Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 109,2657 (2008)	1-Jun-2008

Q(β^-)=−312 *4*; S(n)=5257 *3*; S(p)=6599 *3*; Q(α)=5167.6 *11* 2012Wa38
Note: Current evaluation has used the following Q record −311 3 *5257.0 27* 6598.4 *28* 5167.6 *10* 2003Au03.
Additional information 1.

^{229}Th Levels

Cross Reference (XREF) Flags

A ^{233}U α decay
B ^{229}Ac β^- decay
C ^{229}Pa ε decay
D ^{230}Th(d,t)
E Coulomb excitation

E(level)	J$^\pi$[†]	$T_{1/2}$	XREF	Comments
0.0[#]	5/2$^+$	7880 y *120*	ABCDE	%α=100 μ=+0.46 *4* Q=+4.3 *9* $T_{1/2}$: From 1989Go19. Measured specific activity with mass spectrometry. This value is about 7% larger than 7340 y *160* reported in 1950Ha52. This latter value is relative to $T_{1/2}(^{233}U)=1.62\times10^5$ y, which is about 2% larger than the current accepted value of $T_{1/2}(^{233}U)=1.592\times10^5$ y (2005Si15). The remaining discrepancy of about 5% may be due to an underestimation of the effect of impurities, such as ^{228}Th. J$^\pi$: Measured spin (1964Eg01). Orbital assignment is from measured μ value. See 1972El21 and 1976Ga35 for calculations. Optical spectroscopy (1974Ge06,1989Ra17,2005St24). See also 1964Eg01 and 1964To02. Optical spectroscopy (1974Ge06,1989Ra17,2005St24). See also 1964Eg01.
0.0076[@] *5*	(3/2$^+$)		ABCD	E(level): From precise energy measurement of low-energy γ rays from ^{233}U α decay (2007Be16). Other value: 0.0035 keV 10 (1994He08). J$^\pi$: 71.812γ from (7/2$^+$) state is E2. (d,t) data suggest the possible existence of a very low-energy state practically degenerate with the ground state (2008Bu14).
29.1927[@] *5*	(5/2$^+$)		ABCDE	J$^\pi$: 29.1851γ to (3/2$^+$) is M1[+E2].
42.4349[#] *2*	7/2$^+$	0.172 ns *6*	ABCDE	$T_{1/2}$: from 1970To12 (by (α)(ce)(t)). Other value: <1.9 ns (1967Tr07). J$^\pi$: 42.4349γ M1+E2 to 5/2$^+$ g.s.; Low alpha hindrance factor from ^{233}U α decay suggest same 5/2[633] configuration.
71.8260[@] *5*	(7/2$^+$)		ABCDE	J$^\pi$: 42.6γ (M1) to (5/2$^+$), 71.8γ E2 to (3/2$^+$).
97.13595[#] *24*	9/2$^+$	0.147 ns *12*	AB DE	J$^\pi$: 54.7γ M1+E2 to 7/2$^+$, 97.1γ E2 to 5/2$^+$.
125.4385[@] *10*	(9/2)$^+$		AB D	83.0γ M1+E2 to 7/2$^+$, 125.4γ E2 to 5/2$^+$.
146.3569[a] *14*	(5/2$^-$)		ABC	J$^\pi$: 146.3γ E1 to (3/2$^+$), 117.1γ E1 to (5/2$^+$).
148.1730[a] *22*	(7/2$^-$)		ABC	
163.2542[#] *7*	11/2$^+$		AB DE	J$^\pi$: 66.1γ (M1+E2) to 9/2$^+$, 120.8γ E2 to 7/2$^+$.
164.5317[&] *4*	(3/2$^-$)		AB D	
173.4837[a] *22*	(9/2$^-$)		A	
189.99? *3*			A	
195.7194[@] *16*	(11/2$^+$)		A	
202.4[a] *2*	11/2$^-$		D	J$^\pi$: L=5 in ^{230}Th(d,t).
212.382 *20*	(5/2$^+$)		A	

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Adopted Levels, Gammas (continued)

^{229}Th Levels (continued)

E(level)	J^{π} †	$T_{1/2}$	XREF	Comments
217.1597& 3	(5/2⁻)		AB	
235.1266 11	(5/2⁻,7/2⁻)		AB	
237.366& 5	(7/2⁻)		AB	
241.546# 19	13/2⁺		A E	
255.957 15	(3/2⁺,5/2⁺,7/2⁺)		A	
261.964c 4	(1/2⁺)		AB D	
272.84?@ 3	(13/2⁺)		A	
275a 1	(15/2⁻)		D	
287.895 4	(7/2⁻)		A	
288.491c 14	(3/2⁺)		AB DE	
302.989 4	(7/2⁺)		AB	
317.1731c 7	(5/2)⁺		AB DE	J^{π}: 317γ M1+E2 to 5/2⁺, 274γ M1+E2 to 7/2⁺.
320.5483b 7	(5/2)⁺		AB	J^{π}: 278γ M1+E2 to 7/2⁺, 320γ M1+E2 to 5/2⁺.
327.8# 3	(15/2⁺)		A	
347.800 20	(5/2⁺)		A	
359.6044c 20	(7/2⁺)		A D	
365.8136b 15	7/2⁺		AB	J^{π}: M1+E2 γ rays to 5/2⁺, 7/2⁺, and 9/2⁺ states.
374.815 4	(7/2⁺)		A	
382.54? 5	(7/2⁻,9/2,11/2⁺)		A D	
425.877b 10	(9/2⁺)		A	See also 424.01 ($T_{1/2}$=190 ps 8) and 425.33 ($T_{1/2}$=290 ps 48) populated in ^{229}Ac β^- decay, but de-excited by different γ rays. A 424.1-keV level (L=1) is populated in ^{230}Th(d,t).
428.04 8	(5/2⁺)		A	
436.951 15	(7/2⁻)		A	
449.38 3	5/2⁺,7/2⁺		B	J^{π}: 406.4γ M1+E2 to 7/2⁺, 449.4γ M1+E2 to 5/2⁺.
449.6f 5	1/2⁺		D	J^{π}: L=0 in ^{230}Th(d,t).
465.426 9	(5/2⁻,7/2,9/2⁺)		A	
478.64 2	5/2⁻,7/2⁻		B	J^{π}: 436γ E1 to 7/2⁺, 478γ E1 to 5/2⁺.
478.649 8	(7/2⁺,9/2⁺)	≤16 ps	AB	$T_{1/2}$: From 2006Ru07. A 479.1-keV (L=2) level is populated in ^{230}Th(d,t). Possible 3/2⁺ or 5/2⁺ member of a K^{π}=1/2⁺ band, and a 480 keV 5 level in Coulomb Excitation.
513.479 10	(5/2⁺,7/2,9/2⁺)		A	A 512 keV 5 (5/2⁻) level is populated in Coulomb Excitation.
526.516 9	(5/2,7/2)⁻		AB	J^{π}: 526γ E1 to 5/2⁺, γ rays to J=7/2 states.
536.08d 8	(1/2⁻)		AB D	
569.2721e 12	3/2⁺,5/2⁺		AB	J^{π}: 569γ M1+E2 to 5/2⁺. A 562 keV 5 (7/2⁻) level is populated in Coulomb Excitation.
571.2d 6	(3/2⁻)		AB D	J^{π}: L=1 in ^{230}Th(d,t).
576.39‡ 6			B	
585.237? 10	(5/2⁺,7/2,9/2⁺)		A	A 586.3−keV doublet (L=1(+3)) level is populated in ^{230}Th(d,t).
605.165e 10	5/2⁺,7/2⁺		AB	J^{π}: 562γ M1+E2 to 7/2⁺, 605γ M1+E2 to 5/2⁺. A 611 keV 5 (9/2⁻) level is populated in Coulomb Excitation.
620.837 16	(5/2⁺,7/2)		A	
637.384 18	(5/2⁺,7/2,9/2⁺)		A	See 638.48-keV level populated in ^{229}Ac β^- decay, but de-excited by different γ rays. Also 638.3-keV level populated with L=1 in ^{230}Th(d,t).
653.79‡ 4			B D	
656.89 4	(5/2⁺,7/2,9/2⁺)		A	
661.780‡ 24			B D	
664.98? 7	(1/2,3/2)⁻		A D	J^{π}: L=1 in ^{230}Th(d,t).
689.01 5			B D	

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Adopted Levels, Gammas (continued)

^{229}Th Levels (continued)

E(level)	J^{π}[†]	XREF	Comments
714.5 *10*		D	
743.4 *12*		D	
749.849 *20*	(5/2$^+$,7/2,9/2$^+$)	A	
779.29[‡] *7*		B D	
815.1[g] *8*	(3/2$^-$)	D	J^{π}: L=1 in ^{230}Th(d,t).
825.1 *10*		D	
843.4[g] *13*	(5/2$^-$)	D	J^{π}: L=3 in ^{230}Th(d,t).
895.2 *9*		D	
929.1 *10*		D	
972.6 *12*		D	
982.6 *11*		D	
1019.0 *11*		D	
1051.7 *13*		D	
1061.8 *13*		D	
1093.8 *11*		D	
1104.1 *11*		D	
1121.3 *11*		D	
1135.5 *13*		D	
1192.6 *15*		D	
1207.3 *13*		D	
1241.6 *13*		D	
1266.4 *14*		D	
1302.5 *14*		D	
1336.0 *14*		D	
1382.8 *15*		D	
1406.9 *15*		D	
1463.8 *15*		D	
1500.9 *15*		D	
1513.0 *15*		D	
1538.5 *16*		D	
1575.8 *17*		D	
1628.3 *16*		D	

[†] Spin and parity assignments are based on rotational structure, γ-ray multipolarities, alpha-decay hindrance factors, measured angular momentum transferred (L) in ^{230}Th(d,t), and on the systematic energies of single-particle Nilsson orbitals in this mass region. Specific arguments are given for individual levels de-excited by γ rays with experimentally determined multipolarities. The single-particle Nilsson orbital assignments shown in this evaluation represent the dominant configuration for each rotational band.

