

ABSORPTION SPECTRUM OF ATOMIC CHLORINE 95.0 nm TO 61.0 nm

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The experimental study of atomic chlorine absorption spectra using a flash-pyrolysis system and a 2-m normal incidence spectrograph in the wavelength region 95 nm to 61 nm has produced photoabsorption cross sections, wavelength measurements, and line series identification involving the 3P , 1D and 1S limits. Absorption spectra originating from both levels ($^2P_{3/2}^0$ and $^2P_{1/2}^0$) of the ground state have been produced by this method.

The ground state configuration of atomic Cl is $3s^23p^5$ which yields an inverted 2P term ($^2P_{3/2}^0$ and $^2P_{1/2}^0$), with the splitting of $882.36 \pm 0.05 \text{ cm}^{-1}$. Excitation of one of the five 3p electrons yields ns and nd allowed series converging to five ion states $^3P_{2,1,0}$, 1D_2 and 1S_0 .

Radziemski and Kaufman [1] observed the emission spectrum of Cl in the ultraviolet and visible regions and were able to establish 112 odd and 128 even levels. They computed vacuum ultraviolet wavelengths for lines and determined improved values of the series limits corresponding to Cl II, $3p^4 \ ^3P_{2,1,0}$. From additional work on the Cl II spectrum [2], they determined the limits corresponding to $3p^4 \ ^1D_2$ and 1S_0 .

We recorded the absorption spectrum of Cl in the vacuum ultraviolet region. In the first part of our study about 250 lines were identified and assigned to 30 series converging to $^3P_{2,1,0}$. [3] These transitions involved both levels of the ground state with the same excited upper state. About 100 of the lines were previously predicted, while 120 were newly observed leading to 82 new, even levels.

Ruscic and Berkowitz [4] measured relative Cl photoionization and autoionization cross sections from the 3P limit to 1S_0 near 750 Å. They observed, with ion yield curves, three autoionizing series converging to the 1D_2 ionic state and two series converging to the 1S_0 state. The three were interpreted as $(^1D_2)nd \ ^2P$, $(^1D_2)ns \ ^2D$ and $(^1D_2)nd \ ^2D$ and the two as $(^1S_0)nd \ ^2D$ and $(^1S_0)ns \ ^2S$. Hansen, Cowan, Carter and Kelly [5] revised the $(^1D_2)nd \ ^2D$ identification to

(1D_2) and 2S and suggested that the broad resonances are superpositions of (1D_2) and 2P and 2D .

We have recorded these series in absorption and in many cases have observed them originating from both levels of the ground state.

The essential features of the instrumentation for the absorption experiments were four. A 2-m normal incidence, vacuum spectrograph, equipped with a 1200 lines/mm holographic grating, gave a reciprocal dispersion of 4.2 Å/mm. A modified, BRV light source, powered by a 20 kV, 2.5 μF capacitor provided the background continuum. A 20 cm long absorption tube made from high transparency quartz contained the chlorine sample and provided the vacuum continuity between the BRV light source and spectrograph. A spiral, xenon filled flash lamp powered by a 6-10 kV, 120 μF, low inductance capacitor surrounded the quartz absorption cell and provided the pyrolysis flash.

Many inorganic compounds containing chlorine were used as samples to produce Cl I spectra, but the best results were obtained with copper chloride ($CuCl_2 \cdot 2H_2O$).

He, Ne or Ar were used as buffer gas in the absorption tube and as sources of wavelength reference lines.

Spectra photographed by using Kodak 101-01 film or 101-05 plates. Lines were measured with a digitized microphotometer capable of 2.5 μm steps, corresponding to 0.01 Å.

Densitometer traces of the spectral range show series converging to limits $3p^4 \ ^1D_2$ (at 116245 cm^{-1}) and $3p^4 \ ^1S_0$ (132468 cm^{-1}).

Line identifications and energy levels are available in tables for these series. About 74 levels are listed.

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