



On the spectra of metals at the base of flames

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For want of space I cannot give here the details of the observations, but only the result of the calculations—that is to say, the values of l , l' , l'' for the three needles, combining the series of observations successively in threes:—

		Series			
		A, B, D.	A, C, E.	B, C, F.	D, E, F.
		millim.	millim.	millim.	millim.
Bar	I.	78.1	78.3	78.1	
„	II.	70.0	69.8	69.8
„	III.	61.6	61.7	61.9
„	IV.	49.6	49.9	49.6

I may remark that, once the polar distances are determined, the same experiments will furnish the value of the ratio $\frac{2ml}{H}$, necessary in order to measure the intensity of terrestrial magnetism by Gauss's method.—*Comptes Rendus de l'Académie des Sciences*, Jan. 8, 1877, tome lxxxix, pp. 76–78.

PHOTOGRAPHS OF THE SPECTRA OF VENUS AND α LYRÆ.

NOTE BY PROF. HENRY DRAPER, M.D.

Since the spring of 1872 I have been making photographs of the spectra of the stars, planets, and Moon, and particularly, among the stars, of α Lyræ and α Aquilæ, with my 28-inch reflector and 12-inch refractor. In the photograph of α Lyræ, bands or broad lines are visible in the violet and ultra-violet region unlike any thing in the solar spectrum. The research is difficult and consumes time, because long exposures are necessary to impress the sensitive plate, and the atmosphere is rarely in the best condition. The image of a star or planet must be kept motionless for from ten to twenty minutes; and hence the driving-clock of the telescope is severely taxed.

During last summer I obtained good results, and in October took photographs of the spectrum of Venus which show a large number of lines. I am now studying these pictures, and have submitted them to the inspection of several of my scientific friends, among others Professors Barker, Langley, Morton, and Silliman. There seems to be in the case of Venus a weakening of the spectrum toward H and above that line, of the same character as that I have photographically observed to take place in the spectrum of the Sun near sunset.—Silliman's *American Journal*, February 1877.

ON THE SPECTRA OF METALS AT THE BASE OF FLAMES.

BY M. GOUY.

It is known that a flame produced by a mixture of coal-gas and air, in proportions suitable for burning without the help of the external air, has for its base an inner cone, at the surface of which the combustion commences. This surface is brilliant, of a blue or green colour, and gives the spectrum of carbon. The experiments which I am about to relate show that this same surface gives a very different spectrum from that of the flame of which it forms the base when the combustible mixture holds in suspension saline powders.

The saline solutions are pulverized by a jet of compressed air; the air, charged with powder, enters a regulator, into which the gas also comes, and whence a mixture issues of constant composition. This mixture passes into a vertical tube of 19 millims. diameter, capped with iron-wire gauze, above which it burns with a conical flame 6-8 centims. in height. The height of the inner cone varies from 3 or 4 centims. to zero; and the flame can be rendered oxidizing or reducing.

By means of a lens the image of the flame is thrown upon the slit of the spectroscope. Two spectra are then seen, the one above the other. The lower spectrum is produced by the light of the blue surface; and all the lines of which it is composed remain at exactly the same height. The other is produced by the flame proper; and the lines belonging to it encroach upon the lower spectrum, by reason of the shape of the flame.

When the apparatus is employed void of powder, the lower spectrum shows brightly the carbon-lines. If we pulverize a solution of chloride of lithium, the following is observed:—The upper spectrum shows a very bright red line and a feeble line in the orange. The first of these appears of equal brightness throughout; the other becomes much brighter just at the point where it penetrates into the lower spectrum. Moreover the lower spectrum shows distinctly a blue line (γ of the electrical spectrum), which terminates at the same height as the carbon-lines and is absent from the upper spectrum.

These characters will be again found with other metals:—

Sulphate of Thallium.—This gives its characteristic green line, which is clearly strengthened on penetrating into the lower spectrum.

Chloride of Calcium.—The upper spectrum is deprived of the line proper to the undecomposed chloride. The blue line is a little strengthened on entering the second spectrum.

Chloride of Strontium.—The upper spectrum offers nothing peculiar; the lower shows three faint blue lines, which belong to the electric spectrum of strontium.

Chloride of Barium.—The lines and bands of the upper spectrum are reinforced on penetrating into the other, especially the bright green line.

Chloride of Magnesium.—The upper spectrum shows traces of the lines α and γ of the electric spectrum; the latter is more visible when the flame is oxidizing. The spectrum gives the line α very bright, and close by the green line of carbon. This line is triple in the electric spectrum; I have only been able to distinguish two of the components, the third being doubtless confused with the carbon line. Of these two components the brightest is as bright as the latter; and as it is very near it, one can verify that they have the same height. The line γ is not reinforced in the lower spectrum.

Chloride of Iron.—The flame is pretty luminous, greenish yellow. The upper spectrum consists of bands and numerous fine lines upon a continuous ground; the lower one shows three groups of sufficiently visible lines, corresponding to the groups β and ζ of the electric spectrum between the green and the blue, and γ in the violet.

Chloride of Cobalt.—The flame very much resembles the preceding. The upper spectrum is continuous, and fairly bright; the lower shows three faint lines in the violet and the extreme violet (γ , δ , and η of the electric spectrum).

Chloride of Zinc.—Nothing more than a feeble continuous luminosity in the upper spectrum; the lower shows pretty clearly the violet line α of the electric spectrum.

Chloride of Cadmium.—Nothing in the upper spectrum; the other presents a feeble violet line, β of the electric spectrum.

Nitrate of Manganese.—There is nothing particular in the upper spectrum; the lower shows a group of three feeble violet lines, α of the electric spectrum.

Nitrate of Copper.—The upper spectrum shows several bands; one of them, in the red, is notably reinforced in the lower spectrum.

Nitrate of Lead.—Nothing in the upper spectrum; the other presents a very distinct line in the extreme violet, α of the electric spectrum.

Nitrate of Silver.—Nothing in the upper spectrum; the other shows two well-marked lines, α and β of the electric spectrum.

Chloride of Platinum.—The flame is of a bluish whiteness; its illumination is equal to that of a wax taper. The upper spectrum shows a continuous bright luminosity, with some feeble bands and lines. The lower does not resemble the electric spectrum; it is formed of a fine series of sufficiently brilliant bands, less bright on the side towards the red, their other edge being clean; a few fainter lines are also seen.

Of the other metals, some have not been submitted to experiment, and others have not given any clear results.

The spectra above described were observed with flames in some degree reducing. On charging the flame with gas the interior cone lengthens, and its spectrum becomes less bright without changing its nature. With a large excess of air the cone changes its form, dividing into violet points, sometimes very tall. At this moment the lines of carbon have disappeared, save that in the violet; they are replaced by a continuous ground, on which the metallic lines, enfeebled, detach themselves. The flame properly so called is almost invisible, and shows scarcely a trace of the sodium-line; but it becomes visible and coloured green when it contains copper.

In brief, we have seen that the base of the flame gives, over a very small elevation, a spectrum which approaches the electric spectrum of the same metal; I purpose to extend these researches to other flames.

I will remark in conclusion, that in the usual spectral analyses a mixture of both spectra (of the cone and the flame) is seen; therefore the relative intensity of the lines must change according to the part of the flame which is viewed, as Lecoq de Boisbaudran has observed for the chloride of manganese*.

This investigation was made in the laboratory of M. Desains, at the Sorbonne.—*Comptes Rendus de l'Académie des Sciences*, Jan. 29, 1877, tome lxxiv. pp. 231–234.

* *Spectres Lumineux*, p. 122. From this work we have borrowed the letters assigned to the lines.