[‡] Observed only in ^{229}Ac β^- decay (2002Gu15,2006Ru07).

[#] Band(A): 5/2[633].

[@] Band(B): 3/2[631].

[&] Band(C): 3/2[761].

[a] Band(D): 5/2[752].

[b] Band(E): 5/2[622].

[c] Band(F): 1/2[631].

[d] Band(G): 1/2[501].

[e] Band(H): 3/2[642]?

[f] Band(I): $K^{\pi}=1/2^+$.

[g] Band(J): 3/2[501].

Adopted Levels, Gammas (continued)

γ(^{229}Th)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]	Comments
0.0076	(3/2$^+$)	(0.0076 *5*)		0.0	5/2$^+$				
29.1927	(5/2$^+$)	29.1851[@] *4*		0.0076	(3/2$^+$)	M1[+E2]	0.145[#]	225	
		(29.19)		0.0	5/2$^+$	[M1+E2]			
42.4349	7/2$^+$	42.4349[@] *2*		0.0	5/2$^+$	M1+E2	0.40[#] *10*	130 *40*	B(M1)(W.u.)=0.011 *4*; B(E2)(W.u.)=3.0×10^2 *16*
71.8260	(7/2$^+$)	29.3911[@] *4*	6.1 *11*	42.4349	7/2$^+$				
		42.6333[@] *2*	100 *5*	29.1927	(5/2$^+$)	(M1)		45.8	
		71.812[b] *8*	13.7 *11*	0.0076	(3/2$^+$)	E2		53.9	
		71.8159 *20*	8.8 *6*	0.0	5/2$^+$				
97.13595	9/2$^+$	25.3106[c@] *8*	10.4[c] *6*	71.8260	(7/2$^+$)	[M1]		213	B(M1)(W.u.)=0.0117 *14*
		54.7039[@] *11*	83 *4*	42.4349	7/2$^+$	M1+E2	0.46[#] *3*	53 *4*	B(M1)(W.u.)=0.0076 *12*; B(E2)(W.u.)=1.7×10^2 *3* Mult.,δ: From conversion electron data in 1959Tr31.
		67.9460[@] *5*	1.6 *1*	29.1927	(5/2$^+$)	E2		70.2	B(E2)(W.u.)=6.2 *8*
		97.1346 *3*	100 *1*	0.0	5/2$^+$	E2		12.91	B(E2)(W.u.)=65 *7*
125.4385	(9/2)$^+$	(28.288)	1.0 *3*	97.13595	9/2$^+$	[M1]		153.4	
		53.6106[@] *11*	100 *5*	71.8260	(7/2$^+$)	(M1)	[#]	23.3	
		83.0125 *20*	5.7 *6*	42.4349	7/2$^+$	M1+E2	0.62[#]	12 *1*	
		96.22 *3*	49 *3*	29.1927	(5/2$^+$)	E2		13.49	
		125.43 *4*	1.5 *3*	0.0	5/2$^+$	E2		4.22	
146.3569	(5/2$^-$)	74.542[@] *5*	23 *1*	71.8260	(7/2$^+$)	[E1]		0.255	
		117.162[@] *2*	44 *2*	29.1927	(5/2$^+$)	E1		0.336	
		146.3462[@] *6*	100 *5*	0.0076	(3/2$^+$)	E1		0.198	
148.1730	(7/2$^-$)	76.350[c] *4*	8.3[c] *8*	71.8260	(7/2$^+$)	[E1]		0.240	
		118.968[@] *5*	100 *5*	29.1927	(5/2$^+$)	E1		0.325	
		148.20 *2*	11 *6*	0.0	5/2$^+$	[E1]		0.193	
163.2542	11/2$^+$	37.80 *3*	9.0 *2*	125.4385	(9/2)$^+$	[M1]		65.2	
		66.1183[@] *6*	38 *2*	97.13595	9/2$^+$	(M1+E2)	0.56[#] *20*	29 *9*	
		(91.433)	1.5 *3*	71.8260	(7/2$^+$)	[E2]		17.14	
		120.819[@] *2*	100 *5*	42.4349	7/2$^+$	E2		4.95	
164.5317	(3/2$^-$)	135.3390[@] *5*	33 *2*	29.1927	(5/2$^+$)	E1		0.239	
		164.5240[@] *5*	100 *5*	0.0076	(3/2$^+$)	E1		0.1500	
173.4837	(9/2$^-$)	25.3106[c@] *8*	<5.8[c]	148.1730	(7/2$^-$)	[M1]		213	
		(27.119)	<2.9	146.3569	(5/2$^-$)	[E2]		6.13×10^3	
		76.350[c] *4*	<29[c]	97.13595	9/2$^+$	[E1]		0.240	
		101.70 *5*	100 *22*	71.8260	(7/2$^+$)	[E1]		0.1123	
		131.22 *8*	25 *3*	42.4349	7/2$^+$	[E1]		0.257	

$^{229}_{90}Th_{139}$-4

Adopted Levels, Gammas (continued)

γ(^{229}Th) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]	$I_{(\gamma+ce)}$
189.99?		92.85[d] *3*	100	97.13595	$9/2^+$				
195.7194	$(11/2^+)$	(32.453)	2.2 *4*	163.2542	$11/2^+$	[M1]		102.3	
		70.2813 *13*	80 *6*	125.4385	$(9/2)^+$	[M1+E2]	0.157[#] *3*	11.74	
		(98.565)	14 *2*	97.13595	$9/2^+$	[M1+E2]	0.27[#]	4.50	
		123.886[@] *7*	100 *7*	71.8260	$(7/2^+)$	[E2]		4.45	
		153.17[b] *4*	5.1 *4*	42.4349	$7/2^+$	[E2]		1.84	
212.382	$(5/2^+)$	87.25 *4*	68 *17*	125.4385	$(9/2)^+$	[E2]		21.4	
		212.36 *3*	100 *5*	0.0	$5/2^+$	[M1]		2.20	
217.1597	$(5/2^-)$	52.60 *3*	0.10 *3*	164.5317	$(3/2^-)$	[M1]		24.7	
		68.81 *3*	0.100 *23*	148.1730	$(7/2^-)$	[M1]		11.23	
		145.35 *2*	53 *2*	71.8260	$(7/2^+)$	[E1]		0.202	
		187.9670[@] *3*	57 *3*	29.1927	$(5/2^+)$	[E1]		0.1093	
		217.151[@] *4*	100 *5*	0.0076	$(3/2^+)$	[E1]		0.0778	
235.1266	$(5/2^-,7/2^-)$	86.3[bd] *3*		148.1730	$(7/2^-)$	[M1]	[#]	5.81 *10*	
		88.7 *2*	100	146.3569	$(5/2^-)$	[M1]		5.40	
237.366	$(7/2^-)$	25.02[d] *5*	4.4 *17*	212.382	$(5/2^+)$	[E1]		4.57	
		63.79 *6*	1.3 *5*	173.4837	$(9/2^-)$	[M1]		14.02	
		(72.825)	<1.3	164.5317	$(3/2^-)$	[E2]		50.4	
		89.39 *7*	12.7 *15*	148.1730	$(7/2^-)$	[M1]		5.24	
		90.99 *1*	13.5 *17*	146.3569	$(5/2^-)$	[M1]		4.98	
		111.93 *1*	17.5 *13*	125.4385	$(9/2)^+$	[E1]		0.372	
		165.61 *3*	17.8 *10*	71.8260	$(7/2^+)$	[E1]		0.1476	
		208.179[@] *7*	100 *5*	29.1927	$(5/2^+)$	[E1]		0.0859	
241.546	$13/2^+$	(45.855)	3.0 *5*	195.7194	$(11/2^+)$	[M1]		36.9	
		78.21 *5*	14.7 *23*	163.2542	$11/2^+$	[M1+E2]	0.56[#]	14.45	
		116.3[c] *2*	1.6[c] *3*	125.4385	$(9/2)^+$	[E2]		5.84 *10*	
		144.42 *2*	100 *10*	97.13595	$9/2^+$	[E2]		2.34	
255.957	$(3/2^+,5/2^+,7/2^+)$	43.69 *3*	60 *20*	212.382	$(5/2^+)$	[M1]		42.6	
		226.2 *2*	100 *33*	29.1927	$(5/2^+)$	[M1]		1.84	
		255.91 *2*	56 *4*	0.0	$5/2^+$	[M1]		1.307	
261.964	$(1/2^+)$	97.37 *4*	100 *30*	164.5317	$(3/2^-)$	[E1]		0.1259	
		261.957[@] *4*	14 *7*	0.0076	$(3/2^+)$	M1+E2	0.93 *7*	0.78 *4*	
272.84?	$(13/2^+)$	77.12 *3*		195.7194	$(11/2^+)$	[M1+E2]		23 *16*	
		146.9[d] *5*	100 *9*	125.4385	$(9/2)^+$				0.00035
287.895	$(7/2^-)$	51.0 *3*	4.8 *16*	237.366	$(7/2^-)$	[M1+E2]		1.5×10^2 *13*	
		114.2 *2*	30 *4*	173.4837	$(9/2^-)$	[M1]		12.68	
		139.722[@] *3*	15 *3*	148.1730	$(7/2^-)$	[M1]		7.17	

