^{156}Gd(^{37}Cl,4nγ) 1996RiZZ

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	T. D. Johnson, Balraj Singh	NDS 142, 1 (2017)	15-Apr-2017

Other reaction: ^{159}Tb(^{34}S,4nγ) from 1988GoZN.

1996RiZZ (also 1995Re18): ^{156}Gd(^{37}Cl,4nγ), E=171 MeV. Gammasphere array "Early Implementation Phase". Measured Eγ and $\gamma\gamma$. Details of this study are not available.

1988GoZN: ^{159}Tb(^{34}S,4nγ): two cascades are built on 9/2$^-$ isomeric state: 386.4-314.4-502-502-665-237 and 386.4-480.2-399.0-283.3-407.6-396-463. Level energies relative to 0 for the (9/2$^-$) isomer are: 386.4,11/2$^-$; 700.5,13/2$^-$; 866.6,13/2$^+$; 1203,17/2$^-$; 1265.6,15/2$^+$; 1549,17/2$^+$; 1705; 1828.8; 1956.6; 2353; 2370; 2607; 2816. The 700.5 level also deexcites by a g.s. transition; 1549 also by a 682.4γ and 1828.8 level only by a 563.2γ. Except for 563.2γ from 1828 level, all the others γ rays are in 1996RiZZ but some are differently ordered in the negative parity cascade.

1996RiZZ state that their level scheme does not show the complete information on levels based on 13/2$^+$ state, only the strongest cascade is presented.

^{189}Tl Levels

E(level)[†]	J$^\pi$[@]	$T_{1/2}$	Comments
0?[‡]	1/2$^+$		
257.4[&] *14*	9/2$^-$	1.4 min *1*	%ε+%β^+=98 *2*; %IT<4 E(level): 257.6 keV proposed in 1996RiZZ for the (9/2$^-$) isomer based on connection of high-spin states to low-spin states is not confirmed by ε decay study of 2009Sa09 from their $\gamma\gamma$ coincidence data.
317.9?[‡] *8*	3/2$^+$		
587.1?[‡] *8*	(5/2$^+$)		
643.3[#a] *14*	11/2$^-$		
747.6?[‡] *11*			
957.5[#&] *15*	13/2$^-$		
1038.4?[‡] *11*	(7/2$^-$)		
1122.9[#] *16*	13/2$^+$		
1384.5[#a] *15*	15/2$^-$		
1501.4?[‡f] *15*	(9/2$^-$)		
1521.8[#] *18*	15/2$^+$		
1621.4[#&] *16*	(17/2$^-$)		
1805.0[#] *18*	17/2$^+$		
1820.4[#] *16*	17/2$^-$		
1938.4?[‡f] *18*	(13/2$^-$)		
1970.6[#e] *19*	17/2$^+$		
2123.2[#d] *17*	(19/2$^-$)		
2139.7[#a] *16*	19/2$^-$		
2212.3[#e] *19*	21/2$^+$		
2422.4?[‡f] *21*	(17/2$^-$)		
2477.4[#&] *16*	21/2$^-$		
2608.3[#e] *22*	25/2$^+$		
2624.6[#c] *17*	(23/2$^-$)		
2644.2[#d] *19*	(23/2$^-$)		
2674.5[#a] *17*	23/2$^-$		
2765.0[#b] *18*	(25/2$^-$)		
2962.4?[‡f] *23*	(21/2$^-$)		
3002.0[#c] *19*	(27/2$^-$)		

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^{156}Gd(^{37}Cl,4nγ) 1996RiZZ (continued)

^{189}Tl Levels (continued)

