Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Sources of Atmospherics and Penetrating Radiation

SIMULTANEOUS directional observations have been made of the arrival of atmospherics and of penetrating radiation, using a wireless cathode-ray direction finder and a pair of Geiger-Müller counters. The radio installation was the standard frequency-conversion direction finding apparatus[1] developed and used at the Radio Research Station, Slough, for investigations of the direction of arrival of atmospherics. The arrival of an atmospheric from a particular direction is indicated by the momentary deflection of the beam of a cathode-ray oscillograph in a corresponding direction, and is recorded photographically on film moving continuously in a vertical direction at a speed of 1·25 cm. per second. The counters recording penetrating radiation were arranged to receive particles coming from an easterly direction. Simultaneous discharges of the two counters were selected and used to impress a small unidirectional deflection on the beam of the oscillograph used in the direction finder.

FIG. 1.

In the accompanying figure is shown a sample length of film enlarged three times. The vertical direction corresponds to the north-south line. Near the middle of the record is seen the unidirectional impulse indicating the arrival of penetrating radiation. Before and after it are atmospherics from different directions.

In runs lasting 960 minutes a total of 407 coincident discharges were observed and atmospherics were recorded at a mean rate of 4·21 per second. An analysis of the data obtained shows that :—

(*a*) The number of coincidences between the arrivals of atmospherics and penetrating radiation is no greater than would be expected from a chance distribution.

(*b*) In the intervals 0–1, 1–2 and 2–5 seconds before and after the arrival of penetrating radiation the rates of incidence of atmospherics are as exhibited in the accompanying table, where the factor c is the ratio of the mean rate of incidence of atmospherics in the interval under consideration to the mean rate.

	Before			After		
Interval	2–5 sec.	1–2 sec.	0–1 sec.	0–1 sec.	1–2 sec.	2–5 sec.
c	1·007±0·015	1·024±0·030	1·007±0·029	1·080±0·031	1·062±0·028	1·000±0·012

Each of the quantities c should be unity if there is no correlation between the arrival of penetrating radiation and atmospherics.

In each interval before the arrival of penetrating radiation the factor does not differ from unity by more than probable error. But in the two seconds immediately following, there is an excess amounting in the first case to about 2½ times probable error, and in the second case to twice probable error. The interval, 2–5 seconds following, shows no such excess.

If, as we believe, atmospherics come from thundercloud discharges, our results are in agreement with those of Schonland and Viljoen[2] who found that the number of discharges of a single counter is greater in a small interval before a lightning flash than during a similar interval afterwards. They also support the original theory of C. T. R. Wilson[3] that "runaway" electrons are projected upwards from the intense fields in thunderclouds and are returned to earth by the action of the earth's magnetic field. On the other hand, we have no evidence of simultaneity of incidence of atmospherics and ionising particles as was observed by Schonland and Viljoen.

The whole of the observations of Schonland and Viljoen were made on thunderstorms within a distance of 70 km. The present observations were made in south-east England on quiet autumn days when the atmospherics originated at much greater distances, the sources of those on which measurements were made being possibly at distances between 2,000 and 3,000 km. It is probable that particles produced during a lightning discharge (that is, during a time of decaying moment) would be of lower energy than those produced immediately before a flash, when the potential difference is a maximum ; the absence of coincidences between the arrival of atmospherics and penetrating radiation would then be due to our being beyond the area within which these particles of low energy are bent back to the ground by the earth's magnetic field.

It was hoped that the directional observations would indicate the location of those storms effective in producing the relation between atmospherics and penetrating radiation indicated above, but sufficient data have not yet been accumulated to give definite information on this point.

We are indebted to the Director of the National Physical Laboratory for permission to use the cathode-ray direction finder at the Radio Research Station, Slough, and also to the staff of the Radio Department of the Laboratory—in particular Mr. R. A. Watson Watt and Mr. J. F. Herd—for so generously putting their experience of the instrument at our disposal.

E. V. APPLETON.
E. G. BOWEN.

King's College,
London, W.C.2.
Dec. 9.

[1] Watt and Herd, *J. Inst. Elec. Eng.*, **64**, 611 ; 1926. "The Cathode-Ray Oscillograph in Radio Research", H.M. Stationery Office, 1933.
[2] Schonland and Viljoen, *Proc. Roy. Soc.*, A, **140**, 314 ; 1933.
[3] Wilson, *Proc. Camb. Phil. Soc.*, **22**, 534 ; 1925.