5^- \rangle$		$\langle 7^- \rangle$
162.92(10)**	11^+		17(3)	7.4(11)								
195.71(3)	$\langle 11^+ \rangle$			38(6)			17(3)					
212.34(5)	$\langle 5^+ – 9^+ \rangle$			57(10)								
217.155(1)*	$\langle 5 \rangle^-$					1.4(2)	3.3(6)					
236.35(10)**					77(12)	23(6)						
237.368(3)*	$\langle 7^- \rangle$			11.4(13)	7.6(13)		14(2)	0.8				
287.92(7)	$\langle 7 \rangle$			x	x	10.2(16)		25(5)				x
302.89(10)	$\langle 7 \rangle$					38(6)		18(3)				x
317.17(2)	$\langle 5^+ \rangle$				1.0(2)	0.48(8)	x			0.38(7)		
320.544(1)*	$\langle 5^+ \rangle$		0.25(4)		1.7(4)	0.27(4)	0.44(7)			0.76(12)	x	
365.814(2)*	$\langle 7^+ \rangle$		6(1)	9(2)	4(1)	≈1.3		1.0(2)				
425.50(5)**	$\langle 9 \rangle^+$		21(3)						21(4)			
436.6(3)	$\langle 5^+, 7^- \rangle$		7(3)	25(10)			57(10)					
465.5(2)												22(2)
478.64(2)**	$\langle 5,7 \rangle^-$				4(1)							
526.75(10)**										51(8)		
569.27(2)**	$\langle 3–7 \rangle^+$				4.4(8)		5.6(11)					

Energy levels and branching ratios [89Ak03]. Part 3 **$^{229}_{90}$Th**

E^*	$2J^\pi$	Branching ratios in percentage					
	E_f^*:	241.6	287.92	288.52	302.89	317.17	320.54
[keV]	$2J_f^\pi$:	13^+	$\langle 7\rangle$	$\langle 3^+\rangle$	$\langle 7\rangle$	$\langle 5^+\rangle$	$\langle 5^+\rangle$
320.544(1)*	$\langle 5^+\rangle$		7.5(12)				
327.0(3)	$\langle 15^+\rangle$	x					
365.814(2)*	$\langle 7^+\rangle$			18(3)			
425.50(5)**	$\langle 9\rangle^+$	8(1)					
465.5(2)					78(12)		
526.75(10)**							46(7)
569.27(2)**	$\langle 3–7\rangle^+$					15(2)	
605.0(2)	$\langle 3^+–7\rangle$					15(4)	

Energy levels and branching ratios [93Ak02]. **$^{230}_{90}$Th**

E^*	J^π	L	$d\sigma/d\Omega$	σ (p,t)	S_N	σ (p,t)	R	σ (d,d′)	R	Ref.	Branching ratios in percentage				
											E_f^*: 0.0	53.2	174	357	508
[keV]		(p,t)	μb/sr	μb/sr	(p,t)	*rel.*	(p,t)	μb/sr	(d,d′)		J_f^π: 0^+	2^+	4^+	6^+	1^-
0.0	0^+		300	309	100.0	100*			4.7	72Ma15					
53.20(2)	2^+		94			69(13)		5012	2.3	72Ma15	x				
174.10(3)	4^+		30			18(9)		541	2.1	72Ma15		x			
356.6(5)	6^+					13(9)		29	0.8	74Ta04			x		
508.16(5)	1^-							33	0.9	75Th11	38(2)	62(2)			
571.77(10)	3^-							246	2.0	75Th11		51(3)	49(5)		
594.1(5)	8^+													x	
634.9(1)	0^+	0	73	117	31.9		0.18	8	0.9	04Wi06	x	100			
677.6(1)	2^+		18							72Ma15	38(4)	31(4)	30(5)		
686.7	5^-							40	1.1	75Th11			57(3)	32(2)	
769.6	4^+											55(20)	45(30)	≤25	
781.37(5)	2^+		35					84	2.1	72Ma15	43(2)	55(3)	1.4(7)		
825.8(2)	3^+											85(24)	15(5)		
852.4(4)	7^-													74(4)	
879.7	10^+														
883.6	4^+							12	2.1	75Th11		24.4(20)	67(3)	4.2(10)	
951.94(5)	1^-							12	1.7	75Th11	71(4)	14.2(7)			13.4(9)
971.69(10)	2^-											85(4)			8.5(6)
1009.7(1)	2^+										34(6)	60(6)	3.1(11)		
1012.5(4)	3^-		7					175	1.6	72Ma15		68(17)	4.1(17)		11(2)
1040.0	6^+												24(6)	76(5)	
1052.6(12)	3^+											44(14)	56(21)		
1065.6	9^-														
1079.3(1)	$\langle 2\rangle^-$											51(3)			38(2)
1108.2	4^+											63(16)	37(18)		
1109.0	$\langle 5^-\rangle$							23	1.9	75Th11			x		
1127.9(1)	3^-							28	1.2	75Th11		58(5)	13(3)		12(2)
1178.6	5^+													x	

(continued) **$^{230}_{90}$Th**

E^*	J^π	L	$d\sigma/d\Omega$	σ (p,t)	S_N	R	σ (d,d′)	R	Ref.	Branching ratios in percentage				
										E_f^*:	0.0	53.2	174	357	508
[keV]		(p,t)	μb/sr	μb/sr	(p,t)	(p,t)	μb/sr	(d,d′)		J_f^π:	0^+	2^+	4^+	6^+	1^-
1196.8	$\langle 4^- \rangle$												x		
1207.8	12^+														
1251.4	8^+													38(27)	
1297.1(1)	$[0^+]$			6.7	1.5				04Wi06			87(3)			13.2(7)
1321.9	11^-														
1375.3(1)	$1,2^+$										49(2)	28(2)			18.9(10)
1400.9(1)	2^+										8.9(9)	43(1)	26(2)		18.8(9)
1447.9(5)	$[0^+]$			2.6	0.6				04Wi06						
1485.6(1)												56(5)			16(7)
1520.4	10^+														
1572.9	14^+														
1573.5(2)	$1^-,2^+$						37	1.9	75Th11		x				
1589.8(3)	0^+	0	14	16.2	3.4		38	1.6	72Ma15			x			
1617.5	13^-														
1628(2)							65	1.7	75Th11						
1638.5(2)	$[0^+]$		9	9.6	2.0				04Wi06			42(4)			
1663(3)							23	1.7	75Th11						
1695.7(1)	$1^-,2^+$						20	2.0	75Th11		55(6)	21(4)			25(6)
1718(3)							19	1.5	75Th11						
1744.9(1)												86(5)			
1770.7(1)	$1,2^+$										13(3)	87(5)			
1775.2(1)	$1,2^+$										51(2)	30(2)			19(2)
1789.4(5)	$1^{\langle - \rangle},2^+$						33	2.1	75Th11		x				
1802.5(6)	$[0^+]$			3.3	0.7				04Wi06						
1810.7(1)	$1,2^+$										10.9(10)	55(2)			34(2)
1839.6(2)	$1^{\langle - \rangle},2^+$						26	2.1	75Th11		x				
1849.6(1)	$\langle 2^+ \rangle$												21(5)		
1858.2(6)							37	2.9	75Th11			x			
1902.7(1)	$1,2^+$										82(3)				18(5)
1949	15^-														
1949.8(1)	$1,2^+$										70(1)	30(1)			
1966.9(2)	$1,2^+$										13(3)	87(4)			
1971.5	16^+														
1973.4(2)	$\langle 1^+,2^+ \rangle$										5(2)	50(2)			
2000.9(1)	$1,2^+$										79(8)				
2010.1(2)	$1,2^+$										15(3)	85(5)			
2024.7(2)	$1^+,2^+$										13(5)	11(5)			
2078.3(2)															
2093.9(7)	$[0^+]$			15.2	2.8				04Wi06						
2122.8(1)	$1,2^+$										61(3)	31(3)			
2133.2(2)															≤47
2150.5(6)	$[0^+]$			16.3	3.0				04Wi06						
2151.8(2)	$1,2^+$										4.7(12)	74(4)			
2175.1(6)	$[0^+]$			29.5	5.4				04Wi06						
2268.9(6)	$[0^+]$			35.5	6.4				04Wi06						

(continued) **$^{230}_{90}$Th**

E^*	J^π	L	$d\sigma/d\Omega$	σ (p,t)	S_N	σ (p,t)	R	σ (d,d′)	R	Ref.	Branching ratios in percentage				
											E_f^*: 0.0	53.2	174	357	508
[keV]		(p,t)	μb/sr	μb/sr	(p,t)	*rel.*	(p,t)	μb/sr	(d,d′)		J_f^π: 0^+	2^+	4^+	6^+	1^-
2282.8(5)	$1,2^+$										33(3)	26(5)			
2298.6(3)	$1,2^+$										64(10)	36(18)			
2313	17^-														
2314.3(2)	$1,2^+$										21(5)				
2368.9(2)															
2395.2(7)	$[0^+]$			5.4	0.9					04Wi06					
2397.8	18^+														
2493.8(7)	$[0^+]$			4.0	0.7					04Wi06					
2528.1(7)	$[0^+]$			29.1	4.9					04Wi06					
2706	19^-														
2850	20^+														
3125	$\langle 21^- \rangle$														
3325	22^+														
3812	$\langle 24^+ \rangle$														
5000(4)															
			72Ma15	04Wi06		74Ta04		75Th11	75Th11	Ref.					
					04Wi06		70Ma29			Ref.					

