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A CMB TEMPERATURE ANISOTROPY EXPERIMENT FOR THE LMT

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Current observations of the CMB temperature anisotropies provide data that allow an accurate estimation of the CMB power-spectrum on angular scales $\gtrsim 13'$ ($\ell \lesssim 800$). Measurements on smaller angular scales ($\ell \gtrsim 800$), however, have been limited to ground-based interferometers by the requirement of higher spatial resolution and increased sensitivity. The CMB anisotropies on arc-minute scales are expected to be the seeds of clustered galaxy formation, and can also provide information about the duration of the recombination phase-transition and the reionization epoch of the universe. Furthermore, these fluctuations can be used to test standard and non-standard aspects of the inflationary model.

In this work we test the feasibility of detecting the higher-order acoustic features, and the steepness of the high-ℓ cutoff in the CMB power-spectrum with the Large Millimeter Telescope[2] (LMT) on angular scales $13' \gtrsim \theta \gtrsim 3'$ ($800 \lesssim \ell \lesssim 3000$). Our multicomponet model of the mm sky is described by Chapin et al. (elsewhere in these proceedings). The proposed LMT survey covers a $2^o \times 2^o$ area of the sky to a uniform depth of 0.06 mJy/beam with BOLOCAM-II, a 144 detector array operating at 1.4 mm. The size of the map has been chosen in order to reduce the sampling variance over the angular scales of interest, and to minimize beam-smearing at the resolution of the LMT ($\phi \sim 8''$ at 1.4 mm or $\ell \sim 90000$), whilst retaining the long scans needed to reduce the systematic errors on the larger-scale CMB information. Assuming a NEFD ≈ 2 mJy Hz$^{-1/2}$, we require $\sim$1 yr (6 hr/day) to measure CMB fluctuations at level of 4 μK at $\ell \sim 3000$ over $2^o \times 2^o$. Foreground contamination to CMB observations at 1.4 mm and on small angular scales ($\ell \gtrsim 100$) is due to the atmosphere, Galactic cirrus and extragalactic point-sources. The choice of 1.4 mm minimizes any anisotropies due to the S-Z effect from intervening clusters. Atmospheric effects can be accurately removed using the correlated noise "seen" between the detector signals in large format arrays. Furthermore, the cirrus contribution to the signal at 1.4 mm can be neglected by observing a region of the sky with cirrus at a mean surface brightness $I_{100\mu m} \lesssim 0.6$ MJy/sr, and provided an extrapolation of the FIR power-spectrum to small-scales and mm-wavelengths is valid. Our simulated maps therefore include realizations of the CMB anisotropies, extragalactic point-sources (without clustering), telescope performance and detector noise.

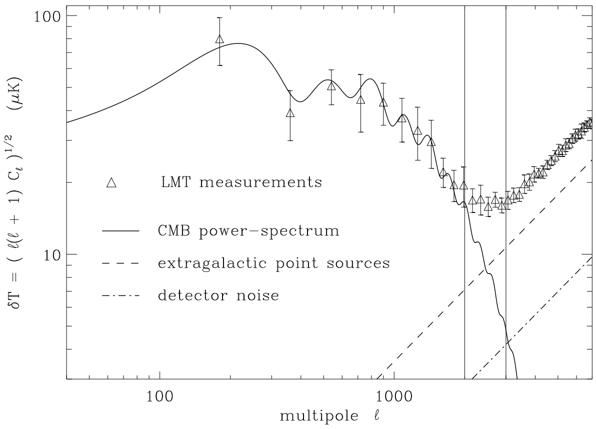

Fig. 1. Recovered power-spectrum from ten LMT simulations including CMB, point-sources and intrument noise.

The recovered power-spectrum (Fig. 1) shows the capability of detecting CMB temperature fluctuations at angular scales $\sim 5'$ ($\ell \sim 2000$) with the LMT, without the need for foreground galaxy subtraction. Furthermore, the high resolution of the LMT compared to these CMB scales will allow a very efficient subtraction of foreground galaxies without the requirement for multi-wavelength observations, improving our results to $\ell \sim 3000$ (Fig. 1). A detector sensitivity closer to the specifications (NEFD ≈ 1 mJy Hz$^{-1/2}$) and a more efficient survey design will considerably reduce the integration time ($\sim$ 3 months). Alternatively, the covered area could be increased to reduce the sampling variance. These simulations are therefore conservative, providing greater confidence in the ability of the LMT to detect the CMB and extract the anisotropy characteristics. Furthermore, since the survey has been optimized to retain the information on scales from 2^o down to the resolution limit of $8''$, then the same experiment will simultaneously satisfy the demands of a study of (mm-wavelength selected) galaxies and their large-scale structure, one of the main scientific goals of the LMT.

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[2] http://www.lmtgtm.org