Coulomb excitation

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 113, 157 (2012)	31-Dec-2010

Additional information 1.

Coulomb-excitation measurements have resulted in the determination of a variety of quantities. These quantities include: B(E2) values (1960Na13,1960Ol02); $\gamma(\theta)$ and δ(M1/E2) (1966As02,1983Ch09,1984Va30); level scheme and Eγ (1958Ch36,1962Gr36,1963Di09,1966Bo16,1967Se09,1983Ch09,1984Va30,1990Le1 7); γ-branching ratios (1966Bo16,1967Se09,1983Ch09,1984Va30); half-lives (1970Ar22,1983Ch09,1984Va30); and conversion electrons (1963Di09). Other: 1961Po08.

Experiments:

1990Le17: E(^{208}Pb)=982 MeV; measured Eγ, Iγ.
1984Va30: E(^{40}Ar)=151 MeV; measured Eγ, $\gamma(\theta)$.
1983Ch09: E(^{40}Ca)=162 MeV; measured Eγ, $\gamma(\theta)$.
1970Ar22: E(α)=4.0 MeV; measured $T_{1/2}$(137) by microwave method.
1967Se09: E(^{16}O)=50 MeV; measured Eγ, Iγ(cascade)/Iγ(crossover).
1966Bo16: E(^{16}O)≈45 MeV; measured Eγ, Iγ(crossover)/Iγ(cascade).
1966As02: E(α)=3.1 MeV; measured Eγ, $\gamma\gamma(\theta)$.
1963Di09: E(^{16}O)=60 MeV; measured Eγ, E(ce), Ice.
1962Gr36: E(^{16}O)=65 MeV; measured Eγ.
1960Na13: E(α)≈17 MeV.
1960Ol02: E(p)=4.5 MeV.
1958Ch36: E(p)=3.7 MeV; measured Eγ.

^{159}Tb Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[#]	Comments
0.0[@]	3/2$^+$	stable	
57.986[@] *10*	5/2$^+$	55.0 ps *22*	B(E2)↑=2.81 *8* $T_{1/2}$: Calculated from B(E2) and properties of 57.9 G. B(E2)↑: From 1960Ol02; other: 1.9 (1958Ma36).
137.476[@] *21*	7/2$^+$	36 ps *4*	B(E2)↑=1.45 *6* B(E2)↑: From 1960Ol02. $T_{1/2}$: From 1970Ar22; other: 43.1 ps *24*, calculated from B(E2) and the γ branching.
241.12[@] *4*	9/2$^+$	27.2 ps *12*	$T_{1/2}$: Weighted average of 27.5 ps *17* (1984Va30) and 26.8 ps *17* (1983Ch09), both by recoil-distance method.
347.8[&]	5/2$^+$		
362.03[@] *4*	11/2$^+$	15.24 ps *24*	$T_{1/2}$: Weighted average of 15.2 ps *3* (1984Va30) and 15.3 ps *4* (1983Ch09), both by recoil-distance method.
363?[a]	5/2$^-$		
429[&]	7/2$^+$		
510.33[@] *5*	13/2$^+$	9.17 ps *22*	$T_{1/2}$: Weighted average of 9.8 ps *4* (1984Va30) and 9.09 ps *17* (1983Ch09) by recoil-distance method and 8.0 ps *10* (1983Ch09) from the Doppler-shift method.
580.2[c]	1/2$^+$	<1.0 ps	$T_{1/2}$: From $T_{1/2}$(580 γ) < 0.5 ps, from Doppler broadening of the conversion-electron line (1963Di09) and the γ branching.
618[c]	3/2$^+$	<1.3 ps	$T_{1/2}$: From $T_{1/2}$(560 γ) < 0.5 ps, from Doppler broadening of the conversion-electron line (1963Di09) and the γ branching.
668.73[@] *7*	15/2$^+$	6.4 ps *5*	$T_{1/2}$: Weighted average of 7.14 ps *21* (1984Va30) and 6.04 ps *14* (1983Ch09) by recoil-distance method. Others: 5.3 ps *6* (1983Ch09) and 5.3 ps *3* (1984Va30) by Doppler-shift method.
674.8[c]	5/2$^+$	<2.3 ps	$T_{1/2}$: From $T_{1/2}$(536 γ) < 0.5 ps, from Doppler broadening of the conversion-electron line (1963Di09) and the γ branching.
859.86[@] *7*	17/2$^+$	3.98 ps *20*	$T_{1/2}$: Weighted average of: 3.3 ps *3* (1984Va30) and 3.3 ps *4* (1983Ch09), by

