^{208}Pb(^{18}O,3nγ) 1988Da15

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	E. Browne	NDS 93, 846 (2001)	1-May-2001

Others: 1984Bu21, 1984Bu38.

^{223}Th Levels

Authors have interpreted the level structure of ^{223}Th in terms of a nucleus with stable quadrupole and octupole ($\varepsilon_3 \approx 0.1$) deformations, based mainly on the observed octupole parity doublet bands connected by strong E1 transitions. Measured g.s. nuclear moments for ^{223}Th are not available. However, the excellent agreement between the experimental mixing ratio δ=0.21 *1* of 51.3γ (M1+E2) with a calculated value of δ=0.21 provides additional evidence for a stable octupole deformation in this nucleus (1988Le13).

E(level)[#]	J^π[@]	$T_{1/2}$	Comments
0.0[†]	$(5/2)^+$	0.60 s *2*	$T_{1/2}$: from Adopted Levels, gammas.
51.3[†] *5*	$(7/2)^+$		
118.9[†] *6*	$(9/2)^+$		
180.5[‡] *5*	$(9/2^-)$		
212.3[†] *6*	$(11/2)^+$		
243.0[‡] *6*	$(11/2^-)$		
320.0[†] *6*	$(13/2^+)$		
324.1[‡] *6*	$(13/2)^-$		
412.4[‡] *6*	$(15/2^-)$		
428.7[†] *6*	$(15/2)^+$		
547.3[‡] *6*	$(17/2)^-$		
569.6[†] *6*	$(17/2)^+$		
657.0[‡] *6*	$(19/2^-)$		
706.0[†] *6*	$(19/2)^+$		
838.1[‡] *6*	$(21/2)^-$		
858.1[†] *6*	$(21/2)^+$		
962.1[‡] *6*	$(23/2^-)$		
1021.6[†] *6*	$(23/2)^+$		
1179.4[‡] *6*	$(25/2)^-$		
1185.4[†] *6*	$(25/2)^+$		
1313.8[‡] *6*	$(27/2)^-$		
1370.6[†] *6*	$(27/2)^+$		
1551.7[†] *6*	$(29/2)^+$		
1558.4[‡] *6*	$(29/2)^-$		
1702.5[‡] *7*	$(31/2)^-$		
1756.8?[†] *6*	$(31/2^+)$		
1952.7?[†] *7*	$(33/2^+)$		

[†] Band(A): 5/2(633) parity doublet rotational band.
[‡] Band(B): 5/2(752) parity doublet rotational band.
[#] Deduced by evaluator from a least-squares fit of γ-ray energies.
[@] From Adopted Levels, gammas, based on rotational structure, γ-ray multipolarities, and on the relationship between γ-ray multiplicities and spins.

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$\gamma(^{223}Th)$

Measured Eγ, Iγ, $\gamma\gamma$ coin, ce γ coin, ce-ce coin, $\gamma(\theta)$, γ-ray multiplicities. Deduced multipolarities. Detectors: high-purity germanium, Si(Li) in a magnetic solenoid spectrometer, NaI crystal ball (151 NaI detectors and 6 Compton-suppressed high-purity germanium detectors).