Additional data on this isotope can be found in [05Lo09, 04Ga03, 03HeZP, 99Am04, 96Ba67, 94Ac02].

* Absolute value of the (p,t) cross section for E_p=52 MeV at θ=6°–43.5° $2\pi\Sigma d\sigma/d\Omega sin\theta d\theta$ for 0^+ state was found to be 38.8(23) μb [74Ta04]; see therein the relative values for 2^+, 4^+ and 6^+ states.

The L and the first value σ (p,t) were obtained in measurements at 60° with E_p=17 MeV [72Ma15].

The second cross section σ (p,t) and relative S_N (in %) were measured at 7.5° with E_p=25 MeV [04Wi06]; the ratio R of the (p,t) reaction cross section to that of the ground state [70Ma29].

σ (d,d′) was measured at 90° and 125°, their ratio R (given in Supplement) was used for estimation of J^π in [75Th11].

Two bands built on the ground state (up to J^π=24^+) and on the 1^- state (up to J^π=23^-) are shown in [99Am04].

Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [93Ak02]. Part 2 **$^{230}_{90}$Th**

E^*	J^π	$T_{1/2}$ or	Ref.	Branching ratios in percentage								
				E_f^*: 571.77	594.1	634.9	677.6	686.7	781.37	825.8	852.4	879.7
[keV]		Γ_{cm}		J_f^π: 3^-	8^+	0^+	2^+	5^-	2^+	3^+	7^-	10^+
0.0	0^+	75380(300) yr	72Ma15									
53.20(2)	2^+	0.354(9) ns	72Ma15									
174.10(3)	4^+	0.166(5) ns	72Ma15									
356.6(5)	6^+		74Ta04									
508.16(5)	1^-		75Th11									
571.77(10)	3^-		75Th11									

(continued) **$^{230}_{90}$Th**

E^*	J^π	$T_{1/2}$ or	Ref.	Branching ratios in percentage								
				E_f^*:	571.77	594.1	634.9	677.6	686.7	781.37	825.8	852.4	879.7
[keV]		Γ_{cm}		J_f^π:	3^-	8^+	0^+	2^+	5^-	2^+	3^+	7^-	10^+
594.1(5)	8^+												
634.9(1)	0^+		04Wi06										
677.6(1)	2^+	6.1(19) ps	72Ma15										
686.7	5^-		75Th11		11(3)								
769.6	4^+												
781.37(5)	2^+	3.3(10) ps	72Ma15				x						
825.8(2)	3^+												
852.4(4)	7^-					22(2)			4(4)				
879.7	10^+					x							
883.6	4^+		75Th11					4.0(20)					
951.94(5)	1^-		75Th11		0.74(13)		0.40(7)	0.24(7)		x			
971.69(10)	2^-				6.5(3)			0.40(17)					
1009.7(1)	2^+	≥0.8 ps					1.3(4)	2.0(7)		<0.2	x		
1012.5(4)	3^-		72Ma15		17(5)								
1040.0	6^+												
1052.6(12)	3^+							x					
1065.6	9^-					67(7)						33(13)	
1079.3(1)	$\langle 2\rangle^-$				8(4)			0.9(2)		1.5(8)	0.8(3)		
1108.2	4^+												
1109.0	$\langle 5^-\rangle$		75Th11		x								
1127.9(1)	3^-		75Th11		15(2)			≈0.9		≤2.1	0.9		
1178.6	5^+												
1196.8	$\langle 4^-\rangle$												
1207.8	12^+												x
1251.4	8^+					62(23)							
1297.1(1)	$[0^+]$		04Wi06										
1321.9	11^-												x
1375.3(1)	$1,2^+$												
1400.9(1)	2^+												
1447.9(5)	$[0^+]$		04Wi06										
1485.6(1)					28(7)								
1520.4	10^+					56(23)							19(11)
1572.9	14^+												
1573.5(2)	$1^-,2^+$		75Th11										
1589.8(3)	0^+		72Ma15										
1617.5	13^-												
1628(2)			75Th11										
1638.5(2)	$[0^+]$		04Wi06										
1663(3)			75Th11										
1695.7(1)	$1^-,2^+$		75Th11										
1718(3)			75Th11										
1744.9(1)													
1770.7(1)	$1,2^+$												
1775.2(1)	$1,2^+$												
1789.4(5)	$1^{\langle-\rangle},2^+$		75Th11										

(continued) **$^{230}_{90}$Th**

E^* [keV]	J^π	$T_{1/2}$ or Γ_{cm}	Ref.	Branching ratios in percentage								
			E_f^*:	571.77	594.1	634.9	677.6	686.7	781.37	825.8	852.4	879.7
			J_f^π:	3^-	8^+	0^+	2^+	5^-	2^+	3^+	7^-	10^+
1802.5(6)	$[0^+]$		04Wi06									
1810.7(1)	$1,2^+$											
1839.6(2)	$1^{\langle-\rangle},2^+$		75Th11									
1849.6(1)	$\langle 2^+\rangle$											
1858.2(6)			75Th11									
1902.7(1)	$1,2^+$											
1949	15^-											
1949.8(1)	$1,2^+$											
1966.9(2)	$1,2^+$											
1971.5	16^+											
1973.4(2)	$\langle 1^+,2^+\rangle$									46(3)		
2000.9(1)	$1,2^+$											
2010.1(2)	$1,2^+$											
2024.7(2)	$1^+,2^+$									38(9)		
2078.3(2)										19(5)		
2093.9(7)	$[0^+]$		04Wi06									
2122.8(1)	$1,2^+$											
2133.2(2)							60(17)					
2150.5(6)	$[0^+]$		04Wi06									
2151.8(2)	$1,2^+$											
2175.1(6)	$[0^+]$		04Wi06									
2268.9(6)	$[0^+]$		04Wi06									
2282.8(5)	$1,2^+$											
2298.6(3)	$1,2^+$											
2313	17^-											
2314.3(2)	$1,2^+$						79(17)					
2368.9(2)				45(9)								
2395.2(7)	$[0^+]$		04Wi06									
2397.8	18^+											
2493.8(7)	$[0^+]$		04Wi06									
2528.1(7)	$[0^+]$		04Wi06									
2706	19^-											
2850	20^+											
3125	$\langle 21^-\rangle$											
3325	22^+											
3812	$\langle 24^+\rangle$											
5000(4)												
		$T_{1/2}$ 75Th11	Ref.									
		Γ_{cm}	Ref.									

Energy levels and branching ratios [93Ak02]. Part 3 **$^{230}_{90}$Th**

E^*	J^π		Branching ratios in percentage									
		E_f^*:	951.94	971.69	1009.7	1065.6	1079.26	1207.8	1321.9	1400.9	1485.6	1572.9
[keV]		J_f^π:	1^-	2^-	2^+	9^-	$\langle 2\rangle^-$	12^+	11^-	2^+		14^+
1127.9(1)	3^-		x									
1321.9	11^-					x						
1375.3(1)	$1,2^+$		3.6(7)									
1400.9(1)	2^+		3.4(7)									
1520.4	10^+							25(8)				
1572.9	14^+							x				
1617.5	13^-							x	x			
1638.5(2)	$[0^+]$				58(6)							
1744.9(1)					14(3)							
1849.6(1)	$\langle 2^+\rangle$			21(2)	47(4)						11(4)	
1949	15^-											x
1971.5	16^+											x
2000.9(1)	$1,2^+$				21(6)							
2024.7(2)	$1^+,2^+$			38(9)								
2078.3(2)					19(8)		62(12)					
2122.8(1)	$1,2^+$						8(3)					
2151.8(2)	$1,2^+$									21(4)		
2282.8(5)	$1,2^+$			42(10)								
2368.9(2)										55(23)		

Energy levels and branching ratios [93Ak02]. Part 4 **$^{230}_{90}$Th**

E^*	J^π		Branching ratios in percentage									
		E_f^*:	1617.5	1744.9	1810.7	1949	1971.5	2313	2397.8	2706	2850	3325
[keV]		J_f^π:	13^-		$1,2^+$	15^-	16^+	17^-	18^+	19^-	20^+	22^+
1949	15^-		x									
2133.2(2)				40(4)								
2313	17^-					x						
2314.3(2)	$1,2^+$				x							
2397.8	18^+						x					
2706	19^-							x				
2850	20^+								x			
3125	$\langle 21^-\rangle$									x		
3325	22^+										x	
3812	$\langle 24^+\rangle$											x

Energy levels and branching ratios [01Br31].

