

In view of the fact that recent investigations, both spectroscopic and theoretical, appear to show that the atmosphere above 100 km. is very poor in molecular oxygen, Bhar's assumption seems to be correct. It may be shown⁶ that the dissociation of O₂ to O is practically complete at about the 130 km. level, and that the region in which the transition of the atmospheric composition (from N₂ and O₂ to N₂ and O) occurs is a fairly sharp one. It is therefore evident that in investigating the upper atmospheric ionization the photo-ionization of molecular oxygen in the transition region below 130 km. should be taken into account, particularly because the ionization potential of O₂ (16.5 ev.), being much different from those of O and N₂, this gas will produce its own level of maximum ionization. J. N. Bhar working in my laboratory has recently carried out the calculation of the photo-ionization of O₂ after Pannekoek's theory in the region of transition of O₂ to O. The result obtained by him and the assumptions on which his calculations are based are given below.

The region of transition (O₂ → O + O) is taken to lie between 80 km. and 130 km. The density of molecular oxygen at the 80 km. level is known to a fair degree of approximation from radio and other meteorological considerations. This is taken⁷ as 1.6×10^{14} molecules/c.c.; at 130 km. the density is assumed to be 10^4 molecules/c.c. Results of Bhar's calculations are depicted in the accompanying graph. For completeness, the ionization distributions for the F₁ and F₂ regions as obtained by him from revised calculations are also given. It is to be noted that the maximum of ionization in the transition layer occurs at the level of the E region, and that the ionized layer is extremely thin, which is in conformity with recent experimental evidence. The definite assertion can thus be made that the region around 100 km. in which rapid transition of O₂ to O occurs is also, as a consequence, the region of maximum ionization of O₂, and that the ionized layer formed near this level is to be identified with the E layer.

For carrying out the above calculations, a knowledge of the absorption coefficient of the gases under consideration is necessary. For atomic oxygen the value deduced recently by Saha and Rai⁸ from wave-mechanical considerations has been used. For molecular oxygen and nitrogen, Bhar, in common with all previous workers, has utilized the well-known Kramers' formula for X-ray absorption with certain modifications. The use of this formula for neutral atoms and particularly for neutral molecules is open to serious objection^{9,10}. Crude as this procedure is, the importance of the analysis still remains, for, if at any future date accurate experimental or theoretical values of the absorption coefficients and their variations with frequency be available, these need only be substituted in the working formula to get a more accurate result.

The origin of the E layer as explained above is due to strong absorption resulting in photo-ionization of molecular oxygen commencing at λ 744 Å. There is, however, absorption due to nitrogen molecules and to oxygen atoms in this range of wave-lengths. The effect of this absorption will be to reduce the intensity of the wave-lengths necessary for the photo-ionization of molecular oxygen. This fact has been taken into account by taking the intensity of the radiation in this range as one-thousandth of what it would have been in the absence of the superincumbent gases.

A fuller and more detailed account of the investigation will shortly appear in the *Indian Journal of Physics*.

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¹ Chapman, *Proc. Roy. Soc., A*, **132**, 353 (1931).

² Pannekoek, *Proc. Amsterdam Acad.*, **29**, 1165 (1926).

³ Bhar, Paper No. 58, Mathematics and Physics Section, Indian Science Congress (January 1938).

⁴ Hulburt, *Phys. Rev.*, **53**, 344 (1938).

⁵ Saha, *Proc. Roy. Soc., A*, **160**, 155 (1937).

⁶ Majumdar, *Ind. J. Phys.*, **21**, 75 (1938).

⁷ Ghosh, M.Sc. Thesis (1938), Calcutta University; see also Martyn and Pulley, *Proc. Roy. Soc., A*, **154**, 455 (1936).

⁸ Saha and Rai, *Proc. Nat. Inst. Sci. Ind.*, **4**, 319 (1938).

⁹ Page, *NATURE*, **141**, 1137 (1938).

Effect of Temperature on the Intensity of X-Ray Reflection

WE have studied with a fibre camera, used in conjunction, and simultaneously, with a flat plate powder camera, the effect of temperature on the intensity of reflection of X-rays from copper. The effect has been examined over a range of temperature extending from room temperature to about 570° C.

According to Debye's theory as modified by Waller, in order to account for the decrease of X-ray reflection from a cubic crystal as the temperature is raised, the intensities of the interference maxima should be multiplied by a temperature factor exp. ($-2M$),

where $M = \frac{6h^2}{mk\Theta} \left(\frac{\varphi(x)}{x} + \frac{1}{4} \right) \cdot \frac{\sin^2\theta}{\lambda^2}$, m is the mass of

the atom concerned, Θ is its characteristic temperature, $x = \Theta/T$ where T is the absolute temperature and $\varphi(x)$ is a certain function of x which Debye evaluates.

Observations made on the intensities of reflection from rock salt and sylvine by James and his collaborators show that the results obtained with these materials agree fairly closely with Waller's modification for temperatures ranging from 85° A. to 400° A., but that for higher temperatures up to about 900° A. there is a definite departure from the Debye-Waller formula, the intensity falling off more rapidly with rise of temperature than is allowed for by the formula.

The present results obtained with copper, which possesses face-centred cubic structure, show that throughout the range of temperature from 290° A. to 840° A., the decline of intensity with increase of temperature is greater than that predicted by the Debye-Waller formula. The experimental results agree closely with the calculated results if the temperature factor is assumed to be exp. ($-3M$) instead of exp. ($-2M$).

A full account of the investigation will shortly be published.

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