Letters to the Editor.

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Radio Echoes and Magnetic Storms.

PROF. STØRMER'S letter (NATURE, Nov. 3, p. 681), on radio echoes heard from 3 to 15 seconds after the signals, raises some interesting points. If the cause is as he suggests, namely, streams of electrons from the sun, associated with auroræ, the observations would seem to give the first direct evidence yet obtained as to the density of these streams, since the reflection of waves of 31·4 metres, at normal incidence (as is necessary for the signals to return to the earth from a great distance), requires an electron density of the order 10^5 to 10^6 per c.c.

Prof. Størmer mentions electrons only, but these must be accompanied by positive ions in approximately equal numbers (assuming them to be singly ionised), since a stream of this order of density, even if it were not practically neutral on emission from the sun, would become so in its passage to the earth, by dispersal of its excess charge. The positive ions will play only a minor part in radio reflection. It is of interest to note that the density of the stream, according to the above estimate, is similar to that of the solar chromosphere. Since the thermal motions of the ions must cause an expansion of the stream during its passage from the sun, the density at emission must be greater.

The fact that the electrons must be accompanied by positive ions will render their motions in the earth's magnetic field very different from those deduced by Prof. Størmer in his valuable mathematical researches on auroræ; Mr. K. C. A. Ferraro and I have made some calculations on this subject, which we hope to publish shortly. The charges in a neutral stream may become separated to some extent by the field, in the earth's neighbourhood, but this can scarcely occur to any extent at the distance of about 200 earth-radii at which the radio signals are supposed to be reflected.

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S.W.7, Nov. 7.

IN NATURE of Nov. 3 there is a letter by Prof. Størmer which I find exceedingly interesting. Although I have never observed the short wave echoes of 3 to 15 seconds' delay reported by him, I have other observations which bear closely on this matter and seem to afford a striking confirmation of his conclusions. These observations refer to a peculiar class of atmospheric, which from their musical nature are appropriately termed 'whistlers.'

It has been known now for some years that if a telephone or any audio amplifying device is placed in series with a big aerial (eliminating all high frequency circuits and rectifiers), disturbances of a musical character can be heard on appropriate occasions. These can be divided into two classes, the short whistlers and the long, but both are characterised by the fact that the disturbance starts with a note of high pitch, which drops rapidly in the first class and slowly in the second class to a note of low pitch, *i.e.* about 200 to 500 cycles per second. The first have been described by me, *Phil. Mag.*, vol. xlix., June 1925, where it is shown that these disturbances are probably produced by an electrical impulse, the component frequencies of which, travelling with different group velocities in the medium, are drawn out into a disturbance of a musical character.

The resemblance between the long and short whistlers suggests that the mechanism is the same in both cases. The observations which bear on Prof. Størmer's results have been made during the past nine months on the long whistlers. The observations have been made daily, and the following general statements may be made:

(1) Whistlers are definitely associated with magnetic storms. That is to say, the frequency of occurrence of these is enormously greater on magnetically disturbed days than on quiet days. During quiet times days may pass with only occasional 'whistlers.'

(2) On many occasions the whistlers occur in groups of echoes preceded by a violent click. The time interval between the click and first echo is approximately 3 seconds, and between each succeeding echo about 3·80 seconds. As many as seven echoes have been heard. Each succeeding whistler is spread over a longer time than the last. The number of echoes and the time interval between them both vary considerably from time to time.

Although there is not sufficient space in a short letter to go into the significance of these results in detail, the connexion between them and Prof. Størmer's long echo is obvious, and one may assume that the mechanism is the same. One may perhaps surmise that the original pulse is produced by a group of charged atoms shot out by the sun and abruptly stopped at the earth's atmosphere; the resulting pulse spreads into the torroidal ring and circulates round it perhaps five or six times before it is finally extinguished. The region within the ring must be slightly dispersive, an electronic density of about one electron per c.c. being sufficient to draw out the pulse into its spectrum of frequencies. The attenuation must be exceedingly low, which suggests a region of very low density.

Whatever the mechanism may be, it is clear that the two sets of observations confirm each other, for if it is possible to have short wave echoes of 3 or more seconds' delay, the explanation that the 'whistler' is a dispersed pulse delayed in travelling by the same interval of time is clearly feasible.

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The 'Dimensions' of Society.

A REMARK of Dr. D. A. Robertson was quoted in NATURE of Sept. 8 last, p. 383, by the reviewer of the book on "American Universities and Colleges": "When the world's work has been analysed and the skills and qualities required for particular jobs have been specified, the schools and colleges can shape their curricula . . . more . . . effectively. . . ."

Doubtless many methods of analysing men's work can be devised. This note presents a classification in six fundamental categories. These have been selected not by a sociologist but by a physicist. To put forward, however tentatively, a system for cataloguing human activities, in the columns of a periodical devoted to the natural sciences, may seem an anomaly. The justification is this: *logic* and *methodology* are capable of transmitting mutual interactions between the disciplines which deal with Nature and those which deal with man. To the extent that modes of thinking may formally be described, independent of the content of thought, the analytical methods which have been developed in the physical sciences possess general significance.

The passage from empiricism to understanding can