E(level)†	Jπ@	E(level)†	Jπ@	E(level)†	Jπ@	E(level)†	Jπ@
3070.3#e 24	29/2+	3877.2#d 24	(31/2−)	4581#d 3	(35/2−)	5337#d 3	(39/2−)
3229.2#d 22	(27/2−)	3934.0#b 20	(33/2−)	4621?‡ 3		5581#e 3	45/2+
3254.0#b 19	(29/2−)	4195?#f 3	(29/2−)	4705.0#b 22	(37/2−)	6308#e 4	49/2+
3559.4?‡f 25	(25/2−)	4207#e 3	37/2+	4868?‡f 3			
3603.0#c 20	(31/2−)	4336.0#c 21	(35/2−)	4871#e 3	41/2+		
3604#e 3	33/2+	4432?‡ 3		4913?‡ 4			

† From least-squares fit to Eγ data, assuming 1 keV uncertainty for each γ ray.

‡ Level not included in the Adopted Levels since the placements of 269, 318, 430, 451, 463, 587 and 781 γ rays shown in band 5 in figure 1 of 1996RiZZ are not confirmed from γγ coin data by 2009Sa09 in their ε decay study, where all these γ rays were seen. 2009Sa09 assign these γ rays to high-spin levels. For this reason, levels and gamma rays shown for band 5 in 1996RiZZ are not listed in Adopted Levels.

A value of 23 keV should be added to level energy in order to match with the corresponding level in Adopted Levels. This difference arises due to the value of 258 keV for the (9/2−) isomer given in 1996RiZZ which has been proven incorrect by 2009Sa09 on the basis of γγ coin data.

@ As proposed in 1996RiZZ based on DCO ratios and band assignments. But DCO ratios are not listed in the reports. In the Adopted Levels, all assignments are given in parentheses due to lack of strong supporting arguments.

& Band(A): π9/2[505], α=+1/2. Interpreted as oblate ($\beta_2\approx0.15$) band from $h_{9/2}$ proton orbital. This band is crossed by a strongly coupled band due to a pair of $i_{13/2}$ neutrons.

a Band(a): π9/2[505],α=−1/2. See comment for α=+1/2 signature partner.

b Band(B): $\pi9/2[505]\otimes\nu i^2_{13/2}$,α=+1/2. The π9/2[505] band is crossed by $\nu i^2_{13/2}$ band, thus producing a sharp backbend.

c Band(b): $\pi9/2[505]\otimes\nu i^2_{13/2}$,α=−1/2. See comment for α=+1/2 signature partner.

d Band(C): Possible π1/2[550] band. Interpreted as oblate hole band.

e Band(D): π1/2[660],α=+1/2. Interpreted as decoupled prolate ($\beta_2\approx0.27$) intruder band from $\pi i_{13/2}$ orbital.

f Band(E): Possible 1/2[541] intruder band (?). This band from 1996RiZZ is not included in the Adopted Levels since low-lying and low-spin sections of the level scheme proposed in 1996RiZZ have not been confirmed by 2009Sa09 in β decay study.

γ(^{189}Tl)

Eγ	Ei(level)	J^π_i	Ef	J^π_f	Comments
140	2765.0	(25/2−)	2624.6	(23/2−)	
165	1122.9	13/2+	957.5	13/2−	
189‡	4621?		4432?		
197	2674.5	23/2−	2477.4	21/2−	
199	1820.4	17/2−	1621.4	(17/2−)	
237	1621.4	(17/2−)	1384.5	15/2−	Additional information 6.
237	3002.0	(27/2−)	2765.0	(25/2−)	
237‡	4432?		4195?	(29/2−)	
242	2212.3	21/2+	1970.6	17/2+	
252	3254.0	(29/2−)	3002.0	(27/2−)	
269†	587.1?	(5/2+)	317.9?	3/2+	
283	1805.0	17/2+	1521.8	15/2+	Additional information 8.
288	2765.0	(25/2−)	2477.4	21/2−	
291†	1038.4?	(7/2−)	747.6?		
292‡	4913?		4621?		
303	2123.2	(19/2−)	1820.4	17/2−	
314	957.5	13/2−	643.3	11/2−	Additional information 2.