$^{229}_{90}Th_{139}$-5

Adopted Levels, Gammas (continued)

γ(^{229}Th) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]	Comments
287.895	(7/2⁻)	162.45[b] *4*	8.7 *9*	125.4385	(9/2)⁺	[E1]		0.1546	
		216.07 *1*	100 *5*	71.8260	(7/2⁺)	[E1]		0.0787	
288.491	(3/2⁺)	32.52 *2*	12 *4*	255.957	(3/2⁺,5/2⁺,7/2⁺)	[M1]		101.7	α(N)=4.94 *7*; α(O)=1.171 *17*; α(P)=0.227 *4*; α(Q)=0.0217 *3*
		141.95 *10*	5.8 *10*	146.3569	(5/2⁻)	[E1]		0.213	
		259.31 *2*	100 *5*	29.1927	(5/2⁺)	[M1]		1.260	
		288.50 *3*	75 *9*	0.0076	(3/2⁺)	[M1]		0.938	
302.989	(7/2⁺)	65.62 *5*	37 *5*	237.366	(7/2⁻)	[E1]		0.358	
		(129.514)	≈42	173.4837	(9/2⁻)	[E1]		0.266	
		154.90 *3*	100 *6*	148.1730	(7/2⁻)	[E1]		0.1732	
		177.91[b] *16*	4.6 *9*	125.4385	(9/2)⁺	[M1]		3.62	
		205.75[b] *6*	16 *2*	97.13595	9/2⁺	[M1]		2.40	
		260.53 *2*	71 *4*	42.4349	7/2⁺	[M1]		1.244	
		273.74 *5*	11 *1*	29.1927	(5/2⁺)	[M1]		1.085	
		302.989[b@&] *4*	54 *3*	0.0	5/2⁺	[M1]		0.820	
317.1731	(5/2)⁺	99.95 *15*	0.27 *8*	217.1597	(5/2⁻)	[E1]		0.1176	
		152.62 *10*	0.15 *4*	164.5317	(3/2⁻)	[E1]		0.179	
		169.002[@] *5*	0.58 *8*	148.1730	(7/2⁻)	[E1]		0.1407	
		170.809[@] *24*	1.41 *8*	146.3569	(5/2⁻)	[E1]		0.1372	
		245.350[@] *1*	50 *3*	71.8260	(7/2⁺)	M1+E2	0.76 *5*	1.05 *4*	
		274.735[@] *1*	5.9 *3*	42.4349	7/2⁺	M1+E2	1.07 *10*	0.62 *5*	
		288.0290[c@] *9*	12.8[c] *7*	29.1927	(5/2⁺)	[M1+E2]		0.6 *4*	
		317.169[c@&] *2*	100[c] *6*	0.0	5/2⁺	M1+E2	1.24 *9*	0.371 *22*	
320.5483	(5/2)⁺	32.73 *5*	21 *3*	287.895	(7/2⁻)	[E1]		2.26	
		85.4221 *9*	2.6 *9*	235.1266	(5/2⁻,7/2⁻)	[E1]		0.1779	
		103.73 *10*	1.4 *4*	217.1597	(5/2⁻)	[E1]		0.1066	
		156.19 *5*	0.78 *6*	164.5317	(3/2⁻)	[E1]		0.1698	
		172.39 *10*	0.49 *5*	148.1730	(7/2⁻)	[E1]		0.1342	
		174.192[@] *2*	3.7 *2*	146.3569	(5/2⁻)	[E1]		0.1309	
		223.37 *3*	0.52 *6*	97.13595	9/2⁺	[E2]		0.443	
		248.724[c@] *1*	30[c] *2*	71.8260	(7/2⁺)	[M1]		1.415	
		278.108[@] *2*	24 *1*	42.4349	7/2⁺	M1+E2	1.14 *10*	0.57 *4*	
		291.355[c@] *9*	100[c] *5*	29.1927	(5/2⁺)	M1+E2	0.80 *6*	0.63 *3*	
		320.547[@&] *1*	60 *3*	0.0	5/2⁺	M1+E2	1.37 *12*	0.334 *25*	
327.8	(15/2⁺)	86.3[c] *3*	15[c] *1*	241.546	13/2⁺	[M1+E2]	0.44[#]	8.52 *17*	
		(132.1)	1.3 *3*	195.7194	(11/2⁺)	[E2]		3.39	
		(164.5)	100 *2*	163.2542	11/2⁺	[E2]		1.385	

$^{229}_{90}Th_{139}$-6

Adopted Levels, Gammas (continued)

γ(^{229}Th) (continued)

E_i(level)	J_i^π	E_γ †	I_γ †	E_f	J_f^π	Mult.‡	δ‡	α[a]	Comments
347.800	(5/2⁺)	44.80 *2*	85 *27*	302.989	(7/2⁺)	[M1]		39.5	
		92.23 *12*	100 *36*	255.957	(3/2⁺,5/2⁺,7/2⁺)	[M1]		4.79	
359.6044	(7/2⁺)	142.69 *1*	13 *2*	217.1597	(5/2⁻)	[E1]		0.211	
		185.76[d] *9*	2.9 *8*	173.4837	(9/2⁻)	[E1]		0.1124	
		317.169[c@] *2*	100[c] *40*	42.4349	7/2⁺	[M1]		0.723	
		359.38[&] *4*	1.8 *6*	0.0	5/2⁺	[M1]		0.513	
365.8136	7/2⁺	153.17[bd] *4*		212.382	(5/2⁺)				
		192.26 *4*	4.7 *5*	173.4837	(9/2⁻)	[E1]		0.1036	
		217.8[d] *2*	<0.4	148.1730	(7/2⁻)	[E1]		0.0773	
		219.43 *2*	15.3 *8*	146.3569	(5/2⁻)	[E1]		0.0759	
		240.373[@] *3*	54 *3*	125.4385	(9/2)⁺	M1+E2	0.79 *7*	1.09 *6*	
		268.675[@] *2*	32 *2*	97.13595	9/2⁺	M1+E2	0.75 *7*	0.82 *5*	
		293.996[@] *9*	16 *1*	71.8260	(7/2⁺)	M1		0.890	
		323.381[@] *14*	100 *5*	42.4349	7/2⁺	M1+E2	1.67 *12*	0.280 *17*	
		336.63 *1*	75 *4*	29.1927	(5/2⁺)	M1+E2	1.59 *24*	0.26 *4*	
		365.820[@&] *3*	100 *5*	0.0	5/2⁺	[M1]		0.489	
374.815	(7/2⁺)	71.812[bd] *8*		302.989	(7/2⁺)				
		86.3[c] *3*	100[c] *23*	288.491	(3/2⁺)	[E2]		22.5 *5*	
		139.3[b] *3*		235.1266	(5/2⁻,7/2⁻)	[E1]		0.223	
		302.989[b@] *4*		71.8260	(7/2⁺)	[M1]		0.820	
		374.71[&] *20*	4 *2*	0.0	5/2⁺	[M1]		0.458	
382.54?	(7/2⁻,9/2,11/2⁺)	209.08 *8*	50 *8*	173.4837	(9/2⁻)				
		310.71 *5*	100 *8*	71.8260	(7/2⁺)				
425.877	(9/2⁺)	184.1 *3*	23 *5*	241.546	13/2⁺	[E2]		0.897	
		188.65 *6*	26 *4*	237.366	(7/2⁻)	[E1]		0.1083	
		230.17 *2*	74 *5*	195.7194	(11/2⁺)	[M1+E2]		1.1 *7*	
		328.758 *19*	83 *4*	97.13595	9/2⁺	[M1+E2]		0.4 *3*	
		354.04 *2*	63 *4*	71.8260	(7/2⁺)	[M1+E2]		0.32 *22*	
		383.43 *3*	100 *5*	42.4349	7/2⁺	[M1+E2]		0.26 *18*	
		396.62 *3*	4.5 *10*	29.1927	(5/2⁺)	[E2]		0.0762	
428.04	(5/2⁺)	125.04 *23*	49 *15*	302.989	(7/2⁺)	[M1]		9.83	
		139.3[b] *3*	100 *11*	288.491	(3/2⁺)	[M1]		7.24	
		210.90 *8*	67 *12*	217.1597	(5/2⁻)	[E1]		0.0833	
436.951	(7/2⁻)	77.12 *3*	100 *9*	359.6044	(7/2⁺)	[E1]		0.233	E_γ: 77.142 and 77.198 form a doublet structure.
		116.3[c] *2*	28[c] *3*	320.5483	(5/2)⁺	[E1]		0.342	
		224.33 *19*	0.30 *9*	212.382	(5/2⁺)	[E1]		0.0721	

