Letters to the Editor

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Polarisation of Wireless Echoes

WE were much interested in Mr. T. L. Eckersley's description [1] of a method of demonstrating the polarisation of wireless echoes, but surprised to find that some of the results he mentions appear both contradictory to the magneto-ionic theory and also to those obtained when other comparable methods of polarisation delineation are employed in the same connexion. Soon after Mr. Builder and one of us described the occurrence of regular echo-doublets and suggested that they were composed of the two oppositely polarised magneto-ionic components, various methods of demonstrating the correctness of this hypothesis were devised by members of the group of workers associated with the Radio Research Board. Some months ago Mr. R. A. Watson Watt and one of us, at the Radio Research Station, Slough, and Mr. E. L. C. White and the other, at the Cavendish Laboratory, Cambridge, independently and simultaneously developed apparatus for demonstrating the different polarisations of the echo-doublet components. The Cambridge apparatus is similar in principle to that of Mr. Eckersley, but is somewhat simpler to construct and to adjust.

In the apparatus used at Slough (and also at Radio Research Station, Tromsö) a radio-polarimeter is used in which the polarisation of the separate components is delineated on a cathode-ray screen. This method possesses the advantage that the complete polarisation specification, circular or elliptical, right-handed or left-handed, is shown by the oscillographic trace, and it is not necessary to assume, *a priori*, as with Mr. Eckersley's apparatus, that the components are circularly, and not elliptically, polarised. (A brief description of this apparatus, together with a statement that the echo-doublet components had been shown to be of opposite polarisation, appeared early in July last.[2])

With both these methods, and also with still another in use at King's College, London, it has been demonstrated that the components of a doublet echo are oppositely polarised in sense, the usual but not quite invariable result being that, when simple splitting is in evidence, the component of lesser delay is of right-handed sense and the component of greater delay left-handed. (We here use the same convention as Mr. Eckersley and view the polarisation looking in the direction of propagation of the waves.) Many observations on split echoes have been made using these methods at Cambridge, the Radio Research Station, Slough, and King's College, London, and a full account of them will, we hope, soon be published. The results obtained by the different methods are in close agreement, and also fit in with those of previous polarisation determinations made on longer wavelengths using the frequency-change method.

In connexion with the daytime absorption of the waves, we find ourselves in disagreement with Mr. Eckersley both as to the experimental results and as to the interpretation of the magneto-ionic theory. Experimentally we have found that, with wavelengths such as Mr. Eckersley mentions, while both components may be present, the left-handed one is more frequently that of greater intensity. The presence of both components is in agreement with the observations of Krüger and Plendl,[3] who found that at vertical incidence waves of 53 metres were returned from the ionosphere plane polarised with a rotating plane of polarisation. This would be the result of the presence of two circularly polarised components with a varying phase difference. Our deduction from the magneto-ionic theory is just the reverse of Mr. Eckersley's, for we find that the theory suggests that it is the right-handed component which suffers the greater absorption.

We cannot understand the contradiction between our results and those of Mr. Eckersley, and look forward to the publication of a full account of his theory and experiments so that we can trace exactly where the difference lies.

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Sept. 14.

[1] NATURE, p. 398, Sept. 10, 1932.
[2] *Wireless World*, July 8, 1932; see also *The Wireless Engineer*, p. 513, Sept. 1932.
[3] *Z. Tech. Phys.*, **12**, p. 673; 1931.

Spectrum of Cosmic Radiation

COSMIC radiation forms a whole series of lines or bands in its spectrum, as can be established by measuring its absorption coefficient. The most penetrating of its constituents, having energy of about 3700 million volts, originates, according to Sir James Jeans, in the annihilation of an α-particle and its two neutralising electrons,[1] while the next softer constituent, of energy about 950 million volts, is formed by the annihilation of one proton and its neutralising electron. In both these cases, as generally accepted, one can scarcely suggest any other interpretation. The interpretation, however, of the softer constituents by the formation of helium and higher atoms from 'metastable clusters' consisting of protons and electrons, as suggested by Prof. R. A. Millikan,[2] has supplemented the first assumption of the origin of cosmic radiation:

$$\text{Proton} + \text{Electron} = h\nu,$$

made by Sir James Jeans, which seemed unable to give more than one line and did not indicate any logical or numerical connexion between the energy value of the proton-annihilation constituent and those of softer ones.

The object of this note is to point out a curious regularity which seems to occur in the energy values of the constituents of cosmic radiation. If we divide the annihilation quantum of the proton $h\nu \cong 950$ million volts by $n(n+1)$, where $n = 0,1,2,3,4, \ldots$ we get the values tabulated below (expressed in millions) together with those observed in cosmic radiation:

n	0	1	2	3	4	5	6	7
$h\nu$ calcul.	950	475	160	80	48	32	22	17
$h\nu$ observed	~950	~450	~180	~100	?	~30	(22·5)	~15

The observed values given under $n = 5$ and $n = 7$ are the limits of the 'soft band' as established by Prof. Millikan by measuring its penetrating power in comparison with that of γ-rays of thorium C'', the value 22·5 million volts being their average.

If this is not a pure accident—and one can scarcely believe it is—it must appear very surprising that an equation of the form

$$h\nu = \frac{h\nu_{\text{annih.}}}{n(n+1)}$$

succeeds so well in reproducing the spectrum of cosmic radiation in terms of the energy value of annihilation