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^{156}Gd(^{37}Cl,4nγ) 1996RiZZ (continued)

$\gamma(^{189}Tl)$ (continued)

E_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.	Comments
318	317.9?	$3/2^+$	0?	$1/2^+$		
319	2139.7	$19/2^-$	1820.4	$17/2^-$		
331	3934.0	$(33/2^-)$	3603.0	$(31/2^-)$		
338	2477.4	$21/2^-$	2139.7	$19/2^-$		
349	3603.0	$(31/2^-)$	3254.0	$(29/2^-)$		
369#	4705.0	$(37/2^-)$	4336.0	$(35/2^-)$		
386	643.3	$11/2^-$	257.4	$9/2^-$		Additional information 1.
395†	1038.4?	$(7/2^-)$	643.3	$11/2^-$		
396	2608.3	$25/2^+$	2212.3	$21/2^+$		Additional information 12.
399	1521.8	$15/2^+$	1122.9	$13/2^+$		Additional information 5.
402#	4336.0	$(35/2^-)$	3934.0	$(33/2^-)$		
407	2212.3	$21/2^+$	1805.0	$17/2^+$		Additional information 11.
427	1384.5	$15/2^-$	957.5	$13/2^-$		
430†	747.6?		317.9?	$3/2^+$		
436	1820.4	$17/2^-$	1384.5	$15/2^-$		
437‡	1938.4?	$(13/2^-)$	1501.4?	$(9/2^-)$		
449	1970.6	$17/2^+$	1521.8	$15/2^+$		
451†	1038.4?	$(7/2^-)$	587.1?	$(5/2^+)$		
462	3070.3	$29/2^+$	2608.3	$25/2^+$		Additional information 14.
463†	1501.4?	$(9/2^-)$	1038.4?	$(7/2^-)$		
480	1122.9	$13/2^+$	643.3	$11/2^-$		Additional information 4.
484‡	2422.4?	$(17/2^-)$	1938.4?	$(13/2^-)$		
484	2624.6	$(23/2^-)$	2139.7	$19/2^-$		Mult.: ΔJ=2, Q transition based on DCO measurements as communicated to the evaluators by W. Reviol in a priv. comm. on Jan 30, 2011.
489	3254.0	$(29/2^-)$	2765.0	$(25/2^-)$		
502	2123.2	$(19/2^-)$	1621.4	$(17/2^-)$	D	Mult.: ΔJ=1, dipole (1995Re18) based on DCO ratios of 303 and 199 γ cascade in parallel to the 502γ. Additional information 10.
502	2624.6	$(23/2^-)$	2123.2	$(19/2^-)$		Additional information 13.
518	2139.7	$19/2^-$	1621.4	$(17/2^-)$		
521	2644.2	$(23/2^-)$	2123.2	$(19/2^-)$		
534	3604	$33/2^+$	3070.3	$29/2^+$		
535	2674.5	$23/2^-$	2139.7	$19/2^-$		
540‡	2962.4?	$(21/2^-)$	2422.4?	$(17/2^-)$		
585	3229.2	$(27/2^-)$	2644.2	$(23/2^-)$		
587†	587.1?	$(5/2^+)$	0?	$1/2^+$		
597‡	3559.4?	$(25/2^-)$	2962.4?	$(21/2^-)$		
601	3603.0	$(31/2^-)$	3002.0	$(27/2^-)$		
603	4207	$37/2^+$	3604	$33/2^+$		
636‡	4195?	$(29/2^-)$	3559.4?	$(25/2^-)$		
648	3877.2	$(31/2^-)$	3229.2	$(27/2^-)$		
657	2477.4	$21/2^-$	1820.4	$17/2^-$		
664	1621.4	$(17/2^-)$	957.5	$13/2^-$		Additional information 7.
664	4871	$41/2^+$	4207	$37/2^+$		
673‡#	4868?		4195?	$(29/2^-)$		
680	3934.0	$(33/2^-)$	3254.0	$(29/2^-)$		
682	1805.0	$17/2^+$	1122.9	$13/2^+$		Additional information 9.
700	957.5	$13/2^-$	257.4	$9/2^-$		Additional information 3.
704	4581	$(35/2^-)$	3877.2	$(31/2^-)$		
710	5581	$45/2^+$	4871	$41/2^+$		
727	6308	$49/2^+$	5581	$45/2^+$		
733#	4336.0	$(35/2^-)$	3603.0	$(31/2^-)$		