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Coulomb excitation (continued)

^{159}Tb Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]	Comments
			Doppler-shift method; and 4.10 ps *10* (1983Ch09) by recoil-distance method.
971?[b]	(1/2+)		
978[b]	(3/2+)		
1052.15[@] *8*	19/2+	2.45 ps *8*	$T_{1/2}$: Weighted average of: 2.15 ps *21* (1984Va30) and 2.5 ps *3* (1983Ch09), by Doppler-shift method; and 2.49 ps *8* (1983Ch09), by recoil-distance method.
1086.5?[b]	(5/2+)		
1102.5?[b]	(7/2+)		
1282.42[@] *10*	21/2+	1.56 ps *17*	$T_{1/2}$: Weighted average of 1.52 ps *28* (1984Va30) and 1.59 ps *21* (1983Ch09) by Doppler-shift method.
1505.04[@] *13*	23/2+	1.05 ps *13*	$T_{1/2}$: Weighted average of 1.11 ps *28* (1984Va30) and 1.04 ps *14* (1983Ch09) by Doppler-shift method.
1769.47 *13*	25/2+	0.69 ps *14*	$T_{1/2}$: From 1983Ch09, by Doppler-shift method.
2019.26[@] *14*	27/2+		
2311.36[@] *15*	29/2+		
2582.9[@] *4*	31/2+		
2893.0[@] *6*	33/2+		
3179.1[@] *6*	35/2+		
3498.0[@] *8*	37/2+		
3794?[@] *1*	(39/2+)		

[†] From least-squares fit to γ energies.
[‡] Assignments are from these studies; they agree with those in the Adopted Levels.
[#] From Coul. ex. only; see ^{159}Tb Adopted Levels for all measurements.
[@] Band(A): $K^\pi=3/2^+$, π3/2[411] band.
[&] Band(B): $K^\pi=5/2^+$, π5/2[413] band.
[a] Band(C): $K^\pi=5/2^-$, π5/2[532] bandhead.
[b] Band(D): $K^\pi=1/2^+$, π1/2[411] band.
[c] Band(E): $K^\pi=1/2^+$,K−2 γ-vibr. built on π3/2[411] g.s. Contains an admixture of π1/2[411].

Coulomb excitation (continued)