$^{231}_{90}$Th

E^* [keV]	$2J^\pi$	Nils.Conf. $2J, 2K[Nn_z\Lambda]$	σ (d,p) μb/sr	σ (d,p) μb/sr	σ (τ,α) μb/sr	S_N (τ,α)	L (τ,α)	S_N (d,t)	σ (d,t) μb/sr	σ (d,t) μb/sr	$T_{1/2}$ or Γ_{cm}	Ref.
0.0	5^+	5,5+[633]						0.0009(2)	3	7	25.52(1) h	72Gr19
41.952(2)	7^+	7,5+[633]	32		1.3(6)	0.13	3=7	0.027(4)	28	33		72Er03
96.129(3)	9^+	9,5+[633]	19	8**	2.4(6)	0.18		0.008(1)	21	25		72Er03
161.94(4)	11^+	11,5+[633]	32	18	13.7(13)	1.29	6,7	0.108(14)	29	40		72Er03
185.714(2)	5^-	5,5–[752]		13					3		0.77(12) ns	72Gr19
205.309(2)	$\langle 7^-\rangle$	7,5–[752]		≈4								87Wh01
221.398(2)	3^+	3,3+[631]		≈8						7	<74 ps	87Wh01
236.893(14)	9^-				5.1(13)		3=6					69El03
240.881(2)	5^+	5,3+[631]	136	51	incl			0.072(8)	180	222		72Er03
247.583(2)	1^+	1,1+[631]		115							<74 ps	87Wh01
272.180(2)	3^+	3,1+[631]	187	213					116	142		72Gr19
275.425(2)	7^+											
277.8(2)	$\langle 11^-\rangle$	11,5–[752]		39	4.1(9)		$\langle 5,6\rangle$		34			72Gr19
301.744(2)	5^+	5,1+[631]	28	21						19		87Wh01
317.082(2)	5^+	5,5+[622]		24								87Wh01
324.913(7)	$\langle 9\rangle^+$	9,3+[631]	265	290	24.2(19)		5.6	0.196(16)	273	290		72Er03
334(2)	$\langle 13^-\rangle$	13,5–[752]		84								87Wh01
351.511(6)	7^+	7,1+[631]	38	28					6	29		72Gr19
377.577(8)	$\langle 7\rangle^+$	7,5+[622]		13					12			72Gr19
385.69(5)	$\langle 11^+\rangle$											
387.827(2)	7^-											
402(2)	$\langle 15^-\rangle$	15,5–[752]	35	39	52.7(27)		7***		43	56		72Gr19
449(1)	$\langle 9^+\rangle$	9,5+[622]		160					7			72Gr19
452.18(2)	9^-											
465(2)			21	22	5.8(21)				27	43		72Gr19
490(3)	$\langle 11^+\rangle$	11,1+[631]		11					6			72Gr19
510.897(10)	5^+–9^+											
530(3)	$\langle 11^+\rangle$			12								87Wh01
530.4(1)	$\langle 11^-\rangle$											
554.651(2)	$\langle 1\rangle^-$	1,1–[501]	41	45				0.409(35)	572	659	503(12) ps	72Er03
568(3)				17								87Wh01
579(1)	$\langle 9^+\rangle$	9,7+[624]		146	7.9(13)		4=7		25			72Gr19
590.838(2)	3^-		19	35					186	246		72Gr19
593.617(2)	3^-								incl		98(35) ps	99Aa03
595.974(2)	5^-											
619.638(4)	3^-								74	101		72Gr19
623.937(18)	5^-			16					30	30		72Gr19
629.342(2)	$\langle 5\rangle^-$									incl		
634.044(13)	$\langle 7^-\rangle$								36			72Gr19
655.981(25)	7^-	7,3–[761]		13	3.2(8)				incl	58		87Wh01
684.490(2)	5^-,7^-	5,5–[503]		20					57	112		72Gr19
687.631(3)	1^+											
704(2)	$\langle 15^-\rangle$	15,7–[743]		19					9			72Gr19
709.099(4)	3^+											
713.753(2)	3^-								21	48		72Gr19

(continued) **$^{231}_{90}$Th**

E^* [keV]	$2J^\pi$	Nils.Conf. $2J, 2K[Nn_z\Lambda]$	σ (d,p) μb/sr	σ (d,p) μb/sr	σ (τ,α) μb/sr	S_N (τ,α)	L (τ,α)	S_N (d,t)	σ (d,t) μb/sr	σ (d,t) μb/sr	$T_{1/2}$ or Γ_{cm}	Ref.
720.298(5)	$\langle 7\rangle^-$	7,1–[770]		9						incl		87Wh01
735.263(6)	$\langle 5\rangle^+$											
745(3)				13	2.4(8)				18			72Gr19
752(2)							5=7					69El03
764*									13			72Gr19
793.026(4)	1^+											
808.507(8)	3^+			36					276	358		72Gr19
813(3)	$[15^-]$			17	11.6(13)		[3]			incl		87Wh01
820.544(7)	1^+											
833.168(4)	$\langle 1\rangle^-$								17	34		72Gr19
839.304(8)	3^+			15					11	incl		72Gr19
867.03(4)	5^-,7^-			44					422	35		72Gr19
871(3)	$\langle 9\rangle^+$				10.9(19)		4		incl			69El03
875.549(4)	$\langle 3\rangle^-$			25					incl	507		87Wh01
889.998(12)	5^+			18					94	117		72Gr19
914.904(40)	$\langle 5\rangle^-$				6.6(19)		4.5		32	61		72Gr19
936.305(10)	$\langle 5\rangle^-$			15					8			72Gr19
960.807(11)	3^+			21					8			72Gr19
967(5)	$\langle 9^+\rangle$				3.9(9)				34	62		72Gr19
984*				9					9			72Gr19
1004.236(20)	3^+			26			$\langle 4\rangle$		33	53		72Gr19
1020.728(5)	3^-			43					15	38		72Gr19
1056.30(3)	$\langle 3^+\rangle$			71						[28]		87Wh01
1066.19(2)	5^+,7^+			47								87Wh01
1074.35(2)	$\langle 3\rangle^-$								55			72Gr19
1081.33(2)	1^-,3^-											
1086.812(10)	5^+			11					10			72Gr19
1102.25(1)	3^-			54	4.5(17)							87Wh01
1114(3)				19	incl							87Wh01
1133.81(8)	1^+,3^+								14			72Gr19
1159.750(7)	$\langle 3\rangle^-$			32								87Wh01
1173.00(2)	3^-			25	$\langle 6.2\rangle$				[31]			72Gr19
1202				73								87Wh01
1213				84								87Wh01
1227				78								87Wh01
1282				65								87Wh01
1329				37								87Wh01
1339				129								87Wh01
1350				107					15	30		72Gr19
1366				43								87Wh01
1376				24								87Wh01
1390				48					76	90		72Gr19
1404				126					27	53		72Gr19
1414				59								87Wh01
1429*									110	162		72Gr19

(continued) **$^{231}_{90}$Th**

E^*	$2J^\pi$	Nils.Conf.	σ (d,p)	σ (d,p)	σ (τ,α)	S_N	L	S_N	σ (d,t)	σ (d,t)	$T_{1/2}$ or	Ref.
[keV]		$2J, 2K[Nn_z\Lambda]$	μb/sr	μb/sr	μb/sr	(τ,α)	(τ,α)	(d,t)	μb/sr	μb/sr	Γ_{cm}	
1443*									22	32		72Gr19
1469					⟨5.4⟩				27	41		69El03
1481*									25	58		72Gr19
1564*									62			72Gr19
1574(3)					6.9(11)		≥2		[36]			69El03
1613*									[33]			72Gr19
1642*									[30]			72Gr19
1675(1)	⟨15$^-$⟩				38.3(47)		6,7***					69El03
		87Wh01	77Wi07	87Wh01	69El03	69El03	69El03	72Er03	72Gr19	77Wi07	99Aa03	Ref.

