PROCEEDINGS OF SCIENCE

Deconvolution Map-Making

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The advantages which motivated the development of the deconvolution map-making method are discussed and some preliminary results of the analysis of Level S simulations generated for the Low Frequency Instrument, LFI, 30 GHz channel are presented. The ability of this method to successfully cope with any arbitrary beams is demonstrated.

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1. Introduction

The deconvolution map-making method is complementary to techniques based on pixelised maps and offers a number of advantages over these methods, namely the ability to perform the analysis with any arbitrary beam, the ability to handle correlated low frequency noise in the time-ordered data, TOD, and the similar treatment of the temperature and polarization data. The method exploits the fact that the TOD for each pointing period may be expressed in terms of Fourier coefficients, which in turn may be related to the underlying $A_{lm}s$ of the sky. A full mathematical description of the method may be found in [1] and [2].

The advantages of this method come with the price of a large computation overhead. This has motivated the sub-division of our method into exact and approximate versions. It is envisaged that at low ℓ the exact version will provide the full convariance matrix and the formal errors, which may then be used as an input to the hybrid estimator. At the expense of losing information on the errors, using a preconditioned conjugate gradient approach provides the solution for much higher values of ℓ than the exact approach. The approximate method can reach values of ℓ which may prove useful for the analysis of the Low Frequency Instrument, LFI, data depending on the computational resources available at the time of launch.

2. Preliminary Results

Here we present some preliminary results of the approximate method, taking as input the TOD as produced by the Level S pipeline for the LFI 30 GHz channel, using the non-ideal beam shown

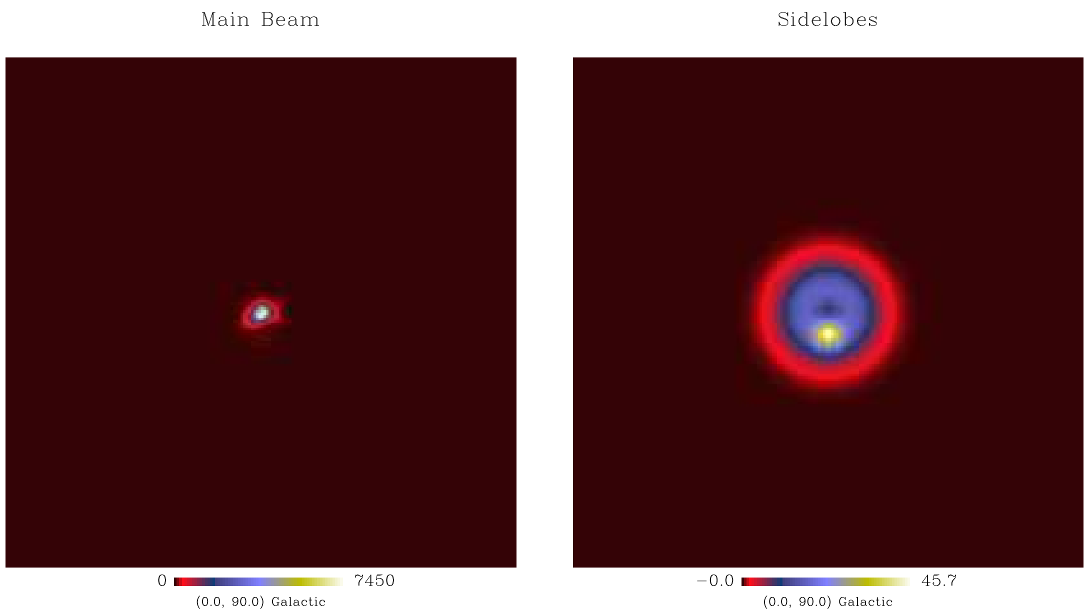

Figure 1: The asymmetric main beam and sidelobes used the production and analysis of the LFI 30 GHz channel data.

in Figure 1. This data was analysed up to an ℓ_{max} of 300 and used a total of 1200 rings. The noise was scaled to be the equivalent of including a full year of data in the analysis. The preliminary treatment of the 1/f noise, increased the noise on all the C_0 Fourier coefficients so as to effectively exclude them from the analysis. The results of this analysis may be seen in Figure 2, where the maps for the Q Stokes parameter are shown.