$^{229}_{90}Th_{139}$-7

Adopted Levels, Gammas (continued)

γ(^{229}Th) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]
436.951	(7/2⁻)	272.39 *2*	16.5 *9*	164.5317	(3/2⁻)	[E2]		0.228
		311.76 *3*	14.7 *9*	125.4385	(9/2)⁺	[E1]		0.0341
		340.19 *8*	0.6 *4*	97.13595	9/2⁺	[E1]		0.0282
449.38	5/2⁺,7/2⁺	161.46[&] *8*	13 *3*	288.491	(3/2⁺)			
		406.45[&] *4*	100 *3*	42.4349	7/2⁺	M1+E2	1.04 *14*	0.213 *22*
		420.70[&] *5*	6.0 *3*	29.1927	(5/2⁺)			
		449.4[&] *2*	≈350	0.0	5/2⁺	M1+E2	1.30 *16*	0.139 *15*
465.426	(5/2⁻,7/2,9/2⁺)	162.45[b] *4*		302.989	(7/2⁺)			
		291.93 *4*	100 *15*	173.4837	(9/2⁻)			
		393.60 *1*	13 *1*	71.8260	(7/2⁺)			
		423.09[c] *14*	0.5[c] *1*	42.4349	7/2⁺			
		436.23[c] *2*	3.4[c] *1*	29.1927	(5/2⁺)			
		465.37[&] *12*	0.5 *2*	0.0	5/2⁺			
478.64	5/2⁻,7/2⁻	436.20 *4*	32 *1*	42.4349	7/2⁺	E1		0.0166
		478.64 *4*	100 *3*	0.0	5/2⁺	E1		0.0138
478.649	(7/2⁺,9/2⁺)	157.98[&] *11*	5 *1*	320.5483	(5/2)⁺			
		189.60[&] *4*	0.50 *6*	288.491	(3/2⁺)			
		241.18[&] *9*	3.1 *5*	237.366	(7/2⁻)			
		261.80[&] *9*	3.3 *5*	217.1597	(5/2⁻)			
		315.39 *13*	4.5 *6*	163.2542	11/2⁺	[M1]		0.734
		330.51[&] *4*	2.8 *1*	148.1730	(7/2⁻)			
		332.52[&] *4*	0.51 *6*	146.3569	(5/2⁻)			
		381.35[d] *8*		97.13595	9/2⁺			
		406.58 *5*	20 *3*	71.8260	(7/2⁺)	[M1]		0.367
		436.23[c&] *2*	32[c] *1*	42.4349	7/2⁺	[M1]		0.303
		449.52 *2*	21 *3*	29.1927	(5/2⁺)	[M1]		0.280
		478.64 *1*	100 *3*	0.0	5/2⁺	[M1]		0.236
513.479	(5/2⁺,7/2,9/2⁺)	387.86 *12*	6.5 *16*	125.4385	(9/2)⁺			
		416.31 *3*	6.5 *5*	97.13595	9/2⁺			
		441.53 *17*	3.9 *12*	71.8260	(7/2⁺)			
		471.06 *1*	100 *10*	42.4349	7/2⁺			
		513.20[b&] *5*	89 *11*	0.0	5/2⁺			
526.516	(5/2,7/2)⁻	167.10 *7*	2.7 *3*	359.6044	(7/2⁺)			
		205.75[b] *6*		320.5483	(5/2)⁺			
		223.85[&] *4*		302.989	(7/2⁺)			
		291.355[c@] *9*	100[c] *40*	235.1266	(5/2⁻,7/2⁻)			

$^{229}_{90}Th_{139}$-8

Adopted Levels, Gammas (continued)

γ(^{229}Th) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]	Comments
526.516	(5/2,7/2)$^-$	309.49 *3*	13 *8*	217.1597	(5/2$^-$)				
		455.48 *25*	0.19 *3*	71.8260	(7/2$^+$)				
		484.34 *3*	0.4 *2*	42.4349	7/2$^+$				
		526.89[&] *7*		0.0	5/2$^+$	E1		0.0114	
536.08	(1/2$^-$)	371.34 *9*	100 *50*	164.5317	(3/2$^-$)	[M1]		0.469	
		536.44 *12*	33 *16*	0.0076	(3/2$^+$)	[E1]		0.01098	
569.2721	3/2$^+$,5/2$^+$	203.47[&] *6*	1.1 *1*	365.8136	7/2$^+$				
		248.724[c@] *1*	11[c] *1*	320.5483	(5/2)$^+$	M1+E2	0.87 *7*	0.94 *5*	
		252.07[&] *4*	34 *11*	317.1731	(5/2)$^+$	M1+E2	0.84 *6*	0.92 *4*	
		280.72[&] *4*	1.10 *3*	288.491	(3/2$^+$)				
		307.45 *19*	2.6 *1*	261.964	(1/2$^+$)	[M1,E2]		0.5 *4*	
		313.45[d] *18*		255.957	(3/2$^+$,5/2$^+$,7/2$^+$)				
		352.07[&] *4*	2.1 *1*	217.1597	(5/2$^-$)				
		404.39 *5*	9.0 *2*	164.5317	(3/2$^-$)	[E1]		0.0195	
		423.09[c] *14*	7.0[c] *2*	146.3569	(5/2$^-$)	[E1]		0.01774	
		526.4[&] *4*	2.4 *9*	42.4349	7/2$^+$				
		540.08[&] *7*	3.4 *10*	29.1927	(5/2$^+$)				
		569.19[&] *2*	100 *2*	0.0	5/2$^+$	M1+E2	1.66 *12*	0.063 *4*	
571.2	(3/2$^-$)	307.45 *19*		261.964	(1/2$^+$)				
576.39		127.02[&] *5*	100 *4*	449.38	5/2$^+$,7/2$^+$	[D,E2]			I_γ: For 127.02+127.6.
		576.2[&] *3*	≈614	0.0	5/2$^+$				E_γ: Eγ for doublet=576.08 *7*.
585.237?	(5/2$^+$,7/2,9/2$^+$)	459.81 *1*	100 *15*	125.4385	(9/2)$^+$				
		513.20[b] *5*		71.8260	(7/2$^+$)				
		542.41 *13*	6 *3*	42.4349	7/2$^+$				
		584.94[b&] *16*	≈3	0.0	5/2$^+$				
605.165	5/2$^+$,7/2$^+$	127.6[&] *1*	2.40 *8*	478.64	5/2$^-$,7/2$^-$				
		156.3[&] *1*	6.7 *25*	449.38	5/2$^+$,7/2$^+$				
		239.41[&] *4*	37 *1*	365.8136	7/2$^+$	M1+E2	0.82 *6*	1.08 *5*	
		284.67[&] *4*	22 *1*	320.5483	(5/2)$^+$	M1+E2	1.00 *8*	0.59 *4*	
		288.0290[c@d] *9*	7.1[c] *12*	317.1731	(5/2)$^+$				
		343.3[&] *1*	0.75 *17*	261.964	(1/2$^+$)				
		364.01[d] *12*		241.546	13/2$^+$				
		367.83[&] *4*	3.8 *1*	237.366	(7/2$^-$)				
		388.05[&] *4*	5.5 *2*	217.1597	(5/2$^-$)				
		440.71[&] *4*	6.3 *2*	164.5317	(3/2$^-$)				

$^{229}_{90}Th_{139}$-9

Adopted Levels, Gammas (continued)

