"An Analysis of the Results from the Kew Magnetographs on *Quiet* Days during the Eleven Years 1890—1900, with a Discussion of certain Phenomena in the Absolute Observations." By CHARLES CHREE, Sc.D., LL.D., F.R.S., Superintendent of the Observatory Department. Received May 1, —Read May 28, 1903.

(From the National Physical Laboratory.)

(Abstract.)

The late Kew Observatory Committee joined in 1890 in a scheme, whereby five days each month were to be selected as magnetically *quiet* days by the Astronomer Royal, with a view to the curves on these days being tabulated by observatories which did not care to undertake the tabulation of every day's curves. That scheme has been persisted in, and the present paper deals with the results it has led to during the eleven years 1890—1900. The paper treats of the secular change in the several elements, of the annual inequality, of the diurnal inequality, and the non-cyclic effect in the diurnal variation. Attention is more particularly given to the declination, inclination, and the horizontal and vertical components, but some consideration is also given to the northerly and westerly components of the horizontal force and to the total force.

Diurnal inequalities are got out for each month of the year in the principal elements. These inequalities are analysed into Fourier's series, and the variation of the Fourier coefficients is traced throughout the year. Attention is also given to the variation throughout the year in the ranges of the diurnal inequalities and in the sum of the twenty-four hourly differences from the mean for the day. The diurnal inequalities are shown graphically in various ways, serving to illustrate different features.

As explained in a "Preliminary Note," the relations between magnetic phenomena and sun-spot frequencies have been investigated. The present paper treats of this investigation in detail. Attention is given to the ranges, and the sum of the twenty-four hourly differences from the mean of the day in the diurnal inequalities, and to the amplitudes and phase angles of the terms in the Fourier series representing these inequalities. Some of the results obtained for Kew are compared with corresponding results for Wilhelmshaven and Parc St. Maur, based on data given by Borgen and Moureaux. The results from the stations compared showed a very good agreement.

It is found that the non-cyclic effect in the diurnal variation, and the variability in the declination—recently discussed by the

author in connection with the observations of the "Southern Cross" Antarctic Expedition—show a relation to sun-spot frequency similar to that observed in the ranges of the diurnal inequalities themselves.

A comparison is made between magnetic and meteorological phenomena at Kew from two groups of years, the one representing large, the other small sun-spot frequency. This serves to bring out the insignificance of the connection between meteorological phenomena at a given station and sun-spots—if any such connection exists—as compared to the connection between magnetic phenomena and sun-spots.

A comparison is instituted *inter alia* between the variation through out the year in the amplitude of the Fourier coefficients in the series found for diurnal inequalities of the magnetic elements and atmospheric temperature, making use of temperature data discussed by General Strachey. It is shown that the amplitudes of the twenty-four-hour term in the Fourier series in the two cases vary in a very similar fashion throughout the year, but that this is not true of the twelve-hour, eight-hour, or six-hour terms. Attention is also called to the fact that, in the temperature diurnal inequality, the twenty-four-hour term preponderates in a way that is not found in any of the magnetic elements. The bearing of this is pointed out on theories as to the source of the magnetic diurnal inequality.

Attention is also drawn to a peculiarity in the variation from month to month in sun-spot frequencies, which enables a somewhat searching inquiry to be made as to the simultaneity of changes in sun-spot frequency and magnetic ranges.

A final section deals with the true nature of the connection between sun-spot frequency and magnetic phenomena. A comparison is made between Wolfer's provisional sun-spot frequencies for all days in the year and for the Astronomer Royal's magnetically quiet days. The conclusion come to is, that sun-spot frequency on any particular day is no guide to the magnetically quiet or disturbed character of the day, and that even mean results for a month for sun-spot frequency and magnetic ranges are but slightly related. It is pointed out that the phenomena observed would be consistent with the view that increased sun-spot activity and increased magnetic activity on the earth are due to some common source external to the sun, whose effect at the same instant varies appreciably throughout the solar system. If the source lies in the sun itself, it is concluded either that sun-spots afford no satisfactory quantitative measurement of it, or else that the effect at the earth is influenced by what takes place at the sun during a considerable time. If the source of the magnetic diurnal inequality be, as has been suggested by various physicists, electrical currents generated by the sun's action in the upper atmosphere, the cause of the increase in the amplitude of the in-

equality at times of great sun-spot frequency may be some form of radiation which reduces the resistance of the atmosphere to currents generated by the sun. This would explain the phenomena without requiring the enormous variations in the sun's output of energy from year to year that would appear necessary to account for the great variations in the magnetic phenomena, variations moreover which—as the paper shows—do not appear to be accompanied by any but the most insignificant changes in the amplitude of the temperature inequality at the earth's surface. The importance is pointed out of reliable information as to whether atmospheric electricity potential, at low and at high levels, resembles magnetic phenomena in being largely different in years of large and small sun-spot frequency.

"On the Theory of Refraction in Gases." By George W. Walker, M.A., A.R.C.Sc., Fellow of Trinity College, Cambridge. Communicated by Professor J. J. Thomson, F.R.S. Received May 2,—Read May 28, 1903.

(Abstract.)

The present theories of refraction in gases lead to expressions for the refractive index, of which the formula

$$\mu^2 - 1 = \mathrm{N}f(p)$$

may be taken as typical.

In the formula μ is the refractive index, N is the number of molecules per unit volume, p is the frequency of the waves, and $f(p)$ is a function of p which depends on the assumptions made as to the constitution of the molecule.

The formula, although it explains the main features in the visible spectrum, cannot always be made to explain the measured temperature effects, even when allowance is made for the deviations from the gaseous laws of Boyle and Charles.

Again, in the case of the dielectric constant for some gases such as SO_2 and NH_3, the value of $\mathrm{K}-1$ is much greater than the value of μ^2-1. In such cases we find that μ^2-1 varies nearly as N, while $\mathrm{K}-1$ is more nearly proportional to N/θ, where θ is the absolute temperature.

The theories are thus inadequate, and a modification is required which will give a greater dependence on temperature.

In the theories of Voigt and Lorentz the molecule is regarded as an aggregate of electrical doublets. The individual parts are assumed to have free periods of vibration, which are naturally identified with the