Additional data on this isotope can be found in [99Aa03, 65Br22, 79Vo03, 70Bo31].
* From the (d,t) cross section measurement at 125° [72Gr19], not included in [01Br31].
** Given here σ (d,p) were measured at 80° in [77Wi07] and at 50° in [87Wh01], respectively.
*** Modified in [01Br31], σ (τ,α) were measured at 5 angles [69El03], here – data for 60°.
Presented data on σ (d,t) cross section (neutron pickup) correspond to measurements at 125° [72Gr19]; the second cross section was measured at 80° [77Wi07]; data on the deuteron stripping [87Wh01] correspond to measurements at 50° (see data for 14 angles therein).
10 bands (including 3 probable ones) were assigned to levels of this nucleus in [87Wh01].
Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [01Br31]. Part 2 **$^{231}_{90}$Th**

E^*	$2J^\pi$		Branching ratios in percentage									
		E^*_f:	0.0	41.9	96.1	162	186	205.3	221.398	236.893	240.881	247.583
[keV]		$2J^\pi_f$:	5$^+$	7$^+$	9$^+$	11$^+$	5$^-$	⟨7$^-$⟩	3$^+$	9$^-$	5$^+$	1$^+$
41.952(2)	7$^+$		100									
96.129(3)	9$^+$		100	≤35								
161.94(4)	11$^+$			100								
185.714(2)	5$^-$		83.9(6)	16.08(15)								
205.309(2)	⟨7$^-$⟩		43	44	13		x					
221.398(2)	3$^+$		100									
236.893(14)	9$^-$			67(1)	23(2)	7(1)	2(1)	1(1)				
240.881(2)	5$^+$		61(4)	39(4)								
247.583(2)	1$^+$		100									
272.180(2)	3$^+$		95(14)	5.2(11)								
275.425(2)	7$^+$		15(3)	61(9)	24(4)							
277.8(2)	⟨11$^-$⟩					≈32		54		≈14		
301.744(2)	5$^+$		53(9)	19(3)					27(4)			
317.082(2)	5$^+$		3.7(8)	80(13)							16(2)	
324.913(7)	⟨9⟩$^+$			38(15)	61.7							
351.511(6)	7$^+$		26(5)	41(9)	33(7)							
377.577(8)	⟨7⟩$^+$				≈25			≈34			41	
385.69(5)	⟨11$^+$⟩			≈19	81							

(continued) **$^{231}_{90}$Th**

E^*	$2J^\pi$		Branching ratios in percentage									
		E_f^*:	0.0	41.9	96.1	162	186	205.3	221.398	236.893	240.881	247.583
[keV]		$2J_f^\pi$:	5^+	7^+	9^+	11^+	5^-	$\langle 7^- \rangle$	3^+	9^-	5^+	1^+
387.827(2)	7^-		2.3(3)	2.3(3)	2.5(3)		67(1)	21(2)		4.7(6)		
452.18(2)	9^-			≈3	≈4	x	5(1)	47(14)		24(3)		
510.897(10)	5^+–9^+			100								
554.651(2)	$\langle 1 \rangle^-$		1.8(3)	0.5(1)			17.6(3)					35.2(4)
590.838(2)	3^-						78(12)	20(3)				
593.617(2)	3^-						59(9)	4.0(13)	28(5)			9(2)
595.974(2)	5^-						12(3)	27(5)	10(2)			
619.638(4)	3^-						58(9)		22(5)			
623.937(18)	5^-						x	100				
629.342(2)	$\langle 5 \rangle^-$		6.5(10)				68(10)	26(5)				
634.044(13)	$\langle 7^- \rangle$						47(3)	53(12)				
655.981(25)	7^-						42(11)			58(13)		
684.490(2)	5^-,7^-						91(15)	8.8(15)				
687.631(3)	1^+		47(7)						38(6)			9(1)
709.099(4)	3^+								12(3)		16(4)	
713.753(2)	3^-						78(12)					
720.298(5)	$\langle 7 \rangle^-$						11(3)	75(11)				
735.263(6)	$\langle 5 \rangle^+$											19(4)
793.026(4)	1^+		21(4)									<4.484
808.507(8)	3^+		19(1)	8(2)					16(3)			11(2)
820.544(7)	1^+		21(5)						12(3)			56(10)
833.168(4)	$\langle 1 \rangle^-$								15(3)			18(3)
839.304(8)	3^+		30(5)	14(3)					10(2)			
867.03(4)	5^-,7^-						35(6)			22(5)		
875.549(4)	$\langle 3 \rangle^-$		48(8)									
889.998(12)	5^+								19(4)		35(6)	
914.904(40)	$\langle 5 \rangle^-$		47(8)				26(4)			10(3)	16(7)	
936.305(10)	$\langle 5 \rangle^-$		36(7)				36(7)					
960.807(11)	3^+			13(2)			7(2)		18(3)		5(1)	26(4)
1004.236(20)	3^+										75(14)	
1020.728(5)	3^-						33(5)		22(4)			11(3)
1056.30(3)	$\langle 3^+ \rangle$			55(11)					19(3)			13(2)
1066.19(2)	5^+,7^+		17(6)	15(5)					9(2)			
1074.35(2)	$\langle 3 \rangle^-$						39(8)					
1102.25(1)	3^-										11(3)	
1133.81(8)	1^+,3^+											34(8)
1159.750(7)	$\langle 3 \rangle^-$						20(7)				33(6)	

Energy levels and branching ratios [01Br31]. Part 3 **$^{231}_{90}$Th**

E^*	$2J^\pi$					Branching ratios in percentage						
		E_f^*:	272.180	275.425	301.744	317.082	351.511	377.577	387.827	554.651	590.838	593.617
[keV]		$2J_f^\pi$:	3^+	7^+	5^+	5^+	7^+	$\langle 7\rangle^+$	7^-	$\langle 1\rangle^-$	3^-	$\langle 3\rangle^-$
452.18(2)	9^-								≈16			
530.4(1)	$\langle 11^-\rangle$								100			
554.651(2)	$\langle 1\rangle^-$		45(1)									
590.838(2)	3^-				2.3(5)							
595.974(2)	5^-		43(6)				8(2)					
619.638(4)	3^-				4.5(9)	16(3)						
687.631(3)	1^+		5.7(9)									
709.099(4)	3^+		61(9)			10(2)						
713.753(2)	3^-		3.9(8)						19(4)			
720.298(5)	$\langle 7\rangle^-$			12(3)	1.9(4)							
735.263(6)	$\langle 5\rangle^+$		35(8)		46(8)							
793.026(4)	1^+		18(3)		61(9)							
808.507(8)	3^+		15(3)		9(2)		21(4)					
820.544(7)	1^+					11(3)						
833.168(4)	$\langle 1\rangle^-$									4.4(9)		63(9)
839.304(8)	3^+		21(4)			19(3)				6(2)		
867.03(4)	5^-,7^-								43(7)			
875.549(4)	$\langle 3\rangle^-$									40(6)		
889.998(12)	5^+			46(7)								
936.305(10)	$\langle 5\rangle^-$					10.7(3)			13(2)			3.9(8)
960.807(11)	3^+		22(4)		5(1)	5(1)						
1004.236(20)	3^+							25(6)				
1020.728(5)	3^-											25(4)
1056.30(3)	$\langle 3^+\rangle$		14(3)									
1066.19(2)	5^+,7^+					21(3)		37(7)				
1074.35(2)	$\langle 3\rangle^-$					27(7)					34(8)	
1081.33(2)	1^-,3^-									22(5)	39(8)	39(8)
1086.812(10)	5^+		12(2)	31(5)	9(1)			45(7)				4.0(8)
1102.25(1)	3^-					27(5)						
1133.81(8)	1^+,3^+		25(6)			41(9)						
1173.00(2)	3^-								51(9)			

Energy levels and branching ratios [01Br31]. Part 4 **$^{231}_{90}$Th**

E^*	$2J^\pi$			Branching ratios in percentage			
		E_f^*:	619.638	629.342	634.044	684.490	713.753
[keV]		$2J_f^\pi$:	3^-	$\langle 5\rangle^-$	$\langle 7^-\rangle$	5^-,7^-	3^-
875.549(4)	$\langle 3\rangle^-$		12(2)				
1020.728(5)	3^-					10(2)	
1102.25(1)	3^-		7(2)		19(4)	14(3)	22(4)
1159.750(7)	$\langle 3\rangle^-$						47(7)
1173.00(2)	3^-			16(4)		11(3)	22(7)

Energy levels and branching ratios [91Sc08].

