A NEW DEEP VLA RADIO SURVEY AT 6 cm

K. I. Kellermann and E. B. Fomalont
National Radio Astronomy Observatory

D. Weistrop, Applied Research Corporation

J. Wall, Royal Greenwich Observatory

INTRODUCTION

We have made a new deep 6 cm survey with the VLA in order to extend the radio source count to a lower flux density and to decrease the limits on the small scale fluctuations in the microwave background. The survey region covers $\sim 10^{-5}$ ster and is nearly coincident with the survey previously reported by Fomalont et al. 1984a and 1984b. Both the observing time and bandwidth were increased by a factor of two over the previous survey to give a factor of two improvement in sensitivity.

We observed for a total of 76 hours spread over eight days. All observations were made at nighttime to eliminate the effects of solar noise. The phase tracking center was shifted outside the primary beam to move the effect of correlator offsets and cross talk between close antenna pairs which limited the sensitivity of the earlier observations; and the rms noise fluctuations on the synthesized map were found to be close to the theoretical value of 4.5 μJy. Within the area of the primary beam we found 16 sources above the "limiting" flux density level which ranges from 25 μJy over to 250 μJy.

In Figure 1 we show the differential 6 cm source count taken from Fomalont et al. 1984b for S > 400 μJy, and with three new points from the present VLA survey at lower flux densities. The new data clearly show the flattening of the 6 cm normalized count to close to the Euclidean slope at low flux densities suggested by the earlier P(D) analysis of Fomalont et al. (1984b) and also reported in deep 21 cm surveys (e.g., Oort and Windhorst 1985; Condon and Mitchell 1984). Limited optical data obtained from KPNO 4 m CCD images suggests that these weak radio sources are identified with moderately faint galaxies.

The rms noise was determined from the negative fluctuations only which are insensitive to confusion by discrete sources (e.g., Mitchell and Condon 1985), and the dependence of the rms noise on the distance from the primary beam center is illustrated in Figure 2. The best fitting value of a sky signal consistent with the primary beam shape and an rms instrumental noise fluctuation of 4.5 μJy is given in Table 1 for the 18" resolution of the synthesized beam as well as for

J.-P. Swings (ed.), Highlights of Astronomy, 367–369.

https://doi.org/10.1017/S153929960000664X Published online by Cambridge University Press

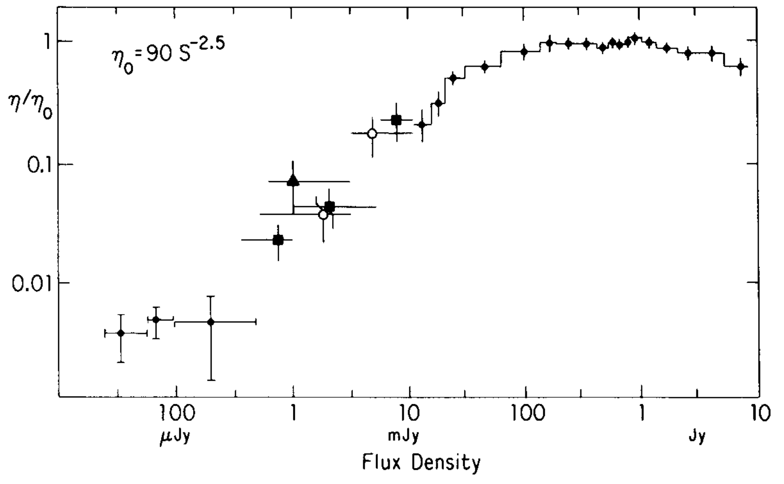

Figure 1. Differential log N-log S at 6 cm normalized to a static Euclidean universe with a number count $n(S)\ dS = 90\ S^{-5/2}\ dS$. The data above 400 μJy are reproduced from Fomalont et al. (1984b).

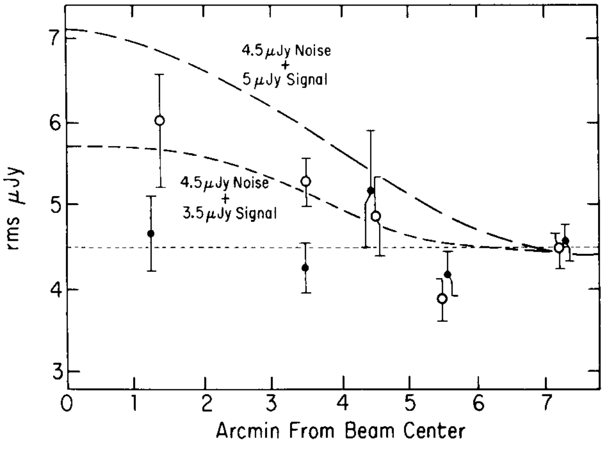

Figure 2. The measured rms noise level versus distance from the center of the 4.5 (HWHP) primary beam. The open circles plot the rms noise for the total intensity and the filled circles for the circularly-polarized intensity in which there should be no "sky signal." The lowest dashed line represents the receiver noise contribution of 4.5 μJy. The middle dashed line shows the best fit to the quadrature sum of the receiver noise and a "sky signal" weighted by the primary beam sensitivity. The top line gives the 2σ upper limit.

60" resolution. The corresponding values of ΔT and $\Delta T/T$ are given along with the 2σ upper limits to $\Delta T/T$.

The values and limits shown in Table 1 are lower than those given in Fomalont et al. 1984a by factors of four and eight at resolutions of 18" and 60", respectively. This improvement is due in part to the longer integration time and greater bandwidth, as well as to the suppression of spurious effects achieved by offsetting the primary beam and phase tracking center. The new values are comparable to those of Uson and Wilkinson (1984) at one minute resolution and lower than any previous results at higher resolutions.

TABLE 1 Background Fluctuations

θ	18"	60"
ΔS (μJy)	3.5 ± 0.7	9 ± 1
ΔT (milli K)	0.55 ± 0.11	0.13 ± 0.02
$\Delta T/T$	$2.0 \pm 0.4 \times 10^{-4}$	$4.8 \pm 0.7 \times 10^{-5}$
$\Delta T/T$ (upper limit)	2.8×10^{-4}	6.2×10^{-5}

Our measured "sky signal" at both resolutions is well above that of receiver noise. We cannot attribute the signal in terms of other non-random noise effects, but at this level, which is about 2×10^{-6} of receiver noise, unknown effects may exist. Confusion by discrete point sources is unlikely to affect the statistics of the negative deflection distribution. Correlator offsets which affected the earlier set of observations were removed, and those remaining should be present only near the phase centers which are 6' north and south of the primary beam center. Other simulations are now underway to try to determine whether the apparent "sky signal" is of instrumental origin.

REFERENCES

Condon, J. J. and Mitchell, K. J. 1984 Astron. J. 89, 610.

Fomalont, E. B., Kellermann, K. I., and Wall, J. V. 1984a Astrophys. J. (Lett.) 277, L23.

Fomalont, E., Kellermann, K. I., Wall, J. V., and Weistrop, D. 1984b Science 225, 23.

Mitchell, K. J. and Condon, J. J. 1985 Astron. J. 90, 1957.

Oort, M.J.A. and Windhorst, R.F A. 1985 Astron. and Astrophys. 145, 405.

Uson, J. M. and Wilkinson, D. T. 1984 Nature 312, 427.

https://doi.org/10.1017/S153929960000664X Published online by Cambridge University Press