

Iterative curved-sky lensing estimates for cmb4 deep

Julien Carron, CMB-S4 meeting March 31 2020

Iterative lens reconstruction

- ϕ_{LM} posterior maximizer given data and fiducial cosmology
- Approach similar than flat-sky version applied to POLARBEAR data

(JC & Lewis 2007
[1704.08230](#) for flat-sky)

Polarbear collab. [1909.13832](#) PRL

$$-2 \ln p(\phi | X^{\text{dat}}) = X^{\text{dat}} \cdot \mathbf{Cov}_{\phi}^{-1} X^{\text{dat}} + \ln \det | \mathbf{Cov}_{\phi} | + \mathbf{G. prior on } \phi$$

'Quadratic' part *'-Mean-field'* *prior*

to solve for ϕ_{LM}^{MAP} , the point where this posterior is maximal.

- **This gives the best lensing map given the data provided the posterior model ingredients above are close to the data.**
--> See Marius works and talk for alternative approach giving joint CMB-lensing posterior maxima.
Here the unseen unlensed CMB fields are marginalized over.

At each step, starting from QE:

- Estimate $E_{\ell m}^{\text{unlensed}}$ (MAP E^{unl} if $\hat{\phi}$ were the truth) (conjugate-gradient inverse of Cov, the hardest part)
- Build the 3 gradients of the posterior from $E_{\ell m}^{\text{unl}}$ and $\hat{\phi}_{LM}$
- Build the next point with gradient and curvature info, and a fancy L -dependent step-length