$\gamma(^{159}Tb)$

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	δ[#]	α[b]	Comments
57.986	5/2$^+$	57.99[@] *1*		0.0	3/2$^+$	M1+E2	+0.119 *2*	10.73	
137.476	7/2$^+$	79.51[@] *2*	670 *27*	57.986	5/2$^+$	M1+E2	+0.126 *8*	4.28	
		137.24 *8*	100	0.0	3/2$^+$	[E2]		0.834	
241.12	9/2$^+$	103.60 *6*	258 *4*	137.476	7/2$^+$	M1+E2	0.111 *5*	1.99	I_γ: The value 127 *6* from 1990Le17 is discrepant.
		183.10 *5*	100	57.986	5/2$^+$	E2		0.308	
347.8	5/2$^+$	210		137.476	7/2$^+$				
		290		57.986	5/2$^+$				
		347.9		0.0	3/2$^+$	M1+E2	0.43 *+10−9*	0.0655 *22*	
362.03	11/2$^+$	120.79 *4*	138 *10*	241.12	9/2$^+$	M1+E2	0.112 *5*	1.281	
		224.62 *5*	100	137.476	7/2$^+$	E2		0.1560	
363?	5/2$^-$	363		0.0	3/2$^+$	E1			δ: See ^{159}Tb Adopted γ radiations for possible M2 mixture.
429	7/2$^+$	289[&c]		137.476	7/2$^+$				
		371		57.986	5/2$^+$	M1+E2	0.05 *5*		
		429[&c]		0.0	3/2$^+$				
510.33	13/2$^+$	148.21 *4*	90.2 *23*	362.03	11/2$^+$	M1+E2	0.107 *6*	0.717	
		269.34 *5*	100	241.12	9/2$^+$	E2		0.0872	
580.2	1/2$^+$	522[&c]		57.986	5/2$^+$				
		580.2		0.0	3/2$^+$				
618	3/2$^+$	560		57.986	5/2$^+$	M1+E2	0.67 *+58−4*	0.018 *3*	
		618		0.0	3/2$^+$				
668.73	15/2$^+$	158.37 *5*	64.3 *20*	510.33	13/2$^+$	M1+E2	0.117 *9*	0.595	
		307.00 *5*	100	362.03	11/2$^+$	E2		0.0581	
674.8	5/2$^+$	538		137.476	7/2$^+$				
		617		57.986	5/2$^+$				
		674[&]		0.0	3/2$^+$				
859.86	17/2$^+$	191.21[a] *8*	53 *5*	668.73	15/2$^+$	M1+E2	0.091 *20*	0.352	
		349.58 *6*	100	510.33	13/2$^+$	E2		0.0394	
971?	(1/2$^+$)	971		0.0	3/2$^+$				
978	(3/2$^+$)	920[&]		57.986	5/2$^+$				
		978[&]		0.0	3/2$^+$				
1052.15	19/2$^+$	192.58[a] *15*		859.86	17/2$^+$	M1,E2		0.30 *5*	
		383.33 *6*		668.73	15/2$^+$	E2		0.0301	
1086.5?	(5/2$^+$)	949[&]		137.476	7/2$^+$				
1102.5?	(7/2$^+$)	965[&]		137.476	7/2$^+$				
1282.42	21/2$^+$	230.11 *11*	26 *5*	1052.15	19/2$^+$				I_γ: The measured values 21.6 *14* (1983Ch09) and 32.0 *15* (1990Le17) disagree. The listed value is a simple average of these two.
		422.69 *10*	100	859.86	17/2$^+$	E2		0.0229	
1505.04	23/2$^+$	222.31 *24*	35 *3*	1282.42	21/2$^+$				
		452.88 *19*	100	1052.15	19/2$^+$	E2		0.0189	

Coulomb excitation (continued)

$\gamma(^{159}Tb)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	E_i(level)	J_i^π	E_γ[†]	E_f	J_f^π
1769.47	$25/2^+$	264.4 *1*	25.7 *19*	1505.04	$23/2^+$	2582.9	$31/2^+$	563.6 *1*	2019.26	$27/2^+$
		487.1 *1*	100	1282.42	$21/2^+$	2893.0	$33/2^+$	581.6 *5*	2311.36	$29/2^+$
2019.26	$27/2^+$	249.8 *1*	24.9 *19*	1769.47	$25/2^+$	3179.1	$35/2^+$	596.2 *5*	2582.9	$31/2^+$
		514.2 *1*	100	1505.04	$23/2^+$	3498.0	$37/2^+$	605.0 *5*	2893.0	$33/2^+$
2311.36	$29/2^+$	292.1 *1*	21.2 *22*	2019.26	$27/2^+$	3794?	$(39/2^+)$	615[c] *1*	3179.1	$35/2^+$
		541.9 *1*	100	1769.47	$25/2^+$					

[†] From 1984Va30 within the ground-state band up through the $23/2^+$ level and from 1990Le17 beyond that (with uncertainties from a general statement) and from 1967Se09 for other levels, unless noted as from 1958Ch36, 1963Di09, or 1983Ch09.
[‡] Weighted averages of values from 1966Bo16, 1967Se09, 1983Ch09, 1984Va30, and 1990Le17 for the relative photon branching from each level.
[#] From ^{159}Tb Adopted γ radiations.
[@] From 1958Ch36.
[&] From 1963Di09.
[a] From level energies.
[b] 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.
[c] Placement of transition in the level scheme is uncertain.

