All-sky reconstruction of the primordial scalar potential & implications

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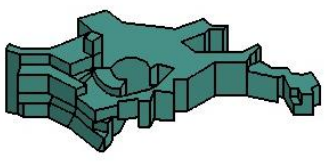
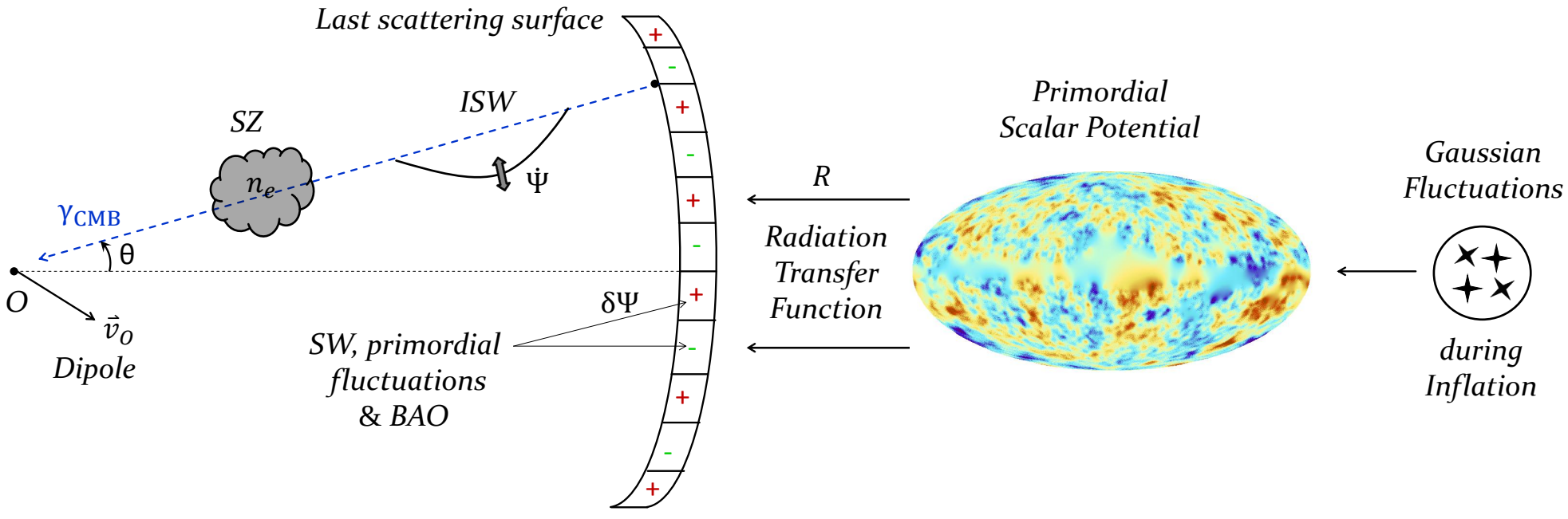
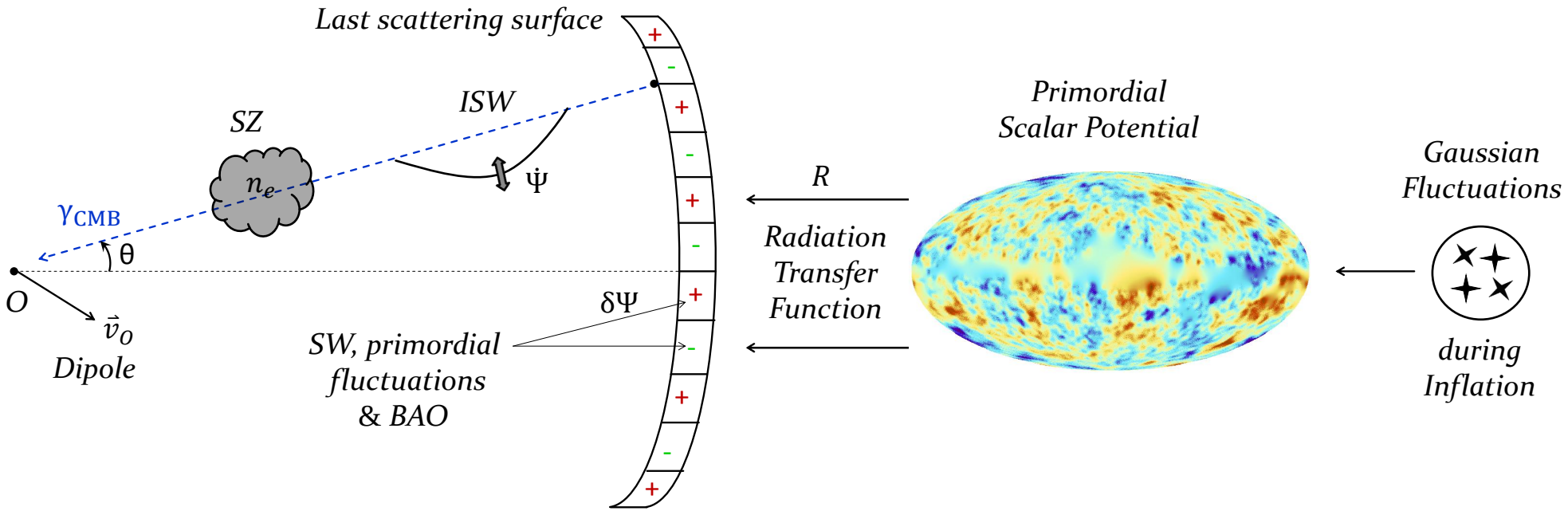


