Lensing Reconstruction in the Presence of Diffuse Polarized Galactic Foregrounds

in prep.

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Lensing Reconstruction

Using an optimally weighted quadratic combinations of CMB fields T, E or B [Okamoto&Hu 2003] to extract a biased estimate of the lensing potential

$$\hat{\phi}^{XY}_{LM} = \sum_{\ell m \ell' m'} W_{LM\ell m\ell' m'} \cdot X_{\ell m} Y_{\ell' m'} \, .$$

The bias in the resulting power spectrum is computed analytically ($N_L^{(0)}$ & $N_L^{(1)}$) and with MC simulations (small residual bias, not including foregrounds).

Polarized Diffuse Foregrounds

An understanding of the contaminating effect of small scale polarized galactic foregrounds on the lensing potential estimation and delensing is essential for B-mode detection. PLANCK provided data on degree-scale polarized foregrounds, understanding the small scale effect relies on simulations, with the main contributors believed to be polarized dust and synchrotron radiation.

Foreground Cleaning

Maximization of the spectral likelihood [Stompor et al. 2009]

$$-\log \mathcal{L} = (A^T N^{-1} d\,)^T (A^T N^{-1} A)^{-1} A^T N^{-1} d$$

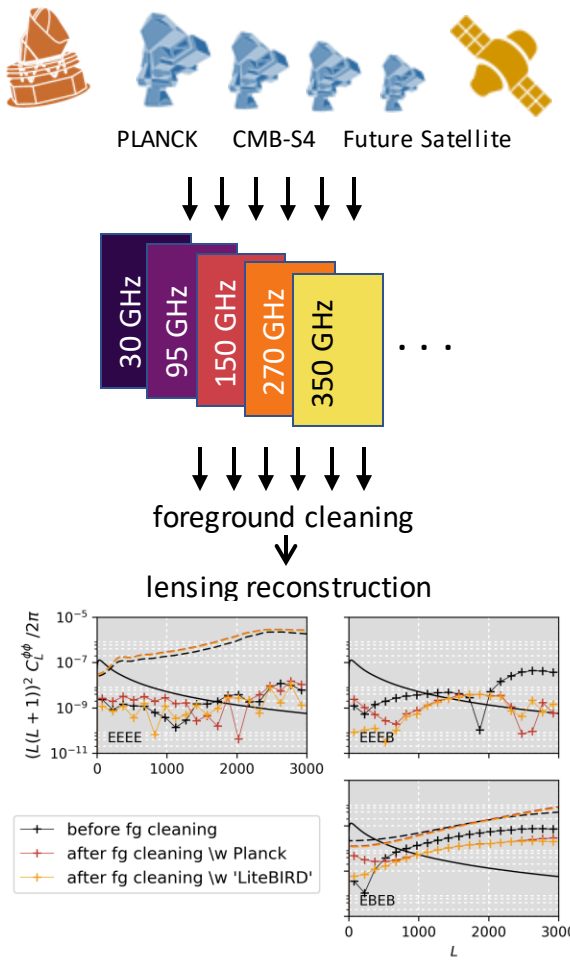
to determine the spectral parameters of the dust and synchrotron scaling relations in the data d. An estimate of the clean CMB is then given by

