^{232}Th(p,t) 2009Le03

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. Morse	NDS 197,259 (2024).	26-Sep-2023

2009Le03: E=25 MeV beam provided by Munich Tandem accelerator. Measured triton spectra, angular distributions at ten angles from 5° to 45° using Q3D magnetic spectrograph at Munich Tandem accelerator facility. The target was 99% isotopically pure. FWHM=4−7 keV. Comparisons with interacting boson model and quasiparticle+phonon model calculations. Coupled−channel (CHUCK code) (mainly for 0^+ and unnatural-parity states) and DWBA analyses. 2004Wi06 is earlier result from same experiment focusing on 0^+ states.

Others: 1996Ba67, 1994Ac02, 1985Mi06, 1982Na06, 1974Ta04, 1972Ma15.

1982Na06 observed a group levels containing deep-hole states in (p,t) around 5 MeV in excitation energy.

^{230}Th Levels

E(level)†	Jπ#	L	Comments
0[b]	0+[a]	0[a]	E(level): Given as 0.1 keV *2*.
53.2[b] *2*	2+[a]	2[a]	
174.0[b] *2*	4+[a]	4[a]	
356.3[b] *2*	6+[a]	6[a]	
508.0[c] *3*	1−[a]	1[a]	
571.7[c] *2*	3−[a]	3[a]	
593.8[b] *3*	8+		
635.1[d] *2*	0+[a]	0[a]	
677.6[d] *2*	2+		
686[c] *1*	[5−]		
775.2[d] *4*	4+		
781.4[e] *2*	2+[a]	2[a]	
825.6&[e] *3*	3+&		
852.7[c] *4*	[7−]		
884.2[e] *4*	4+[a]	4[a]	
923.3[d] *5*	6+		
952.6[f] *5*	(1−,0+)[a]	(1,0)[a]	Jπ: $\sigma(\theta)$ is not typical of 1^- which was assigned in earlier studies, but $\sigma(\theta)$ can be fitted with a one-step or 2-step excitation, as well as with an 0^+ excitation.
972.1&[f] *5*	2−&		
1011.6[f] *5*	2+,3−		
1022‡ *2*			
1040.0[e] *7*	6+		
1052.0& *7*	3+&		
1065.9&[f] *8*	4−&		
1079.4& *8*	2−&		
1089‡ *2*			
1108.7 *5*	4+		
1125.6 *5*	(0+,1−)[a]	(1,0)[a]	
1144‡ *2*			
1148.0 *9*			
1184.8 *9*			
1241.2 *9*			
1256.0 *9*			
1259.2 *6*	(3−)[a]	(3)[a]	
1283.6 *6*	(5−)[a]	(5)[a]	
1297.8 *6*	0+[a]	0[a]	

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^{232}Th(p,t) 2009Le03 (continued)

^{230}Th Levels (continued)