Motivation


Last scattering surface
SZ
ISW
n_e
Ψ
γ_{CMB}
θ
O
$\vec{v}_O$
Dipole
δΨ
SW, primordial
fluctuations
& BAO
R
Radiation
Transfer
Function
Primordial
Scalar Potential
Gaussian
Fluctuations
during
Inflation

Motivation



⇒ So why actually don't we infer these properties directly from Φ?

Data model: $d_{\mathrm{CMB}} = R\Phi + n$

The naive ansatz: $\hat{\Phi} = WF\left(d_{\mathrm{CMB}}\right)$

(WF: Wiener filter operation)

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$$N_{\mathrm{pixel}} \begin{cases} (d_{\mathrm{CMB}}) \propto \mathcal{O}(10^7) \\ (\Phi) \propto \mathcal{O}(10^7)^{3/2} \\ (R) \propto \mathcal{O}(10^7)^3 \end{cases}$$

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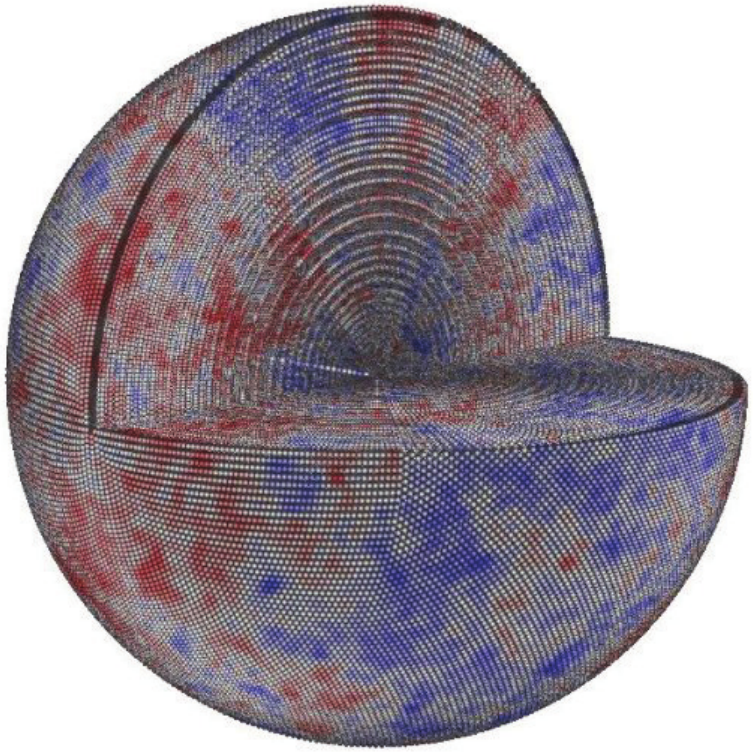
Φ inference hardly numerically feasable & very expensive!

