

The Spectra of Chlorine, Cl III, Cl IV and Cl V

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About 200 additional lines have been classified in Cl III. 21 of these are intercombination lines. This analysis fixes most of the doublet and quartet terms arising from

the addition of a $4s$, $5s$, $4p$, $3d$ or $4d$ electron to either the 3P or 1D state of the core. Approximately 50 new lines have been classified in Cl IV and 20 in Cl V.

THE spectrum of chlorine in the range from 200A to 600A was photographed with a grazing incidence spectrograph of two meters focus, and from 400A to 3000A with a normal incidence vacuum spectrograph of one meter focus. In both instruments the source was a vacuum spark between electrodes into which NaCl or LiCl had been fused. From 2400A to 5100A the spectrum of a condensed discharge in CCl_4 vapor was recorded with a 6.5 meter focus Rowland spectrograph. This was supplemented in the range from 2100A to 3000A with plates taken on a quartz spectrograph.

The structure of the Cl III spectrum was first investigated by the present writer¹ who classified over 80 lines, largely in the quartet system. Later Gilles² identified a group of lines that corresponded to transitions to the s^2p^23d 4P terms from the already classified quartet terms of the s^2p^24p configuration. Majumbar and Deb³ and Murakawa⁴ independently classified this same group of lines as well as another group connecting the s^2p^24d 4F terms with the s^2p^24p configuration. These later analyses accounted for about 30 more lines.

About 200 additional lines have been classified in the course of the present investigation. All of the lines of Cl III that have been identified by various investigators are given in Table I with the exception of the quartet lines, listed in the author's earlier paper which are omitted to save

space. In a few cases in which the line was recorded on the quartz spectrograph only, the more accurate values of the wave-length determined by Jevons⁵ have been substituted.

Table II lists the values of all of the terms of Cl III that have thus far been fixed. Since a large number of intercombination lines were found the relative positions of the doublet and quartet terms are accurately fixed.

Because of perturbations by the sp^4 and s^2p^24s configurations, the terms arising from the addition of a $3d$ electron to the 3P state of the core are quite abnormal. Consequently the exact classifications of the doublet levels of this configuration are somewhat uncertain although the large number of transitions involving them leaves little doubt as to the presence of terms at the energy levels listed. One or two other terms such as the $s^2p^2(^1D)4d$ 2D terms were also identified on somewhat meager evidence.

The writer's first paper also contained the classification of about 20 lines each in Cl IV and Cl V. It has now been possible to classify about 50 additional lines in Cl IV and 20 in Cl V. These are given in Tables III and V, respectively. Lines correctly identified in the earlier paper have been omitted except in a very few cases in which more accurate measurements of wave-length are now available. Tables IV and VI give all term values in Cl IV and Cl V, respectively, that have thus far been located. In Table VI the quartet and doublet term values were fixed independently as no intercombination lines were identified.

¹ I. S. Bowen, Phys. Rev. **31**, 34 (1928).

² M. J. Gilles, Comptes Rendus **188**, 1158 (1929).

³ K. Majumbar and S. C. Deb, Ind. J. Sci. **3**, 445 (1929).

⁴ K. Murakawa, Sci. Pap. Tokyo Inst. Phys. and Chem. **15**, 105 (1931).

⁵ W. Jevons, Proc. Roy. Soc. **A103**, 193 (1923).

TABLE IV. Term values of Cl IV.

$\Sigma l = 1$	2	3
	$s^2p^2\ ^3P_0$ 431226.	$sp^3\ ^3D_1$ 328474.
	$s^2p^2\ ^3P_1$ 430735.	$sp^3\ ^3D_2$ 328439.
	$s^2p^2\ ^3P_2$ 429885.	$sp^3\ ^3D_3$ 328357.
		$sp^3\ ^3P_2$ 310970.
		$sp^3\ ^3P_1$ 310952.
		$sp^3\ ^3P_0$ 310926.
		$sp^3\ ^3S$ 266505.
$s^2p4s\ ^3P_0$ 216200.0	$s^2p4p\ ^3D_1$ 183650.9?	$s^2p3d\ ^3P_2$ 249583.
$s^2p4s\ ^3P_1$ 215836.7	$s^2p4p\ ^3D_2$ 183199.9	$s^2p3d\ ^3P_1$ 249153.
$s^2p4s\ ^3P_2$ 214757.9	$s^2p4p\ ^3D_3$ 182264.8	$s^2p3d\ ^3P_0$ 248926.
	$s^2p4p\ ^3P_0$ 179754.6	$s^2p3d\ ^3D_1$ 244218.
$s^2p5s\ ^3P_0$ 118479.	$s^2p4p\ ^3P_1$ 179500.2	$s^2p3d\ ^3D_2$ 244052.
$s^2p5s\ ^3P_1$ 118235.	$s^2p4p\ ^3P_2$ 178829.3	$s^2p3d\ ^3D_3$ 243880.
$s^2p5s\ ^3P_2$ 117001.		