$$s = [(A^T N^{-1} A\,)^{-1} A^T N^{-1} d\,]_{CMB}$$

with a noise given by

$$[(A^T N^{-1} A)^{-1}]_{CMB \times CMB}.$$

Foreground Residuals in $C_L^{\phi\phi}$

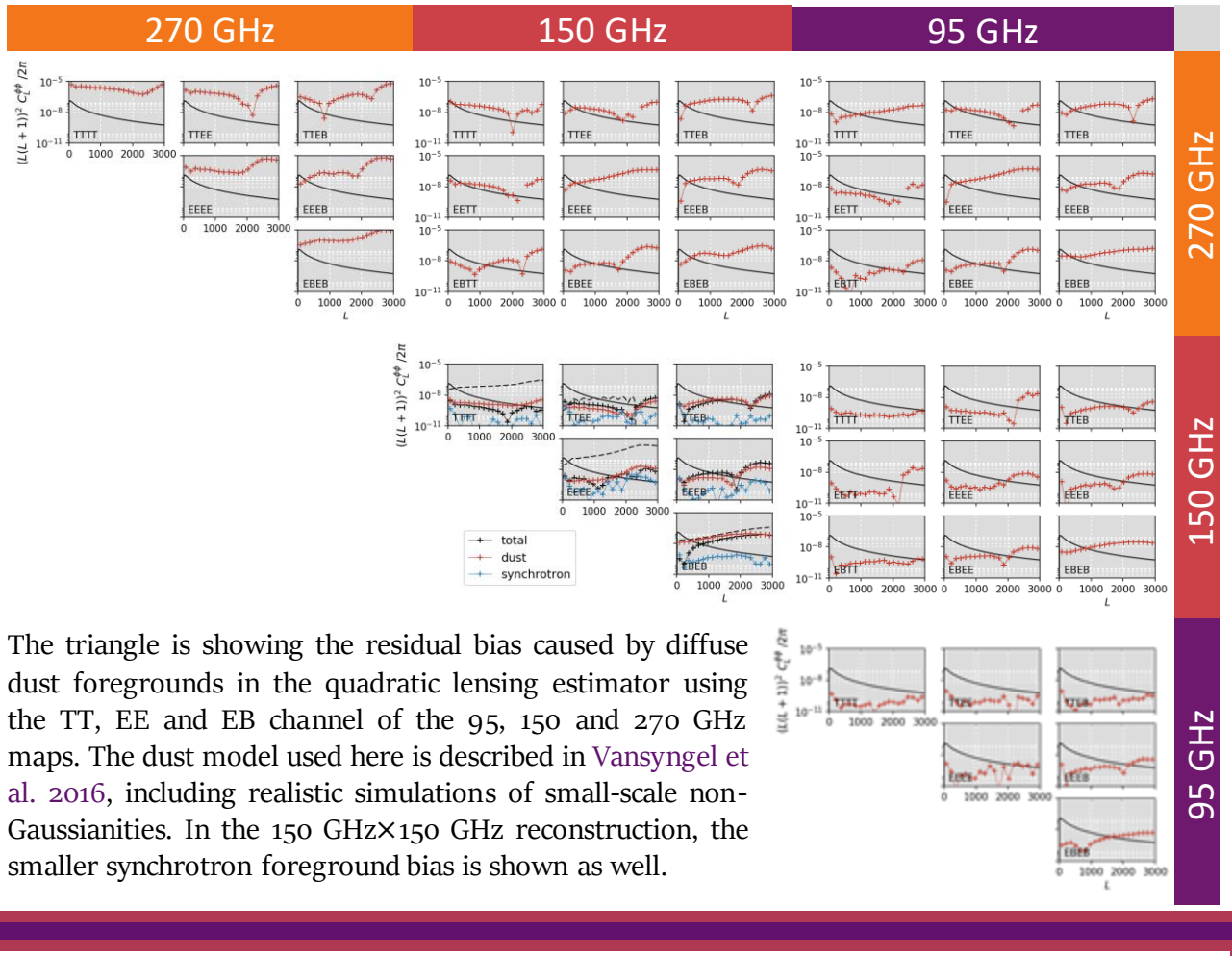


Fake total neutrino mass due to foregrounds

	Before cleaning	After cleaning
$\sum m_\nu$	1.3 eV	230 meV
$\sigma(\sum m_\nu)$	0.2 eV	90 meV

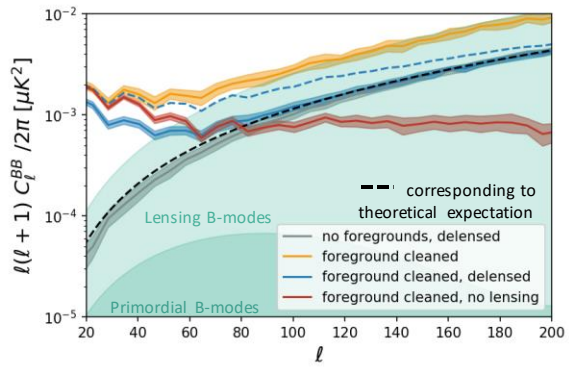
The above table is showing the mean and standard deviation of the best-fit values of the total neutrino mass, fitted to $C_L^{\phi\phi}$ as it is reconstructed from simulated, foreground cleaned CMB maps, including no massive neutrinos.

Frequency Dependent Foreground Bias



The triangle is showing the residual bias caused by diffuse dust foregrounds in the quadratic lensing estimator using the TT, EE and EB channel of the 95, 150 and 270 GHz maps. The dust model used here is described in Vansyngel et al. 2016, including realistic simulations of small-scale non-Gaussianities. In the 150 GHz×150 GHz reconstruction, the smaller synchrotron foreground bias is shown as well.

CMB Internal Delensing with Foregrounds



$50 \leq \ell \leq 200$
$2.7\ \mu K\ arcmin$
25 % of the sky
$r_{fid.} = 0.001$

The foreground biased estimate of ϕ can be used to delens the contaminated CMB, finding an improvement $\frac{\sigma_{del}(r)}{\sigma_{len}(r)} = 0.72$.

$r/10^{-3}$	Lensed	Delensed
No FGs	1 ± 0.92	1 ± 0.50
FG residuals	15.4 ± 1.21	17.9 ± 0.87

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