LETTERS TO THE EDITORS

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E Region during the Solar Eclipse of February 25, 1952

DURING an eclipse of the sun, changes in the electron density (N) in an ionospheric layer of Chapman type may be represented by the relation :

$$\frac{dN}{dt} = q - \alpha' N^2, \qquad (1)$$

in which q is rate of production of electrons and α' is effective recombination coefficient. If the ionizing radiation were emitted uniformly from all parts of the disk, q would be proportional to the fraction (A_x) of the disk unobscured by the moon. Observations made at optical frequencies show that the disk radiation is not uniformly distributed. Consequently, if we assume that the ionizing radiation has a similar distribution, it is necessary to represent q during an eclipse by two terms denoting the intensity of the radiation coming from the uniform ($A_x I_0$) and non-uniform (I_s) components respectively. Thus :

$$q = K \cos\chi \, (A_x I_0 + I_s), \qquad (2)$$

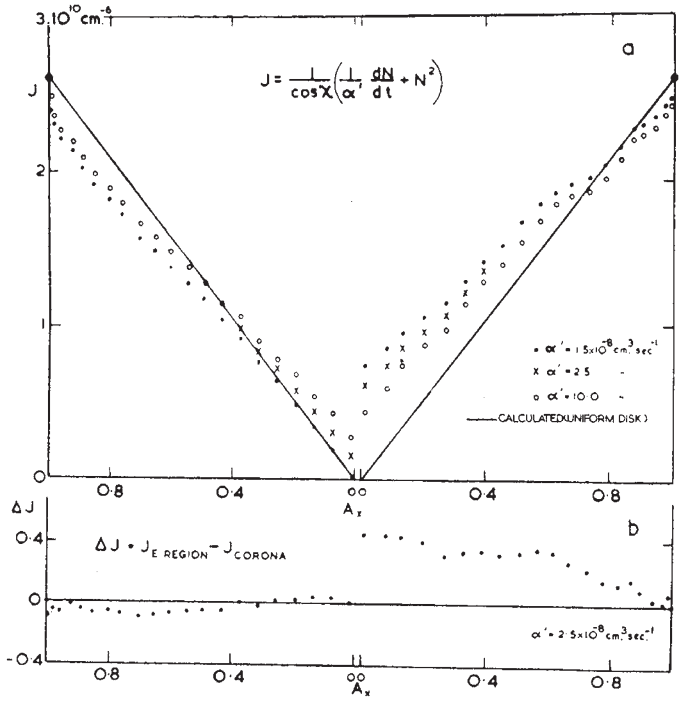
where K is a constant and χ is zenith angle of sun.

Substituting this in equation (1), we can write :

$$\frac{K}{\alpha'}[A_x I_0 + I_s] = \frac{1}{\cos\chi}\left[\frac{1}{\alpha'}\frac{dN}{dt} + N^2\right] \; (= J). \qquad (3)$$

On the right, $\cos\chi$ is known, and N and dN/dt can be deduced from the changes in E-region critical frequency (foE) during the eclipse. Hence the values of J calculated from ionospheric measurements can be compared with those obtained by inserting different values of I_0 and I_s in the left of equation (3).

Measurements of foE were made at intervals of four minutes at Khartoum during the total solar eclipse of February 25, 1952. The standard deviation of the error in measuring foE was about 0·01 Mc./s. and, since special precautions were taken to ensure accurate timing, the maximum error in calculating dN/dt is probably about ± 10 per cent. J has been computed for several values of α', and the experimental points are shown in Fig. 1 with the computed values for a uniformly radiating disk. J has been plotted as a function of A_x since the slope of the line through the points is then proportional to I_0 (equation 3).



(1) Change in $J = q/\alpha'$ cos χ during total eclipse, calculated from E-region measurements. (2) Difference between J derived from E-region measurements and from intensity distribution of coronal line 5303 A.

The observations imply that the uniform (J_0) and non-uniform (J_s) components have magnitudes : $J_0 = 200 \times 10^8$ cm.$^{-6}$; $J_s = 60 \times 10^8$ cm.$^{-6}$. Part of the non-uniform component is divided about equally between the east and west limbs of the sun, since a sharp fall in J occurred just after first contact and a similar rise preceded fourth contact. It also seems probable that J did not fall to zero during totality.

These conclusions are consistent with the distribution of intensity over the disk of the green coronal line, information on which has been obtained through the courtesy of M. L. d'Azambuja, of the Paris Observatory at Meudon. The difference between the value of J calculated from the coronal data, assuming an extension to 1·04 solar diameters, and from the E-region measurements, assuming $\alpha' = 2{\cdot}5 \times 10^{-8}$ cm.^{3} sec.$^{-1}$, is shown in Fig. 2. The main discrepancy appears abruptly just after totality, and suggests the existence of an intense source of ionizing radiation near the west limb of the sun which cannot be accounted for in terms of the solar data available at present. If J is not allowed to become negative just before totality, the minimum possible value of α' is $1{\cdot}5 \times 10^{-8}$ cm.^{3} sec.$^{-1}$. This would imply that J rose from 0 just before, to 73 ± 10^8 cm.$^{-6}$ just after, totality, and also that 28 per cent of all the ionizing radiation was emitted from 0·4 per cent of the disk area. On these grounds a somewhat higher value of α' may be required, at least near totality.

A fuller account of these and other ionospheric measurements made during the eclipse will appear elsewhere. The work described above was carried out as part of the programme of the Radio Research Board and this note is published by permission of the Department of Scientific and Industrial Research.

C. M. MINNIS

Radio Research Station,
Ditton Park,
Slough, Bucks.
July 19.