Polarization of the Solar Corona

DURING the eclipse of June 19, 1936, at the observation station near the village of Kalenoe on the banks of the Ural River (U.S.S.R.), an investigation of the polarization of the solar corona was carried out by the expedition from Abastumani Observatory. The observations were made under perfect atmospheric conditions. A polarigraph with a reflecting analyser was used. The polarization was studied in two regions of the spectrum, corresponding to photographic and visual rays. In each series three plates were obtained with planes of polarization making angles of 60°. This enabled us to determine the degree and the direction of polarization at each point. On the plates the zone from 10′ to 40′ from the limb was found to be suitable for accurate photometric measurements. *The effect of polarization is obvious.*

From the study of the distribution of the degree and direction of the polarization, we can draw the following preliminary conclusions:

(1) The degree of polarization is different for different regions of the spectrum.

(2) The change of the polarization with increasing distance from the moon's limb is different for different heliographic latitudes, and depends on the structure of the corona. At places with a sharp radial structure (in corona streams) the polarization changes little, while between the streams it diminishes with the distance from the moon's limb.

(3) The direction of the polarization, while remaining approximately radial close to the solar poles and between streams, undergoes a strong but regular perturbation in the streams themselves.

The distribution of the direction of polarization in the outer corona (considering it as a vector) shows a certain analogy to the field of force.

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Anomalous Dielectric Constant of Artificial Ionosphere

SINCE the earliest experiments of Barton and Kilby[1] in 1913 on the dielectric properties of ionized air, there have been many attempts by investigators to record experimentally the depression of the dielectric constant of an artificial ionosphere (as the ionized air in a discharge tube may more properly be called) to a value less than unity. It has, however, been found by almost every investigator that the reduced value of the dielectric constant could be obtained only under very special experimental conditions such as low value of ionization in the experimental discharge tube or ultra-high frequency of the exciting wave; while, more often than not, the value of the dielectric constant recorded was greater than unity. This latter result is usually believed to be contradictory to the theory, and various explanations have been put forward to explain the apparent anomaly.

The purpose of this note is to show from a consideration of the ionospheric dispersion formula that the so-called anomaly is not an anomaly at all, since the formula itself yields values of the dielectric constant greater than, equal to, or less than unity, depending upon the experimental conditions of the discharge tube such as the degree of ionization, the pressure (that is, collisional frequency) and the exciting wave frequency.

The complete dispersion formula is given by

$$\left(\mu - \frac{ic\kappa}{p}\right)^2 = 1 + \frac{1}{\alpha + i\beta} \quad . \quad . \quad . \quad (1)$$

Where $\alpha = -\frac{p^2m}{4\pi Ne^2}$ and $\beta = \frac{mp\nu}{4\pi Ne^2}$.

The symbols have their usual significance.

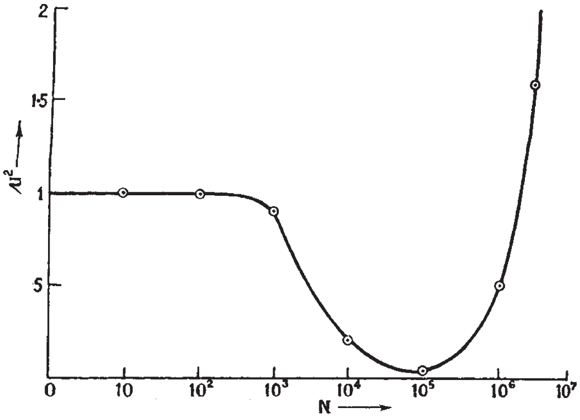

Fig. 1.

Separating the real and the imaginary parts, we have[2]

$$2\mu^2 = \sqrt{1 + \frac{2\alpha + 1}{\alpha^2 + \beta^2}} + \frac{\alpha}{\alpha^2 + \beta^2} + 1 \quad . \quad . \quad (2)$$

$$\frac{2c^2\kappa^2}{p^2} = \sqrt{1 + \frac{2\alpha + 1}{\alpha^2 + \beta^2}} - \frac{\alpha}{\alpha^2 + \beta^2} - 1 \quad . \quad . \quad (3)$$

It is easily seen from expressions (2) and (3) that μ^2 is greater than, equal to, or less than, unity, according as

$$\frac{|\alpha|}{\alpha^2 + \beta^2} \lesseqgtr \frac{c^2\kappa^2}{p^2}$$

If $\alpha \gg \beta$, expression (2), reduces to

$$\mu^2 = 1 - \frac{4\pi Ne^2}{m(p^2 + \nu^2)} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The approximate formula (4), which apparently suggests that μ^2 cannot attain a value greater than unity, has been responsible for the widespread belief "that the theoretical expression for the dielectric constant of an ionized medium does not permit values greater than unity, whatever the ionic concentration may be"[3]. Calculation of values of μ^2 from the complete dispersion formula shows, however, that the theoretical expression for the dielectric constant *does* permit values both greater, and less than, unity.

Figs. 1 and 2 are plots of equation (2). In Fig. 1, the dielectric constant is plotted against the ionic density N, all other quantities remaining constant. It is seen that only within a limited range of N can values of μ^2 less than unity be recorded. If N is increased beyond this range, the value of the dielectric constant increases and becomes greater than unity.

Fig. 2 is drawn for values of ν, N and p as were obtained in an actual experiment by Mitra and Banerjee[4]. The broken line prolongation of the left-hand portion of the curve is obtained by using the approximate formula (4). Mitra and Banerjee had explained the upward swing of the curve to the right

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