E$_\gamma$	I$_\gamma$[‡]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.[†]	δ[†]	α[@]	Comments
[x]23.0 *3*	35								
[x]28.1 *3*	21								
31.9 *3*	19 *9*	212.3	(11/2)$^+$	180.5	(9/2$^-$)				
[x]34.8 *3*	9								
[x]49.7 *3*	9								
51.3 *5*	6.8 *19*	51.3	(7/2)$^+$	0.0	(5/2)$^+$	M1+E2	0.214 *10*	39.2 *10*	α(L)= 29.2 *7*; α(M)= 7.32 *18*; α(N+..)= 2.69 *7*
[x]61.8 *3*	5								
67.5 *3*	12 *3*	118.9	(9/2)$^+$	51.3	(7/2)$^+$	M1+E2	≈0.2	15 *3*	α(L)= 11.2 *17*; α(M)= 2.8 *4*; α(N+..)= 1.01 *20*
76.8 *2*	63 *12*	320.0	(13/2$^+$)	243.0	(11/2$^-$)				
87[a]		412.4	(15/2$^-$)	324.1	(13/2)$^-$				
87.4 *2*	43 *4*	657.0	(19/2$^-$)	569.6	(17/2)$^+$				
92.3 *2*	83 *11*	412.4	(15/2$^-$)	320.0	(13/2$^+$)				
93.4 *2*	11 *3*	212.3	(11/2)$^+$	118.9	(9/2)$^+$	M1+E2	0.27 *6*	5.7 *3*	α(L)= 4.23 *25*; α(M)= 1.04 *7*; α(N+..)= 0.39 *3*
[x]98[a] *1*									
[x]103.1 *2*	24 *3*								
103.8[#] *5*	150[#] *15*	962.1	(23/2$^-$)	858.1	(21/2)$^+$				I$_\gamma$: Iγ(103.8γ + 104.8γ).
104.8[#] *5*	150[#] *15*	428.7	(15/2)$^+$	324.1	(13/2)$^-$				I$_\gamma$: Iγ(104.8γ + 103.8γ).
[x]107.1 *2*	13								
108.6[#] *2*	36[#] *3*	320.0	(13/2$^+$)	212.3	(11/2)$^+$				I$_\gamma$: Th K x ray + ^{223}Th.
109[a]		428.7	(15/2)$^+$	320.0	(13/2$^+$)				
109[a]		657.0	(19/2$^-$)	547.3	(17/2)$^-$				
111.4 *2*	76 *4*	324.1	(13/2)$^-$	212.3	(11/2)$^+$	E1		0.387	α(K)= 0.298; α(L)= 0.0675; α(M)= 0.0163; α(N+..)= 0.00579
118.7 *2*	35 *8*	547.3	(17/2)$^-$	428.7	(15/2)$^+$	E1		0.333	α(K)= 0.257; α(L)= 0.0572; α(M)= 0.0138; α(N+..)= 0.00491
119.0 *5*	5.5 *31*	118.9	(9/2)$^+$	0.0	(5/2)$^+$	E2		5.40	α(K)= 0.258; α(L)= 3.73; α(M)= 1.03; α(N+..)= 0.382
124.1 *2*	77	243.0	(11/2$^-$)	118.9	(9/2)$^+$				
128.1 *3*	14 *2*	1313.8	(27/2)$^-$	1185.4	(25/2)$^+$	E1		0.276	α(K)= 0.214; α(L)= 0.0469; α(M)= 0.0113; α(N+..)= 0.00402
129.3 *2*	50 *3*	180.5	(9/2$^-$)	51.3	(7/2)$^+$				
131.9 *2*	37 *8*	838.1	(21/2)$^-$	706.0	(19/2)$^+$	E1		0.258	α(K)= 0.200; α(L)= 0.0435; α(M)= 0.0105; α(N+..)= 0.00373
									I$_\gamma$: ^{223}Th + ^{222}Th.
[x]133 *1*	<6								
136.0[&a] *2*	12[&] *5*	547.3	(17/2)$^-$	412.4	(15/2$^-$)				
136.0[&a] *2*	12[&] *5*	706.0	(19/2)$^+$	569.6	(17/2)$^+$				

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$\gamma(^{223}Th)$ (continued)