Figure 3 shows the power spectra, up to an ℓ_{max} of 100, of the input sky, used by the Level S pipeline, for temperature and polarisation, black crosses. The coloured symbols show the residuals between the input and the recovered power spectra, with the diamonds representing experiments where Gaussian beams were used and asterisks were the non-ideal beam in Figure 1 was used. In each experiment the A_{lm} values were recovered up to $\ell_{max} = 100$. The analysis of a full year of data, 8784 rings, is shown by the purple symbols, while the analysis of $4 \times \ell_{max}$ rings with scaled noise is shown by the red symbols, and the noise-free case is shown by blue symbols. The residuals in the noise-free case are due to the differences in the methods implemented in the production of the Level S simulations and our analysis software; the exact cause is still uncertain.

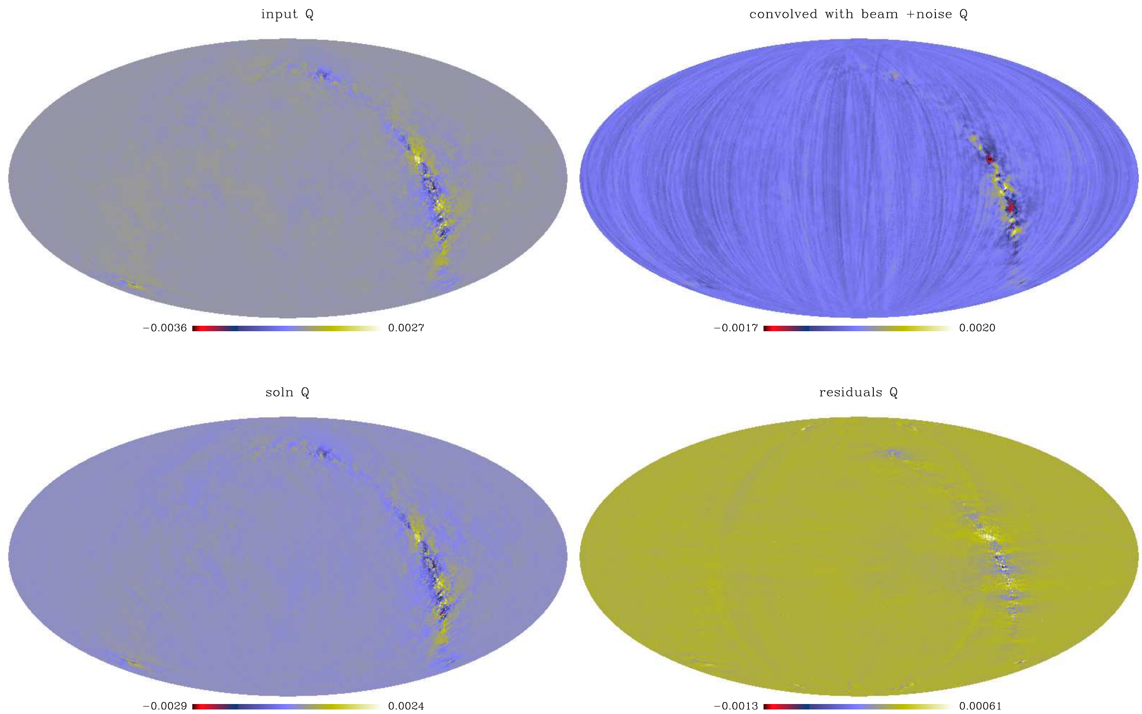

Figure 2: Top left: The input sky map for the Q Stokes parameter, Top right: Convolved with beam plus noise, Bottom left: The recovered map for Q, Bottom right: The residuals between the input and recovered maps.