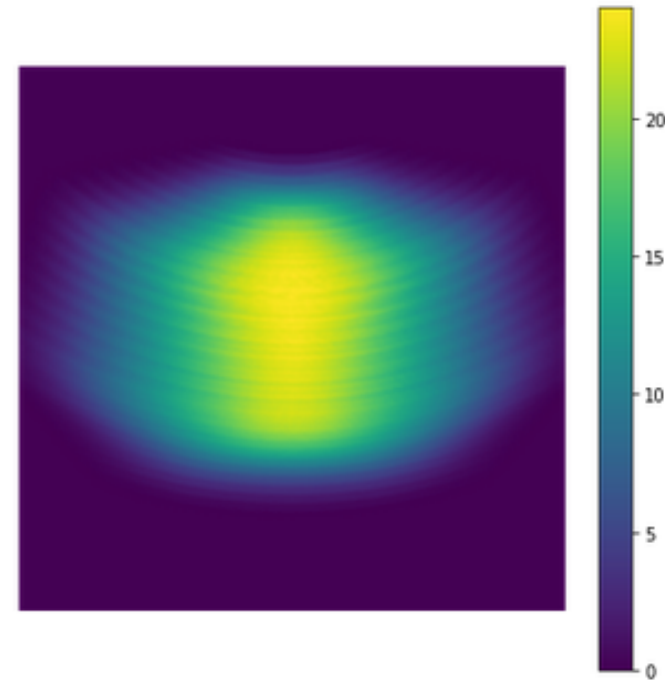
Reconstruction on s06b at 95 GHz

$$f_{\text{sky}} = 5\%$$

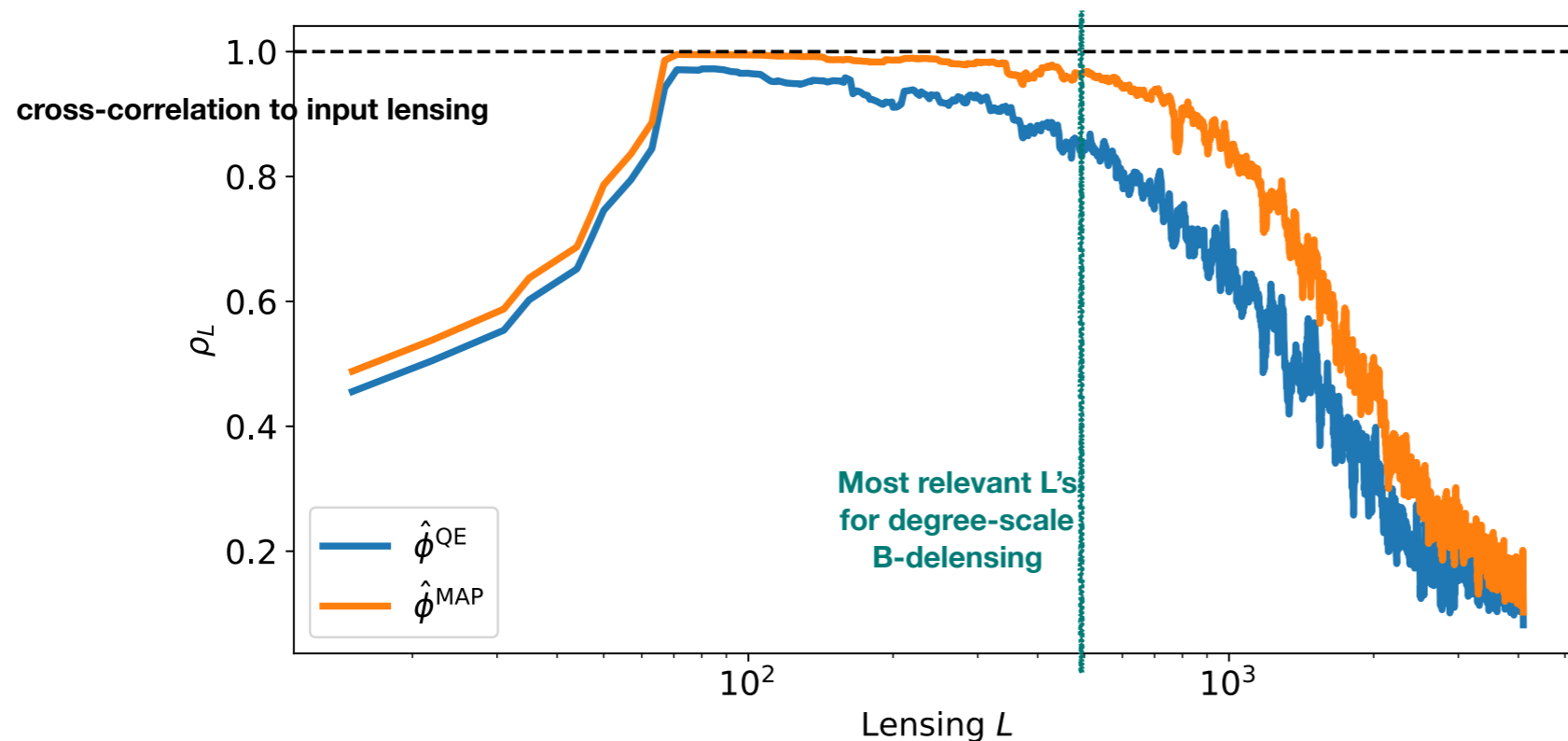
beam 2.3 amin

center pol noise level ~ 0.35 uK-amin

sort of 'if can do this one can do them all'-map



Results on map without foregrounds:

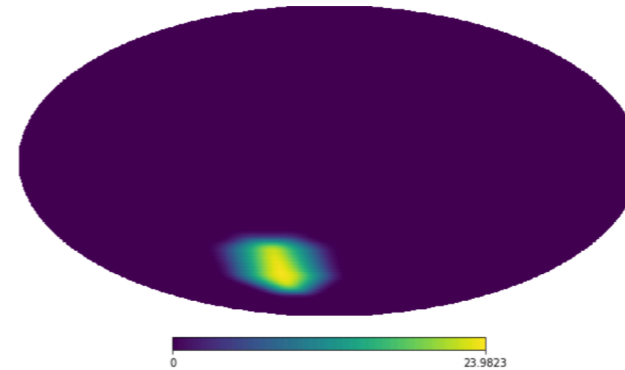


Cov inverse variance

At $L \sim 500$ goes from 85% (QE) to 96-97% (MAP) correlation
(suggests can bring down lensing power AL from 0.3 (QE) to ~ 0.07)

Ingredients:

- Sky curvature
- Inhomogeneous noise (hit map)
- Identical mask and noise mean-field for each step (but that's OK! see last slide)
- $\hat{\phi}$ -induced mean-field neglected (but that's OK! see last slide)
- low- ℓ_B masking (all ℓ_B, m_B below $\ell_B \leq 200$) performed with a dense 40397^2 matrix