E_γ	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	α[@]	Comments
140.9[a] 2	<4	569.6	(17/2)$^+$	428.7	(15/2)$^+$			
x146.6 2	25 2							
150.7 3	18 4	1702.5	(31/2)$^-$	1551.7	(29/2)$^+$	E1	0.187	α(K)= 0.146; α(L)= 0.0309; α(M)= 0.00743; α(N+..)= 0.00264
x152.0# 3	16# 3							^{223}Th + ^{220}Ra.
157.1# 3	104# 4	569.6	(17/2)$^+$	412.4	(15/2$^-$)	E1	0.170	α(K)= 0.133; α(L)= 0.0278; α(M)= 0.00668; α(N+..)= 0.00237 I_γ: Iγ(157.1γ + 157.6γ).
157.6# 3	104# 4	1179.4	(25/2)$^-$	1021.6	(23/2)$^+$	E1	0.168	α(K)= 0.132; α(L)= 0.0275; α(M)= 0.00662; α(N+..)= 0.00235 I_γ: Iγ(157.6γ + 157.1γ).
158.6# 2	64# 3	706.0	(19/2)$^+$	547.3	(17/2)$^-$	E1	0.166	α(K)= 0.130; α(L)= 0.0271; α(M)= 0.00652; α(N+..)= 0.00231
161.0# 5	15# 5	212.3	(11/2)$^+$	51.3	(7/2)$^+$			
x164 1	13 3							
x166.3 2	<11							
170.0 2	8 4	412.4	(15/2$^-$)	243.0	(11/2$^-$)			
x176.1 2	10 3							
x181.1 2	23 2							
183.3# 3	38# 9	1021.6	(23/2)$^+$	838.1	(21/2)$^-$	E1	0.117	α(K)= 0.0923; α(L)= 0.0187; α(M)= 0.00451; α(N+..)= 0.00160
187.8 2	49 3	1558.4	(29/2)$^-$	1370.6	(27/2)$^+$	E1	0.111	α(K)= 0.0872; α(L)= 0.0176; α(M)= 0.00424; α(N+..)= 0.00150
191.3 2	38 3	1370.6	(27/2)$^+$	1179.4	(25/2)$^-$	E1	0.106	α(K)= 0.0835; α(L)= 0.0168; α(M)= 0.00405; α(N+..)= 0.00143
x194.0 5	8 2							
198.4[a] 2	23 2	1756.8?	(31/2$^+$)	1558.4	(29/2)$^-$	E1	0.0971	α(K)= 0.0767; α(L)= 0.0154; α(M)= 0.00370; α(N+..)= 0.00131
200.9& 2	64& 3	320.0	(13/2$^+$)	118.9	(9/2)$^+$			
200.9& 2	64& 3	858.1	(21/2)$^+$	657.0	(19/2$^-$)			
x203.0 5	18							
x205.0 3	16							
x213.7 2	17 3							
216.6 3	20 3	428.7	(15/2)$^+$	212.3	(11/2)$^+$	E2	0.504	
x217.9 2	<7							
x219.6 2	20 3							
223.2& 2	54& 3	547.3	(17/2)$^-$	324.1	(13/2)$^-$	E2	0.453	α(K)= 0.131; α(L)= 0.234; α(M)= 0.0637; α(N+..)= 0.0235
223.2& 2	54& 3	1185.4	(25/2)$^+$	962.1	(23/2$^-$)			
237.8 2	30 3	1551.7	(29/2)$^+$	1313.8	(27/2)$^-$	E1	0.0635	α(K)= 0.0505; α(L)= 0.00982; α(M)= 0.00236; α(N+..)= 0.000832
x240.9 2	20 2							
244.6# 2	14# 6	657.0	(19/2$^-$)	412.4	(15/2$^-$)			
249.5# 3	31# 5	569.6	(17/2)$^+$	320.0	(13/2$^+$)			I_γ: Iγ(249.5γ + 250.2γ).
250.2#[a] 3	31# 5	1952.7?	(33/2$^+$)	1702.5	(31/2)$^-$			I_γ: Iγ(250.2γ + 249.5γ).
x260.0 2	9							
x262.0 2	6							
x265.0 2	3.6							
x270.3 2	11							
277.4# 2	11# 2	706.0	(19/2)$^+$	428.7	(15/2)$^+$	E2	0.219	α(K)= 0.0863; α(L)= 0.0972; α(M)= 0.0262; α(N+..)= 0.00964
288.5 2	3.8 8	858.1	(21/2)$^+$	569.6	(17/2)$^+$	E2	0.194	α(K)= 0.0799; α(L)= 0.0834; α(M)= 0.0224; α(N+..)= 0.00825

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^{208}Pb(^{18}O,3nγ) 1988Da15 (continued)

γ(^{223}Th) (continued)

