The investigation will be continued with the idea of extending the observations to other elements and, also, of getting more accurate measurements of various factors involved.

[1] Hughes, *Bulletin, Nat. Res. Council, Washington,* **2,** 1921 (86).

[2] Steubing, *Physik. Zs.,* **10,** 1909 (787).

[3] Anderson, *Physic. Rev.,* **1,** 1913 (233).

[4] Gilbreath, *Ibid.,* **10,** 1917 (166).

[5] Kunz and Williams, *Ibid.,* **15,** 1920 (550).

[6] Tate & Foote, *Phil. Mag.,* **36,** 1918 (64).

[7] Hughes, *loc. cit.* (168).

[8] Wood, *Phil. Mag.,* **18,** 1909 (531).

THE ABSORPTION OF LIGHT BY SODIUM AND POTASSIUM VAPORS

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The continuous absorption found at the limit of the principal series in sodium and potassium is of great importance on the Bohr theory of atomic structure, corresponding as it does to the ejection of an electron from the atom. It was first noticed by Wood[1] in sodium, who mentioned that it began in his pictures at the last resolved line, and extended to the extreme ultraviolet. Holtsmark[2] studied it in sodium and found it also in potassium though to a less marked degree.

The present work was undertaken to study the relation of the band, line, and continuous absorption in sodium and potassium vapors, to temperature, hydrogen pressure, and vapor saturation. It was thought that some change in absorption might be obtained if the vapor was superheated.

Experimental Arrangements.—The metal was enclosed in iron tubes of 4 cm. diameter and length from 15 to 200 cm., depending upon the type of absorption to be studied. A side arm was welded to the center of the absorption tube, and so arranged that it could be heated separately. Clean sodium was then placed directly in the side arm, and after the main tube had been pumped out and raised to the desired temperature a small quantity of sodium could be distilled into it from the side tube at will. In this way a rough degree of control could be exercised on the saturation of the vapor.

Blast flames were used as a source of heat. The main tube was closed by quartz lenses kept cool with water jackets. To prevent too rapid condensation of the vapor and coating of the windows, slits were placed at each end of the hot column and kept at a red heat. A mercury manometer was kept permanently connected to the main tube, which could be exhausted to a cathode ray vacuum in three minutes with a Gaede cylinder pump. Temperatures were measured with a thermocouple calibrated by the Bureau of Standards. A cadmium spark in air was used as a light source, supplemented by electrically exploded wires of various metals in regions where Cd emission lines interfered. For photographing the transmitted light a Fery spectrograph made by Hilger was used, having a range 2100 to 6000 Angstroms, and a dispersion sufficient to resolve the lines to $n = 32$ in Na.

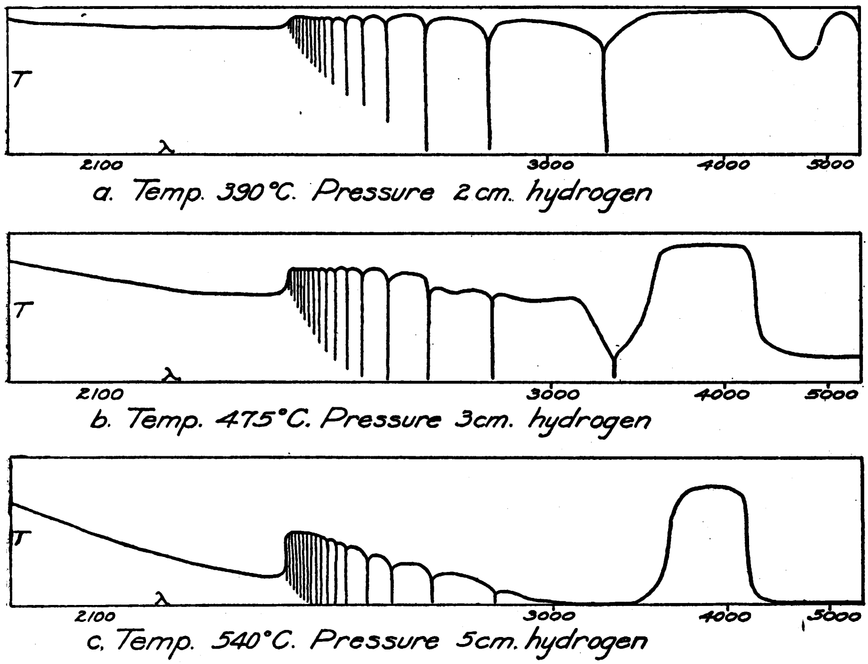

FIG. 1

Curves showing the relation of absorption at different wave-lengths to vapor density in saturated sodium vapor, with hot column 30 cm. long. Hydrogen pressures from 1 to 400 mm. had no apparent effect.