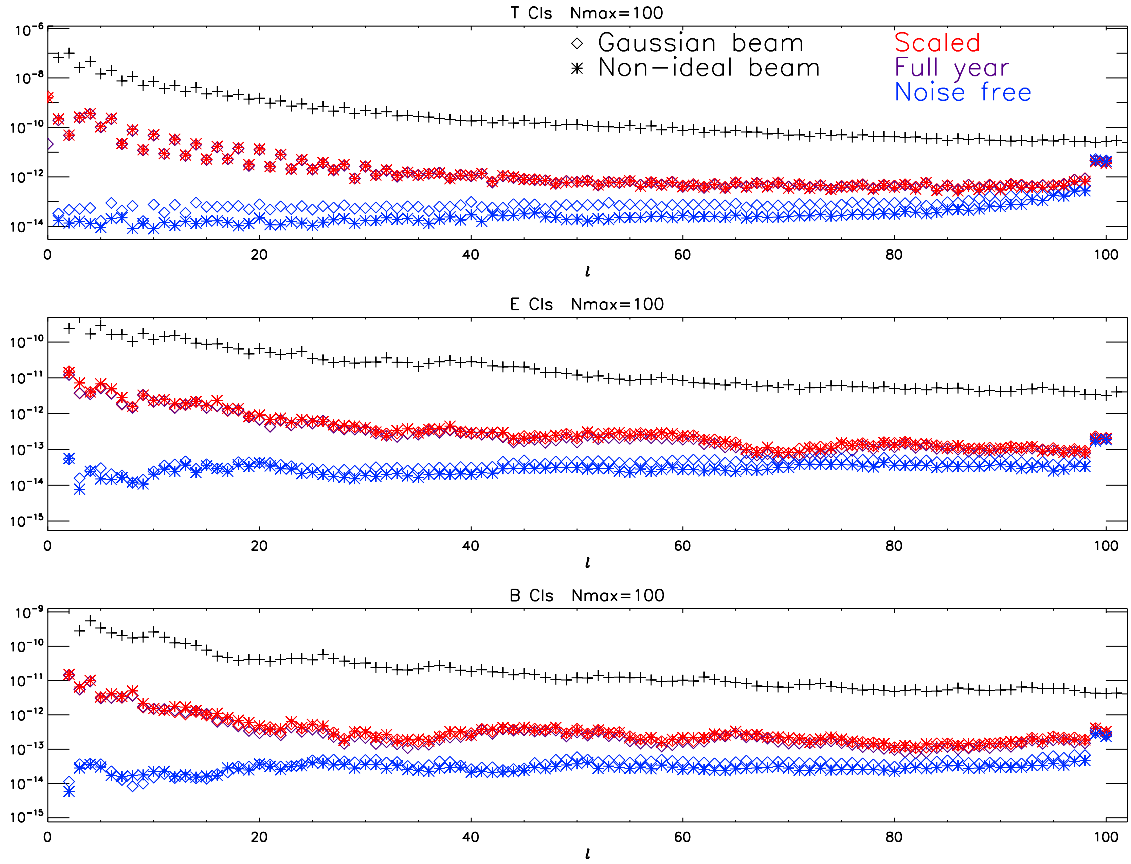

Figure 3: The power spectra of the input sky is shown, black crosses, together with the residuals between the input and recovered maps for various experiments. The beams are Gaussian for the diamonds and asymmetric for the asterisks. The analysis of a full year of data, 8784 rings, is shown by purple symbols, while red symbols show the analysis of scaled experiments of $4 \times \ell_{max}$ rings and the blue symbols show the noise-free case.

References

[1] F. van Leeuwen, A.D. Challinor, D.J. Mortlock, M.A.J. Ashdown, M.P. Hobson, A.N. Lasenby, G.P. Efstathiou, E.P.S. Shellard, D. Munshi, V. Stolyarov, *Harmonic analysis of cosmic microwave background data - I. Ring reductions and point-source catalogue*, *MNRAS*, 331, 975

[2] A.D. Challinor, D.J. Mortlock, F. van Leeuwen, A.N. Lasenby, M.P. Hobson, M.A.J. Ashdown, G.P. Efstathiou, *Harmonic analysis of cosmic microwave background data - II. From ring-sets to the sky*, *MNRAS*, 331, 994