Langmuir. From both of these considerations it is believed that the latter value of b is the more reliable.

The derivation of Richardson's equation, with the assumptions involved, requires that the values of Φ and of bk/e for a given material be identical. The values of b given above correspond to values of bk/e that are, respectively, 0.8 per cent. and 2.7 per cent. lower than the calorimetrically determined Φ . Since the value of b , corresponding to the greater of these discrepancies is regarded as the more reliable, a real, though small, difference between the constants is indicated. There is some question, however, as to what probable error should be assigned to the values of b . For this reason we do not feel that a difference between Φ and bk/e can be regarded as definitely established.

RESEARCH LABORATORIES OF THE
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A SPECTROSCOPIC METHOD FOR DETERMINING THE EFFECTIVE TEMPERATURE OF ABSORBING AND EMITTING MOLECULES.

BY RAYMOND T. BIRGE.

IN a preliminary investigation¹ of the distribution of intensity in typical band series, as affected by temperature, it was found that Kemble's formula for the statistical distribution of angular velocities did not exactly represent the intensity distribution. This is to be expected, since the intensity, on the quantum theory of band spectra,² should be given by $I = (E - E')B_m'^m(a_m)$. If this expression refers to absorption spectra, then, labeling the missing line $m = 0$, the value of m for any line refers to the number of quanta of angular momentum in the initial state.³ The third factor, a_m' then gives the distribution of angular momentum, and if "J" is a constant, the distribution of angular velocities as well. On this assumption Kemble's formula is the theoretical expression for a_m .

Now $E - E' (= h\nu)$ varies only slightly throughout a band. $B_m'^m$, from the author's curves of intensity distribution, varies slowly with m , if m is not too small. The moment of inertia of the molecule in its initial condition (J) can be obtained from the coefficient of the first power term of the Deslandres' formula for the series considered.⁴ The deviations of the CN series from a parabolic law show that J is not constant, but that it is approximately so.

The value of m corresponding to maximum intensity, in Kemble's formula, is

$$m_m = \frac{2\pi}{h} \sqrt{kJT},$$

where k is the gas constant per molecule. This connects m with the absolute

¹ PHYS. REV., 18, 319, 1921.

² Heurlinger, Zeit. f. Physik, 1, 82, 1920.

³ Kratzer, Zeit. f. Physik, 3, 289, 1920.

⁴ See Sommerfeld's Atombau, 2d edition, p. 555.

temperature of the absorbing or emitting gas, with the approximations mentioned. These approximations are such as to have little effect on the position of m_m , although they decidedly affect the form of other parts of the intensity curve. Introducing the known values for the A series of the 3883 CN band, we have $T = 5.5m^2$.

In active nitrogen,⁵ m_m is estimated to be at 9 ± 2 . For the 4216 band,¹ for which J is the same, I estimate m_m at $8 \pm 1\frac{1}{2}$. This latter figure gives $T = 80^\circ \text{ C.} \pm 150^\circ$. The actual temperature is believed by investigators to be somewhere between room temperature and 100° C. In King's 2700° furnace spectra, m_m should be 23.25,—in the 2500° spectra, 22.45. In each case I find it to be 23 ± 2 . (This result has been obtained with far greater care than the preliminary value of 22 previously published.²)

Assuming then the approximate validity of the formula, we obtain for King's 4 amp. arc a temperature of $4000^\circ \text{ C.} \pm 300^\circ$ (from $m_m = 28 \pm 1$), and for my 13 amp. arc $4700^\circ \text{ C.} \pm 300^\circ$ (from $m_m = 30 \pm 1$). These values are consistent with previous estimates of the temperature of the arc. A spectrogram taken by King, showing the 3883 band in absorption at about 3000° C. indicates, as nearly as can be judged, that the intensity distribution in absorption is the same as in emission, at the same temperature. Assuming this, an examination of a solar spectrogram lent by Dr. St. John indicates an effective temperature for the CN (or possibly N_2) molecules of the reversing layer of the sun probably hotter than King's arc, and as nearly as can be judged, the same as the 13 amp. arc, *i.e.*, 4700° C. This estimate is probably too low, if anything, due to the approximations used. It is believed however that this method can be employed for the quantitative determination of effective solar temperatures.

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THE EXCITATION OF THE ENHANCED SPECTRA OF SODIUM AND POTASSIUM IN A LOW VOLTAGE ARC.

BY PAUL D. FOOTE, W. F. MEGGERS, AND F. L. MOHLER.

THE enhanced spectrum of sodium and its L-radiation are excited at about the same voltage. Similarly, the M-radiation and the enhanced spectrum of potassium appear simultaneously.

The highest frequency in the simply enhanced spectrum of sodium is estimated to be in the neighborhood of 14 volts and of potassium, 11 volts.

The evidence confirms the theories of Bohr and Sommerfeld which attribute enhanced lines to the ionized atom, and arc lines to the neutral atom.

The following table summarizes the values of the critical voltages characterizing the three-stage development in the spectra of sodium and potassium.

¹ Strutt and Fowler, Proc. Roy. Soc., A86, Plate op. p. 117, 1911.

² All the results here quoted were obtained before their quantitative theoretical significance was realized. They are therefore unbiased in this respect.