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Multifrequency Observations of the S-Z Effect towards A1656

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Abstract. Observations of the Sunyaev-Zeldovich (S-Z) effect offer the possibility of both investigating evolution of clusters and of determining cosmological parameters when combined with X-ray observations. We describe a dedicated instrument (MITO) consisting of a 2.6-m in diameter telescope operating at 3500 m a.s.l. in the 2.1, 1.4, 1.1 and 0.8 mm channels with $\sim$ 10% bandwidths. Here we briefly report the results of MITO measurements towards the Coma cluster.

1. Instrument

A mm-telescope for the measurement of CMB anisotropies has been developed and it is operating at the Millimetre and Infrared Testagrigia Observatory (3480 m a.s.l. - Testa Grigia - Val d'Aosta) (De Petris et al. 1996). A single-dish approach has been adopted with an aplanatic Cassegrain solution: a 2.6-m in diameter primary mirror and a 41-cm wobbling subreflector. Consequent drawbacks due to the presence of a moving optical element have been considered: spillover problems, instrument inhomogeneous emission and microphonics. In order to disentangle the S-Z effect from spurious contaminating sources we use a single-pixel 4-channel photometer. Four NTD Ge composite bolometers are cooled down to 290 mK by a double stage He^3-He^4 fridge. The bands are centered at peak wavelengths of 2.1 mm, 1.4 mm, 1.1 mm and 850 micron with bandwidths (%) equal to 21, 14, 12 and 10, matching the available atmospheric windows. At the telescope focal plane the photometer has a 17 arcminutes FWHM field of view.

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2. Observations and Results

As a first step in looking for the S-Z effect in nearby clusters, we have tested our instrument, observational strategy and data reduction on the Coma cluster (A1656). During February and March 2000 campaigns we observed the source in drift scan mode (R.A. scanning 10 minutes) with 3-field spatial modulation (square wave like profile at 3 Hz and a 41′ beamthrow). The collected 83 data strips have been handled as follows (a full description will be given in an upcoming paper):

1.- rejection of all drifts with spikes: cosmic rays induced or EMI generated;

2.- removal of drifts for which the Ch_i *vs* Ch_4 correlation (i=1,2 and 3) is lower than 0.9, *i.e.* necessary condition for efficient decorrelation procedure;

3.- removal of drifts for which the channel ratios have bimodal distribution; typical in presence of fluctuations of atmospheric constituents at different layers;

4.- removal of baseline to each channel for each drift with a linear fit avoiding in this way a strong conditioning to the expected signal;

5.- filtering the signals by gaussian smoothing with τ= 40 s.

The resulting 23 drifts have been decomposed in atmospheric and S-Z components by the simultaneous use of spatial and spectral information. The time-dependent atmospheric mask has been monitored by Ch_4 while a S-Z profile is derived by geometrical consideration on source (described by β and θ_{core} parameters) and observation strategy (f.o.v. and 3 fields modulation). Each S-Z profile has been attenuated following a secant law atmospheric transmission, *i.e.* $SZ'_i = SZ cos z_i$. The equations we have considered are the following:

$$S_{1res} = S_1 - \alpha_{14}(S_4 - b_4 w SZ') - wSZ'$$
$$S_{3res} = S_3 - \alpha_{34}(S_4 - b_4 w SZ') - w b_3 SZ'$$

where S_1, S_3 and S_4 are the voltage signals for the respective bands, α_{14} and α_{34} are the optimized atmospheric ratios for 1 and 3 channels with respect to channel 4. Also, w is the amplitude (in voltage) of the S-Z effect in the first channel while b_i are the estimated S-Z voltage ratios between i-channel and channel 1. We have estimated the b coefficients from the S-Z spectrum, bands transmission and optical responsivities. The final w value has been obtained by weighting the result for each drift by its noise or by the amplitude of the χ^2 function at 1 sigma. The two methods are consistent within errors.

The value of w has been converted to the central thermodynamic temperature for the i_{th} channel considering gaussian filter attenuation, geometric form factor η and responsivity. For channel 1 the measured ΔT_{CMB} is equal to -230 ± 27 μK, and given the value of η this implies $-575 \pm 68\mu$K for the central value. This value is converted to a measured central Comptonization parameter $y_o = (2.23 \pm 0.27) \cdot 10^{-4}$. An isothermal β-model with $\theta_c = 10.5$' and β=0.75 is consistent with our measurements.

References

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