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^{156}Gd(^{37}Cl,4nγ) 1996RiZZ (continued)

$\gamma(^{189}Tl)$ (continued)

E_γ	E_i(level)	J_i^π	E_f	J_f^π	E_γ	E_i(level)	J_i^π	E_f	J_f^π
741	1384.5	$15/2^-$	643.3	$11/2^-$	781[†]	1038.4?	$(7/2^-)$	257.4	$9/2^-$
755	2139.7	$19/2^-$	1384.5	$15/2^-$	848[#]	1970.6	$17/2^+$	1122.9	$13/2^+$
756	5337	$(39/2^-)$	4581	$(35/2^-)$	856	2477.4	$21/2^-$	1621.4	$(17/2^-)$
771[#]	4705.0	$(37/2^-)$	3934.0	$(33/2^-)$	863	1820.4	$17/2^-$	957.5	$13/2^-$

[†] Placement in the level scheme is suspect in view of $\gamma\gamma$ coin data from 2009Sa09, which did not confirm placements of 269, 318, 430, 451, 463, 587 and 781 γ rays in the lower section of sequence 5 in figure 1 of 1996RiZZ. Thus this γ ray is not included in the Adopted Gammas.

[‡] This γ not included in Adopted Levels, Gammas dataset due to uncertain and unconfirmed nature of the lower section of the sequence 5 in figure 1 of 1996RiZZ.

