THE DISCRETE SOURCE OF RADIO WAVES AT THE GALACTIC CENTRE

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The discrete source of radio emission in Sagittarius is among the most intense in the whole sky, but its situation in the belt of emission from ionized hydrogen and other sources associated with the galactic plane makes it difficult to observe. The observations described in this paper were made at frequencies of 38, 81·5, 210, and 500 Mc./s.; at these low frequencies it is particularly difficult to obtain sufficient aerial resolving power to distinguish the discrete source from the background. Interferometer aerials were therefore used, and at 38 and 210 Mc./s. spacings up to $\lambda 60$ were used, sufficient to resolve the source completely. At 81·5 Mc./s. various sections of the large interferometer aerial were used.

These observations gave the following values of the flux density ($\pm 20\%$) and of the diameter (to half-brightness) of the source:

Frequency (Mc./s.)	Flux density 10^{-22} w.m.$^{-2}$ (c./s.)$^{-1}$	Diameter (°)
38	1·0	2·0
81·5	1·0	—
210	1·0	1·1
500	0·73	—

The spectrum of the source may now be found by combining these results with observations at 1420 Mc./s. by Hagen, Lilley and McClain (1954) [1] and at 3200 Mc./s. by Haddock, Mayer and Sloanaker (1954) [2]. In calculating the flux density at these frequencies it has been assumed that the source is 1·1° in diameter throughout, corresponding to the measured diameter at 210 Mc./s. At the lower frequencies some absorption may be expected to occur in the galactic plane, and the optical depth at 38 Mc./s. would be expected to be about unity if the source is as far distant as the galactic centre. In the spectrum suggested in Fig. 1 the intensity at 38 Mc./s. has accordingly been increased by a factor of 2·5. Absorption

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of this order would also account for the larger diameter observed at this frequency.

The suggestion has been made by Davies and Williams (1955 [3]; see also paper 12) that in spite of the remarkable coincidence in position this source is not at the centre of the Galaxy, but considerably nearer. Their proposed distance of about 3 kiloparsecs is based on a measurement of the depth and width of the absorption line at 1420 Mc./s. They point out that an H II region exists at their suggested location.

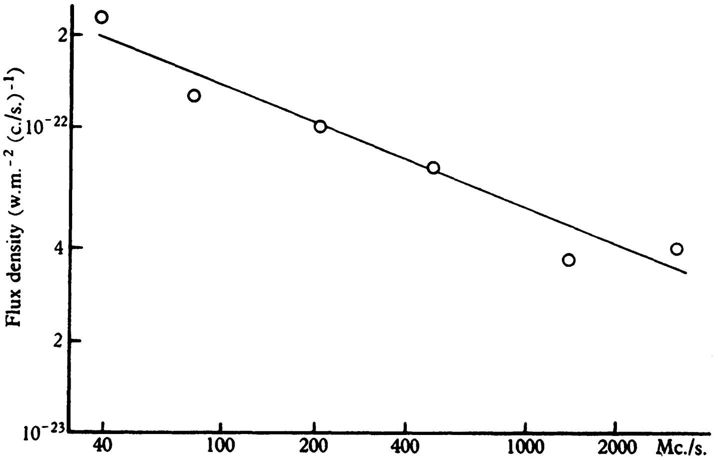

Fig. 1. Spectrum of the galactic centre source.

Our observations at low frequencies have led us to suggest a spectrum where flux density varies as $\lambda^{-0\cdot4}$, which is closer to the spectra of the non-thermal discrete sources than to that of ionized hydrogen. The source observed at these frequencies cannot in any case be an ionized hydrogen region radiating thermally, since the brightness temperature exceeds 10^5 °K.—ten times greater than that expected and observed from other such regions.

The position of the source was measured on all four frequencies, and clear support was found for previous suggestions that the source lies very closely in the direction of the galactic centre. It seems that it might still be considered as being in fact at the centre, at which distance it would have a diameter of 150 parsecs.

REFERENCES

[1] Hagen, J. P., Lilley, A. E. and McClain, E. F. *N.R.L. Report*, no. 4448, 1954; *Ap. J.* **122**, 361, 1955.

[2] Haddock, F. T., Mayer, C. H. and Sloanaker, R. M. *Nature*, **174**, 176, 1954.

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Haddock: The source at the centre observed at 3 cm. with a beam-width of 9′.5 appears to have a small diameter (a fraction of a degree) and the surrounding region is complex. The 10 cm. result would have to be raised by a factor 8 if the diameter were 1°. I simply cannot accept such a large multiplication of the flux density.

Pawsey: Studies of the region around the galactic centre by members of the Radiophysics Laboratory indicate that this region is very complex. Observations taken under different circumstances yield different results (cf. McGee, Slee and Stanley (1955) [1]) and it seems most likely that the pattern is not only complex but changes radically with frequency. For example, while Sydney observations at 400 Mc./s. and Washington ones at a few thousand Mc./s. show a concentrated bright region in the suspected direction of the galactic centre, preliminary Sydney observations at 85 Mc./s. with the Mills Cross show isophotes with several adjacent maxima but a small depression in the actual direction of the high-frequency source.

In a complex region such as this, interferometer observations could be grossly misleading. There is a high probability that the measurements cited by Smith refer to the sum of contributions from a number of diverse objects with differing spectra differently compounded at each frequency.

Smith: Fine structure along the galactic plane should have been revealed also by the interferometer measurements. The point we wish to emphasize is that over the whole frequency range 38 to 500 Mc./s. the source is one discrete object, with an angular size of the order of 1°.

Bolton: However, Mills' fine structure is along a line perpendicular to the axis of your interferometer and therefore you cannot resolve it.

REFERENCE

[1] McGee, R. X., Slee, O. B. and Stanley, G. J. *Aust. J. Phys.* **8**, 347 (no. 3), 1955.