E_γ	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	α[@]	Comments
290.9 *2*	15 *2*	838.1	$(21/2)^-$	547.3	$(17/2)^-$	E2	0.189	α(K)= 0.0785; α(L)= 0.0808; α(M)= 0.0217; α(N+..)= 0.00799
[x]297.6 *2*	4							
305.2 *2*	19 *2*	962.1	$(23/2^-)$	657.0	$(19/2^-)$	E2	0.163	α(K)= 0.0714; α(L)= 0.0671; α(M)= 0.0180; α(N+..)= 0.00662
315.7 *2*	4.8 *9*	1021.6	$(23/2)^+$	706.0	$(19/2)^+$	E2	0.147	α(K)= 0.0667; α(L)= 0.0590; α(M)= 0.0158; α(N+..)= 0.00581
326.8[#] *5*	8[#] *2*	1185.4	$(25/2)^+$	858.1	$(21/2)^+$	E2	0.133	α(K)= 0.0623; α(L)= 0.0518; α(M)= 0.0139; α(N+..)= 0.00509
								I_γ: Iγ(326.8γ + 326.9γ).
[x]326.9[#] *5*	8[#] *2*							I_γ: Iγ(326.9γ + 326.8γ).
[x]331.8[#] *2*	13[#]							I_γ: Iγ(331.8γ + 332.2γ).
[x]332.2[#] *5*	13[#]							I_γ: Iγ(332.2γ + 331.8γ).
341.4 *2*	8 *3*	1179.4	$(25/2)^-$	838.1	$(21/2)^-$	E2	0.117	α(K)= 0.0571; α(L)= 0.0441; α(M)= 0.0117; α(N+..)= 0.00431
349.0 *2*	11 *4*	1370.6	$(27/2)^+$	1021.6	$(23/2)^+$			
351.9 *2*	20 *5*	1313.8	$(27/2)^-$	962.1	$(23/2^-)$			
[x]354.1 *2*	10							
[x]358.9 *2*	7							
[x]363.1 *2*	3.8							
366.3 *2*	9 *3*	1551.7	$(29/2)^+$	1185.4	$(25/2)^+$	E2	0.0962	α(K)= 0.0497; α(L)= 0.0341; α(M)= 0.00905; α(N+..)= 0.00332
[x]372.8 *2*	3.9							
378.9[#] *5*	12[#] *3*	1558.4	$(29/2)^-$	1179.4	$(25/2)^-$	E2	0.0877	α(K)= 0.0465; α(L)= 0.0302; α(M)= 0.00801; α(N+..)= 0.00293
								I_γ: Iγ(378.9γ + 379.0γ).
[x]379.0[#] *5*	12[#] *3*							I_γ: Iγ(379.0γ + 378.9γ).
386.2[a] *2*	4.6 *18*	1756.8?	$(31/2^+)$	1370.6	$(27/2)^+$	E2	0.0833	α(K)= 0.0448; α(L)= 0.0282; α(M)= 0.00747; α(N+..)= 0.00274
388.8 *2*	11 *3*	1702.5	$(31/2)^-$	1313.8	$(27/2)^-$	E2	0.0818	α(K)= 0.0442; α(L)= 0.0276; α(M)= 0.00730; α(N+..)= 0.00267
[x]393.6 *2*	4							
[x]396.3 *2*	5.2							
401.0[a] *5*	4.2 *20*	1952.7?	$(33/2^+)$	1551.7	$(29/2)^+$	E2	0.0753	α(K)= 0.0417; α(L)= 0.0248; α(M)= 0.00653; α(N+..)= 0.00239
[x]413.2 *2*	5.6							
[x]418.2 *2*	14							
[x]421.5 *2*	8.7							
[x]440.8 *2*	20							
[x]444.3 *2*	8.7							