Results with Sodium.—The continuous absorption was found to be much more pronounced in certain pictures than in others, but the only determining factor seems to be vapor density. The presence of hydrogen in pressures from one to 400 mm. had no visible effect. The absorption begins at the last resolved line of the principal series, which is about five Angstrom units from the theoretical head. No definite break is observable, which is to be expected, since in the region near the limit there is an integrated intensity of unresolved line absorption and the unabsorbed spaces between.

An important point, which was indicated by all photographs showing the continuous absorption, is that this does not extend undiminished to the extreme ultraviolet. It decreases rapidly with decreasing wave-length; that is, the vapor is much more transparent fifty Angstroms below the head of the series than it is right at the head (2413 Å). In fact, the region at 2200 Å is one of the most transparent in the whole range of wave-lengths studied.

From the analogy to a similar case with X-rays, where continuous absorption decreases as the cube of the wave-length, it would be of interest to know the function determining the falling off of the absorption in the present case. It is expected that in a fuller report on this work to be published elsewhere definite data on this can be given.

In figure 1 a set of curves for sodium is given showing transmission of light as ordinates and wave-lengths as abscissas. These are given to show the manner in which the absorption changes with vapor density throughout the visible and ultraviolet. The curves are to be taken as merely qualitatively correct, since the photometric method used was necessarily rough due to irregularities in the background.

With unsaturated vapor the band absorption is tremendously weakened in comparison to the line and continuous absorption. It is difficult to get pictures which can be compared, since we have no way of determining the relative amounts of sodium present in the absorbing columns in the two cases. The best available method seems to be to take two pictures which show line 2853 (say) absorbed to the same degree in both and use this for a parameter. Two such pictures being chosen it was found that the band absorption was visible around the first four lines in the case of the saturated vapor, and about the D-lines alone, very faintly, in the unsaturated. Potassium is now being tested for a similar effect.

This evidence seems to indicate that the bands may be due to loose molecular aggregates which are broken up when the mean free path becomes greater and the temperature motion more violent. Sodium vapor is supposedly monatomic, but Hackspill's[3] vapor pressure determinations seem to show that loose aggregates may exist, since the results with saturated vapor are not very concordant.

It was noticed that the fluorescence, which was quite marked in saturated vapor, practically disappeared on superheating. Van der Lingen and Wood[4] found a similar effect in mercury vapor. The intimate connection between the mechanisms of fluorescence and band absorption has been definitely established by the work of Wood and others.

Results with Potassium.—This metal showed similar continuous absorption to that of sodium, the saturated vapor only having been studied to date. Apparently Holtsmark's result of less continuous absorption in potassium than in sodium was due merely to difference in vapor density. Curves are given for potassium in figure 2.

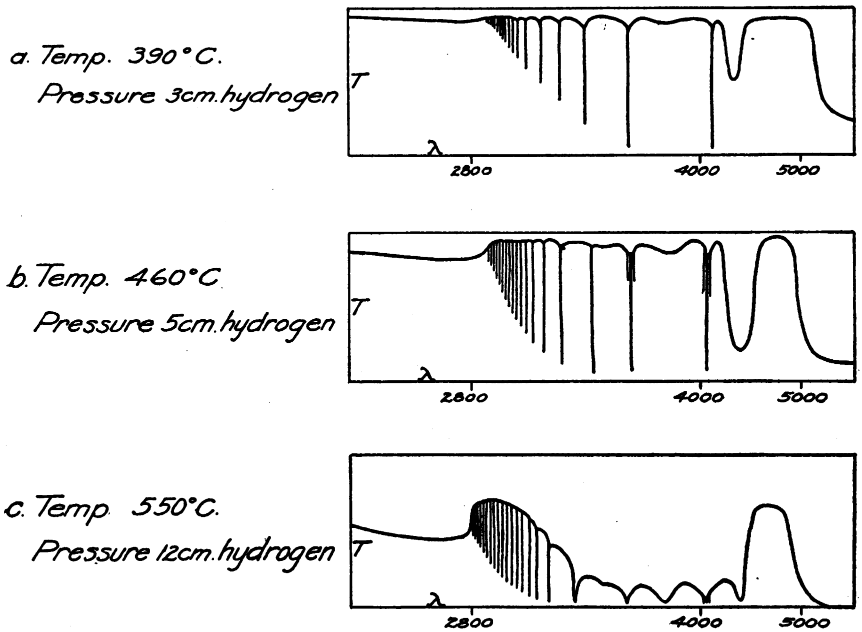

FIG. 2
Potassium

This work is being conducted under the guidance of Dr. D. L. Webster, whose aid is gratefully acknowledged.

[1] Wood, *Phil. Mag.*, **8**, 18, 1909 (530).

[2] Holtsmark, *Physik. Zs.*, **20**, 1919 (88).

[3] Hackspill, *Ann. Chim. Phys.*, **28**, 8, 1914 (613).

[4] Van der Lingen and Wood, *Chicago, Astroph. J.*, **54**, 1921 (149).