RADIOPHYSICS

Scintillations on the Small Diameter Radio Sources

IRREGULARITIES in the solar wind appear to be responsible for the rapid scintillations on the radiation from small diameter radio sources¹, and for some of the fine structure on Jovian decametric bursts². At the Arecibo Ionospheric Observatory the irregularities as well as the sources are being examined by their scintillations. Early results of this programme have been reported by Cohen and Drake³. The purpose of this communication is merely to report that the scintillation phenomenon has been seen over an extended range of frequencies and positions, and that it is very strong and persistent.

Fig. 1. 195 Mc/s records of 3C-298 and 3C-317, May 22, 1965. Successive on-off records are shown. Time constant 0.1

The scintillations are very strong when the source is very narrow and close to the Sun. For example, on May 23, 1965, CTA-21 was about 11° from the Sun. At 430 Mc/s the scintillations were very strong, with minima about 0.2 the mean value. As another example, on June 13, 1965, 3C-138 was about 7° from the Sun. Strong scintillations were observed on 195, 430 and 611 Mc/s. On all these frequencies the minima were about half the mean value. These observations were made with the 1,000-ft. spherical reflector, using point feeds giving beamwidths of 33', 16' and 14' at 195, 430 and 611 Mc/s, respectively. Small diameter sources, such as CTA-21 and 3C-138 (ref. 4), can readily be found by their very strong scintillations, if they are close to the Sun.

The very narrow sources, furthermore, always scintillate, even when they are far from the Sun. Fig. 1 shows 195

Fig. 2. Autocorrelation functions (in arbitrary units) for 3C-298 (scintillating) and 3C-317 (non-scintillating). Samples were taken 10 times per sec for 5 min; 90 lags are shown

Mc/s records of 3C-298 and 3C-317, taken on May 22, 1965, when 3C-298 was about 11 h east of the Sun. The two sources have approximately the same strength, as shown by the records; 3C-298 scintillates, but 3C-317 does not. The effect of scintillations shows up strongly in Figs. 2 and 3. Fig. 2 shows the unnormalized autocorrelation functions obtained from 5-min samples of the records, sampled 10 times per sec. The 3C-317 autocorrelation function has essentially the same strength and shape as those functions obtained when tracking the cold sky; it is an exponential with e^{-1} width equal to the output time constant of the radiometer. The autocorrelation function at zero lag is proportional to the variance of the fluctuating output signal, and so the root mean square fluctuation level for 3C-298 is twice that which would have been expected in the absence of scintillations. The scintillation index for 3C-298 is 0.041. (Index is defined as excess root mean square fluctuations divided by antenna temperature.)

Fig. 3 shows the power spectra of the radiometer output signals, obtained by computing the approximate Fourier transforms of the autocorrelation functions. The 3C-298 spectrum has excess energy only at low frequencies. This excess is the scintillation spectrum; it is roughly gaussian in shape, with an e^{-1} width of 0.55 ± 0.05 c/s. The peaks at 3.3 c/s are apparently due to aliasing.

A short radiometer time constant is required for scintillation observations, since the fluctuations may have periods of 1 sec or less. This results in a poor signal-to-

Fig. 3. Power spectra (in arbitrary units) for 3C-298 (scintillating) and 3C-317 (non-scintillating)

noise ratio for weak sources. Digital processing, however, can greatly increase the visibility of the scintillations.

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¹ Hewish, A., Scott, P. F., and Wills, D., *Nature*, **203**, 1214 (1964).

² Douglas, J. N., *I.E.E.E. Trans. Mil. Elec.*, **MIL-8**, 173 (1964).

³ Cohen, M. H., and Drake, F. D., U.R.S.I. Spring Meeting, Washington (April, 1965).

⁴ Anderson, B., Donaldson, W., Palmer, H. P., and Rowson, B., *Nature*, **205**, 375 (1965).