UPPER LIMITS ON SUB-ARCMINUTE FLUCTUATIONS IN THE CBR

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The use of aperture synthesis allows one to search for fluctuations in the CBR on angular scales below 1 arcminute. I report here *tentative* results of an experiment carried out with E. B. Fomalont, R. Windhorst and J. Lowenthal using the Very Large Array of the National Radio Astronomy Observatory in New Mexico. We used the instrument in its tightest configuration and at a wavelength of 3.6 cm; the corresponding angular resolution was ~10". We were able to set limits on fluctuations in the CBR on a range of angular scales, 10"-90", and these are among the most sensitive upper limits on CBR fluctuations yet published.

We observed two different regions of the sky, both selected to be free of bright radio sources. However, when we made maps of these two regions we naturally discovered weaker radio sources, and it is their presence that provides the main limitations on the sensitivity of our results.

We analyzed our data in two quite separate ways. First, we used our radio observations to make maps of the two regions. Then, using standard NRAO software, we eliminated the radio sources visible on the map (and their side-lobes). We then measured the rms fluctuations in the residual maps. There were three major contributions to the fluctuation level: instrument noise, the effect of even weaker, subliminal radio sources not removed as described above, and possible fluctuations in the CBR. We used several means to estimate and subtract instrument noise (for instance, looking at circular polarized maps, which contained instrument noise but not sources, or the differential response of the telescopes across the map; see Knoke et al., 1984). Once the instrument noise was subtracted, we were left with the following 95% confidence upper limits on *all* residual sources of fluctuation: $\Delta T/T \leq 2\times10^{-4}$ at 10" and $\Delta T/T \leq 2\times10^{-5}$ at 60". We discovered, however, that the remaining fluctuations were dominated by weak, subliminal radio sources. We therefore sought to model their contribution by extrapolating radio source counts to smaller flux limits and higher frequencies. No great extrapolation was required; and if we take fairly conservative estimates of the contribution of

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subliminal radio sources we arrive at improved limits on CBR fluctuations alone:

$$\Delta T/T \leq 6\times10^{-5} \text{ at } \sim10'' \text{ and } \Delta T/T \leq 8\times10^{-6} \text{ at } \sim60''.$$

The latter value is the most sensitive upper limit on microwave background fluctuations yet obtained.

Aperture synthesis produces raw data that is the Fourier transform of the microwave intensity of the sky. The Fourier transform, in turn, is directly linked to the autocorrelation function calculated by theorists interested in the origin of large-scale structure. Therefore, there is a certain elegance in looking at the limits on $C(\theta)$ using the raw data rather than maps. There is a slight complication that one needs to correct for the effect of weak radio sources. Nevertheless, my colleagues and I have attempted this technique and obtained results on angular scales 10"–90" in good agreement with the figures given above (see our 1992 paper for details).

It should be apparent that a major impediment in setting tighter limits on $\Delta T/T$ is the effect of weak radio sources (see Franceschini et al. 1989). We may eventually be able to do a better job of removing their effect because we have multiwavelength observations available--deep maps at 20 and 6 cm and optical CCD photographs of the regions used in this analysis.

References

Franceschini, A., Toffolatti, L., Danese, L., and De Zotti, G. 1989, *Ap. J.*, 344, 35.

Knoke, J. E., Partridge, R. B., Ratner, M. I., and Shapiro, I. I. 1984, *Ap. J.*, 284, 479.

Partridge, R. B., Fomalont, E. B., Windhorst, R. A. and Lowenthal, J. R. 1992, submitted to *Ap. J.*