γ(^{229}Th) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]
605.165	5/2$^+$,7/2$^+$	456.87 *16*	12.0 *4*	148.1730	(7/2$^-$)			
		458.87[&] *5*	0.67 *4*	146.3569	(5/2$^-$)			
		533.53 *5*	17.0 *4*	71.8260	(7/2$^+$)	M1+E2	1.13 *20*	0.098 *14*
		562.61 *6*	32.0 *8*	42.4349	7/2$^+$	M1+E2	1.36 *16*	0.075 *8*
		576.00 *7*	≈11	29.1927	(5/2$^+$)	M1+E2	1.55 *22*	0.064 *8*
		605.16[&] *1*	100 *3*	0.0	5/2$^+$	M1+E2	1.10 *13*	0.072 *7*
620.837	(5/2$^+$,7/2)	474.41 *8*	23 *3*	146.3569	(5/2$^-$)			
		523.68 *6*	28 *7*	97.13595	9/2$^+$			
		578.42 *2*	100 *32*	42.4349	7/2$^+$			
		591.64 *7*	21 *7*	29.1927	(5/2$^+$)			
		620.81[&] *3*	44 *18*	0.0	5/2$^+$			
637.384	(5/2$^+$,7/2,9/2$^+$)	402.22 *2*	100 *19*	235.1266	(5/2$^-$,7/2$^-$)			
		425.46 *10*	11 *2*	212.382	(5/2$^+$)			
		540.52 *6*	23 *3*	97.13595	9/2$^+$			
		608.15 *5*	6.5 *30*	29.1927	(5/2$^+$)			
		637.25[&] *10*	≈3	0.0	5/2$^+$			
653.79		84.8[&] *1*		569.2721	3/2$^+$,5/2$^+$			
		489.21[&] *4*	100 *6*	164.5317	(3/2$^-$)	[D,E2]		
		653.86[&] *10*	11 *6*	0.0	5/2$^+$	[D,E2]		
656.89	(5/2$^+$,7/2,9/2$^+$)	177.91[b] *16*		478.649	(7/2$^+$,9/2$^+$)			
		531.54 *8*	17.5 *60*	125.4385	(9/2)$^+$			
		559.87 *18*	≈6	97.13595	9/2$^+$			
		584.94[b] *16*		71.8260	(7/2$^+$)			
		614.45 *7*	17.5 *60*	42.4349	7/2$^+$			
		627.70 *8*	12 *6*	29.1927	(5/2$^+$)			
		656.89[&] *5*	100 *25*	0.0	5/2$^+$			
661.780		444.40[&] *4*	84 *3*	217.1597	(5/2$^-$)	[D,E2]		
		497.35[&] *4*	58 *2*	164.5317	(3/2$^-$)	[D,E2]		
		515.25[&] *7*	100 *3*	146.3569	(5/2$^-$)	[D,E2]		
		661.59[&] *7*	30 *1*	0.0	5/2$^+$	[D,E2]		
664.98?	(1/2,3/2)$^-$	500.40 *9*	100 *32*	164.5317	(3/2$^-$)			
		665.03[&] *10*	≈33	0.0	5/2$^+$			
689.01		83.9[&] *2*		605.165	5/2$^+$,7/2$^+$			
		540.9[&] *2*	100 *9*	148.1730	(7/2$^-$)	[D,E2]		
		542.68[&] *7*	77 *2*	146.3569	(5/2$^-$)	[D,E2]		
		688.96[&] *8*	29 *2*	0.0	5/2$^+$	[D,E2]		

$^{229}_{90}Th_{139}$-10

Adopted Levels, Gammas (continued)

γ(^{229}Th) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]
749.849	(5/2$^+$,7/2,9/2$^+$)	514.81 *11*	100 *16*	235.1266	(5/2$^-$,7/2$^-$)	
		652.79 *19*	≈2	97.13595	9/2$^+$	
		707.41 *2*	18 *8*	42.4349	7/2$^+$	
		720.62 *11*	4 *2*	29.1927	(5/2$^+$)	
		749.8[&] *9*	4 *2*	0.0	5/2$^+$	
779.29		614.82[&] *7*	100 *6*	164.5317	(3/2$^-$)	[D,E2]
		779.00[&] *15*	31 *6*	0.0076	(3/2$^+$)	[D,E2]

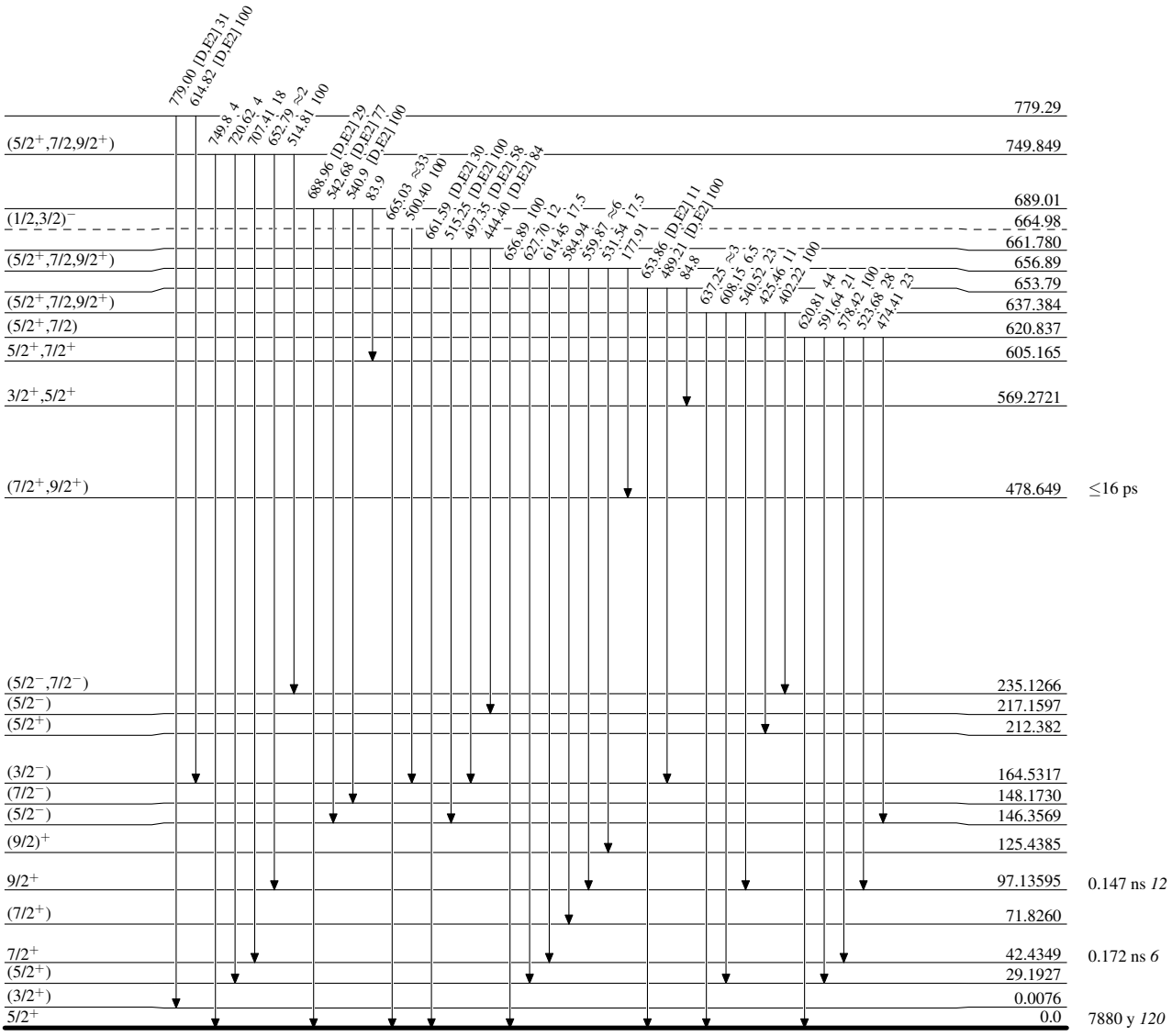
[†] From ^{233}U α decay or ^{229}Ac β^- decay, unless otherwise specified.
[‡] From ^{229}Ac β^- decay (2002Gu15), unless otherwise specified.
[#] Calculated from strong coupling rotational model (2003Ba78).
[@] High-precision measurement using a micro-calorimeter (2007Be16).
[&] From ^{229}Ac β^- decay (2002Gu15,2006Ru07).
[a] 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.
[b] Multiply placed.
[c] Multiply placed with intensity suitably divided.
[d] Placement of transition in the level scheme is uncertain.

$^{229}_{90}Th_{139}$-11

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



$^{229}_{90}Th_{139}$

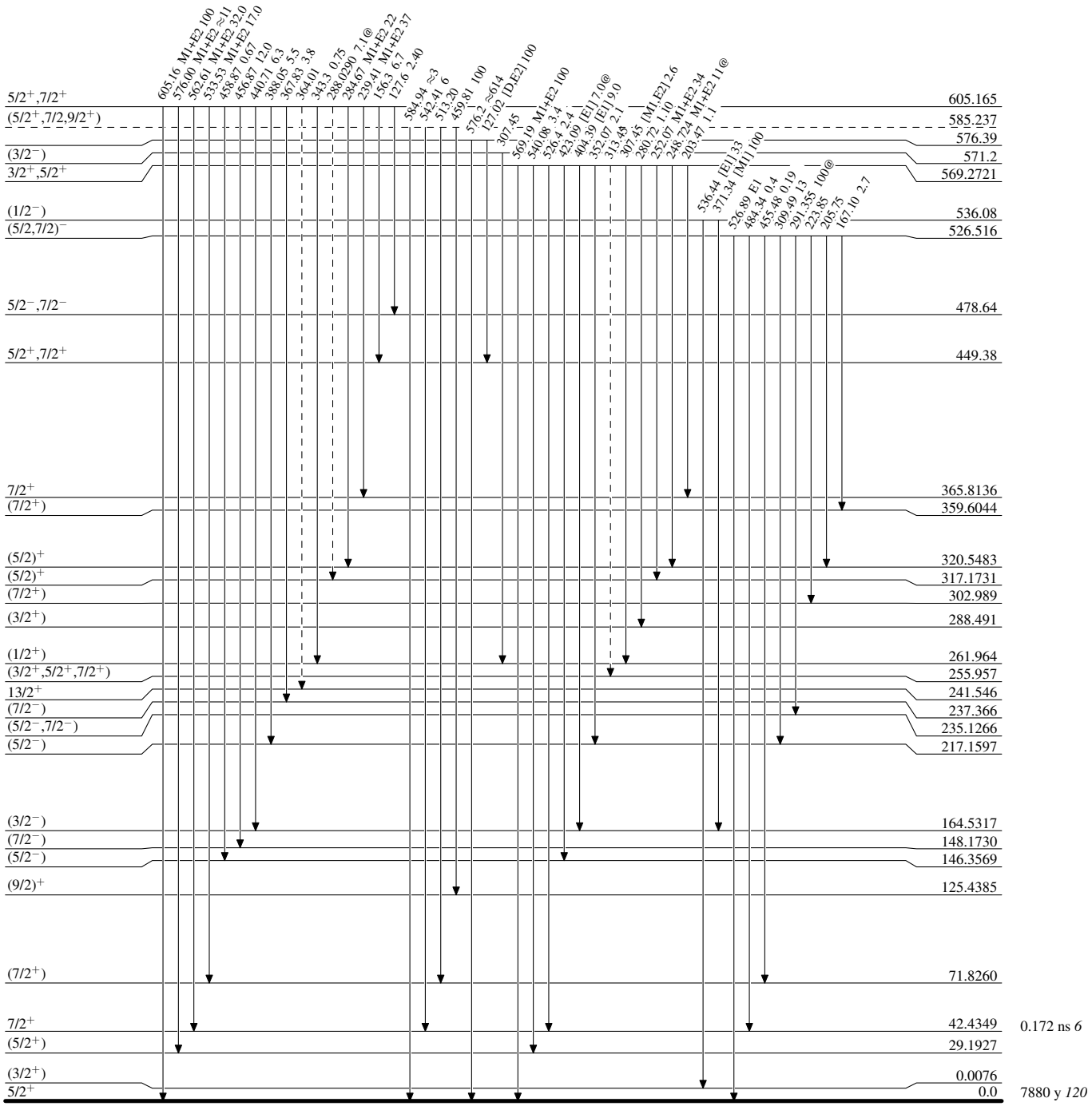
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