E(level)[†]	Jπ[#]	L	Comments
1322.3 *5*	(3⁻)		
1337.2 *5*	4⁺		
1359.5 *7*	(2⁺)		
1376.6 *7*	1⁺,5⁻		
1401.5 *5*	2⁺		
1420.4[&] *5*	(3⁺)[&]		
1440.4[&] *8*	(3⁺)[&]		
1447.9 *5*	0⁺[a]	0[a]	
1485.6 *5*	4⁺		
1496 *1*			
1507.4 *5*	4⁺		
1524.8 *5*	2⁺		
1566.2 *6*	(1⁻)[a]	(1)[a]	
1574.5[&] *6*	(2⁻)[&]		
1584.7 *6*	(4⁻,5⁺)		
1590.2 *5*	0⁺[a]	0[a]	
1594.7 *8*	(1⁻)[a]	(1)[a]	
1601.2 *11*	(3⁻)		
1612.1[&] *10*	(4⁻,5⁺)[&]		
1618.7[&] *9*	(4⁻,5⁺)[&]		
1630.1 *7*	2⁺		
1639.3 *6*	0⁺[a]	0[a]	
1653.2 *11*	(6⁺)[a]	(6)[a]	
1668.2 *7*	4⁺		
1679.1 *7*	2⁺[a]	2[a]	
1683.3[&] *7*	(4⁻)[&]		
1694.9 *7*	(4⁺)[a]	(4)[a]	
1708.8 *8*	2⁺		
1723.5 *7*	(4⁺)		
1745.3 *8*	(0⁺)[@a]	(0)[a]	Jπ: assigned 0⁺ in table II of 2009Le03, but L=(0) in authors′ figure 4.
1750.7 *8*	(3⁻)		
1762.3 *8*	(4⁺)		
1769.6 *8*	(4⁺)[a]	(4)[a]	
1774.1 *9*			
1793.1 *6*	(5⁻)		
1802.5 *6*	0⁺[a]	0[a]	
1812.0 *8*	4⁺		
1824.9 *7*	(6⁺)		
1840.0 *8*	2⁺		
1851.4 *7*	(3⁻)[a]	(3)[a]	
1859.3 *7*	(3⁻)		
1868.9 *7*		(0)	Fit as a doublet line, with spins (0⁺) and (6⁺).
1887.0 *9*	(2⁺)		
1910.0 *9*	(6⁺)[a]	(6)[a]	
1914.7 *9*	(1⁻)		
1926.0 *7*	4⁺[a]	4[a]	
1931.1 *8*	(1⁻)		
1939.8 *11*	(1)		
1947.0 *6*	4⁺		
1956.4 *6*	2⁺[a]	2[a]	
1967.1 *7*	2⁺		
1972.0 *9*	2⁺		

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^{232}Th(p,t) 2009Le03 (continued)

^{230}Th Levels (continued)

E(level)†	Jπ#	L	Comments
1985.4 *8*	(5−)		
2001.6 *8*	(3−)[a]	(3)[a]	
2010.3 *6*	2+		
2017.3 *7*	(3−)		
2025.6 *6*	2+		
2032.8 *7*	4+		
2039.1 *7*	4+		
2048.7 *7*	(4+)		
2060.9 *12*	(3−)[a]	(3)[a]	
2073.2 *8*	(8+)		
2074.9 *8*	(4+)		
2085.9 *8*	(4+)		
2093.9 *7*	0+[a]	0[a]	
2102.0 *7*	4+		
2118.4 *6*	4+[a]	4[a]	
2130.7 *7*	2+		
2137.9 *7*	2+		
2150.5 *6*	0+[a]	0[a]	
2168.8 *7*	(4+)		
2175.1 *6*	0+[a]	0[a]	
2181.7 *7*	(4+)		
2187.1 *6*	2+		
2194.8 *8*	(6+)		
2205.4 *10*	2+		
2207.8 *8*	(4+)		
2216.0 *7*	(4+)		
2226.0 *6*	2+		
2241.0 *7*	2+		
2249.9 *7*	(6+)[a]	(6)[a]	
2255.3 *7*	4+		
2268.9 *6*	0+[a]	0[a]	
2276.0 *8*	(4+)		
2282.1 *10*			
2295.9 *8*	4+		
2305.4 *7*	2+		
2311.2 *8*	(4+)		
2317.7 *7*	4+		
2329.6 *7*	2+		
2337.1 *8*	(5−)		
2354.8 *10*	(6+)		
2368.5 *7*	(0+)@[a]	(0)[a]	
2383.8 *8*	(4+)		
2388.4 *10*			
2395.2 *7*	0+[a]	0[a]	
2402.0 *8*	(6+)		
2411.6 *7*	2+		
2422.7 *7*			Fit as a doublet line with spins (0+) and (4+).
2426.4 *9*	(0+)@[a]	(0)[a]	
2436.6 *9*	2+		
2442.5 *8*	2+		
2449.2 *2*	(3−)		
2461.0 *7*	2+[a]	2[a]	
2467.2 *7*	2+		
2474.3 *8*	2+		

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^{232}Th(p,t) 2009Le03 (continued)

^{230}Th Levels (continued)

