New Cosmological Data and the Values of the Fundamental Parameters
IAU Symposium, Vol. 201, 2005
Anthony Lasenby and Althea Wilkinson, eds.

Results from the Tenerife Experiments.

R. A. Watson, J. F. Macias-Perez, R. D. Davies, R. J. Davis, A. Wilkinson

Jodrell Bank Observatory, University of Manchester, Macclesfield, Cheshire, SK11 9DL, UK

R. Rebolo, C. Gutierrez

Instituto de Astrofisica de Canarias, La Laguna, SPAIN

Abstract. The Jodrell-IAC CMB experiments at Teide Observatory, Tenerife consisting of switching radiometers operating at 10, 15 and 33 GHz, and a 33 GHz short baseline interferometer, have covered up to an area of 1 steradian at angular scales from 1° to 10° ($\ell = 20 - 210$) . Sensitivities of 10μK per beam area have been reached for a combination the most sensitive experiments allowing a measure of the CMB fluctuation amplitude of $30 \pm 8\mu$K using mapping techniques which fully exploit the whole data set. Attempts have been made to separate out galactic radio foregrounds and to place limits on a possible spinning dust contribution.

1. Introduction

The Tenerife experiments, the three switched beam radiometers working at 10.45, 14.9 and 32.5 GHz (named 10, 15 and 33 GHz for simplicity) and a single baseline interferometer (also 32.5 GHz), measure anisotropy of the Cosmic Microwave Background (CMB) on scales of 8° to 1°. All instruments use cryogenically cooled HEMT amplifiers and benefit from the dry high altitude site of the Tenerife Teide Observatory to make long integrations to produce sensitive stacked drift scans dominated by CMB fluctuations. These experiments are a collaboration between the Jodrell Bank Observatory (JBO)(Univ.Manchester), the Instituto de Astrofisica de Canarias (IAC) and the Cavendish Astrophysics Group (CAG)(Univ.Cambridge). With more than a sterdian of sky has been covered by the 15 GHz radiometer with a sensitivity of about 20μK per beam and 10 GHz data covering just under a steradian with a sensitivity of 50μK per beam and the 33 GHz radiometer having covered a few declinations modifications have been and are being made to improve both these latter two instruments with a view to complete the survey to provide a available source of data to establish the contributions of anisotropy of due to intrinsic CMB and diffuse galactic emission at these frequencies.

2. Galactic Emission

The greatest potential source of contamination at these frequencies is from galactic free-free and synchrotron. A joint maximum likelihood analysis (Gutierrez et

al 1999) of common 10 and 15 GHz data finds a CMB band power of $30^{+10}_{-8}\mu$K (68% c.l.) and an upper limit of 28μK on a possible free-free contribution at 10 GHz. A better estimate of the galactic emission including COBE DMR data and 33 GHz radiometer data to constrain a MEM multifrequency reconstruction (Jones et al 1999) of CMB fluctuations and possible galactic emission at 10 GHz which is of similar rms amplitude to the CMB; 42μK CMB and 35μK galactic. The CMB reconstruction is very similar to that obtained from 15 GHz alone, which again assuming free-free emission would only suffer from 15μK galactic contamination. Spinning dust has been proposed (Drain and Lazarian 1998) to to be an important contaminant at these frequencies. This was the conclusion of de Oliveira-Costa et al 1999 who claim to have found DIRBE-correlated emission enhanced in 15 GHz suggesting the rising spectrum of spinning dust. Mukherjee,Jones and Lasenby 2000 have examined the more complete Tenerife data set find the correlation is confined to close to the galactic plane ($\approx 20°$) and has a free-free like spectral index

3. Improvements

Due to the increased air-masses in the two outer negative beams in the triple beam pattern of the 33 GHz radiometer there is a large -80 mK to -50 mK offset which depends on the water vapour content of the atmosphere. This results in relatively large baseline gradients, which have significant power on the time scales of expected astronomical signals. Therefore only exceptionally good days could be used (10%). This problem has been eliminated by the change of the 8° hour angle mirror "wagging" to a 7.5° declination "nodding", which removes the offset as now all beam switching is made at the same air mass. The original triple beam profile becomes four beams arranged in a square ("quad beam"). The resulting window function to angular power is very similar to the original so data can be compared to that of other radiometers. In oldest of the radiometers (10 GHz) the room temperature switch circulator both limits noise figure (adding 30K) and band-width (500MHz). By going to a correlation receiver including new lower noise HEMT amplifiers we hope to more than half the system noise and double the band-width, which opens up the possibility to look for spinning dust or at least establish the levels of diffuse galactic emission.

References

de Oliveira-Costa, A., Tegmark, M., Gutierrez, C. M., Jones, A. W., Davies, R. D., Lasenby, A. N., Rebolo, R. & Watson, R. A. 1999, ApJ, 527, L9

Draine, B. T. & Lazarian, A. 1998, Ap.J., 494, L19

Gutierrez, C. M., Rebolo, R., Watson, R. A., Davies, R. D., Jones, A. W. & Lasenby, A. N. 1999, ApJ., 529, 47

Jones, A. W., Lasenby, A. N., Mukherjee, P., Gutierrez, C. M., Davies, R. D., Watson, R. A., Hoyland, R. & Rebolo, R. 1999, MNRAS, 310, 105.

Mukherjee, P., Jones, A. W., Kneissl, R. & Lasenby, A. N. 2000 submitted to MNRAS(astro-ph/0002305)