γ Decay (Uncertain)



$^{229}_{90}Th_{139}$

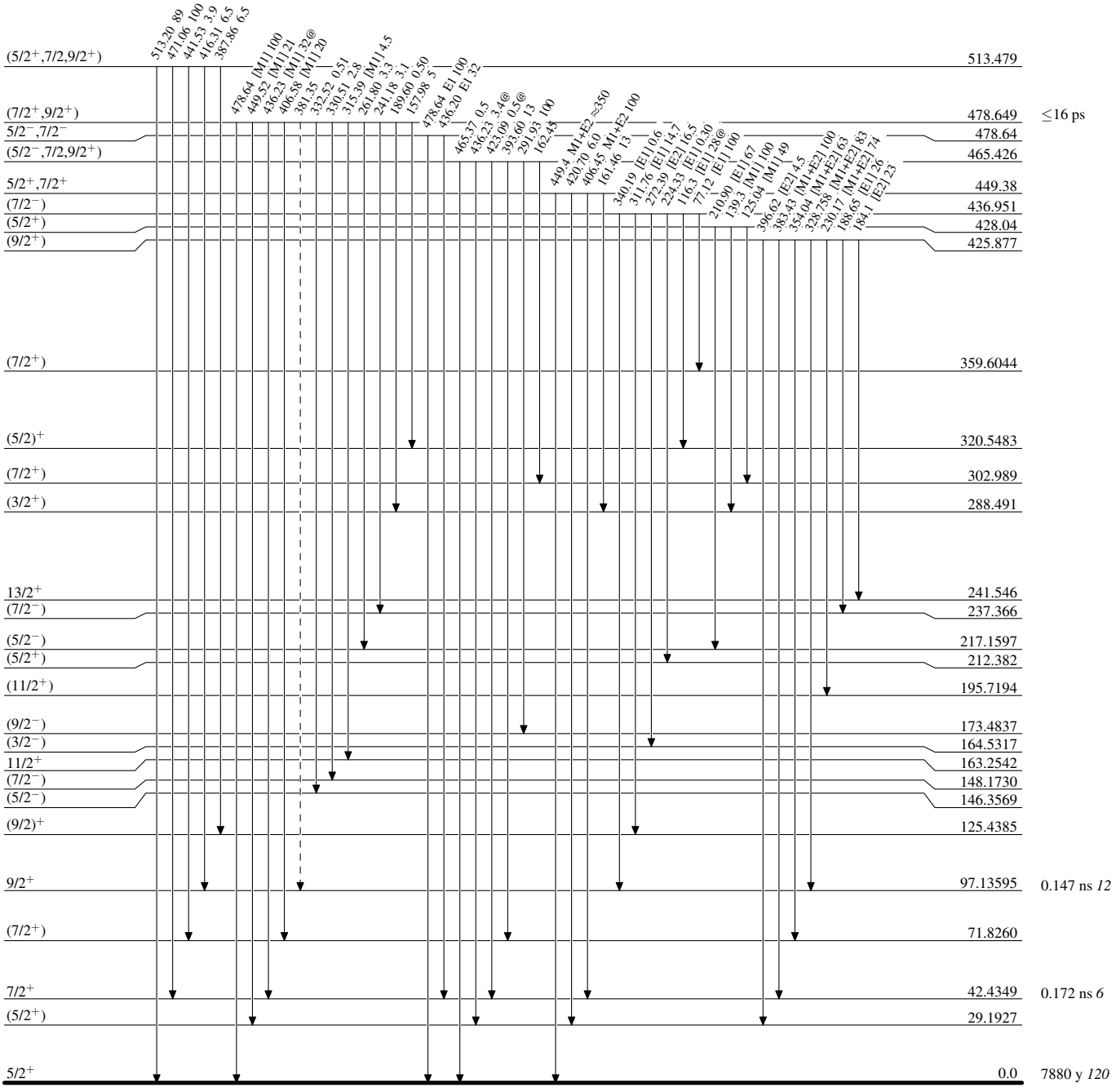
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

γ Decay (Uncertain)



$^{229}_{90}Th_{139}$

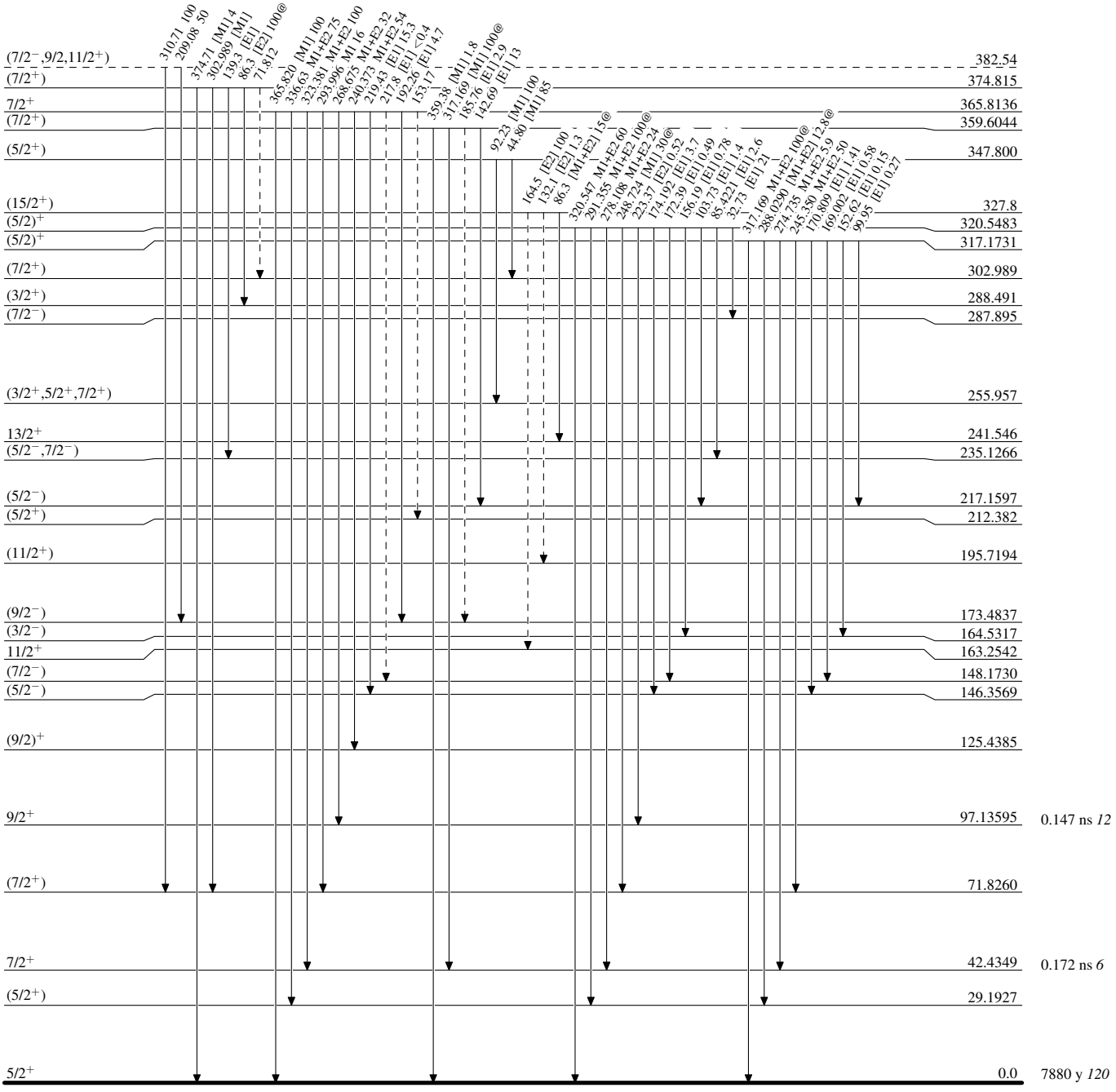
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