The solution: Reconstruct Φ slice by slice!



[Yadav & Wandelt et al. '05]

Approach

- 1 slice = WF result $\hat{\Phi}$ projected onto a sphere:

$$\hat{\Phi}^{(2)} = T\left(\hat{\Phi}\right)$$

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- Resulting WF for 1 slice:

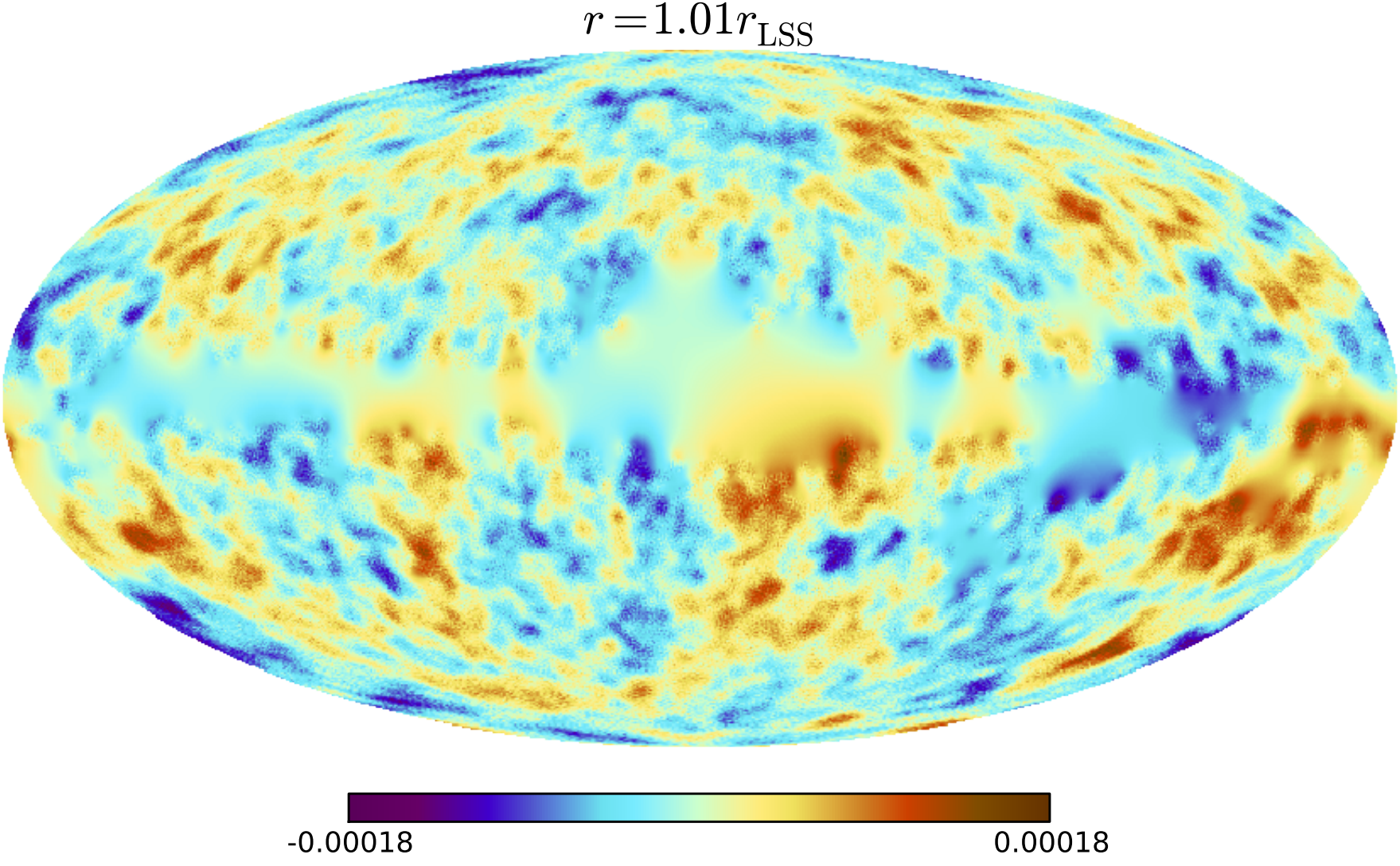
$$\hat{\Phi}^{(2)} = P_\ell^\Phi R^{(2)\dagger} C_d^{-1} d$$

