Studies of the Spectrum of Chlorine I
Emission and Absorption Spectra

By

Masamichi Kimura and Mitsuharu Fukuda

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The band emission spectrum of chlorine is not yet thoroughly studied, and its relation to the absorption spectrum of that vapour seems to be quite unknown. In the case of iodine, one of the present writers in collaboration with Prof. R. W. Wood[1] found that the emission and absorption spectra of iodine are not complementary, though every emission line of the band has an absorption line in coincidence with it, but there are many absorption lines which are not represented in the emission spectrum of iodine.

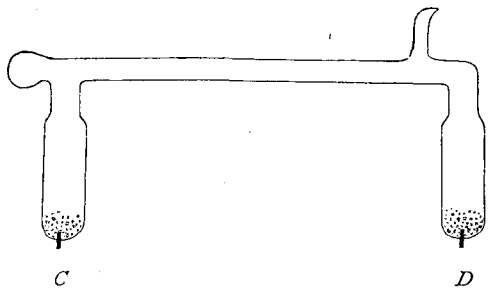
It is the object of the present experiment to see whether a similar result holds true in the case of chlorine, and the result thus far obtained will be described below. The emission band will be first described and it will then be compared with the absorption spectrum.

In the preliminary part of the work we had considerable difficulty in getting a good tube emitting bright light in the band spectrum, and we found that tubes having sodium chloride electrodes work fairly well. The form of tube used is shown Fig. 1. A certain quantity of welldried pure sodium chloride was put in the side tubes *C* and *D* just enough to cover the platinum wires sealed at the ends and these were connected by a piece of tubing of about 5 mm. diameter,

1 Astrophys. J. **46**, 181 (1917).

and 20 cm. in length, one end of which was blown out into a fine bulb. The tube thus prepared was connected to a pump and a heavy discharge was sent through during the evacuation. When the tube was sealed off from the pump the carbon monoxide band soon appeared which superposed upon the band spectrum of chlorine, so that to get rid of the monoxide the tube was connected to the pump during the exposure to a spectrograph. The image of an end-on emission from the tube was projected on the slit of a spectrograph having a good Hilger replica grating and the spectrum was photographed with an achromatic objective of 55 cm. focus. An exposure of one hour was sufficient to secure a good negative on a Wratten panchromatic plate, the linear dispersion on the plate in the first order spectrum being about 0·033 mm. per 1 A at λ 4900 and 0·031 mm. at λ 4200.

FIG. 1.



One of the plates thus obtained is reproduced in Fig. 2. with wave lengths for certain lines. Here lines in the line spectrum of chlorine are superposed on the back ground of the band spectrum extending from red to violet. The spectrograph employed was, of course, not powerful enough to resolve individual lines belonging to the band spectrum, but the general features could be seen with it.

The relative intensities of the line and the band spectra emitted by such a tube depended upon the diameter of the tube and the current density, and the greater the diameter and the smaller the current density, the stronger was the band in comparison with the line spectrum. Several photographs were taken with tubes having sodium chloride, potassium chloride and bismuth trichloride, as electrodes, and the same band was always obtained with these salts. Thus it is clear that the band recorded here is due to chlorine.

The brightest part of this band lies between λ 5100 and λ 4800, but a weaker portion of it extends farther up to λ 6500 on the red side and down to about λ 3800 or more on the violet side. With the

dispersion used the spectrum presents an irregular fluted appearance, but it did not appear to have heads.

The emission band described above is now to be compared with the absorption spectrum of chlorine. The latter was investigated minutely by Laird[1], who found that the spectrum consists of a line absorption extending from blue to yellow and a very broad general absorption in the violet region. The line absorption spectrum of one meter of chlorine at one atmospheric pressure begins at about λ 4800 and extends up to λ 5350, while the general absorption starts nearly at λ 4700. This limit proceeded toward the red side as the length of the chlorine tube was increased.

If we compare these results with that obtained in our case of the emission band of chlorine, we see that the emission band is strongest at the region where the general absorption of the gas is so. In order to ascertain this the absorption spectrum was photographed with the same instrument. The gas was chemically prepared in the ordinary way and after being well dried, it was filled at one atmospheric pressure in a piece of glass tubing of about two meters long. A crater of a carbon arc was projected through the gas on the slit of the spectrograph, and after an exposure of a few minutes the slit was illuminated by the light from a chlorine tube to give a comparison spectrum.

An enlarged photograph thus obtained is reproduced in Fig. 3. Lines of the absorption spectrum were barely resolved on the original negative especially in the region from λ 5100 to λ 5200, while the emission band in the same region showed only a fluted appearance. This fluting did not coincide exactly with that of the absorption spectrum. Moreover, the structure of the emission band seems to be more complex than that of the absorption band.

It will be further observed that the emission band begins to become intense as the region is approached where the absorption get strong, and that in the part of the spectrum from yellow to red where the gas is very transparent, the band emission is very faint, while the gas is very opaque in the region blue to violet, but the emission is very strong there.

Thus it may generally be concluded that chlorine, when excited electrically, emits light strongly in the band spectrum in the region where the gas absorbs light most intensely.

[1] Astrophys. J. **14**, 85 (1901).

In the near future the authors wish to resume the investigation with an instrument having a higher resolving power sufficient to resolve the lines in the emission band of chlorine.

Summary

1. The emission and absorption band spectra of chlorine vapour were studied with a grating spectrograph having a moderate dispersion.

2. It was found that they are not exactly complementary, but chlorine emits light strongly in the region where the vapour absorbs light most intensely.

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