LETTERS TO THE EDITORS

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A Simple Method of Demonstrating the Circular Polarization of Ionospherically Reflected Radio Waves

SINCE the ionosphere is a doubly refracting medium, due to the influence of the earth's magnetic field, a plane-polarized radio wave incident normally on it is split into two elliptically polarized components of opposite rotational sense. For a certain range of frequencies, in the neighbourhood of the gyro-frequency, only one of these two components is reflected in strength, the other being strongly absorbed. In northern temperate latitudes this reflected component is of left-handed, approximately circular, polarization. In corresponding latitudes in the southern hemisphere the sense of the polarization is reversed.

To demonstrate the circular polarization of ionospherically reflected waves in such cases it is necessary to show that the two components of the magnetic vector along the two axes Ox and Oy in the ground plan are equal and are 90° out of phase. (See Fig. 1, where the direction of propagation of the downcoming waves is supposed to be normally into the paper.) If two equal loop aerials are placed with their axes along these directions, the electromotive forces in these aerials will have the same phase difference as the magnetic vector components ; but to exhibit the value of this quantity on a cathode-ray oscillograph requires both pulse transmissions and elaborate receiving equipment in the form of two high-frequency amplifiers of exactly similar phase and amplitude characteristics.

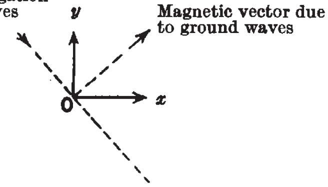

Fig. 1.

It is, however, possible to demonstrate this phase difference in a much simpler manner. Let us suppose that the incoming signal is caused to beat with a locally produced oscillation, the frequency of which is very slightly less than that of the downcoming waves. Low-frequency beats can then be obtained from the signals in the two aerials, and it may be shown that the phase difference of the two beat envelopes is then exactly the same as that of the two high-frequency components under examination in the two aerials.

To produce the required low-frequency beats it is not necessary to provide a separate heterodyne, since the oscillations produced by the ground waves answer the same purpose. During the early morning when the height of ionospheric reflection is being slowly reduced, under the increasing solar influence, the frequency of the reflected waves is slightly higher than that of the ground waves due to Doppler effect. The variations which then take place in the outputs from the two aerials are due to the beats between ground and ionospherically reflected waves, and the phase difference we seek to demonstrate is equal to that between the signal variations in the two systems. If we set the two loops at 45° to the directions of propagation of the ground waves, we ensure that the ground waves have equal influence on both systems, and, if each aerial is provided with a rectifier and recording galvanometer, the relative magnitudes of the fading depths and the phase difference between the fading cycles can be simply demonstrated.

With waves of frequency of 2–3 Mc./s., the early morning fading is usually quite regular and the two records are similar to those shown in Fig. 2. It will be seen that the vector along Ox leads that along Oy by 90° and this, together with the fact that the fading is of equal depth in the two cases, shows that the downcoming wave is of left-handed circular polarization.

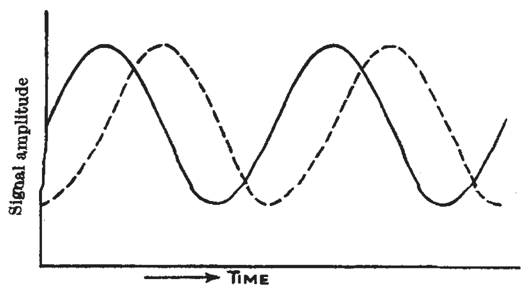

Fig. 2. THE FULL LINE REPRESENTS THE SIGNAL VARIATIONS IN THE LOOP WITH AXIS Ox; THE DOTTED LINE THOSE IN THE LOOP WITH AXIS Oy.

In the case of observations made in the evening (for example, on medium wave broadcasting stations) the ionospheric height of reflection is increasing, and the frequency of the down-coming waves is therefore slightly less than that of the ground wave. The phase difference between the beats as produced with a common heterodyne (that is, the ground wave) is then shown by the examination of the fading curves read in the *negative* direction along the time axis, since the beat notes are then reversed in phase relative to the original signals.

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Absolute X-ray Wave-lengths

AN important discrepancy is beginning to make itself felt in X-ray diffraction measurements. At present, lattice spacings of crystals are based on the Siegbahn X-unit[1], which is defined as 1/2814·00 of the 200 spacing of rocksalt ; this definition made the X-unit as near as possible to 10^{-3} A., in the light of the then-known value for Avogadro's number, N_0. Such a standard was necessary because relative measurements of wave-lengths could be made much more accurately than absolute ones.

So long as the same value of N_0 was used both to specify the scale of X-ray wave-lengths and to work out the contents of a unit cell, no important errors could arise. Now, however, the accepted value of