$^{159}_{65}Tb_{94}$-4

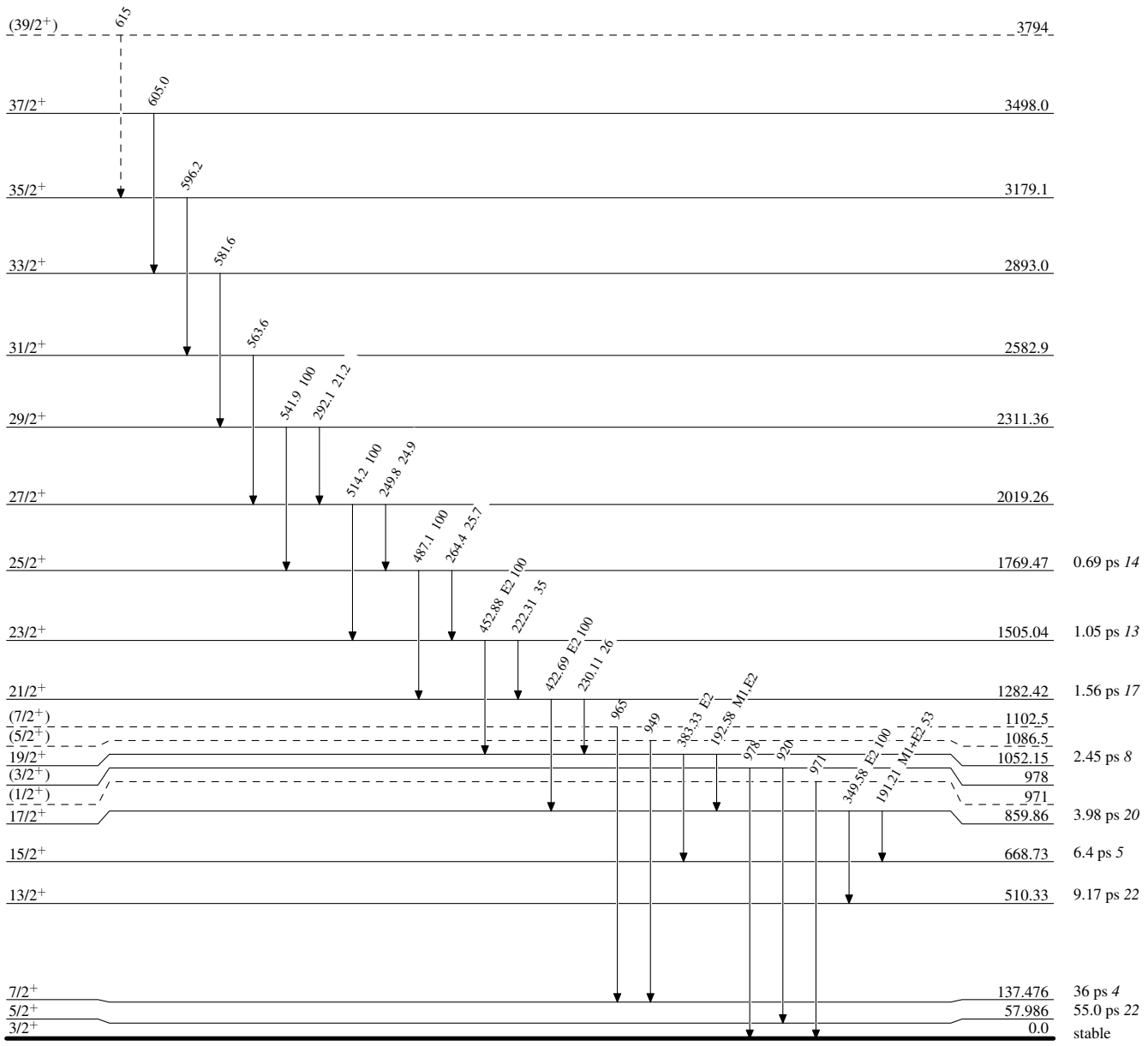
Coulomb excitation

Legend

Level Scheme

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