$^{232}_{90}$Th

E^*	J^π	σ (t,p)	σ (d,d′)	$\Gamma_\circ$	$B(M1)$	$T_{1/2}$ or	Ref.	Branching ratios in percentage				
								E_f^*:	0	49.4	162	333	557
[keV]		arb.u	μb/sr	[meV]	[μ_N^2]	Γ_{cm}		J_f^π:	0^+	2^+	4^+	6^+	8^+
0	0^+	73	8330			$1.405(6)\cdot10^{10}$ yr	73Ba72						
49.369(9)	2^+	25	1948			345(15) ps	73Ba72		100				
162.12(2)	4^+	7	233			164(13) ps	73Ba72			100			
333.2(2)	6^+		36			63(4) ps	72El08				100		
556.9(3)	8^+		4			24(1) ps	72El08					100	
714.25(10)	1^-		24				72El08		14(2)	86(2)			
730.35(15)	0^+	<2	5				72El08		x	100			
774.1(2)	2^+	13	105			5.8(23) ps	73Ba72		69	≈1.2	≈30		
774.4(2)	3^-		incl				93Mc07			≈7	93		
785.3(2)	2^+		43			2.7(2) ps	72El08		36(3)	64(3)	≈0.5		
827.0(4)	10^+					10.4(6) ps							100
829.6(2)	$\langle 3^+\rangle$									80(5)	20(5)		
873.0(2)	4^+									45(15)		55	
883.6(3)	5^-		22				72El08				1.8(14)	98	
890.1(2)	4^+									15(3)	81(3)	4.1(13)	
960.4(2)	$\langle 5^+\rangle$										66(3)	34(3)	
1023.1(6)	6^+										63	x	37(6)
1042.9(5)	7^-											0.6(6)	99
1049.9(6)	6^+										[65]	x	>35
1053.6(2)	$\langle 2^+\rangle$		3				72El08		44(5)	56(3)			
1072.9(3)	2^+									100			
1077.5(2)	$\langle 1^-\rangle$	12	4				73Ba72		100				
1078.7(2)	$\langle 0^+\rangle$									100			
1094.4(2)	$[2^+]$						93Mc07			56(4)	44(4)		
1105.7(2)	3^-		81				72El08			64(6)	8(2)		
1121.8(2)	$\langle 2^+\rangle$								4(2)	71(3)	25(3)		
1137.1(5)	12^+					5.5(4) ps							
1143.3(2)	$\langle 4^-\rangle$		7				72El08				100		
1146.0(10)	$\langle 7^+\rangle$		incl									x	
1148.3(2)	$\langle 4^+\rangle$		incl								68(12)	32(12)	
1182.5(2)	3^-		5				72El08			77(3)	23(3)		
1208.9(3)	$\langle 5^-\rangle$		11				72El08				100		
1218.1(10)	$\langle 4–6\rangle$											100	
1222.1(8)	8^+											x	
1249.6(5)	9^-												
1258.7(10)	$\langle 8^+\rangle$												
1293.2(10)	$[5^-]$		3				93Mc07			100			
1322.3	$[2^+]$						93Mc07						
1329.4(2)	$[2^+]$		2				93Mc07				100		
1370	$\langle 9^+\rangle$												
1387.2(2)	2^+					1.4(2) ps			17(4)	32(2)	51(8)		
1414(5)	$\langle 4^+\rangle$												
1419(2)			3				72El08						
1450.3(2)										x			
1469.3	$\langle 10^+\rangle$												x

(continued) **$^{232}_{90}$Th**

E^*	J^π	σ (t,p)	σ (d,d′)	$\Gamma_\circ$	$B(M1)$	$T_{1/2}$ or	Ref.	Branching ratios in percentage				
								E_f^*:	0	49.4	162	333	557
[keV]		arb.u	μb/sr	[meV]	[μ_N^2]	Γ_{cm}		J_f^π:	0^+	2^+	4^+	6^+	8^+
1477.0	[2^+]						93Mc07						
1480.1(2)			14				72El08			100			
1482.8(7)	14^+		incl			3.1(2) ps							
1484.9(2)	$\langle 5^- \rangle$		incl								100	x	
1489.3(2)	$\langle 1,2^+ \rangle$		incl						47(7)	53(7)			
1490	$\langle 5^+ \rangle$												
1498.8(6)	11^-												
1511.9	$\langle 10^+ \rangle$												
1519.7(2)										100			
1554.2(2)	2^+					95(10) fs			23(7)	61(3)	16(6)		
1561.5(2)	$\langle 1,2^+ \rangle$		12				72El08		100				
1573.0(2)	$\langle 1,2^+ \rangle$								69(12)	31(12)			
1573	$\langle 6^+ \rangle$												
1578.5(4)	$\langle 2^+ \rangle$								33(6)	31(6)	36(6)		
1609.1(5)											100		
1618.0(7)			3				72El08			100			
1640	$\langle 11^+ \rangle$												
1647.6(8)											100		
1690.9(10)			4				72El08			100			
1727.3(8)									38(12)	62			
1738.1(10)	$\langle 1,2^+ \rangle$		7				72El08		100				
1755.0	$\langle 12^+ \rangle$												
1780	$\langle 7^+ \rangle$												
1784.8(7)	13^-												
1791(2)			10				72El08						
1801.2	$\langle 12^+ \rangle$												
1858.6(7)	16^+					2.1(2) ps							
2043(1)*	1^+			49(3)	1.48(9)	77(5) meV	88He02		65	35(1)			
2080.3	$\langle 14^+ \rangle$												
2101.7(7)	15^-												
≈2117.3	$\langle 14^+ \rangle$												
2248(2)	1^+			24(3)	0.56(7)	37(5) meV	88He02		70	30(5)			
2262.9(8)	18^+					1.3(2) ps							
2274(5)	1^+			10.3(14)	0.24(3)	17(3) meV	88He02		62	38(8)			
2296(5)	1^+			14(3)	0.31(6)	25(8) meV	88He02		59	41(17)			
2440.7	$\langle 16^+ \rangle$												
2445.4(9)	17^-												
2445.7	$\langle 16^+ \rangle$												
2691.5(9)	20^+					1.2(2) ps							
2766.6	$\langle 18^+ \rangle$												
2813.2(14)	19^-												
2831.6	$\langle 18^+ \rangle$												
3144.2(10)	22^+					0.8(2) ps							
3203.8(17)	21^-												
3249	$\langle 20^+ \rangle$												

(continued) **$^{232}_{90}$Th**

E^*	J^π	σ (t,p)	σ (d,d′)	$\Gamma_\circ$	$B(M1)$	$T_{1/2}$ or	Ref.	Branching ratios in percentage					
								E_f^*:	0	49.4	162	333	557
[keV]		arb.u	μb/sr	[meV]	[μ_N^2]	Γ_{cm}		J_f^π:	0^+	2^+	4^+	6^+	8^+
3616.4(20)	23^-												
3619.6(14)	24^+					1.1(3) ps							
4050.2(22)	25^-												
4116.2(18)	26^+					0.6(2) ps							
4506(3)	$\langle 27^- \rangle$												
4631.8(20)	$\langle 28^+ \rangle$					≈0.25 ps							
5162(3)	$\langle 30^+ \rangle$												
		73Ba72	72El08	88He02	88He02		Ref.						

Additional data on this isotope can be found in [04Ga03, 00Ma97, 00Gu22, 93Ko42, 72Ca19, 72Va20].

Abundance: 100 %.

* The ratio Γ_o^2/Γ=30.5(17) meV for these levels was obtained by nuclear resonance fluorescence (NRF) method [90He03]; less prominent effects were noticed at 2248, 2274 and 2296 keV; parameters $B(M1)$ for these levels are given in Supplement.

σ (d,d′) [72El08] were measured at 90° and 125°, data from the second set are given here.

Two bands built on the ground state (up to J^π=30^+) and on the 1^- state (up to J^π=27^-) are shown in [00Gu22].

Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [91Sc08]. Part 2 **$^{232}_{90}$Th**

E^*	J^π											
		E_f^*:	774	785.3	827.0	829.6	883.6	890.1	1042.9	1137.1	1249.6	1482.8
[keV]		J_f^π:	2^+	2^+	10^+	$\langle 3^+ \rangle$	5^-	4^+	7^-	12^+	9^-	14^+
1042.9(5)	7^-						x					
1105.7(2)	3^-		28(6)									
1137.1(5)	12^+				100							
1222.1(8)	8^+				x							
1249.6(5)	9^-				x				x			
1414(5)	$\langle 4^+ \rangle$			x		x		x				
1482.8(7)	14^+									100		
1498.8(6)	11^-									x	x	
1573	$\langle 6^+ \rangle$							100				
1784.8(7)	13^-											x
1858.6(7)	16^+											100

Energy levels and branching ratios [91Sc08]. Part 3 **$^{232}_{90}$Th**

E^*	J^π					Branching ratios in percentage					
		E_f^*:	1498.8	1784.8	1858.6	2101.7	2262.9	2445.4	2691.5	2813.2	3144.2	3203.8
[keV]		J_f^π:	11^-	13^-	16^+	15^-	18^+	17^-	20^+	19^-	22^+	21^-
1784.8(7)	13^-		x									
2101.7(7)	15^-			x	x							
2262.9(8)	18^+				100							
2445.4(9)	17^-					100						
2691.5(9)	20^+						100					
2813.2(14)	19^-							100				
3144.2(10)	22^+								100			
3203.8(17)	21^-									100		
3616.4(20)	23^-											100
3619.6(14)	24^+										100	

Energy levels and branching ratios [91Sc08]. Part 4 **$^{232}_{90}$Th**

E^*	J^π			Branching ratios in percentage			
		E_f^*:	3616.4	3619.6	4050.2	4116.2	4631.8
[keV]		J_f^π:	23^-	24^+	25^-	26^+	$\langle 28^+ \rangle$
4050.2(22)	25^-		100				
4116.2(18)	26^+			100			
4506(3)	$\langle 27^- \rangle$				100		
4631.8(20)	$\langle 28^+ \rangle$					100	
5162(3)	$\langle 30^+ \rangle$						100

Energy levels and branching ratios [90Ak02, 05Si0A]. **$^{233}_{90}$Th**

E^*	$2J^\pi$	σ (d,p)	S_N	σ (d,p)	S_N	$T_{1/2}$ or	Ref.
[keV]		μb/sr	(d,p)	μb/sr	(d,p)	Γ_{cm}	
0.0[k]	1^+	59	0.052**	47	0.060(9)	21.83(4) m	72Er03
0+x[m]	$\langle 9^- \rangle$						05Si0A
6.04(2)[a]	$\langle 5 \rangle^+$		<0.01	<20			72Vo08
6.06[l]	$\langle 7 \rangle^-$						79Je01
16.86[n]	3^+	87	0.081	98	0.129(10)		72Er03
50.38(2)[a]	$\langle 7 \rangle^+$		<0.005	<4			72Vo08
54.546[k]	5^+	4	0.0022	4	0.003(1)		72Er03
93.62[n]	7^+	9	0.14	13	0.033(6)		72Er03
107.34(2)[a]	$\langle 9^+ \rangle$	128	0.112	128	0.155(15)		72Er03
143.2+x[m]	$\langle 13^- \rangle$						05Si0A
144.1[l]	$\langle 11^- \rangle$						05Si0A
158.0[k]	$\langle 9^+ \rangle$	60	0.050	59	0.060(7)		72Er03

(continued) **$^{233}_{90}$Th**

E^* [keV]	$2J^\pi$	σ (d,p) μb/sr	S_N (d,p)	σ (d,p) μb/sr	S_N (d,p)	$T_{1/2}$ or Γ_{cm}	Ref.
178(2)	$\langle 11^+ \rangle$	5	0.020	6			72Vo08
220[n]	$\langle 11^+ \rangle$	14	0.047	11			72Vo08
252.3(5)	$\langle 15^- \rangle$	32	$\langle 0.18 \rangle$	$\langle 30 \rangle$	0.178(30)		72Er03
262.24(2)[b]	$\langle 5 \rangle^+$						79Je01
279.40(2)[c]	$\langle 7 \rangle^+$	14	0.011	11			72Gr19
309.5(20)	$\langle 1,3 \rangle$						
313.2[k]	$\langle 13^+ \rangle$	16					72Gr19
318.7[l]	$\langle 15^- \rangle$						05Si0A
326.0(10)[c]	$\langle 9^+ \rangle$	99	0.070	87	0.104(10)		72Er03
334.3+x[m]	$\langle 17^- \rangle$						05Si0A
335.928(3)[d]	3^+		0.0035	5			72Vo08
337.35(6)	$\langle 5,7 \rangle^+$						79Je01
371.17(2)[d]	$\langle 5 \rangle^+$	21	0.0106	23			72Gr19
388.5(10)[c]	$\langle 11^+ \rangle$	9	$\langle 0.04 \rangle$	$\langle 10 \rangle$			72Gr19
388.5(10)[b]	$\langle 9^+ \rangle$		$\langle 0.008 \rangle$	incl			72Vo08
405.8(20)	$1,3,5^+$						
410.0(15)		14					72Gr19
413.8(20)	$\langle 1,3 \rangle$						
421.15(2)[d]	$\langle 7 \rangle^+$		<0.005	<5			72Vo08
443(5)		4					72Gr19
464(3)[b]	$\langle 11^+ \rangle$		0.024	6			72Vo08
478.36(17)[e]	$\langle 5 \rangle^-$	13					72Gr19
480.9(10)[d]	$\langle 9^+ \rangle$	incl	0.014	19			72Vo08
515.7[k]	$\langle 17^+ \rangle$	4					72Gr19
538.1[l]	$\langle 19^- \rangle$						05Si0A
539.61(2)[f]	$\langle 1 \rangle^-$	25	$\langle 0.03 \rangle$	$\langle 28 \rangle$			72Gr19
570.6+x[m]	$\langle 21^- \rangle$						05Si0A
572.70(3)[g]	$\langle 3 \rangle^-$						79Je01
583.932(8)[h]	$\langle 1 \rangle^+$	37	$\langle 0.03 \rangle$	$\langle 49 \rangle$			72Gr19
586.135(9)[f]	3^-						79Je01
599.29(6)	$\langle 5^- \rangle$						79Je01
611.476(12)[h]	$\langle 3 \rangle^+$						79Je01
628.97(2)[h]	$\langle 5 \rangle^+$	52					72Gr19
632.8(20)	$1–5^+$						
645.5(20)	1,3						
681.846(19)	$\langle 1 \rangle^-$	50					72Gr19
682.11(3)	$\langle 3^- \rangle$	incl					79Je01
691.2(15)							
695.6(20)	$1–5^+$						
711.19(18)[i]	$\langle 5 \rangle^+$						79Je01
713.72[j]	1^+						79Je01
721.84(5)[f]	3^+	39					72Gr19
725.8(10)							
741.32(4)	$\langle 3 \rangle^-$						79Je01
749.9(20)	1,3	17					72Gr19