γ Decay (Uncertain)



$^{229}_{90}Th_{139}$

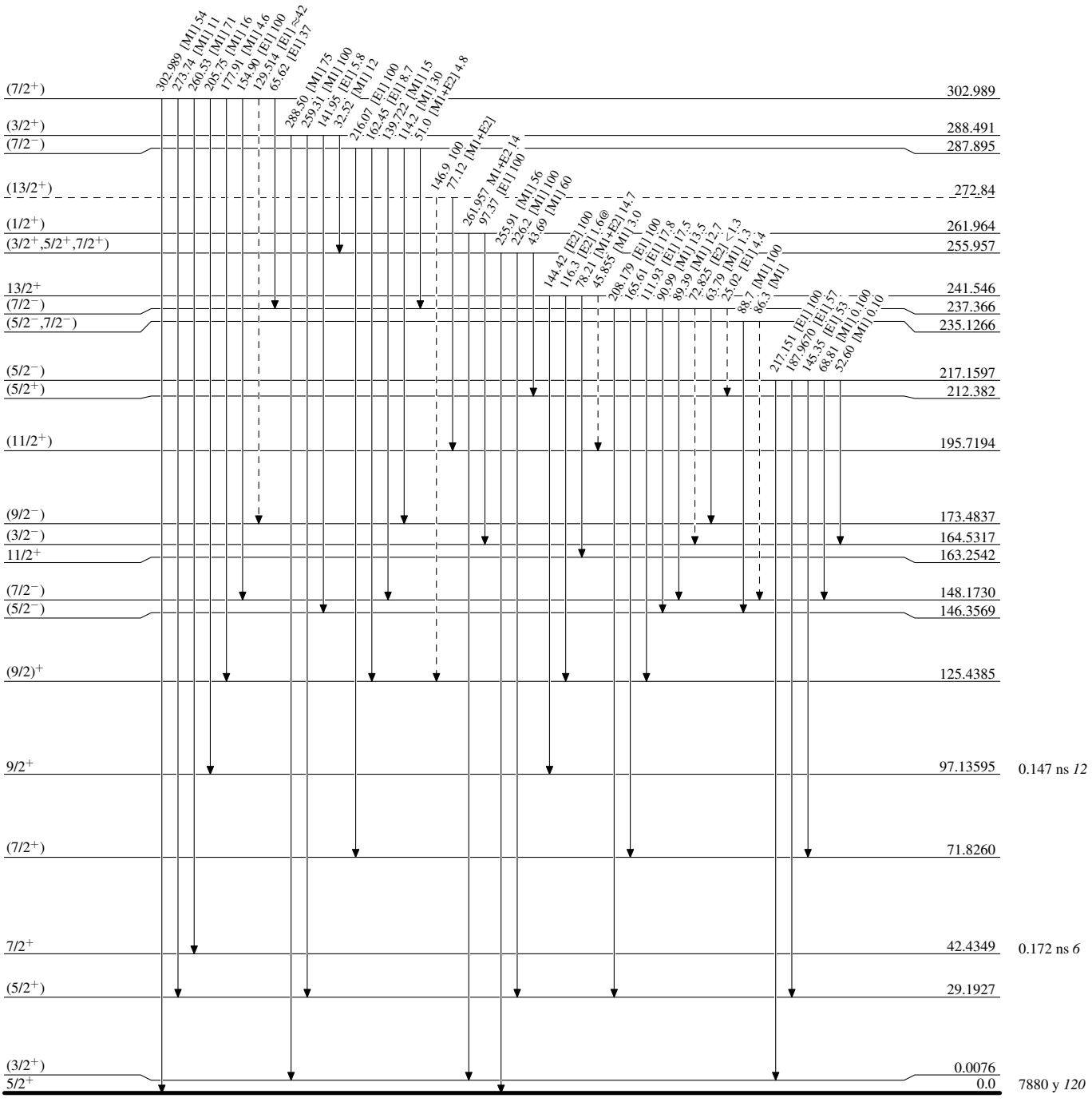
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

γ Decay (Uncertain)



$^{229}_{90}Th_{139}$

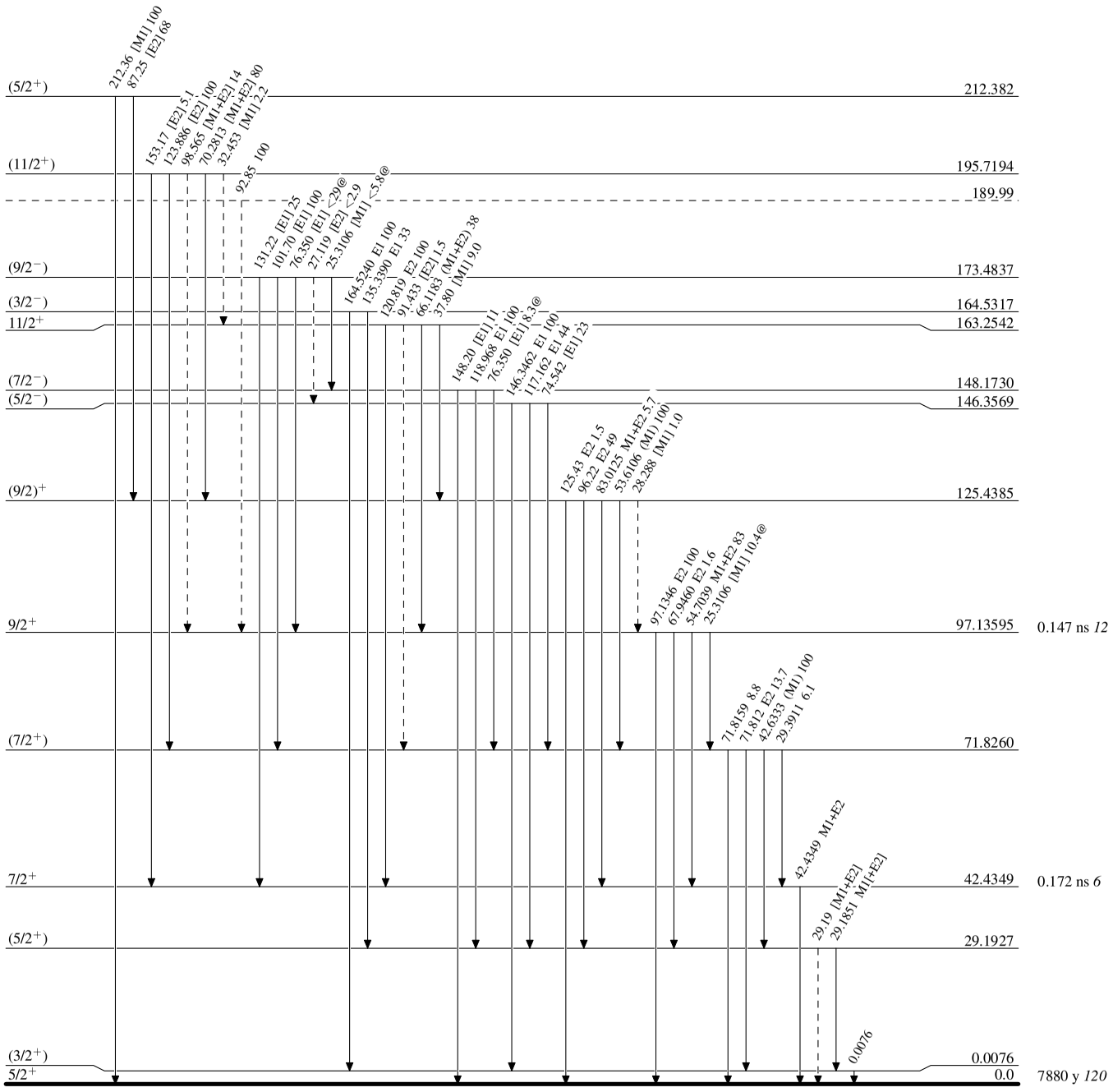
Adopted Levels, Gammas

Legend

Level Scheme (continued)

