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Tenerife Experiments: Galactic Contribution to CMB Observations at 1° angular scales

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Abstract. Cosmic Microwave Observations at 1° scales are extremely important on the understanding of modern Cosmology. At those angular scales the CMB power spectrum presents the first Doppler Peak. The position and amplitude of this peak provide strong constraints on cosmological parameters as H_0 and Ω_0. The JBO-IAC interferometer has observed those angular scales as well as the BOOMERANG and MAXIMA teams. The results from these groups show the existence of the first Doppler Peak. We present a detailed estimate of the galactic contribution to the JBO-IAC interferometer data set using data from the Tenerife and COSMOSOMAS experiments.

1. Low Frequency Instruments

The 33GHz JBO-IAC interferometer is a single baseline interferometer performing drift scans at constant declination (Dicker et al. 1999). It consists of two horn antennae, two channels and a correlator. The instrument can operate at 2° scales (short spacing) and 1° scales (wide spacing) wich are equivalent to multipoles l=109 and l=208 respectively. The interferometer is a high sensitivity instrument and provides very good weather rejection. The Tenerife experiment (Davies et al 1996) consists of three beam-switching type radiometers at 10,15 and 33 GHz. Each radiometer has two independent channels which operate using a double-difference technique of the form -0.5,+1.,-0.5. Angular scales from 5° to 10° which are equivalent to the multipole range l=10-30 are covered by the instrument. Sensitivity of $20\mu K$ per 5° beam is achieved. The COSMOSOMAS experiment consists of two independent radiometers (Gallegos et al. 2000). Each radiometer is composed of a flat spinning mirror, a parabolic dish and a horn antenna. For the purpose of the following analysis, data from one of the COSMOSOMAS radiometers is used. This radiometer has three independent channels at 13,15 and 17 GHz and covers the angular scale range between 1 and 4 degrees. The instrument performs circular scans on the sky covering a 20° (declination) by 360° (RA) strip per day. Daily sensitivity of the order of 0.6 mK per 1° beam is achieved.

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2. Galactic Contribution to CMB Observations at low Frequencies

This section discusses the possible contamination of CMB observations by galactic foregrounds. At low frequencies, free-free and synchrotron emissions dominate. Spinning dust has also been proposed as a possible contaminant (de Oliveira-Costa et al. 2000) but its contribution is not yet well understood. We have convolved the COSMOSOMAS data set with the JBO-IAC interferometer beam pattern at both short and wide configurations. The 13 and 15 GHz maps have been combined to reduce the noise contribution. The r.m.s signal of the convolved data has been calculated and extrapolated to 33 GHz using a power law spectrum ($\nu^{-\alpha}$) for both free-free ($\alpha = 2.1$) and synchrotron ($\alpha = 3$) emissions. On the other hand, the Tenerife data at 15 GHz has also been extrapolated to 33GHz as above. In this case, we needed also to extrapolate on spatial frequencies from $5° - 10°$ to $1°$ angular scales. We have assumed that free-free and synchrotron emissions depend on the multipole value as follows $C_l \propto l^{-3}$. Contributions from galactic foreground can be expressed in a simple manner as extra error on the determination of the cosmological signal. Previous analysis (Harrison et al. 2000) have measured cosmological signals $\Delta T = 43^{+13}_{-12}$ at $l = 109$ and $\Delta T = 63^{+7}_{-6}$ at $l = 208$. Including galactic contribution from the above analysis we can state $\Delta T = 43^{+12}_{-17}$ at $l = 109$ and $\Delta T = 63^{+7}_{-11}$ at $l = 208$ for free-free, and $\Delta T = 43^{+12}_{-14}$ at $l = 109$ and $\Delta T = 63^{+7}_{-7}$ at $l = 208$ for synchrotron.

3. Conclusions

Galactic foreground contamination in the observed JBO-IAC data is negligible on both the short and wide spacing. Therefore, the first Doppler peak has a cosmological origin. A conservative estimation of the galactic contribution will lead to an increasing of the error bars of the band power measured by the JBO-IAC interferometer.

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