Letters to the Editor.

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The Kerr Effect in Wireless Transmission.

MR. HOLLINGWORTH's observations (NATURE, Sept. 18, p. 409) on the polarisation of long wireless waves by day and by night are of great interest in connexion with the attempts which have been made to explain the diurnal variation of atmospheric influences on wireless transmission.

According to the original theory of diurnal variation proposed by Dr. Eccles (*Proc. Roy. Soc.*, A, vol. 87, p. 79, 1912), atmospheric deviation of wireless waves is produced during the day by ionic refraction in a somewhat diffuse layer in the middle atmosphere, while at night true reflection of all wave-lengths takes place from the sharp boundary of the Heaviside layer in the upper atmosphere. According to this theory, the difference between the 'reflection coefficients' of the day and night layers is due to the difference in the degree of variation of ionic content of the under boundaries of the layers.

More recently (NATURE, March 7, 1925; *Electrician*, April 3, 1925) a somewhat different theory has been found useful in linking the mass of evidence relating to geophysical influences on wireless transmission which has accumulated during the last few years. According to this view, the increase of signal strength at night, which is noticeable particularly on the shorter waves, is attributed not to an increase in ionic gradient but to a general lifting of the layer after sunset. The reduction in the collisional 'friction' of the electrons in the layer, due to the increased height and lower pressure, makes deviation with reduced absorption possible. In this connexion it seems clear that the difference between reflection and refraction is determined by the ratio of the thickness of the transitional layer to the wave-length, and, since a transitional layer of several kilometres is contemplated both by day and by night, we may generalise roughly and say that long wireless waves are deviated by reflection and short waves by refraction. The gradient of conductivity (which is determined not only by the gradient of ionic content, but also by the gradient of τ, the time between two collisions of an electron with the gas molecules) is sufficiently high to deviate long waves within a wave-length, while the shorter waves are deviated by ionic refraction brought about by a diminution of the refractive index. Experimental evidence is steadily accumulating which shows that in the latter case ionic refraction without absorption is only brought about, as Sir Joseph Larmor first predicted on theoretical grounds, when the frequency of the waves is higher than the frequency of the electron collisions with gas molecules.

In linking up these ideas with the magneto-ionic theory, in which the effect of the earth's magnetic field on the motion of the electrons is taken into account, a Kerr effect was predicted (*Proc. Camb. Phil. Soc.*, vol. 22, Part 5, p. 675, 1925) for long waves when reflected by the ionised layer at night. Mr. Hollingworth's observations on long waves seem to show that such an effect is appreciable. Considered in conjunction with Dr. Smith-Rose and Mr. Barfield's observations with the Adcock system, they also constitute another confirmation of Mr. T. L. Eckersley's theory of the nature of directional errors.

A consideration of the magneto-ionic formulæ for the conductivity and dielectric constant of ionised gas shows that, in cases of reflection, there is a certain critical height in the atmosphere above which the conductivity in the direction of the earth's lines of magnetic force is appreciably different from that in a direction at right angles. This is the height at which the frequency of the electron collisions with gas molecules is equal to the angular frequency with which the electrons normally spiral round the lines of magnetic force. Taking the earth's field as 0·5 gauss, the critical value of τ is found to be equal to 10^{-7}. Estimates of both mean free paths and air pressures at different heights in the atmosphere, as given by different writers, vary somewhat, but from the available data we may, using the above value of τ, put the critical height somewhere about 70 km. to 80 km. When the waves are deviated below this height, practically no abnormal polarisation is produced, but when deviated above, both Kerr and Faraday effects will be produced according to the wave-length. The fact that the Kerr effect is found at night and not by day indicates that the ionised layer passes from or below this critical region to a height appreciably above it at sunset. Current determinations of the height of the layer for these wave-lengths by day and by night support this conclusion.

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Early Egypt and the Caucasus.

As the careful summary of the meeting on this subject at Oxford (NATURE, September 25, p. 463) stops short before my reply to the difficulties there raised, I trust that I may be allowed to complete the report. We must consider the reasons for retaining the view of the dependence of the Fayum on the Nile flow, which has been held by engineers, geologists, and historians during the last fifty years—much of history depends on the conclusions.

The essential question is to choose between the received view (*a*) that the Fayum lake gradually rose by the rise of Nile level up to 205 or 220 feet over the present lake, and was suddenly dried up by restricting the inflow, under the Ptolemies; or the new view (*b*) that there was a high lake in the early human period, which was gradually dried down to the present size. The complete drying up would not take more than twenty-five years.

For the view (*a*) there are six reasons. Physically there is (1) an open channel from the Nile, the mud in which is at least as low as the Nile was at 5000 B.C., and it is unlikely that this would become blocked when a large mass of water was flowing to and fro every year. (2) It would be impossible to maintain a lake at high level unless fed by the Nile; the adjacent deep basin of Wady Rayan has not had any historical lake, because there is no Nile inflow. Historically we see (3) there are an early cooking-pot, fire, and flints *in situ* at 170 feet level, while the water in Greek times must have been up to over 200 feet, by a site being called the "crocodile island," so the lake level was rising and not falling. (4) There is no trace of human work anywhere below the Nile level of its own age, which points to the lake covering the ground up to Nile level. (5) There are four structures of stone, all at the same level, which cannot be reasonably explained except as quays of late origin, and these are at 215 feet level, showing the late lake to have been far above the early flint work. (6) Direct evidence is that of Herodotus; he states