(continued) **$^{233}_{90}$Th**

E^* [keV]	$2J^\pi$	σ (d,p) μb/sr	S_N (d,p)	σ (d,p) μb/sr	S_N (d,p)	$T_{1/2}$ or Γ_{cm}	Ref.
753.98(5)[i]	$\langle 7\rangle^+$						79Je01
761.7[k]	$\langle 21^+\rangle$						05Si0A
768.18(2)	$1^+,3^+$	20					72Gr19
769.60[j]	5^+	incl					79Je01
783.64(8)	$1^+,3^+$	7					72Gr19
796(3)							
797.8[l]	$\langle 23^-\rangle$						05Si0A
803.41(6)	$\langle 5\rangle^+$						79Je01
814.74(13)	3^+	23					72Gr19
830.5(20)	$\langle 1,3\rangle$						
839.66(8)	$\langle 3^-\rangle$						
842.26(9)	$\langle 1,3\rangle^+$	71					72Gr19
846(3)							
848.6+x[m]	$\langle 25^-\rangle$						05Si0A
852.28(17)	1^+–5^+						79Je01
861.54(11)	$1^+,3^+$						79Je01
873.7(15)	$1,3,5^+$	32					72Gr19
884.94(8)	1^+–5^+	46					72Gr19
891.4(2)	1,3						
900(3)							
904.6(5)	$\langle 1^+,3^+\rangle$						
918.0(10)	$\langle 1^-,3^-\rangle$	48					72Gr19
924.58(20)	$\langle 3\rangle^-$						79Je01
947.2(4)	$\langle 3^-\rangle$	28					72Gr19
954(4)							
957.5(15)	$\langle 5^+\rangle$						
968.1(2)	$\langle 1,3\rangle^+$	20					72Gr19
973(4)							
984.2(8)	$\langle 1^+,3^+\rangle$						
991(3)		35					72Gr19
1013.1(3)	$1^-,3^-$						
1026(3)		77					72Gr19
1031.6(2)	$1^-,3^-$						
1040.0(3)	$\langle 1,3\rangle$						
1046(4)		30					72Gr19
1047.3[k]	$\langle 25^+\rangle$						05Si0A
1051.5(5)	$\langle 3\rangle^-$						
1061.43(15)	$\langle 1^+,3^+\rangle$						
1074.0(6)	$\langle 1^-,3^-\rangle$	15					72Gr19
1087.4(5)	$\langle 1,3\rangle$						
1094.6[l]	$\langle 27^-\rangle$						05Si0A
1101.7(7)	$\langle 1^+,3^+\rangle$	173					72Gr19
1115.3(7)	$\langle 1^+,3^+\rangle$						
1125*		58					72Gr19
1132.11(9)	$\langle 3\rangle^+$						

(continued) **$^{233}_{90}$Th**

E^* [keV]	$2J^\pi$	σ (d,p) μb/sr	S_N (d,p)	σ (d,p) μb/sr	S_N (d,p)	$T_{1/2}$ or Γ_{cm}	Ref.
1151.72(22)	$\langle 3,5\rangle^+$	81					72Gr19
1164(4)							
1164.5+x^m	$\langle 29^-\rangle$						05Si0A
1171.2(10)	3^-	61					72Gr19
1182.8(6)	$1,3,5^+$						
1185.5(4)	$\langle 3^+\rangle$						
1212.5(12)	$1,3,5^+$	33					72Gr19
1219(5)							
1225.7(7)	$\langle 1^+,3^+\rangle$						
1238.2(6)	$1,3,5^+$						
1256.7(6)	$1^-,3^-$	122					72Gr19
1259.4(5)	1,3						
1262.8(6)	1,3						
1276.8(5)	$1,3,5^+$						
1282.9(6)	1,3	70					72Gr19
1293.4(4)	$1^-,3^-$						
1304.8(6)	$\langle 1^+,3^+\rangle$	61					72Gr19
1313.41(8)	$\langle 3\rangle^-$						
1324.7(4)	$1–5^+$	40					72Gr19
1330.2(6)	$\langle 1,3\rangle$						
1338.1(6)	$1^-,3^-$	45					72Gr19
1344(5)							
1350.7(2)	$\langle 3\rangle^-$						
1367(5)		24					72Gr19
1370.1^k	$\langle 29^+\rangle$						05Si0A
1388.5(10)	$\langle 1^-,3^-\rangle$	58					72Gr19
1395.2(4)	1,3	29					72Gr19
1402(5)							
1408.4(3)	1,3						
1422.6(4)	$1,3,5^+$	47					72Gr19
1425.1^l	$\langle 31^-\rangle$						05Si0A
1430(4)							
1445.5(10)	1,3						
1459.7(6)	1,3	28					72Gr19
1479.1(4)	$1^-,3^-$	36					72Gr19
1491.0(4)	$1,3,5^+$						
1498.1(4)	1,3						
1509.9(4)	$1,3,5^+$						
1514.7+x^m	$\langle 33^-\rangle$						05Si0A
1517.4(7)	$1,3,5^+$						
1525.1(4)	$1,3,5^+$						
1532.7(8)	$\langle 1,3\rangle$						
1540.8(5)	$1,3,5^+$	36					72Gr19
1554.7(5)	$1,3,5^+$						
1557.5(5)	$1,3,5^+$						

(continued) **$^{233}_{90}$Th**

E^* [keV]	$2J^\pi$	σ (d,p) μb/sr	S_N (d,p)	σ (d,p) μb/sr	S_N (d,p)	$T_{1/2}$ or Γ_{cm}	Ref.
1580.2(8)	$\langle 1,3\rangle$	72					72Gr19
1589.8(10)	$1^-,3^-$						
1601.3(5)	$1,3,5^+$						
1612.3(5)	$1,3,5^+$						
1638.0(3)	1,3						
1653.6(5)	$1,3,5^+$						
1658.7(4)	$1,3,5^+$						
1668.3(5)	$\langle 1^+,3^+\rangle$						
1688.7(13)	$1^+,3^+,5^+$						
1699.3(4)	1,3						
1716.5(12)	$1^{\langle-\rangle},3^{\langle-\rangle}$						
1726.2[k]	$\langle 33^+\rangle$						05Si0A
1727.7(7)	1,3						
1730.6(7)	$1,3,5^+$						
1736.7(7)	$1,3,5^+$						
1741.2(9)	$1,3,5^+$						
1776.4(8)	$1,3,5^+$						
1786.9[l]	$\langle 35^-\rangle$						05Si0A
1796.8(5)	$1,3,5^+$						
1805.6(5)	1,3						
1816.0(5)	$1,3,5^+$						
1842.0(11)							
1859.7(9)	$1,3,5^+$						
1862.5(7)	$1,3,5^+$						
1894.9(7)	$1,3,5^+$						
1895.6+x[m]	$\langle 37^-\rangle$						05Si0A
1905.4(4)	1,3						
1935.4(5)	$1,3,5^+$						
1944.4(7)	$1^-,3^-$						
1948.0(6)	$1,3,5^+$						
1961.4(5)	1,3						
1964.2(6)	$1,3,5^+$						
1970.7(10)	$1,3,5^+$						
1979.0(5)	1,3						
1991.0(7)	$1,3,5^+$						
1995.9(7)	$1,3,5^+$						
2002.1(5)	$1,3,5^+$						
2014.7(7)	$1,3,5^+$						
2026.4(7)	$1,3,5^+$						
2041.5(6)	$1,3,5^+$						
2046.6(6)	$1,3,5^+$						
2053.5(4)	$1,3,5^+$						
2066.3(5)	1,3						
2069.6(9)	$1,3,5^+$						
2073.9(4)	1,3						

(continued) **$^{233}_{90}$Th**

E^* [keV]	$2J^\pi$	σ (d,p) μb/sr	S_N (d,p)	σ (d,p) μb/sr	S_N (d,p)	$T_{1/2}$ or Γ_{cm}	Ref.
2083.1(5)	1,3						
2097.2(6)	1,3,5$^+$						
2113.3^k	$\langle 37^+ \rangle$						05Si0A
2114.5(5)	1,3,5$^+$						
2126.8(4)	1,3						
2132.9(4)	1,3						
2145.1(5)	1,3						
2150.1(7)	1,3,5$^+$						
2156.2(5)	1,3,5$^+$						
2176.3(6)	1,3,5$^+$						
2179.5^l	$\langle 39^- \rangle$						05Si0A
2179.6(7)	1,3,5$^+$						
2189.4(4)	1,3						
2195.3(6)	1,3,5$^+$						
2228.1(6)	1,3,5$^+$						
2234.4(6)	1,3,5$^+$						
2240.9(6)	1,3,5$^+$						
2244.0(7)	1,3,5$^+$						
2261.5(6)	1,3,5$^+$						
2282.6(6)	1,3						
2300.6(6)	1,3,5$^+$						
2303.4+x^m	$\langle 41^- \rangle$						05Si0A
2529.1^k	$\langle 41^+ \rangle$						05Si0A
2600.0^l	$\langle 43^- \rangle$						05Si0A
2735.1+x^m	$\langle 45^- \rangle$						05Si0A
2971.2^k	$\langle 45^+ \rangle$						05Si0A
3047.0^l	$\langle 47^- \rangle$						05Si0A
3186.2+x^m	$\langle 49^- \rangle$						05Si0A
3438.7^k	$\langle 49^+ \rangle$						05Si0A
3515.6^l	$\langle 51^- \rangle$						05Si0A
3652.2+x^m	$\langle 53^- \rangle$						05Si0A
3924.0^k	$\langle 53^+ \rangle$						05Si0A
4002.9^l	$\langle 55^- \rangle$						05Si0A
4433.6^k	$\langle 57^+ \rangle$						05Si0A
4512.0^l	$\langle 59^- \rangle$						05Si0A
		72Gr19	72Vo08	72Vo08	72Er03		Ref.