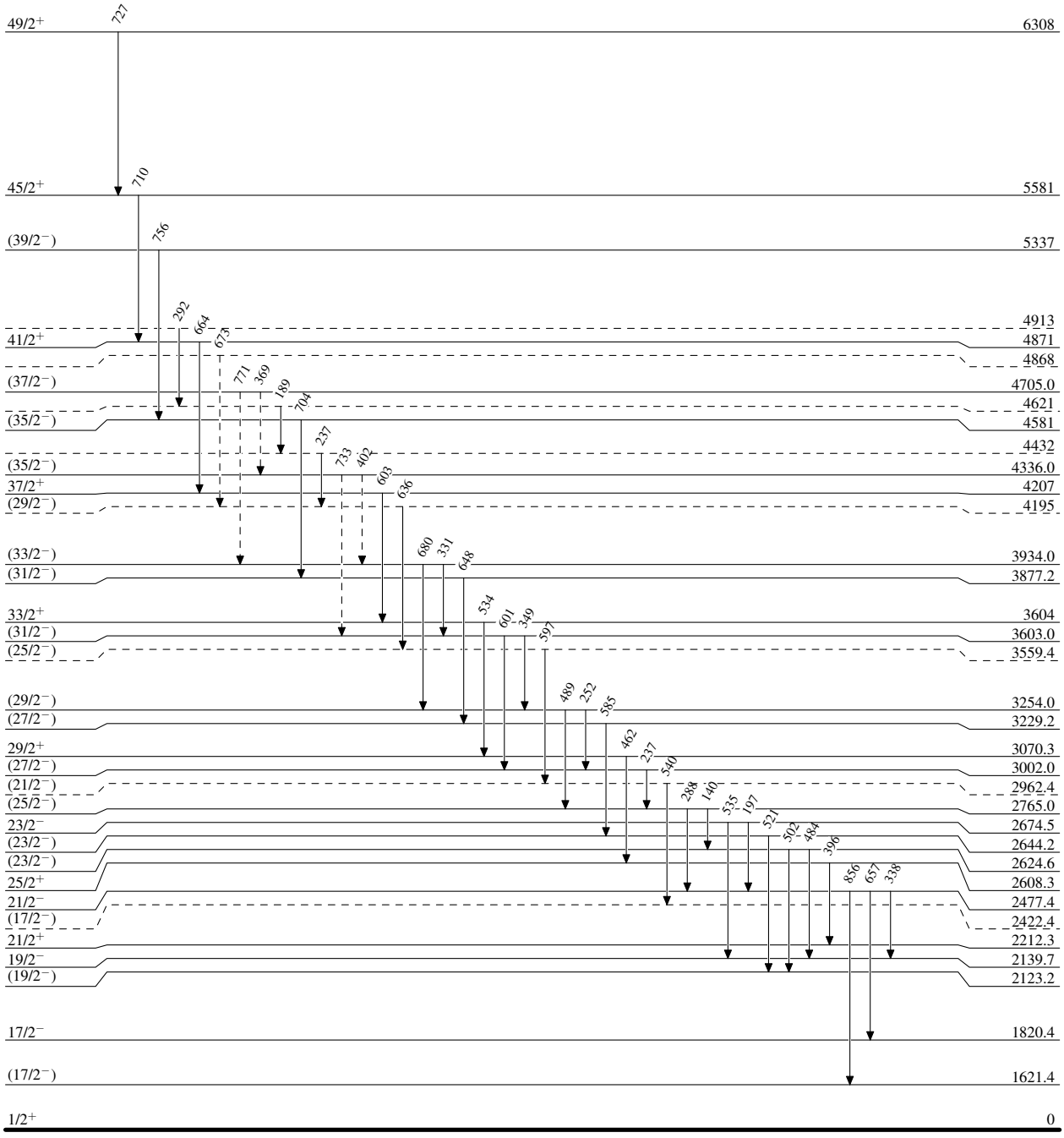
[#] Placement of transition in the level scheme is uncertain.

Legend

^{156}Gd(^{37}Cl,4nγ) 1996RiZZ

Level Scheme

γ Decay (Uncertain)



