outline of the »Electrod. Wave-Theory of Phys. Forc.« the following figure was used to illustrate the propagation of wireless waves around the earth.

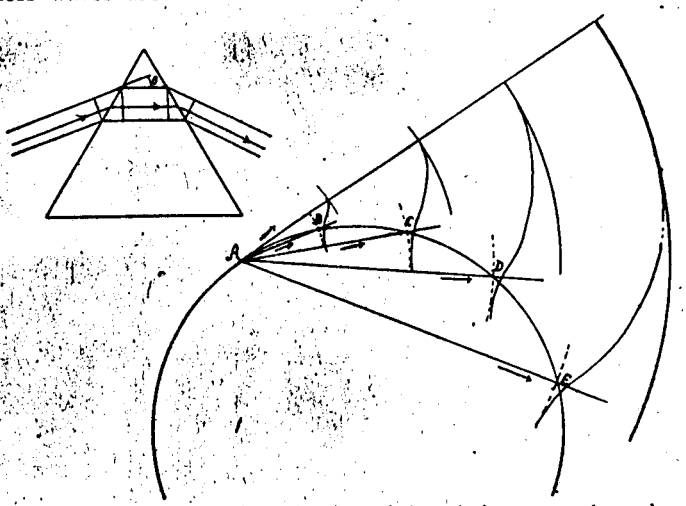

Fig. 2. Illustration of the refraction of the wireless wave about the earth, and of light in a prism, owing to slower propagation of waves in dense masses.

It is a sufficient explanation of this figure to say that it corresponds exactly with the propagation of light through a glass prism, as shown in the figure of the prism above. The wireless waves travel faster in air than through the solid earth. The enormous elasticity of the aether, as set forth in section 4, prevents bodily rupture of the medium; and this secures continuity of the wave front, by bending the surface backward near the globe, to correspond to the slower propagation in that dense mass. The retardation of the waves propagated straight through the earth causes the wave front to be bent and held back near the curved surface of the earth, and thus the wireless wave is refracted around the earth by the much greater resistance encountered in that solid mass.

The correct theory of the bending of the wireless wave about the globe is thus the same as that of a ray of light by a prism, as shown in the accompanying figure. The speed in the air is 4, but in the glass only 3, and thus there is a bending of the wave front through the angle θ when the light enters the glass, and also when it leaves the glass, as long recognized by physical investigators.

The explanation of the refraction of light in a prism is directly confirmed by *Foucault*'s celebrated experiment on the relative velocity of light in air and in water, (Annales de Chim. et de Phys. Sér. 3, t. 41, 1854), which has always been recognized as a crucial test of the wave theory of light, and which finally led to the total rejection of the emission theory.

The simplicity of the above explanation of the propagation of wireless waves about the globe is thus remarkable. But it is also confirmed experimentally by observations made by officers of the American Navy, upon wireless waves sent from Mare Island to San Diego, California, and received by submarines lying on the bed of the sea, through a depth of some 30 metres of sea water. In some experiments with the receiving apparatus underground the same effect was observed. It appears that the earth also conducts the signals, so that wireless apparatus may be installed and used in deep mines, which would enormously increase the power of signalling in case of accidents interrupting communication by the shafts and tunnels.

It is probable, however, that the irregularity in the structure and conducting power of the earth's strata would somewhat handicap such underground signalling, yet not prevent the successful development of the method of signalling through the earth to the limited depths at which miners work.

The problem of explaining the propagation of wireless waves about the earth has hitherto challenged the ingenuity of the foremost mathematicians. It has been unsuccessfully attacked by Professor *H. M. Macdonald* (Proc. Roy. Soc. 1903 and Phil. Trans. 1910), Lord *Rayleigh* and Prof. *H. Poincaré* (Proc. Roy. Soc. 1903). See also *Poincaré*'s Lectures of 1908 (La Lumière Électrique, vol. 4, 2nd series, Nov. 28, Dec. 5, 12, 19, 1908, especially p. 323). Professor *A. Sommerfeld* (Ann. der Phys., vol. 28, p. 665, 1909) has shown that a surface wave should exist; and Professor *J. W. Nicholson* (in the Phil. Mag., March, April, May, 1910) has dealt with certain problems of the exponential factor of the wave amplitude, but none of these eminent mathematicians arrived at any satisfactory theory of wave propagation about the globe.

In his well known work on the Principles of Electric Wave Telegraphy and Telephony, London, 3rd edition, 1916, p. 826–851, Professor *J. A. Fleming* gives a full and accurate account of the difficulty experienced by these and other mathematicians. In this revised edition of 1916, *Fleming* gives the following: »General conclusions as to the mode of propagation of long electric waves round the earth«.

»Summing up the conclusions so far reached by radiotelegraphists we may say that the effect produced by a radiotelegraphic transmitter at a great distance, say 2000 or 6000 miles over the surface of the earth, is a complex one in which several different actions play a part«.

»There is, first, a propagation through the aether of a true space electromagnetic wave which is diffracted round the earth. The extent to which this contributes to the whole effect is, perhaps, greater than was formerly supposed, but is yet an undetermined quantity. Some mathematicians are now inclined to attribute to it the major portion of the transmission by day«.

»Then in the next place there is undoubtedly a contribution made to the effect by waves which have suffered a refraction equivalent to a reflection by ionized air at high altitudes, and a very small effect due to the decrease in refractive index of air as we ascend upwards«.

»These causes tend to make the ray follow round the curvature of the earth and so assist as it were diffraction. It is to this variable ionic refraction that we must attribute the diurnal and annual variations in signal strength, and also the greater signalling distance by night as well as the irregularities attending the transition times of sunrise and sunset«.

»Then in addition we may inquire how far any contribution is made by a surface wave of the type investigated by *Sommerfeld*, which is equivalent to an electric wave propagated through or along the earth«.