FOREGROUND CONTAMINATION AROUND THE NORTH CELESTIAL POLE

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We cross-correlate the Saskatoon Q-Band data with different spatial template maps to quantify possible foreground contamination. We detect a correlation with the Diffuse Infrared Background Experiment (DIRBE) 100 µm map, which we interpret as being due to Galactic free-free emission. Subtracting this foreground power reduces the Saskatoon normalization of the Cosmic Microwave Background (CMB) power spectrum by roughly 2%.

1 INTRODUCTION

One of the major concerns in any Cosmic Microwave Background (CMB) analysis is to determine if the observed signal is due to real CMB fluctuations or due to some foreground contaminant. At the frequency range and angular scale of the Saskatoon experiment, there are two major potential sources of foreground contamination: diffuse Galactic emission and unresolved point sources. The diffuse Galactic contamination includes three components: synchrotron and free-free radiation, and thermal emission from dust particles. Although from a theoretical point of view, it is possible to distinguish these three components, there is no emission component for which both the frequency dependence and spatial template are currently well known. The purpose of this paper is to use the Saskatoon data to estimate the Galactic emission at degree angular scales.
2 DATA ANALYSIS

We based our analysis on the 1994-1995 data from Saskatoon experiment\textsuperscript{1,2,5}. We cross-correlate the Saskatoon Q-Band data with two different synchrotron templates: the 408 MHz survey\textsuperscript{6} and the 1420 MHz survey\textsuperscript{7}. To study dust and free-free emission, we cross-correlate the Saskatoon data with the Diffuse Infrared Background Experiment (DIRBE) sky map at wavelength 100 $\mu$m\textsuperscript{8}. In order to study the extent of point source contamination in the Saskatoon data, we cross-correlate it with the 1Jy catalog of point sources at 5 GHz\textsuperscript{9}. The templates used in this analysis, as well as the Saskatoon data, are shown in Figure 1.

The synchrotron templates, as well as the point source template, are found to be uncorrelated with the Saskatoon data. The DIRBE far-infrared template show a correlation, indicating a detection of signal with common spatial structure in the two data sets. Kogut et al.\textsuperscript{4,10} detect a positive correlation between the DIRBE far-infrared maps and the DMR maps at 31.5, 53, and 90 GHz, which they identify as being the result of a free-free emission. Assuming that
this hypothesis can be extended to Saskatoon scales, we argue that the correlation between the DIRBE template and the Saskatoon data is most likely due to free-free contamination.\footnote{11}

3 CONCLUSIONS

In summary, we find a cross-correlation (at 97\% confidence) between the Saskatoon Q-Band data and the DIRBE 100 $\mu$m map. The $r_{ms}$ amplitude of the contamination correlated with DIRBE 100 $\mu$m is $\approx 17$ $\mu$K at 40 GHz. We argue that the hypothesis of free-free contamination at degree angular scales is the most likely explanation for this correlated emission. Accordingly, the spatial correlation between dust and warm ionized gas observed on large angular scales seems to persist down to the smaller angular scales.

As reported by Netterfield et al.\footnote{2} the angular power spectrum from the Saskatoon data is $\delta T_l=49^{+8}_{-5}$ $\mu$K at $l=87$ (corresponding to $r_{ms}$ fluctuations around 90 $\mu$K on degree scales). This value of $\delta T_l$ is a much higher signal than any of the contributions from the foreground contaminants cited above, and shows that the Saskatoon data is not seriously contaminated by foreground sources. Since the foreground and the CMB signals add in quadrature, a foreground signal with $17\mu$K /$90\mu$K $\approx 20\%$ of the CMB $r_{ms}$ only causes the CMB fluctuations to be over-estimated by $\sqrt{1 + 0.20^2} - 1 \approx 2\%$.

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