P_ℓ^Φ: primo. power spectrum projected onto a sphere
C_d: data (CMB) covariance
$R^{(2)}$: 2d response, includes beam, mask, convolutions, physics

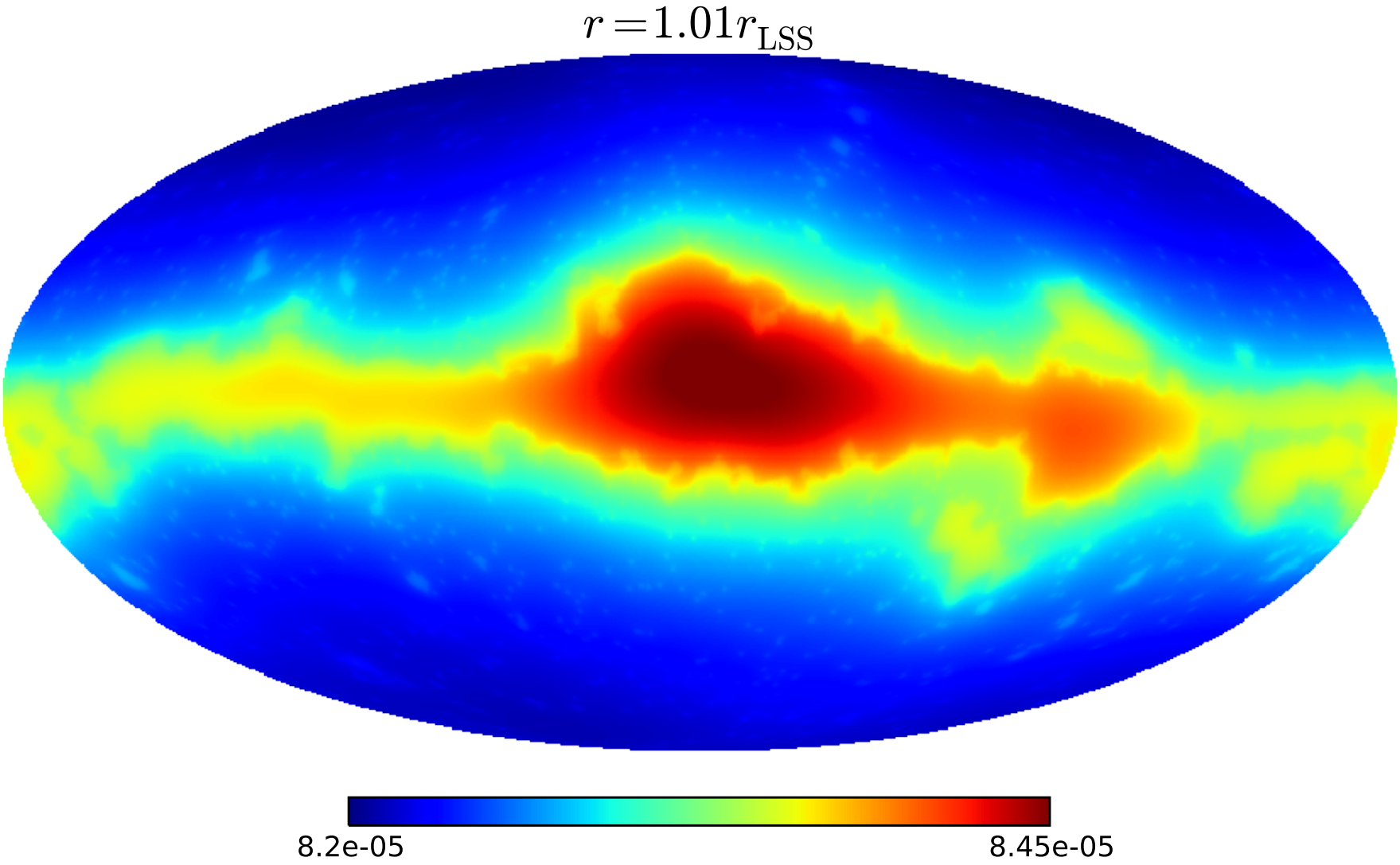
Achievements

- Full parallelization of the 3d WF
- Fast & cheap reconstruction
- Inclusion of polarization data simple
- Uncertainty estimates (sampling) per slices affordable