{159}_{65}Tb_{94}$

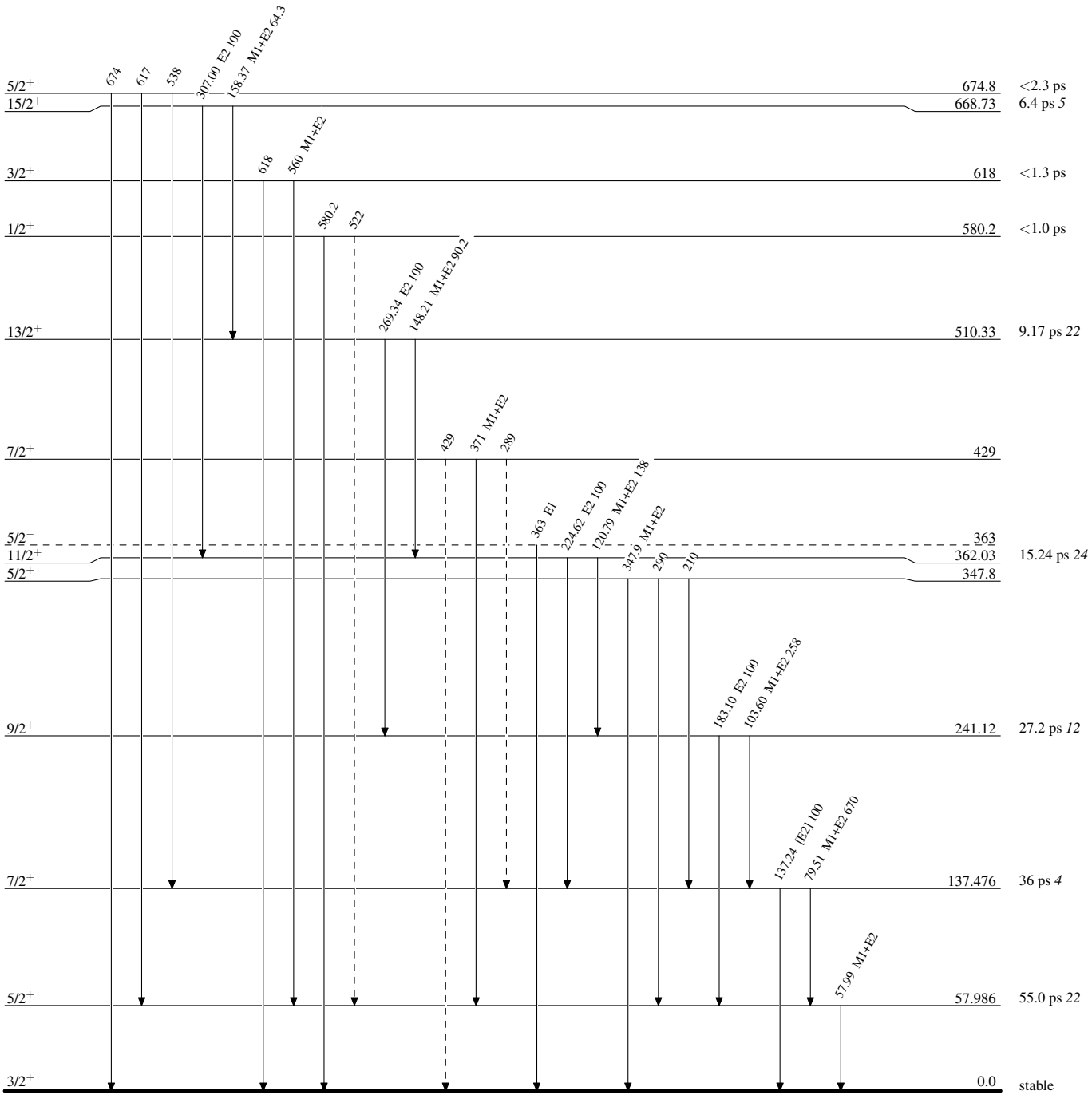
Coulomb excitation

Legend

Level Scheme (continued)