TABLE V. Classified lines of Cl V.

Int.	λ Vac.	ν	Classification
2	286.127	349495.	$s^23p\ ^2P_{1\frac{1}{2}}$ $-s^24d\ ^2D$
3	287.327	348036.	$s^23p\ ^2P_{1\frac{1}{2}}$ $-s^24d\ ^2D$
2	372.589	268392.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp4s\ ^4P_{2\frac{1}{2}}$
2	373.165	267978.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp4s\ ^4P_{1\frac{1}{2}}$
3	373.776	267540.	$sp^2\ ^4P_{2\frac{1}{2}}$ $-sp4s\ ^4P_{2\frac{1}{2}}$
0	373.911	267443.	$sp^2\ ^4P_{1\frac{1}{2}}$ $1\frac{1}{2} -sp4s\ ^4P_{1\frac{1}{2}}$
1	374.662	266907.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp4s\ ^4P_{1\frac{1}{2}}$
2	375.103	266593.	$sp^2\ ^4P_{2\frac{1}{2}}$ $-sp4s\ ^4P_{1\frac{1}{2}}$
4	390.148	256313.	$s^23p\ ^2P_{1\frac{1}{2}}$ $-s^24s\ ^2S$
5	392.433	254821.	$s^23p\ ^2P_{1\frac{1}{2}}$ $-s^24s\ ^2S$
2	535.455	186757.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp3d\ ^4D_{1\frac{1}{2}}$
2	535.916	186596.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp3d\ ^4D_{1\frac{1}{2}}$
3	536.532	186382.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp3d\ ^4D_{1\frac{1}{2}}$
4	537.006	186218.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp3d\ ^4D_{1\frac{1}{2}}$
4	538.681	185639.	$sp^2\ ^4P_{2\frac{1}{2}}$ $-sp3d\ ^4D_{3\frac{1}{2}}$
3	538.977	185537.	$sp^2\ ^4P_{2\frac{1}{2}}$ $-sp3d\ ^4D_{2\frac{1}{2}}$
0	539.441	185377.	$sp^2\ ^4P_{2\frac{1}{2}}$ $-sp3d\ ^4D_{1\frac{1}{2}}$
2	551.117	181450.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp3d\ ^4P_{1\frac{1}{2}}$
1	551.643	181277.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp3d\ ^4P_{1\frac{1}{2}}$
2B	552.908	180862.	$sp^2\ ^4P_{1\frac{1}{2}}$ $-sp3d\ ^4P_{2\frac{1}{2}}$
1	554.210	180437.	$sp^2\ ^4P_{2\frac{1}{2}}$ $-sp3d\ ^4P_{1\frac{1}{2}}$
1	555.484	180023.	$sp^2\ ^4P_{2\frac{1}{2}}$ $-sp3d\ ^4P_{2\frac{1}{2}}$

B, blend.

TABLE VI. Term values of Cl V.

$\Sigma l = 0$	1	2	3
	$s^23p\ ^2P_{1\frac{1}{2}}$ 547000.	$sp^2\ ^4P_{1\frac{1}{2}}$ 461000.	$p^2\ ^4S$ 313243.
	$s^23p\ ^2P_{1\frac{1}{2}}$ 545508.	$sp^2\ ^4P_{1\frac{1}{2}}$ 460462.	$sp3d\ ^4P_{2\frac{1}{2}}$ 279598.
		$sp^2\ ^4P_{2\frac{1}{2}}$ 459619.	$sp3d\ ^4P_{1\frac{1}{2}}$ 279184.
		$sp^2\ ^2D_{1\frac{1}{2}}$ 433766.	$sp3d\ ^4P_{1\frac{1}{2}}$ 279012.
		$sp^2\ ^2D_{2\frac{1}{2}}$ 433694.	$sp3d\ ^4D_{1\frac{1}{2}}$ 274404.
		$sp^2\ ^2S$ 400356.	$sp3d\ ^4D_{1\frac{1}{2}}$ 274243.
		$sp^2\ ^2P_{1\frac{1}{2}}$ 389069.	$sp3d\ ^4D_{2\frac{1}{2}}$ 274081.
		$sp^2\ ^2P_{1\frac{1}{2}}$ 388108.	$sp3d\ ^4D_{3\frac{1}{2}}$ 273980.
		$s^23d\ ^2D_{1\frac{1}{2}}$ 361139.	
		$s^23d\ ^2D_{2\frac{1}{2}}$ 361107.	
$s^24s\ ^2S$ 290687.	$sp4s\ ^4P_{1\frac{1}{2}}$ 193555.	$s^24d\ ^2D$ 197489.	
	$sp4s\ ^4P_{1\frac{1}{2}}$ 193022.		
	$sp4s\ ^4P_{2\frac{1}{2}}$ 192075.		