THE SPECTRAL ENERGY CURVE OF THE ACETYLENE FLAME.

BY G. W. STEWART.

IN a previous paper¹ on this subject, I used a modification of Paschen's method of obtaining the actual distribution of energy in a pure spectrum from the observations taken with a spectrometer and radiometer or bolometer. This modification proves to be a mistake, and, since the correct curves for the distribution of energy in the spectrum of acetylene are of some service, I have redrawn the curves, using the proper method of correction. Moreover, in view of the fact that this modification of Paschen's method has received favorable comment from some quarters, I shall point out the error made in the previous paper and at the same time present experimental proof of the correctness of his formula.

There are two articles, one by Runge² and the other by Paschen,³ which give an accurate formulæ for the correction of observed curves in spectral energy work. The two equations which they present are identical save that Runge has a^2 where Paschen has a . This, together with the fact that Runge says, "Die Wirkung auf den Bolometerstreifen wächst daher annähernd proportional ab " (that is, a^2 when the bolometer strip b equals the spectrometer slit width a), led me to the hasty conclusion that the two equations were not the same, one of them stating that the energy falling on the radiometer or bolometer strip is approximately proportional to the square of the slit width, and the other that it is approximately proportional to the slit width. A closer examination of Runge's article shows that his formula is identical with Paschen's; that he defines another term in the formula, $f(x)$, in such a way that his $af(x)$ is the same as Paschen's $f(x)$; and that the above quotation is true,

¹ PHYSICAL REVIEW, Vol. XIII., No. 5, November, 1901.

² Zeitschr. für Math. und Phys., 42, 1897, p. 205.

³ Annal. der Phys., 60, 1897, p. 712.

if one bears in mind that he imposes the condition that the spectrometer slit width, α , in wave-lengths is the same for all wave-lengths, *i. e.*, is a constant in the formula.

The errors made in my discussion in the article already cited are found on pages 275 and 276. On page 275 the statement, "In different parts of this spectrum, the slit has different widths when expressed in wave-lengths," is true, but one should at this point consider only the actual width, which is constant. On page 276 occurs the sentence, "If the radiometer slit is at x , then an image of the spectrometer slit due to the wave-length x will fall entirely within the radiometer slit, and the intensity of this image is $af(x)$."

Fig. 1.

If a were the actual width in centimeters, say, the intensity would be proportional to $af(x)$ or to $f(x)$, a then being constant. But a is the slit width in wave-lengths. Hence instead of $af(x)$ I should have written $f(x)$. This change makes the resulting equations identical with Paschen's.

In order to demonstrate experimentally the correctness or incorrectness of Paschen's method, I found the distribution of energy of the acetylene flame using a rock-salt prism, angle $59^{\circ} 47' 53''$, in place of the fluorite, which was used in the previous work. The apparatus otherwise was precisely the same as before.

The proper correction applied to the observed fluorite and rock-salt curves should give the same result. In Fig. 1 curves 1 and 1' are the observed and corrected curves, respectively, when rock-salt was used, and 2 and 2' are those obtained with the fluorite. Curves 1' and 2' will be seen to agree very closely, particularly when one considers the very great difference in the observed curves.

The water emission bands at 1.46μ and 1.90μ do not appear in curve 1' because enough observations were not taken to bring them out. In fact the curve represents one of the two series of observations which were made. This, together with the small deflection in the region 0.7μ to 1.0μ would account for the discrepancy in that portion of the curve. The refractive indices of rock-salt used are those of Rubens.¹

Fig. 2.

The new curves for the distribution of energy in the spectrum of acetylene, when the correction has been made by the method of Paschen, are shown in Figs. 2 and 3, curves 2. In making the

¹ Kayser, *Handbuch der Spectr.*, 1 Band, p. 371.

correction only the first two terms of Paschen's formula was used, viz.,

$$af(x) = F(x) - \frac{1}{6}F_1(x).$$

In a recent article¹ Ångström finds the efficiency of the acetylen flame to be 5.5 per cent. The efficiency as given by the ratio of the area of curve 2, Fig. 2, as far as 0.76μ , to the total area, is 3.9 per cent. While the accuracy of this method in practice is questionable, yet in this case the observations in the visible spectrum were made with great care, as will be seen by Fig. 3. The errors

Fig. 3.

in the infra-red due to CO_2 and H_2O absorption increase the value of the efficiency. One is inclined to think, therefore, that the value 3.9 per cent. is none too small.

PHYSICAL LABORATORY, CORNELL UNIVERSITY,
November, 1902.

¹ Physikal. Zeitschr., 15 März, 1902, p. 257.