LETTERS TO THE EDITOR

ASTROPHYSICS

Terrestrial, Interplanetary and Universal Expansion

A REMARKABLY close agreement between the rate of increase of the Earth's radius¹ and that of the universe, according to Hubble's law², was recently pointed out by MacDougall *et al.*³

Extending this line of investigation to the recession of the Moon from the Earth, assuming the same expansion rate, Hubble's constant $H = 100$ km/s megaparsec². We then arrive at a recession rate for the Moon of 3.9 cm per annum, whereas the observed recession, found as far back as 1878 by G. H. Darwin, amounts to 13 cm per annum. This recession is usually ascribed to a tidal effect. Does perhaps part of this recession stem from the general expansion of the universe?

Both these 'local' applications of Hubble's law have already been pointed out recently by me⁴. Hubble's law appears, in my theory, as an apparent, general expansion, due to a combined general contraction of the measuring rod and the time scale, in conjunction with a combined continuous creation of new matter and generation of gravitational fields.

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¹ Egyed, L., *Nature*, **197**, 1059 (1963).

² Struve, O., and Zeberg, V., *Astronomy of the 20th Century*, 469 (The Macmillan Co., New York and London, 1962).

³ MacDougall, J., Butler, R., Kronberg, P., and Sandqvist, A., *Nature*, **199**, 1080 (1963).

⁴ Klepp, H. B., *Outline of a Unitary Theory* (Publication from the Royal Norwegian Naval Academy, June 1963).

RADIOPHYSICS

Observations of Background Electromagnetic Noise in East Greenland

A PROGRAMME for the observation of naturally occurring background noise in the 3–10-ke/s frequency range of the electromagnetic spectrum was undertaken by the Cambridge East Greenland Expedition, 1963. Observations were made at Cambridge, England (geomagnetic coordinates, 54° N., 84° E.), and at 'quiet' sites in Iceland (70° N., 75° E.) and East Greenland (76° N., 80° E.), where man-made interference was negligible. As has been suggested¹, "it is important to determine the spatial distribution of 'hiss' with geomagnetic latitude. This could be accomplished using . . . spaced station studies along a line of equal geomagnetic longitude".

The receiving aerial consisted of two coils, each of 110,000 turns of 39 standard wire gauge enamel-coated wire, mounted on a μ -metal rod 1 in. in diameter and 36 in. long. Because each coil had an inductance of several thousand henries, a resistance of 31 k Ω and a self-capacity of about 100 pF, the natural frequency of the aerial was 30 c/s. The aerial responded very well in the earth-ionosphere cavity resonator region of the spectrum (5–30 c/s), and sufficiently well in the ke/sec band. Battery operated transistor amplifiers were built incorporating parallel T filters and emitter follower circuits². The signal received, together with a time and voltage calibration, was recorded directly on to magnetic tape for 2 min, beginning at 10 min before each hour U.T. on selected days throughout July and August 1963.

The signals in the bands 770 ± 10 c/s, 1–6 ke/s, and 8 ± 1 ke/s were rectified and integrated; the signal powers above arbitrary levels were plotted against universal time. In the lower frequency bands a maximum power at about 3 h before midnight was observed, and at 8 ke/s maxima at 03.00 and 18.00 h were noted. Fig. 1 shows the dependence of the power in the 1–6-ke/s band on local geomagnetic time³. Part of the increased signal intensity occurred on July 19 and 20 during a magnetically disturbed period. The signal in Iceland was normally about 5 db. greater than in England or Greenland; observations in Cambridge⁴ with a receiver⁵ tuned to 5.36 ± 0.19 ke/s have shown a typical day-time value of the signal to be $0.1 (\mu V/m)^2/c/s$ with a broad maximum 3 db. greater than this around geomagnetic midnight. At 770 c/s (the proton gyro-frequency at ionospheric heights), the signals observed in Greenland and Iceland were of comparable magnitude, and 8 db. above those recorded in Cambridge. 'Hiss' at 8 ke/s was 5 db. stronger in Iceland—in the auroral zone—than in Greenland and 10 db above that observed in England; 8 ke/s 'hiss' has been associated with certain kinds of aurora observed at high latitudes^{1,6}.

Fig. 1. Diurnal variation of noise intensity in the 1–6-ke/s band. O, Cambridge; +, Iceland; ●, East Greenland

The average signal intensity of recordings made with the aerial in different positions was investigated in East Greenland. For example, with the axis of the aerial north-south and perpendicular to the geomagnetic field lines, it was found that the signal power at 8 ke/s was 1.1 db. above that received with the aerial in its normal position, that is, with its axis horizontal and east-west. This is interpreted as meaning that the signal propagating along a line of force of the Earth's magnetic field, B_E , is 1.1 db. stronger than that propagating north-south in a wave-guide mode under the ionosphere. The results are summarized in Table 1.

Table 1

Frequency	Received power, db.; waves with magnetic vector H in stated direction			
	H horizontal		$H \perp B_E$, N-S	
	E-W	N-S		$H \parallel B_E$
770 c/s	0	-0.2	-0.7	-0.5
1-6 ke/s	0	-0.4	-0.3	-0.7
8 ke/s	0	-0.3	+1.1	-0.8

It would seem that the signal at 770 c/s is predominantly due to protons gyrating or mirroring above the observer, whereas that in the ke/sec band is 'hiss' which has propagated northwards from the auroral zone.