LETTERS TO THE EDITOR

ASTRONOMY and PHYSICS

Low-frequency (100 kc./s.) Radio Noise from the Aurora

EXTRATERRESTRIAL radio 'noise' has been intensively studied during the past decade. The steady background radiation or 'cosmic noise' from interstellar space has been observed[1] at frequencies down to about 1 Mc./s. and an intensity of about 10^{-19} watts per square meter per cycle per second ($W.m.^{-2}$ $(c./s.)^{-1}$). Ellis[2] later showed that cosmic noise at lower frequencies could not penetrate the earth's magneto-ionic upper atmosphere. Reber[3], however, reported observations of steady noise of intensity 10^{-22} $W.m.^{-2}$ $(c./s.)^{-1}$ at frequencies of 520 kc./s. and 140 kc./s. This appeared to be correlated with sidereal time and so was claimed to be cosmic noise.

Recently[4] extraterrestrial continuous ('white') noise has been studied in the audio-frequency band. This normally shows peak intensity (10^{-16} $W.m.^{-2}$ $(c./s.)^{-1}$) at around 4 kc./s. It appears to be generated in the upper atmosphere by auroral particles[5], it is highly correlated with auroral airglow[6], and it has been designated 'hiss'.

I have also carried out observations of 'hiss' at Hobart, Tasmania, to provide a comparison with those of Ellis at Sydney. Results appeared broadly similar but the intensity at Hobart is much higher (10^{-15} $W.m.^{-2}$ $(c./s.)^{-1}$). In view of Reber's observations (and similar observations of mine[7] at 450 kc./s. at Macquarie Island) it was decided to operate on five frequency channels simultaneously, covering the gap from the normal 'hiss' frequencies to the controversial 100 kc./s. band. The centre frequencies of these channels were 4·6, 9·6, 27, 70 and 180 kc./s. For the loop antenna and amplifiers used the sensitivity increased with frequency, so at the lower two channels it was about 10^{-17} $W.m.^{-2}$ $(c./s.)^{-1}$ and for the higher two it was around 10^{-21} $W.m.^{-2}$ $(c./s.)^{-1}$. It was found that the intensity of both the 'back-ground' radiation and the usual 'bursts' showed a general decrease with frequency so that normally nothing was observed at 70 and 180 kc./s.

On one occasion, however (April, 1959) a number of bursts were observed which showed deep fading. When the records of the five channels were examined together it was found that strong noise was present on all channels. Moreover, the fades on each channel showed a strong one-to-one correspondence and were simultaneous to the limit of reading ($\sim$ 10 seconds). The noise level of these bursts at the lower frequencies was fairly typical of the more usual bursts (10^{-15} $W.m.^{-2}$ $(c./s.)^{-1}$ at 4·6 kc./s.) but at 70 and 180 kc./s. the noise power was at least two or three orders of magnitude greater than normal (to about 10^{-19} $W.m.^{-2}$ $(c./s.)^{-1}$).

Unfortunately it is not known exactly on what day this occurred nor whether a notable geomagnetic event took place at the same time, for the research station together with the equipment and records was destroyed by fire on May 24, 1959. It is probably a rare event as it only occurred on one occasion in about two months observing. It is none the less established that 'hiss' can sometimes occur at frequencies up to 180 kc./s. at least, suggesting that extraterrestrial noise much below a megacycle might be 'hiss' (that is generated in the upper atmosphere) rather than 'cosmic noise'.

My thanks are due to Mr. G. T. Goldstone, who built and operated much of this equipment and assisted in the observations, and to Dr. G. R. A. Ellis, Upper Atmosphere Section, C.S.I.R.O., who provided part of the equipment and circuits and who suggested the 4·6 kc./s. and 9·6 kc./s. observations.

R. L. DOWDEN
Commonwealth Ionospheric Prediction Service,
Hobart, Tasmania.
Aug. 19.

[1] Reber, G., and Ellis, G. R., *J. Geo. Res.*, **61**, 1 (1956).
[2] Ellis, G. R., *J. Atmos. Terr. Phys.*, **9**, 51 (1956).
[3] Reber, G., *J. Geo. Res.*, **63**, 109 (1958).
[4] Ellis, G. R., Plan. Space Sci. (in the press).
[5] Ellis, G. R., *J. Atmos. Terr. Phys.*, **10**, 302 (1957).
[6] Duncan, R. A., and Ellis, G. R., *Nature*, **183**, 1618 (1959).
[7] Dowden, R. L., *J. Atmos. Terr. Phys.* (in the press).

Red-Shift Absorption Spectrum of the Cygnus-*A* Radio Source

A MEASUREMENT to check the 21-cm. hydrogen line absorption spectrum of Cygnus-*A* (*19N4A*) reported by Lilley and McClain[1] is important in view of the cosmological significance of their result. The absorption was observed by these authors within a 3 Mc./s. band centred on 1341 Mc./s. and was considered to be due to absorption in a neutral hydrogen cloud associated with the Cygnus-*A* source and receding with it at the optically determined[2] velocity of 16,800 km./sec.

The present measurement was made with a hydrogen-line receiver in conjunction with the 250-ft. radio telescope at Jodrell Bank. The receiver employed a first local oscillator which was rapidly switched between two frequencies 6 Mc./s. apart and a synchronized output detector which measured the difference between the two received signals separated by 6 Mc./s. No radio-frequency image rejection (60 Mc./s. above) was employed.

The observing programme consisted of obtaining sets of three frequency scans, one on each of the following: Cygnus-*A*, Cassiopeia-*A* and Taurus-*A* or a reference region at Dec. $= +53°$, R.A. $= 19^h\ 00^m$. Total power as well as switched receiver outputs were recorded. The scans on Cassiopeia-*A* and the reference region provided a method of removing a small background deflexion which was proportional to the total power of the signal received from the source. Thus the profile expected from Cygnus-*A* in the absence of absorption was obtained for each set. The observed frequency scan was subtracted from this and a difference (absorption) profile was obtained for Cygnus-*A*. The calibration of this absorption