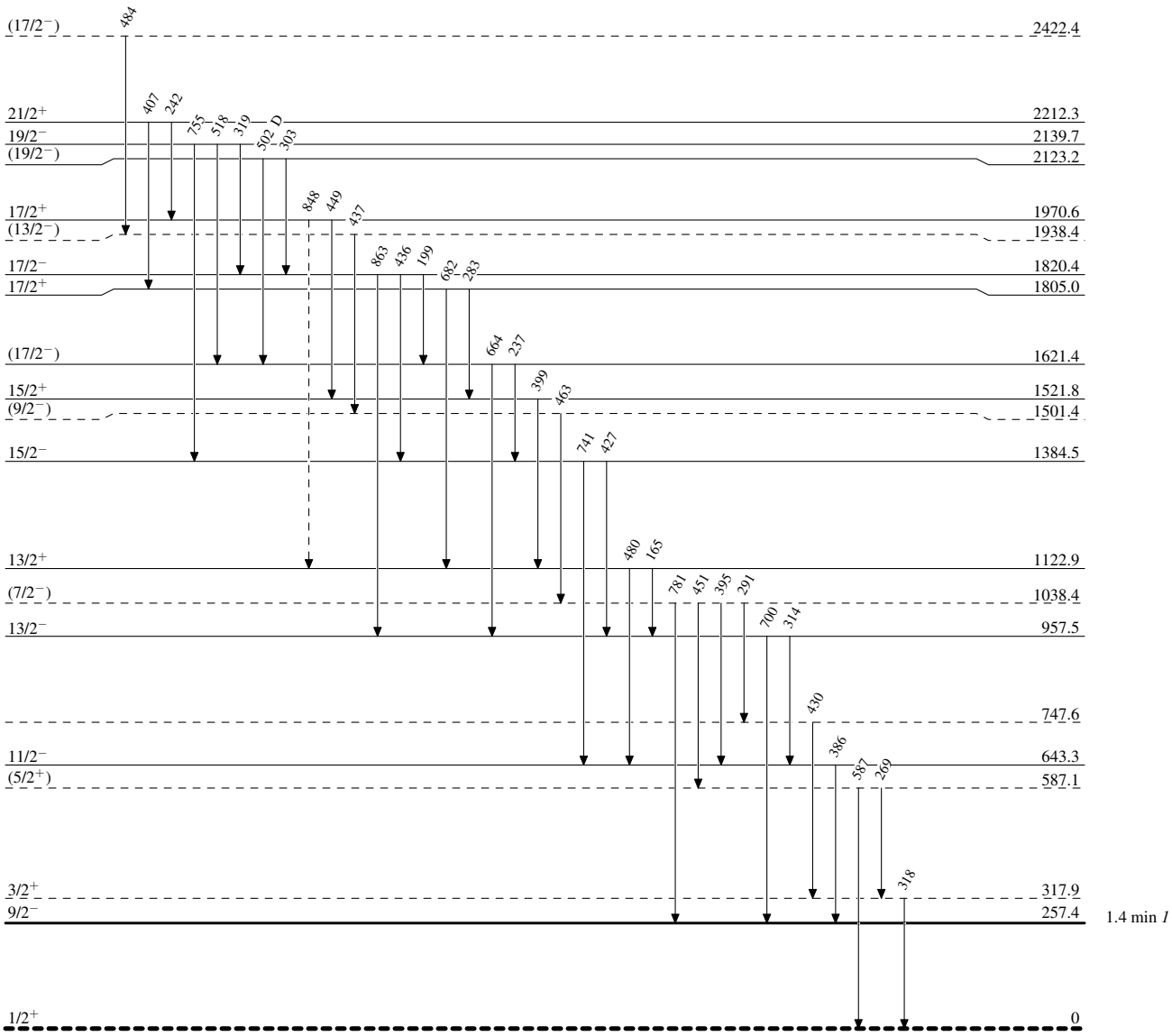
$^{189}_{81}Tl_{108}$

Legend

^{156}Gd(^{37}Cl,4nγ) 1996RiZZ

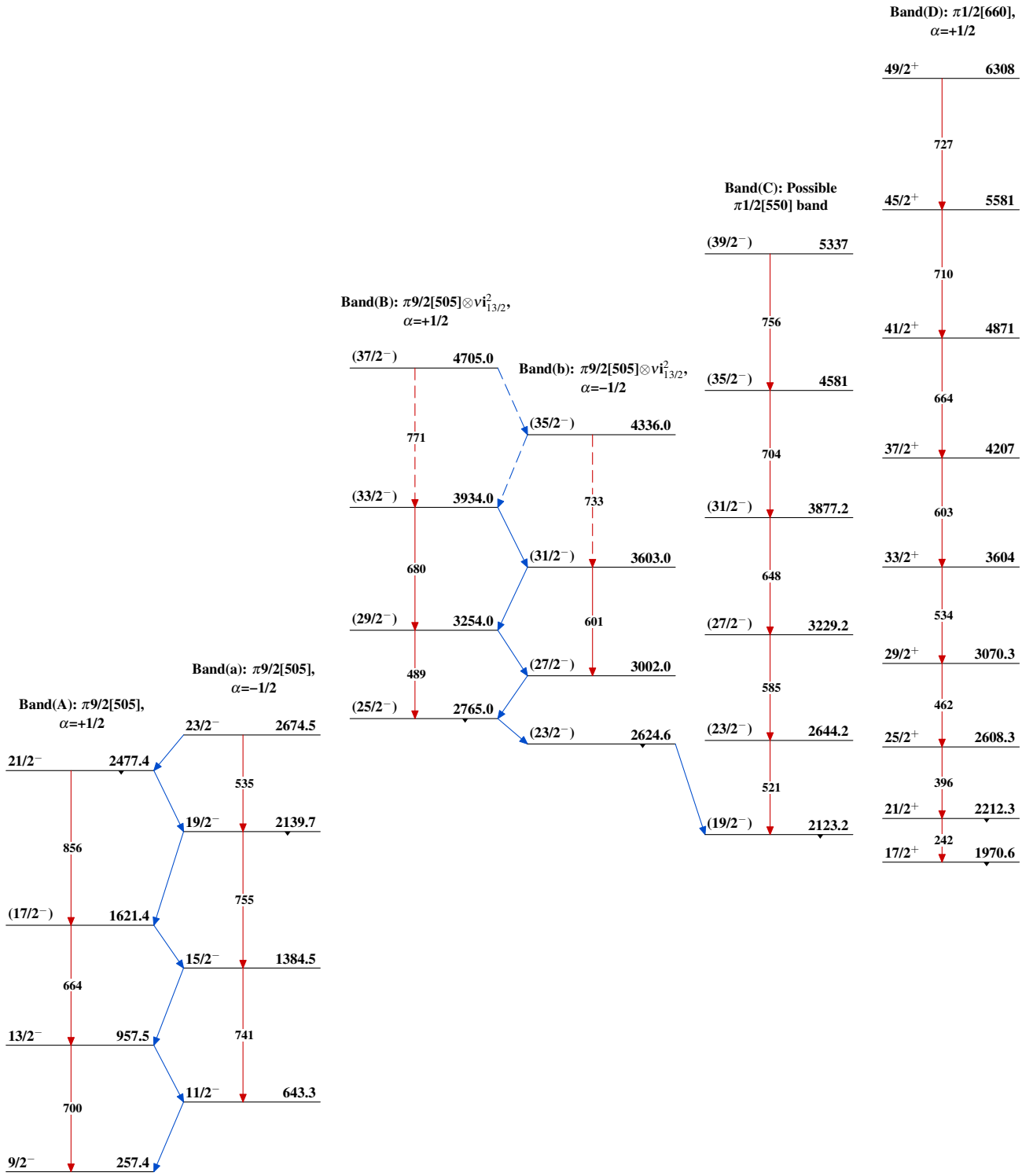
Level Scheme (continued)

γ Decay (Uncertain)