Reconstruction From Nine-Year WMAP T-Data (V-Band)



[SD et al. '14]



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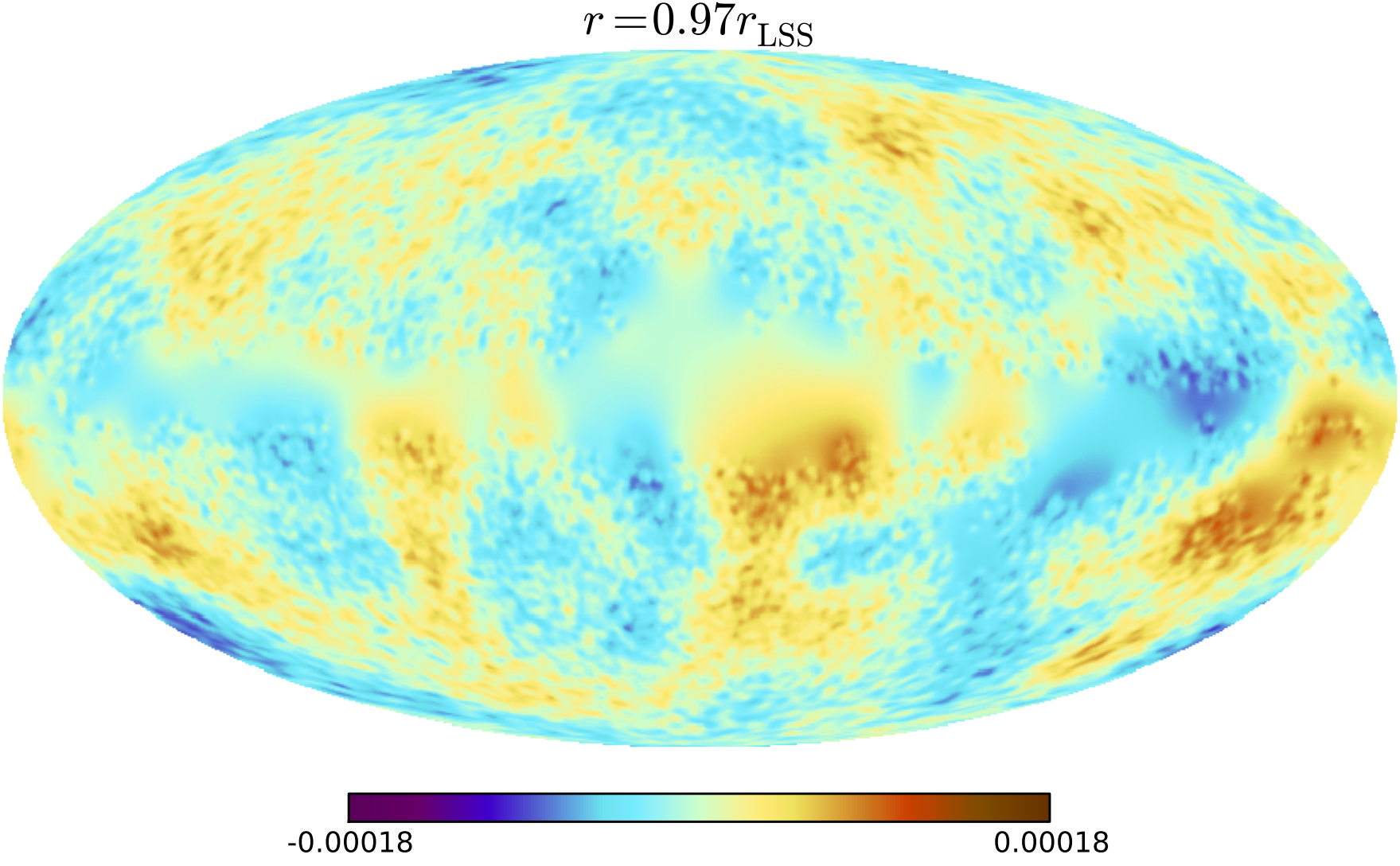
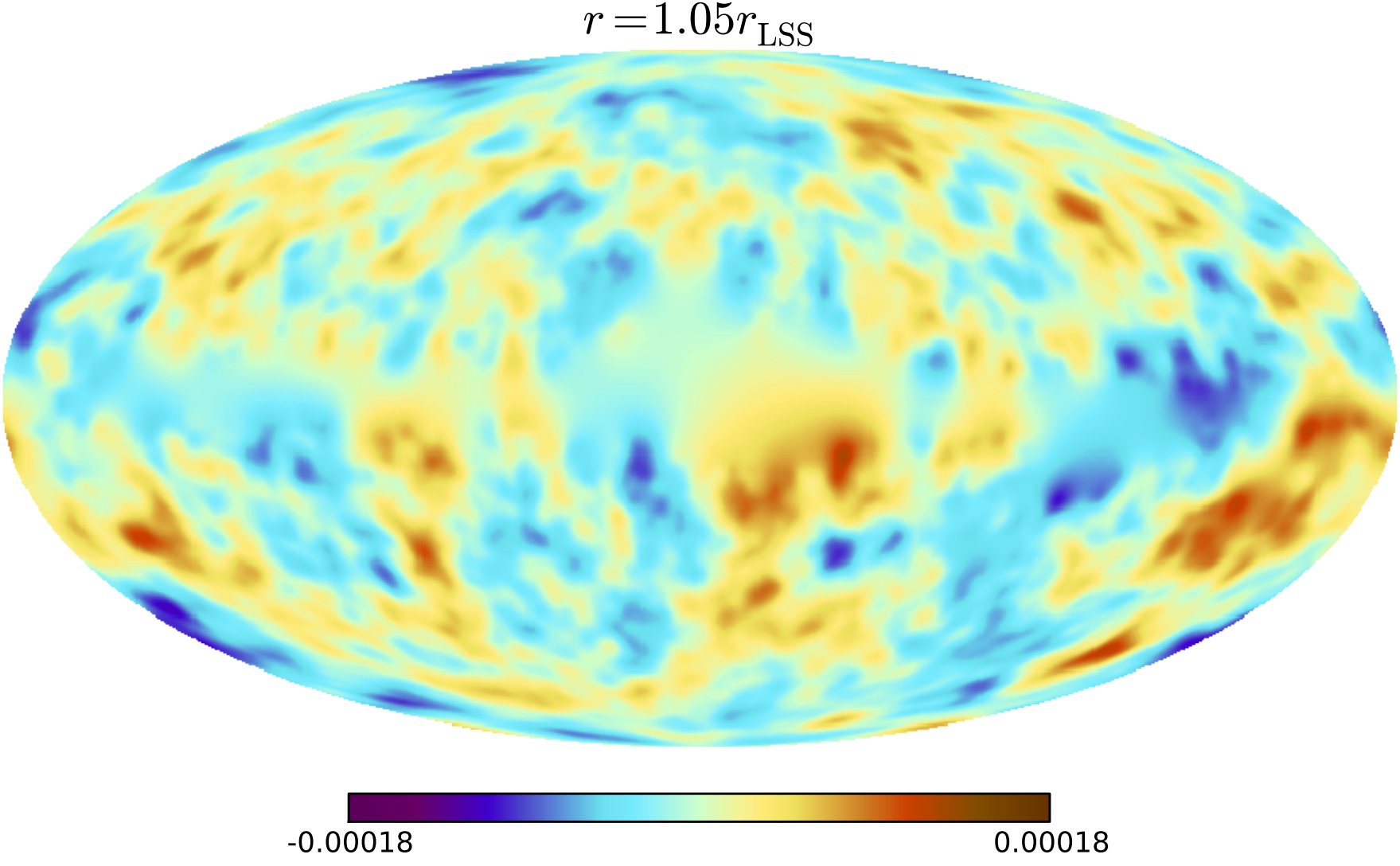