[†] From L-subshell ratios and γ-ray angular distributions. E1 multipolarities have been assigned to transitions for which conversion-electron lines were not observed.
[‡] For a projectile energy E(^{18}O)=86 MeV.
[#] Doublet.
[@] 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.
[&] Multiply placed with undivided intensity.
[a] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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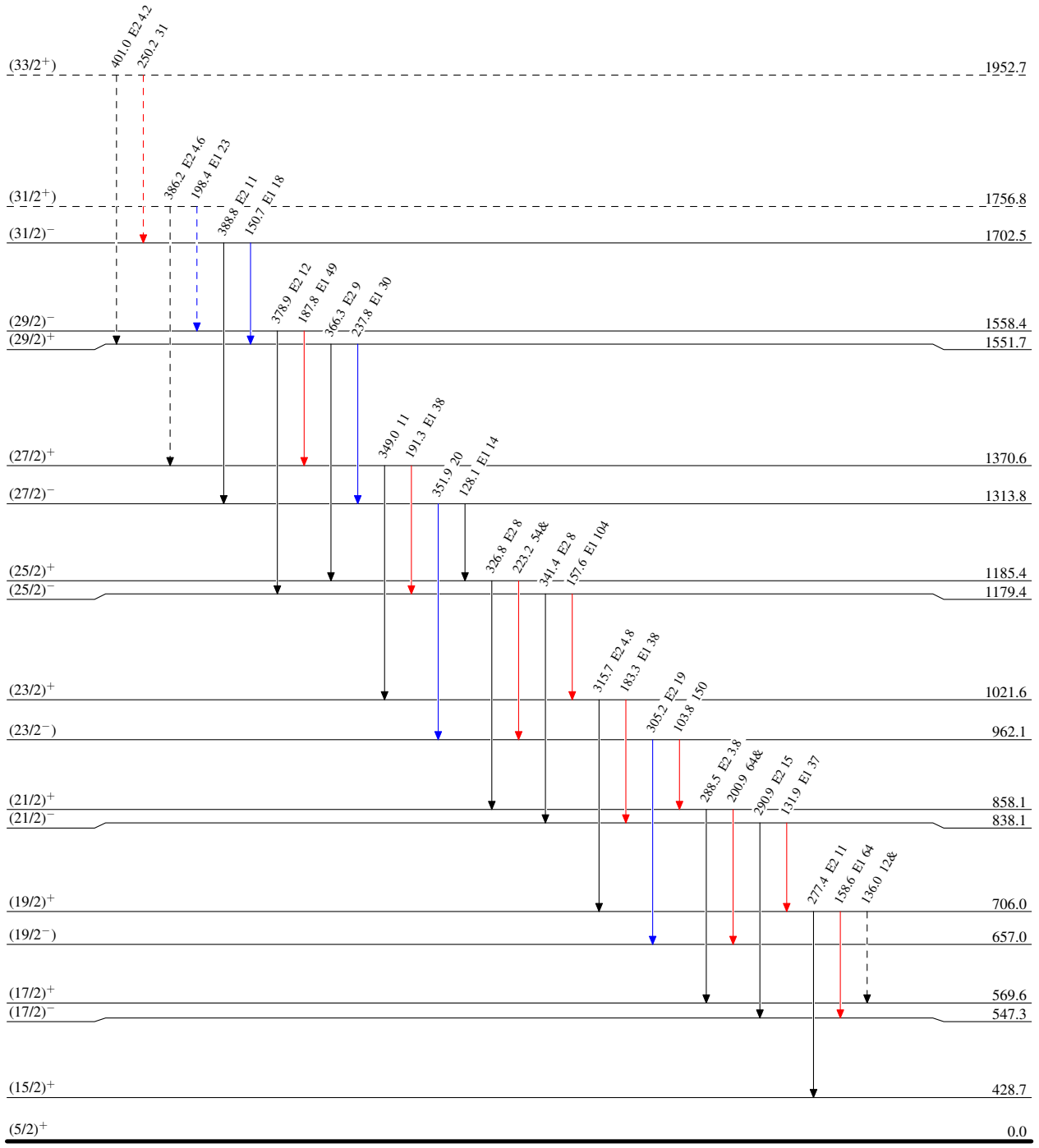
Level Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)