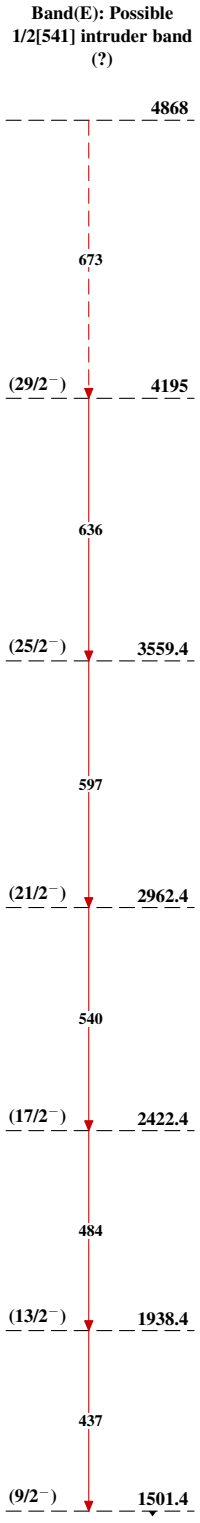
$^{189}_{81}Tl_{108}$

^{156}Gd(^{37}Cl,4nγ) 1996RiZZ



$^{189}_{81}Tl_{108}$

^{156}Gd(^{37}Cl,4nγ) 1996RiZZ (continued)



$^{189}_{81}Tl_{108}$