Additional data on this isotope can be found in [79Je01].
* Not included in [90Ak02]; σ (d,p) in [72Gr19] were measured at 3 angles, here – data for 125°.
** $S_N = d\sigma_{exp}/(1.5(2J+1)d\sigma_{DWBA})$ [72Vo08].
The values in the second column of S_{dp} [72Er03] are given for comparison.
14 band (marked here a-n) are assignment to excited states of this nucleus in [05Si0A].
Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [90Ak02, 05Si0A]. Part 2

$^{233}_{90}$Th

E^*	$2J^\pi$		Branching ratios in percentage									
		E_f^*:	0.0	6.04	6.06	16.86	50.38	54.546	93.62	107.34	262.24	335.928
[keV]		$2J_f^\pi$:	1^+	$\langle 5\rangle^+$	$\langle 7\rangle^-$	3^+	$\langle 7\rangle^+$	5^+	7^+	$\langle 9^+\rangle$	$\langle 5\rangle^+$	3^+
50.38(2)[a]	$\langle 7\rangle^+$			x								
54.546[k]	5^+		x	x		x						
93.62[n]	7^+					x		x				
107.34(2)[a]	$\langle 9^+\rangle$						x					
279.40(2)[c]	$\langle 7\rangle^+$						81(11)			19(6)		
335.928(3)[d]	3^+		42(5)	11(1)		38.9(4)		8(1)				
337.35(6)	$\langle 5,7\rangle^+$			91(10)			9(9)					
371.17(2)[d]	$\langle 5\rangle^+$				4.6(7)	37(5)	5(1)	39(4)	14(2)			
421.15(2)[d]	$\langle 7\rangle^+$							35(5)	65(7)	x		
478.36(17)[e]	$\langle 5\rangle^-$				x							
539.61(2)[f]	$\langle 1\rangle^-$		39(4)			61(7)						
572.70(3)[g]	$\langle 3\rangle^-$				97(10)							3.1(7)
583.932(8)[h]	$\langle 1\rangle^+$		36(4)	64(10)								
586.135(9)[f]	3^-		45(5)			11(2)		44(5)				
599.29(6)	$\langle 5^-\rangle$				83(9)	17(5)						
611.476(12)[h]	$\langle 3\rangle^+$			41(4)			27(3)	32(3)				
628.97(2)[h]	$\langle 5\rangle^+$			14(2)		27(3)	29(4)	9(1)	10(2)	11(4)		
681.846(19)	$\langle 1\rangle^-$		x									
682.11(3)	$\langle 3^-\rangle$				4.7(13)	95(10)						
711.19(18)[i]	$\langle 5\rangle^+$		31(6)	x		34(7)	34(10)					
713.72[j]	1^+		58(9)			42(6)						
721.84(5)[f]	3^+		19(4)			49(7)			23(3)			
741.32(4)	$\langle 3\rangle^-$		30(4)	30(4)								
753.98(5)[i]	$\langle 7\rangle^+$				37(15)		63(19)					
768.18(2)	$1^+,3^+$					100						≤69
769.60[j]	5^+		18(4)			26(4)		56(9)				
783.64(8)	$1^+,3^+$			80(22)								
803.41(6)	$\langle 5\rangle^+$				70(14)	17(5)					13(3)	
814.74(13)	3^+		39(5)	36(5)		25(6)						
839.66(8)	$\langle 3^-\rangle$		13(3)	87(12)								
842.26(9)	$\langle 1,3\rangle^+$		9(3)			16(3)					21(3)	14(3)
852.28(17)	1^+–5^+					x					x	
861.54(11)	$1^+,3^+$		62(11)			38(9)						
884.94(8)	1^+–5^+							75(11)				25(3)
924.58(20)	$\langle 3\rangle^-$			27(4)		19(4)					14(2)	19(4)
947.2(4)	$\langle 3^-\rangle$		12(2)		50(9)						38(5)	
968.1(2)	$\langle 1,3\rangle^+$		52(9)			10(3)		26(5)				11(3)
1013.1(3)	$1^-,3^-$		76(14)			16(5)						
1031.6(2)	$1^-,3^-$		9(3)			91(16)						
1051.5(5)	$\langle 3\rangle^-$		36(8)			64(15)		x				
1061.43(15)	$\langle 1^+,3^+\rangle$			50(10)		50(10)						
1132.11(9)	$\langle 3\rangle^+$				33(4)		16(4)				51(9)	
1151.72(22)	$\langle 3,5\rangle^+$		13(3)		21(5)		40(6)	17(2)				
1171.2(10)	3^-				46(5)	23(4)		32(11)				
1185.5(4)	$\langle 3^+\rangle$		42(6)						9(3)			49(10)

Energy levels and branching ratios [90Ak02, 05Si0A]. Part 3

$^{233}_{90}$Th

E^*	$2J^\pi$	Branching ratios in percentage						
	E_f^*:	371.17	478.36	539.61	583.932	586.135	611.476	6.05
[keV]	$2J_f^\pi$:	$\langle 5\rangle^+$	$\langle 5\rangle^-$	$\langle 1\rangle^-$	$\langle 1\rangle^+$	3^-	$\langle 3\rangle^+$	
262.24(2)[b]	$\langle 5\rangle^+$							85(10)
721.84(5)[f]	3^+			10(3)				
741.32(4)	$\langle 3\rangle^-$	9(2)	16(2)	14(3)				
768.18(2)	$1^+,3^+$					x		
783.64(8)	$1^+,3^+$	20(3)						
803.41(6)	$\langle 5\rangle^+$	x						
842.26(9)	$\langle 1,3\rangle^+$	12(3)			16(calc)		14(2)	
861.54(11)	$1^+,3^+$				x			
924.58(20)	$\langle 3\rangle^-$	14(2)		7(2)				
1013.1(3)	$1^-,3^-$					8(2)		
1151.72(22)	$\langle 3,5\rangle^+$	9(2)						
1313.41(8)	$\langle 3\rangle^-$		x					
1350.7(2)	$\langle 3\rangle^-$		x					

Energy levels and branching ratios [94Ak05].

$^{234}_{90}$Th

E^*	J^π	σ (t,p)	σ (d,^{6}Li)	S_α	γ_α^2	$T_{1/2}$ or	Ref.
[keV]		arb.u	μb/sr	(d,^{6}Li)	[eV]	Γ_{cm}	
0.0	0^+	83	92(24)	0.017	44	24.10(3) d	73Ba72
49.55(6)	2^+	30	151(31)	0.027	68	0.37(3) ns	73Ba72
163.0(1)	4^+	3	115(27)	0.013	26		73Ba72
336.5(4)	6^+		44(17)	0.004	6		81Ja01
564.8(4)	8^+		69(21)	0.007	7		81Ja01
688.5(3)	$\langle 1^-\rangle$						
810(30)	$\langle 0^+\rangle$		553(59)	125*	108*		81Ja01
843.0(5)	10^+						
996.1	$\langle 7^-\rangle$						99Am04
1150(40)	$\langle 0^+\rangle$		342(46)	83*	67*		81Ja01
1160.2(7)	$\langle 12^+\rangle$						
1470(40)	$\langle 0^+\rangle$		309(44)	82*	63*		81Ja01
1896(2)	$\langle 1,2^+\rangle$						
1912(2)	$1,2^+$						
		73Ba72	81Ja01	81Ja01	81Ja01		Ref.

Additional data on this isotope can be found in [99Am04, 72Ca19, 72Va20].

* Relative to 100 for the group of states close to the ground state [81Ja01].

Two bands built on the ground state (up to J^π=24^+) and on the 1^- state (up to J^π=21^-) are shown in [99Am04].

Data for this isotope are considered in vol. LB I/18C.

Energy levels and branching ratios [94Ak05]. Part 2 **$^{234}_{90}$Th**

E^*	J^π		Branching ratios in percentage					
		E_f^*:	0.0	49.55	163.0	336.5	565	843.0
[keV]		J_f^π:	0^+	2^+	4^+	6^+	8^+	10^+
49.55(6)	2^+		x					
163.0(1)	4^+			x				
336.5(4)	6^+				x			
564.8(4)	8^+					x		
688.5(3)	$\langle 1^- \rangle$		63(9)	37(8)				
843.0(5)	10^+						x	
1160.2(7)	$\langle 12^+ \rangle$							x
1896(2)	$\langle 1,2^+ \rangle$		39(9)	61(10)				
1912(2)	$1,2^+$		61(12)		39(10)			