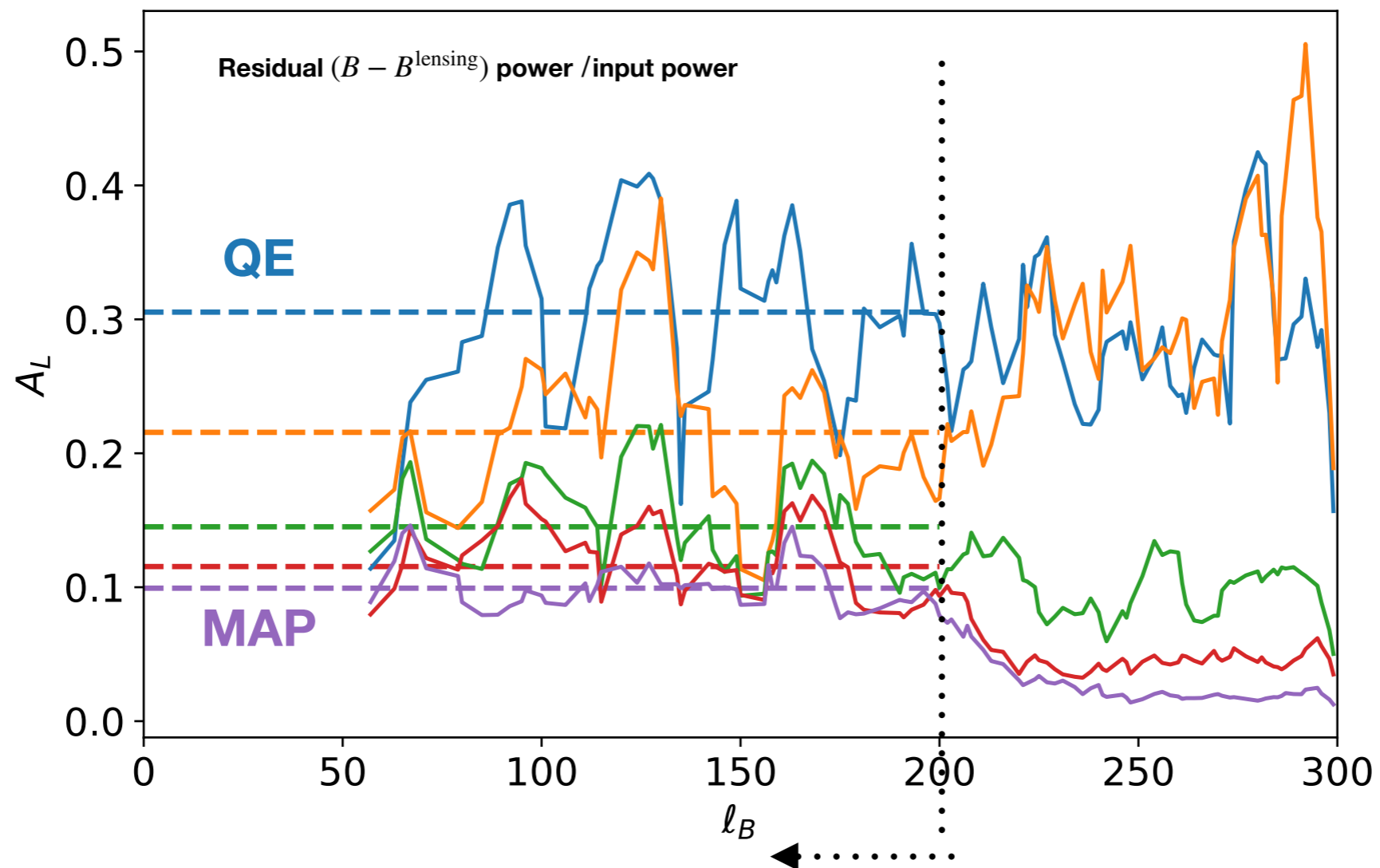
Lensing tracer *completely* blind to these modes

(can't just simply remove these modes from the data to start with)

From $\hat{\phi}_{LM}$ to $\hat{B}_{\ell m}^{\text{lensing}}$:

Here I just remap the estimated $E_{\ell m}^{\text{unl,WF}}$ with $\hat{\phi}_{LM}$

Reaches **residual lensing power amplitude of 0.1** on s06b wo fg:



All these modes projected out when building the tracer

Summary:

- 'exact' curved-sky MAP lensing estimation work on cmb4 s06b wo fg with reasonable execution time
- At $L \sim 500$ correlation to lensing input from 85% (QE) to 96-97% (MAP) (suggests can bring down lensing power AL from 0.3 (QE) to ~ 0.07)
- Simplest B-template gives residual lensing power amplitude of 0.1

Thanks !

Possibly for technical details