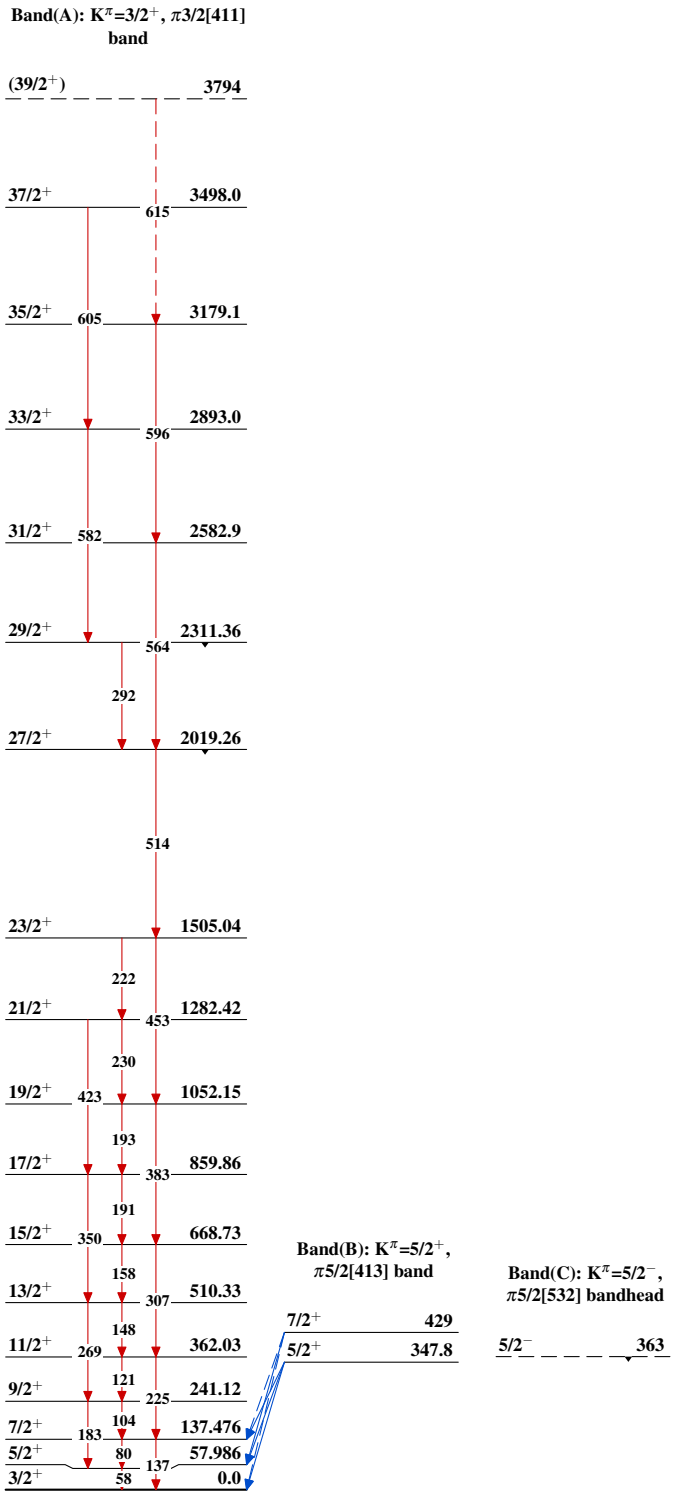
Intensities: Relative photon branching from each level

γ Decay (Uncertain)



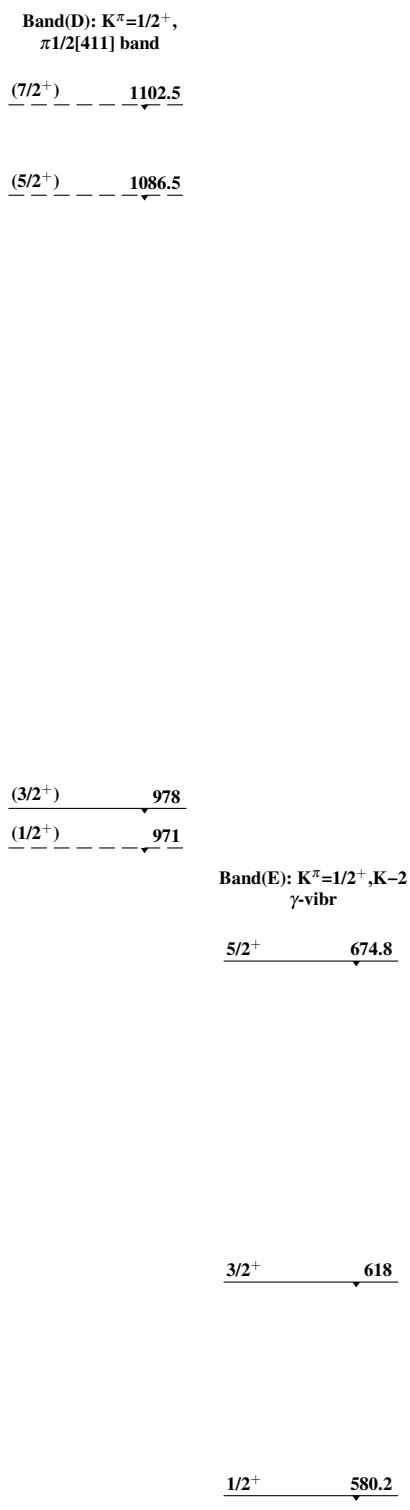
$^{159}_{65}Tb_{94}$

Coulomb excitation



$^{159}_{65}Tb_{94}$

Coulomb excitation (continued)



$^{159}_{65}Tb_{94}$