ABSTRACT

We report the results of our continued study of arcminute scale anisotropy in the Cosmic Microwave Background (CMB) with the Berkeley-Illinois-Maryland (BIMA) array. Modeling the observed power spectrum with a single flat band power with average multipole of $\ell_{eff} = 6864$, we find $\Delta T = 14.2^{+4.8}_{-6.0}\,\mu$K at 68% confidence. The signal in the visibility data exceeds the expected contribution from instrumental noise with 96.5% confidence. We have also divided the data into two bins corresponding to different spatial resolutions in the power spectrum. We find $\Delta T_1 = 16.6^{+5.3}_{-5.9}\,\mu$K at 68% confidence for CMB flat band power described by an average multipole of $\ell_{eff} = 5237$ and $\Delta T_2 < 26.5\,\mu$K at 95% confidence for $\ell_{eff} = 8748$.

Introduction

Fluctuations in the distribution of matter at the epoch of recombination create large angular scale anisotropy in the Cosmic Microwave Background (CMB). This primordial anisotropy has been studied extensively at degree and sub-degree angular scales in order to place constraints on the parameters of cosmological models. At arcminute scales, the primordial anisotropy is damped to negligible amplitude due to photon diffusion and the finite thickness of the last scattering surface. On these smaller scales, anisotropies generated by the reionization of the Universe such as the Sunyaev-Zeldovich (SZ) effect are expected to dominate the signal of the CMB power spectrum. Studies of secondary anisotropy in the CMB have the potential to be a powerful probe of the growth of structure in the Universe.

Observations

- Ten fields selected from IRAS $100\,\mu$m and VLA NVSS radio surveys to lie in regions with low dust contrast and no bright radio sources.

- All anisotropy observations from the BIMA array at Hat Creek using 28.5 GHz receivers, providing a 6.6' FWHM field of view and average temperature sensitivity of $\sim\ 15\,\mu$K for a 2' synthesized beam.

- Point source positions recorded from observations with the VLA at 4.8 GHz with RMS flux of $\sim 25\,\mu$Jy.

Selected Fields

Field Positions and Observation Times

Fields	R. A. (J2000)	Decl. (J2000)	Year(s)	Time (Hrs)
BDF4	$00^{h}\,28^{m}\,04.4^{s}$	$+28^{\circ}\,23'\,06''$	98	77.6
HDF	$12^{h}\,36^{m}\,49.4^{s}$	$+62^{\circ}\,12'\,58''$	98, 01	59.9
BDF6	$18^{h}\,21^{m}\,00.0^{s}$	$+59^{\circ}\,15'\,00''$	98, 00	81.2
BDF7	$06^{h}\,58^{m}\,45.0^{s}$	$+55^{\circ}\,17'\,00''$	98, 00	68.2
BDF8	$00^{h}\,17^{m}\,30.0^{s}$	$+29^{\circ}\,00'\,00''$	00, 01	53.3
BDF9	$12^{h}\,50^{m}\,15.0^{s}$	$+56^{\circ}\,52'\,30''$	00, 01	53.9
BDF10	$18^{h}\,12^{m}\,37.2^{s}$	$+58^{\circ}\,32'\,00''$	00, 01	53.3
BDF11	$06^{h}\,58^{m}\,00.0^{s}$	$+54^{\circ}\,24'\,00''$	00, 01	50.0
BDF12	$06^{h}\,57^{m}\,38.0^{s}$	$+55^{\circ}\,32'\,00''$	01	54.8
BDF13	$22^{h}\,22^{m}\,45.0^{s}$	$+36^{\circ}\,37'\,00''$	01	54.5

CMB Power Spectrum From Interferometer Data

$$\mathcal{L}\left(\{C_\ell\}\right) = \frac{1}{\pi^n \det C} \, \exp\left[-V^*(\mathbf{u}_i) C_{ij}^{-1} V(\mathbf{u}_j)\right] \quad (1)$$

$$C_{ij} = C_{ij}^V + C_{ij}^N + C_{ij}^C \quad (2)$$

$$C_{ij}^V = \frac{1}{2\pi}\left(\frac{\partial B_\nu}{\partial T}\right)^2 \Delta T^2 \int_0^\infty \frac{dw}{w} W_{ij}(w) \quad (3)$$

$$C_{ii}^N = \frac{1}{\sigma_i^2} \quad (4)$$

$$C_{ij}^C = \sum_{n,n'} \Lambda_{ni} \kappa_n \Lambda_{n'j} \kappa_{n'} \quad , \quad (5)$$

Results

Image Statistics and Estimated Power in Blank Fields in u-v range $0.63 - 1.7$ kλ

Field	Synthesized Beamsize($''$)	RMS (μJy beam^{-1})	RMS (μK)	$\Delta T(\mu\mathrm{K})$ Most Likely	$\Delta T(\mu\mathrm{K})$ 68%
BDF4	87.1×94.6	103.5	18.8	0.0	$0.0 - 14.4$
HDF	87.4×90.9	111.3	21.0	0.0	$0.0 - 17.4$
BDF6	86.6×90.9	89.9	17.3	24.0	$14.2 - 34.6$
BDF7	86.4×90.4	101.6	19.5	17.4	$2.6 - 27.6$
BDF8	84.1×87.5	108.5	22.1	0.0	$0.0 - 12.6$
BDF9	85.3×88.6	110.6	22.0	12.4	$0.0 - 21.6$
BDF10	85.8×86.8	108.6	21.9	0.0	$0.0 - 15.6$
BDF11	85.2×88.3	109.1	21.8	0.0	$0.0 - 17.6$
BDF12	87.3×88.6	112.3	21.8	35.8	$23.2 - 50.2$
BDF13	86.8×89.1	112.9	21.9	27.2	$11.4 - 41.4$
All Fields				14.2	$8.2 - 19.0$

What's Left to be Done?