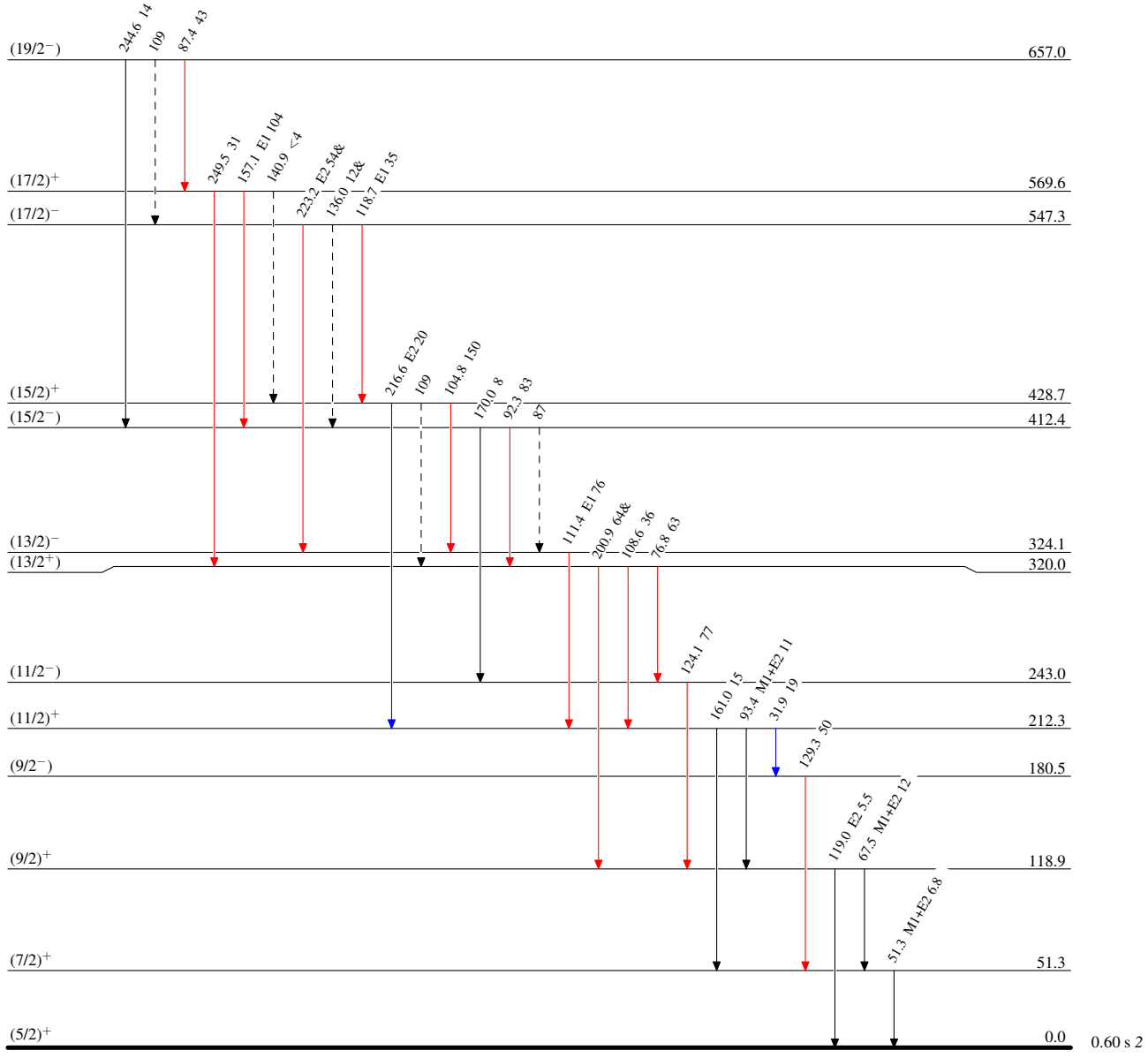
$^{223}_{90}Th_{133}$

^{208}Pb(^{18}O,3nγ) 1988Da15

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)



$^{223}_{90}Th_{133}$

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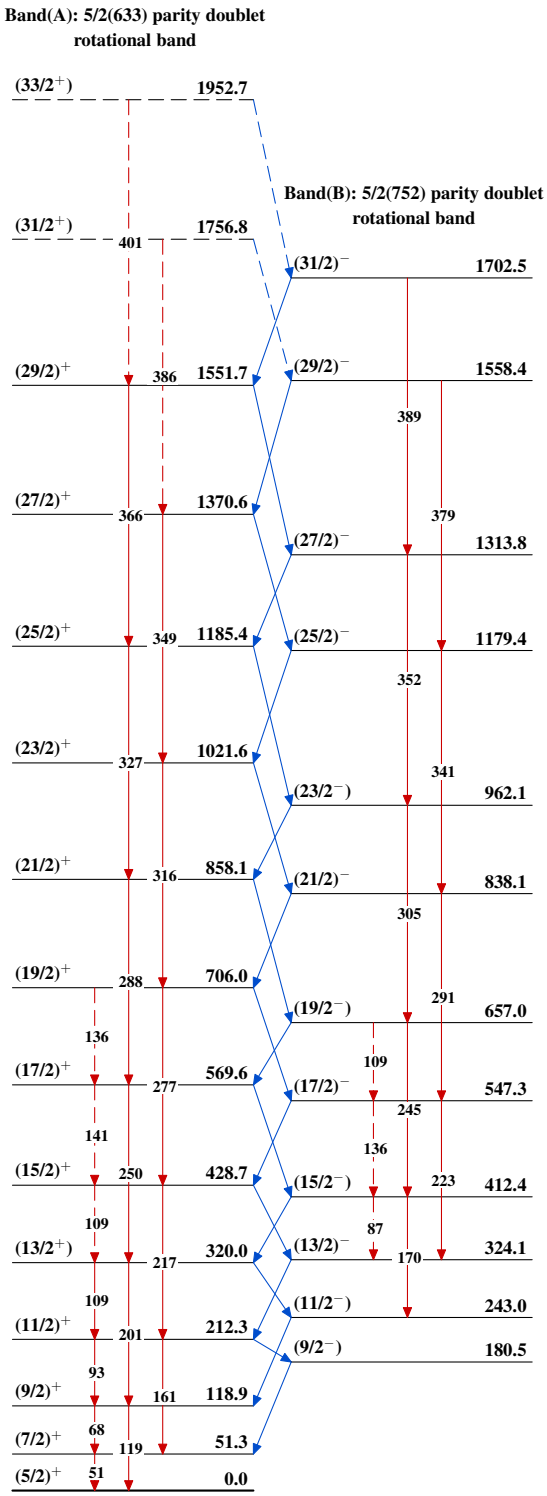

$^{223}_{90}Th_{133}$