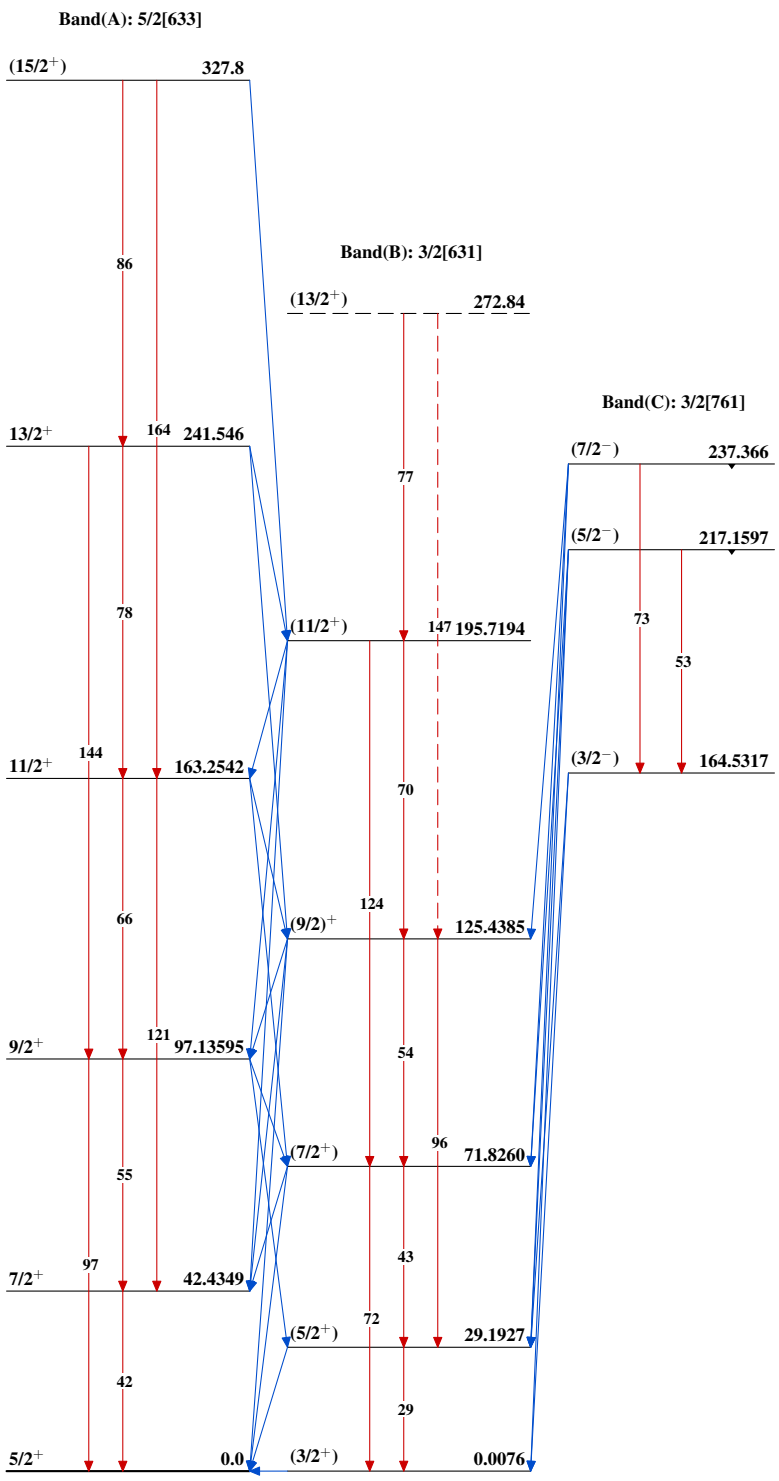
Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

γ Decay (Uncertain)



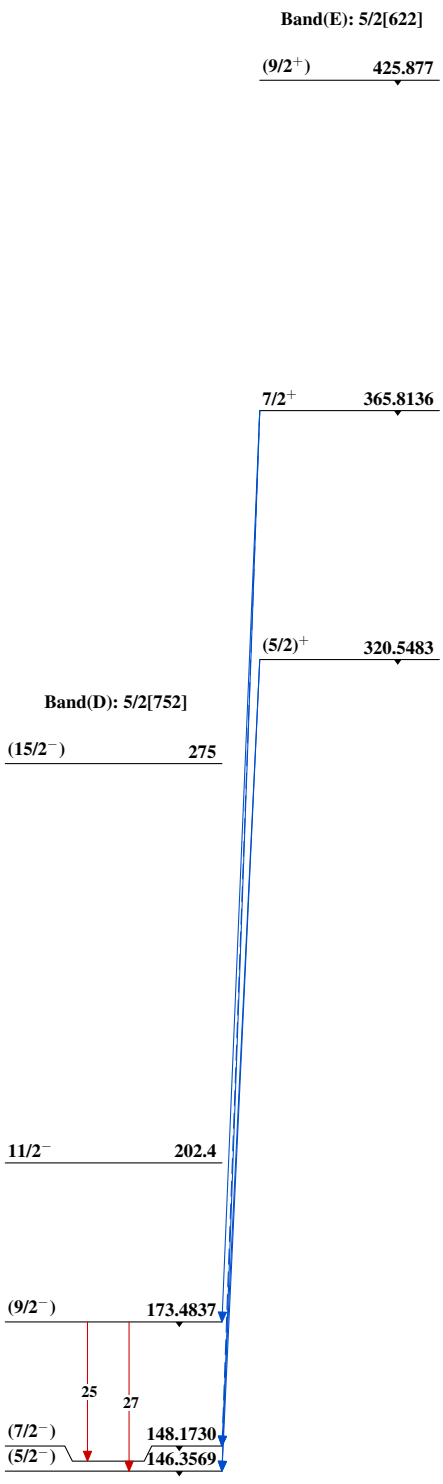
$^{229}_{90}Th_{139}$

Adopted Levels, Gammas



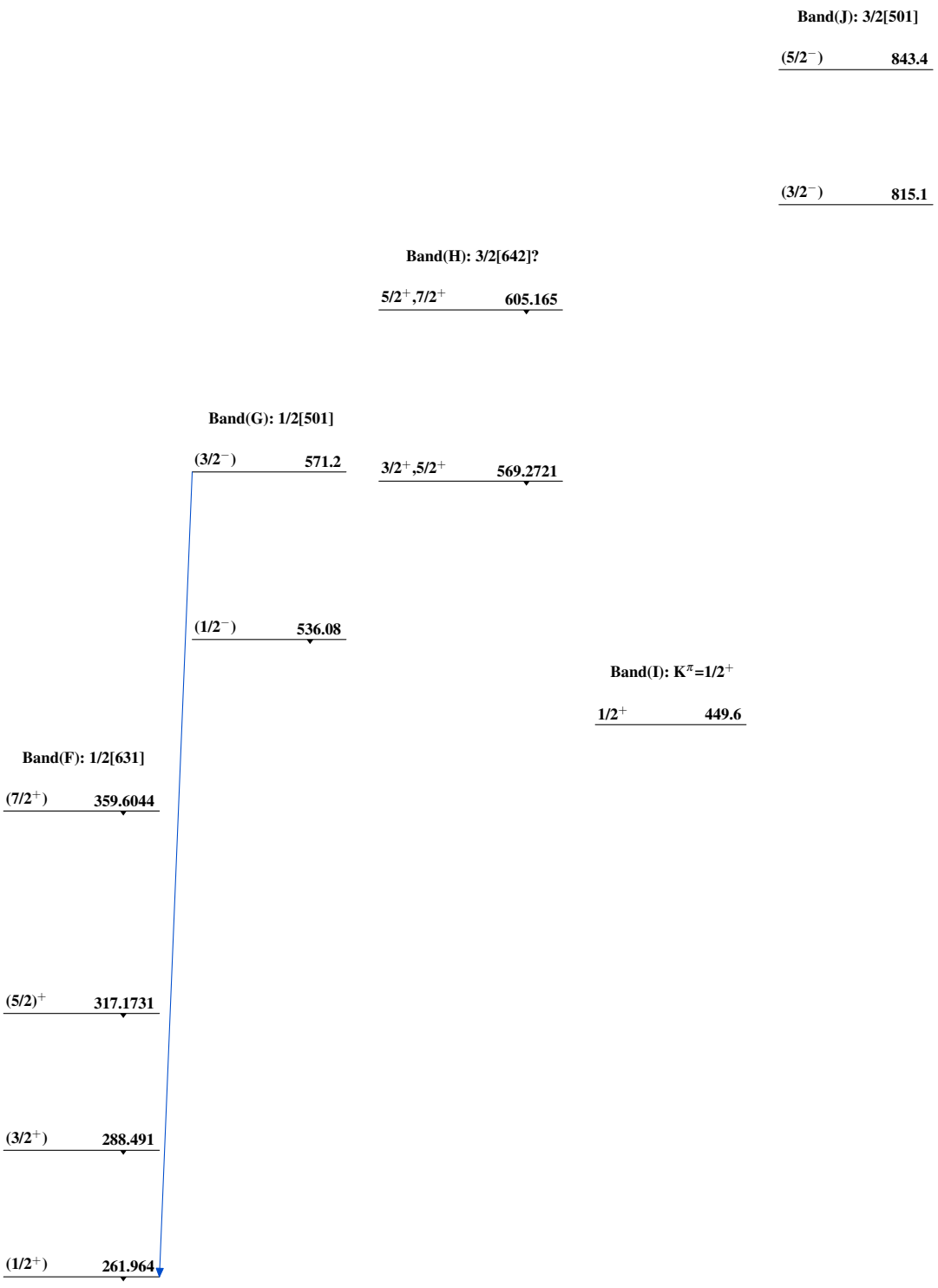
$^{229}_{90}Th_{139}$

Adopted Levels, Gammas (continued)



$^{229}_{90}Th_{139}$

Adopted Levels, Gammas (continued)



$^{229}_{90}Th_{139}$