- Expand sky coverage with another 600 hours of observation in July and August of 2002.
- Search for non-Gaussian signature of the SZ effect from BIMA images. What depth of observation is required to identify skewness or kurtosis in the BIMA images?
- Analyze optical images from Lick Observatory and Keck Observatory for clustering of galaxies in BDF6 and BDF12.
- Compare with hydrodynamic simulations of structure formation through mock observations.

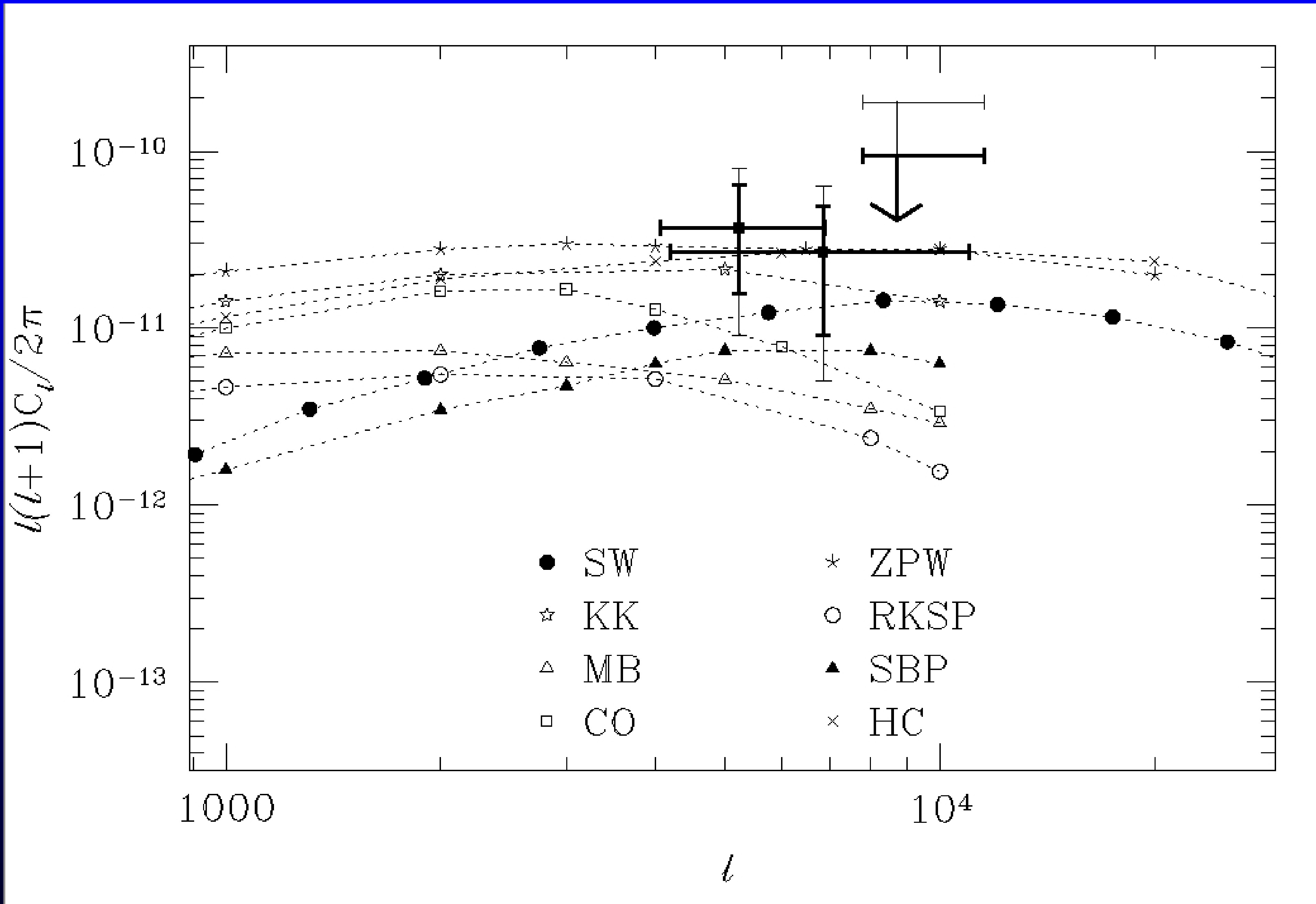

Figure 1. Published estimates of the thermal SZ power spectrum compared to the result of this work.

References

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