

Sodium in the High Atmosphere

BERNARD has described in NATURE¹ his observations proving that the yellow radiation of the night sky and of the twilight-sky, 5893 Å., can be identified with the two sodium *D* lines. With regard to this communication we wish to make the following comments:

(1) Attribution of the yellow radiation at night to the sodium was examined for the first time by Dufay². Interstellar sodium was first in question, but rough measurements of the ratio of intensity at the zenith and near the horizon, and, in particular, the variation of intensity from night to night, brought evidence that the radiation was emitted in the upper atmosphere. Furthermore, a long series of observations made by Garrigue³ at the Pic du Midi put the atmospheric origin of the yellow radiation beyond all doubt.

(2) After further observations made at Montpellier, Cabannes and Dufay⁴ pointed out the probable complexity of the 5893 radiation. In the same paper, the authors examined the hypothesis of an emission by sodium atoms in the atmosphere and announced that interferential analysis was in progress.

(3) Increasing intensity of the yellow radiation at twilight had been previously discovered by Currie and Edwards⁵ at Chesterfield (Canada), during the International Polar Year, 1932-1933. Bernard's attempts to show that the observations of Currie and Edwards did not concern the 5893 radiation. The wave-length measured by Currie and Edwards was indeed 5940 Å., but their measurements were not precise and they concluded that "this radiation is due to a luminescence distinct from the aurora and is probably the radiation 5893 Å. observed by Vegard and Tönsberg in the night-sky light". Bernard's argument, therefore, does not seem convincing to us.

(4) We have analysed the yellow radiation at night and at twilight, following two different methods:

(a) A Fabry-Perot interferometer was adjusted in front of a small two-prism spectrograph of which the camera lens has a relative aperture $F/1$ and 25 mm. focal length. A lens of 6 cm. or 10 cm. focal length projects the fringes on to the slit. With exposures of 20 hours or more, at night, we have observed very crowded fringes on the yellow radiation. The aspect of these fringes was exactly the same as that of the fringes given by the sodium flame. The first positive result at night was thus obtained with a 27-hour exposure between February 28 and March 4, 1938.

We have carried out the same experiments at twilight, when interferential analysis of the 5893 radiation is much easier than at night, because of its stronger intensity.

(b) At the same time, a second Fabry-Perot étalon was used without a spectrograph, and placed in front of a camera lens of 25 mm. focal length and relative aperture $F/1$. An orange filter (Schott glass OG2, 2 or 4 mm. thick) absorbs the green line 5577 Å. In order to be free from the red line 6300, plates of which the sensitiveness is small at 6300 were used. Interferential fringes were thus photographed at twilight with exposures of 15-30 minutes. Using alternately air spaces of 0.30 mm. and 0.15 mm. thickness between the half-silvered surfaces, one or two systems of fringes appeared. In every case their diameters differed by almost 0.01 mm. from the diameters of the sodium fringes photographed on the same plate. The D_2 fringes are, as in the laboratory, about twice as intense as the D_1 fringes.

Bernard's observations are identical with our own, when following this second method. Our results⁷ were communicated to the Academy of Sciences at the same meeting, March 21, 1938, as those of Bernard. Interferential fringes photographed at night without the use of a spectrograph are then weak, but, some days later, fringes obtained at night with a 22-hour exposure were as strong as those taken previously at twilight.

In conclusion, we wish to point out that the identification of the sodium *D* lines in the atmosphere, suggested by our previous experiments, was made simultaneously by Bernard and ourselves.

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May 10.

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¹ NATURE, 141, 788 (April 30, 1938).

² C.R., 194, 1897 (1932).

³ C.R., 202, 1807 (1936).

⁴ C.R., 206, 221 (1938).

⁵ Terr. Mag., 41, 265 (1936).

⁶ C.R., 206, 1137 (1938).

⁷ C.R., 206, 870 (1938).

Adsorption of Gaseous Mixtures at Solid Surfaces

In a recent paper¹, the statistical mechanics of gaseous adsorption at solid surfaces has been developed using the method of partition functions. The imperfection of the adsorbed phase was taken into account and adsorption isotherms appropriate to various models of the adsorbed phase were developed.

The method can be extended quite simply to gaseous mixtures. The partition function for a gaseous system consisting of N_1 molecules of a gas R and N_2 molecules of a gas S is

$$H(\theta) = \{h_1(\theta)\}^{N_1} \{h_2(\theta)\}^{N_2} B(\theta),$$

where $h_1(\theta)$ and $h_2(\theta)$ are partition functions for the molecular internal and translational energies of R and S respectively, and $B(\theta)$ is the partition function for the potential energy of the whole system; which includes not only the volume term but also a term which accounts for the potential energy of those molecular interactions which are responsible for gaseous imperfection. For a gas mixture in a potential field ϕ , we can write

$$\log_e B(\theta) = (N_1 + N_2) \log_e V e^{\phi/RT} - \frac{1}{V} \left[\beta_1 N_1^2 + 2\beta_{12} N_1 N_2 + \beta_2 N_2^2 \right] - \dots,$$

where β_1 , β_2 and β_{12} are the usual virial coefficients. Writing suffix g and a for the gaseous and adsorbed phases respectively and assuming the gas phase to be perfect, it is now easy to prove that:

$$\log_e \frac{x_1}{p_1} = \log_e \frac{V_a}{RT} + \log_e \left\{ \frac{h_a(\theta)}{h_g(\theta)} \right\}_1 + \frac{\phi_1}{RT} - \frac{2}{V_a} \left[\beta'_1 x_1 + \beta'_{12} x_2 \right] - \dots$$

$$\text{and } \log_e \frac{x_2}{p_2} = \log_e \frac{V_a}{RT} + \log_e \left\{ \frac{h_a(\theta)}{h_g(\theta)} \right\}_2 + \frac{\phi_2}{RT} - \frac{2}{V_a} \left[\beta'_2 x_2 + \beta'_{12} x_1 \right] - \dots,$$

where x_1 and x_2 are the amounts of R and S adsorbed per unit area at partial pressures of p_1 and p_2 respectively, and ϕ_1 and ϕ_2 are the adsorption potentials of R and S respectively; V_a is the adsorption volume. The values of $\{h_a(\theta)/h_g(\theta)\}$ can be evaluated