LETTERS TO THE EDITOR

RADIO ASTRONOMY

Low-frequency Spectrum from Radio Source 3C84

Recently, Roger *et al.*[1] reported some measurements of the flux densities from the discrete source 3*C*84 at two frequencies—10·03 Mc/s and 22·2 Mc/s. These and measurements reported by other research workers[3,4] were used to plot the radio spectrum of 3*C*84 in the frequency range 10–10^4 Mc/s.

Roger *et al.* reached the conclusion that the source 3*C*84 (which has been identified as the Seyfert Galaxy NGC 1275 (ref. 2)) has an unusual spectrum both at high and low frequencies. They commented that the spectrum of the source 3*C*84 has a slope of about -2 at the frequencies $-f > 20$ Mc/s, instead of $-0{\cdot}7$ at the frequencies 10^2 Mc/s $\leqslant f \leqslant 3 \times 10^3$ Mc/s; moreover, they found an anomaly in the radio spectrum range 10–20 Mc/s.

In earlier publications[5,6] we described some measurements of flux densities of the source 3*C*84 on frequencies 20, 25, 31 and 38·5 Mc/s. Flux densities were measured relative to Cassiopeia-*A*(3*C*461), and the absolute calibration of the radio telescope system was made at seven frequencies for Cassiopeia $-A$ in the frequency range 12·5–40 Mc/s (ref. 7). The slope of the spectrum of 3*C*84 for frequencies from 20 Mc/s to 150 Mc/s was found to be $-1{\cdot}15$ (Fig. 1).

For $f \geqslant 150$ Mc/s, flux densities were taken from ref. 8.

It can be seen from Fig. 1 that the flux density for 3*C*84 at 22·2 Mc/s as given in ref. 1 fits the spectrum with a slope of $-1{\cdot}15$.

It should be pointed out, however, that the flux density given by Roger *et al.* for 3*C*84 at $f = 10{\cdot}03$ Mc/s is incorrect. As an absolute calibration of the system was not available at 10·03 Mc/s, they used the flux densities measured relative only to 3*C*274 (Virgo-*A*), and the flux density of 3*C*274 was obtained by linear extrapolation of the measured values from very high frequencies. But it is well known[7] that for Virgo-*A* the flux density, S_D, is almost constant in the region from $f = 35$ Mc/s to $f = 12{\cdot}5$ Mc/s; moreover, $S_D \approx 5 \times 10^{-23}$ Wm^{-2} (c/s)$^{-1}$ (ref. 7) and not $S_D \approx 10^{-22}$ Wm^{-2} (c/s)$^{-1}$ as given by Roger *et al.* Thus the flux density of 3*C*84 at $f = 10{\cdot}03$ Mc/s must equal $(490 \pm 170) \times 10^{-26}$ Wm^{-2} (c/s)$^{-1}$, that is, half the value given by them.

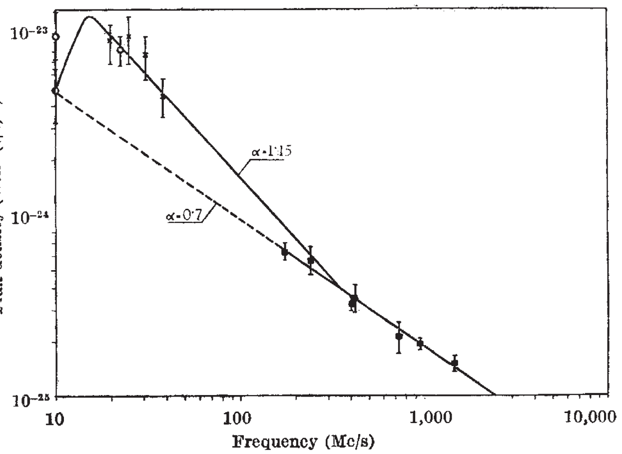

Fig. 1. Radio spectrum of source 3*C*84. ×, Flux densities from refs. 5 and 6; ○, flux densities from ref. 1

All the experimental points fitted a smooth solid curve and the shape of the spectrum of 3*C*84 can be seen in Fig. 1. Between 10 and 20 Mc/s there is a sharp change in slope and the curve becomes very steep.

It is obvious that the exact shape of the spectrum of 3*C*84 in the frequency ranges 10–20 Mc/s and 50–150 Mc/s is unknown: it will be necessary to make many further measurements before the spectrum of 3*C*84 is established.

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GEOPHYSICS

A Helium Whistler observed in the Canadian Satellite *Alouette* II

Like her sister *Alouette* I, the *Alouette* II satellite carries a broad band, very-low-frequency receiver, but the pass band has been extended to (0·05–30 kc/s) from (0·4–10 kc/s). The *Alouette* II orbit has almost the same inclination as that of *Alouette* I ($\sim$ 80°), but is elliptical with a perigee of 501 km, and an apogee of 2,983 km, rather than the almost circular 1,000 km orbit of *Alouette* I. One of the significant discoveries made by analysis of very-low-frequency data recorded by the *Alouette* I satellite[1] was that an atmospheric (an electromagnetic impulse originating from a lightning flash) that had propagated upwards to the satellite was often immediately followed by a novel type of very-low-frequency signal. Initially, the frequency of this signal rose rapidly; the rate of increase then gradually diminished until the frequency approached a nearly constant value. These signals have been termed proton whistlers, and analysis[2] has shown that they are due to coupling of wave energy from the (electron) whistler mode into ion cyclotron waves. Such coupling is possible only at frequencies below the proton gyro-frequency. The coupling occurs over a range of heights below the satellite, with a given frequency component coupling most strongly at a height determined solely by the positive ion composition of the ionosphere. The resulting ion cyclotron waves propagate upwards to the satellite and suffer increasing time delay as their frequency approaches the local proton gyro-frequency. This interpretation explains the form of dispersion exhibited by proton whistler signals, and why such signals are observed only after the occurrence of a normal short fractional hop whistler as well as the manner in which the wave energy enters and propagates through the lower ionosphere.

At the time that this interpretation of the proton whistler was developed it was realized that a similar phenomenon might occur in the vicinity of the helium gyro-frequency. However, none of the very-low-frequency