E(level)[†]	Jπ[#]	L	E(level)[†]	Jπ[#]	L	E(level)[†]	Jπ[#]
2478.5 *8*	4^+		2726.6 *7*	2^+		2999.0 *7*	2^+
2481.3 *12*	(6^+)		2740.6 *7*	2^+		3009.9 *8*	2^+
2493.8 *7*	0^+[a]	0[a]	2746.2 *7*	4^+		3020.6 *8*	2^+
2501.1 *7*	4^+[a]	4[a]	2754.2 *10*	(6^+)		3030.3 *9*	2^+
2508.3 *7*			2764.9 *7*	2^+		3043.0 *7*	2^+
2519.3 *7*	(6^+)		2777.3 *7*	2^+		3052.4[&] *9*	(3^+)[&]
2528.1 *7*	0^+[a]	0[a]	2791.5 *7*	4^+		3064.3 *15*	(2^+)
2536.9 *7*	4^+		2799.7 *8*	2^+		3072.6 *8*	(6^+)
2549.8 *11*	0^+[a]	0[a]	2808.1 *7*	0^+[a]	0[a]	3083.8 *7*	2^+
2556.2 *8*	(4^+)		2824.4 *10*	4^+		3100.9 *7*	2^+
2562.9 *9*	(4^+)		2834.0 *10*	2^+		3113.9 *12*	(0,1,2,3,4)
2573.2 *7*	(6^+)		2841.3 *7*	(2^+)		3124.7 *8*	(4^+)
2589.1 *7*	2^+		2855.9 *7*	2^+		3135.9 *10*	(0,1,2,3,4)
2596.4 *8*	(0^+)[@a]	(0)[a]	2862.9 *7*	2^+		3147.4 *8*	(0,1,2,3,4)
2601.3 *7*	(4^+)		2870.6 *10*	(3^-)		3162.0 *7*	2^+
2616.0 *7*	2^+		2879.7 *7*	2^+		3173.6 *8*	2^+
2625.9 *7*	2^+		2886.1 *10*	(1^-)		3186.1 *7*	(6^+)
2640.0 *8*	4^+		2896.1 *7*	2^+		3198.4 *7*	2^+
2660.9 *7*	4^+		2906.4 *8*	(3^-)		3212.2 *7*	2^+
2666.4 *7*	(2^+)		2913.6 *15*	(4^+)		3223.1 *7*	2^+
2671.6 *7*	4^+		2923.7 *9*	2^+		3234.0 *7*	
2679.2 *8*	2^+		2930.6 *7*	2^+		3248.6 *7*	2^+
2694.9 *7*	2^+		2940.6 *7*	2^+		3258.8 *8*	
2706.5 *7*	2^+		2950.5 *8*	(6^+)		3269.9 *12*	(2^+)
2712.9 *5*	(6^+)[a]	(6)[a]	2987.9 *10*	(6^+)			

[†] From 2009Le03. For calibration of triton spectra, other (p,t) reactions on ^{184}W, ^{186}W and ^{234}U targets were measured at the same magnetic settings and some precisely known level energies in ^{230}Th were included (2009Le03). Values agree with those in 2004Wi06 and 1996Ba67.

[‡] Reported in 1994Ac02 and 1996Ba67.

[#] From $\sigma(\theta)$ distributions (2009Le03). Coupled-channel analysis (CHUCK code) was used to interpret angular distributions.

[@] 0^+ assignment is relatively firm from $\sigma(\theta)$ but statistical accuracy is limited.

[&] Unnatural-parity states, spin from analysis with the CHUCK code.

[a] Angular distribution is displayed in one of the figures 4, 7 and 8 in 2009Le03, L value assigned as implied by the spin-parity assignment in 2009Le03.

[b] $K^\pi=0^+$ g.s. rotational band.

[c] $K^\pi=0^-$ octupole vibrational band.

[d] $K^\pi=0^+$ band.

[e] $K^\pi=2^+$ γ vibrational band.

[f] $K^\pi=1^-$ octupole vibrational band.