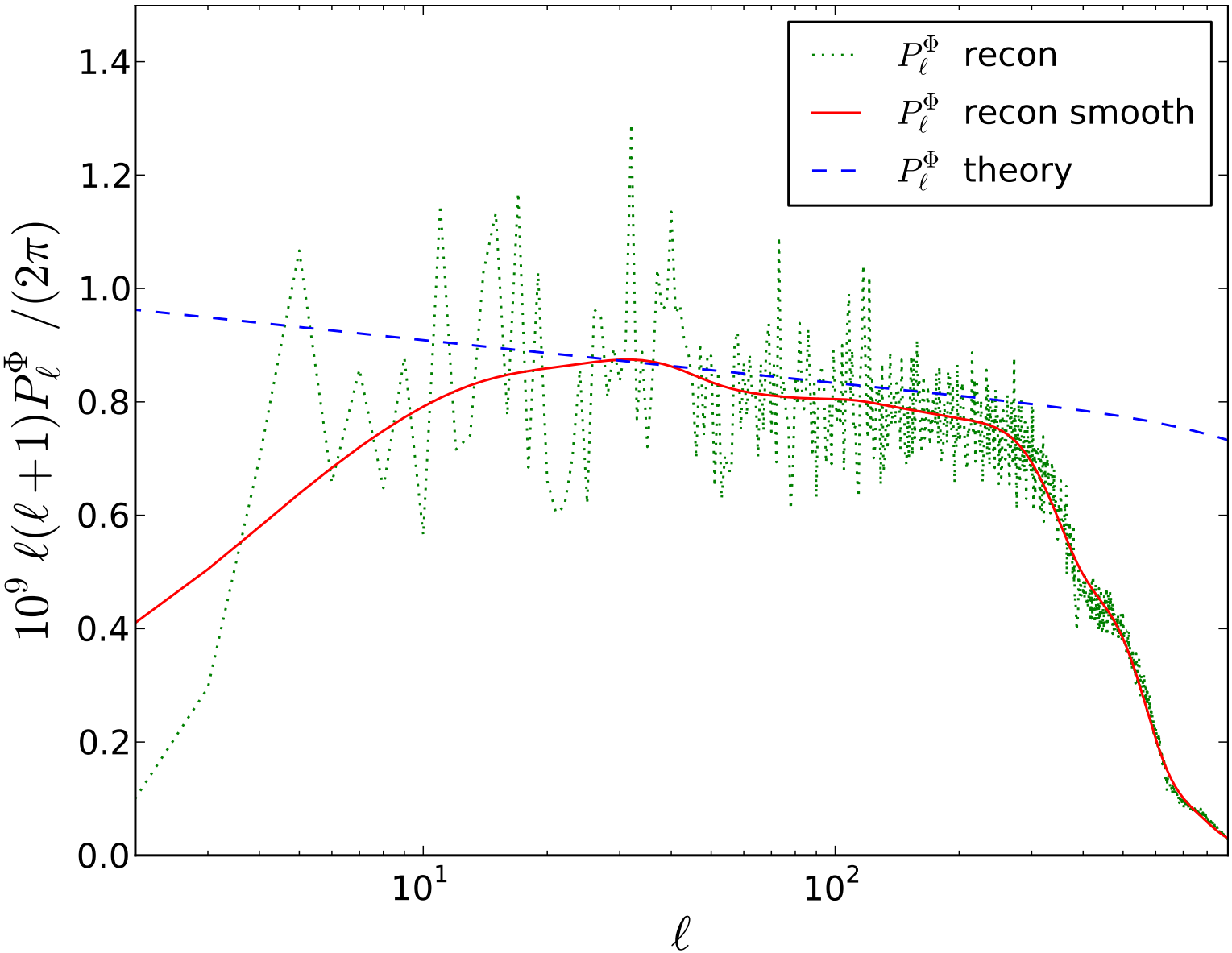


[SD et al. '14]



[SD et al. '14]

Primordial Power Spectrum ($r = r_{LSS}$), T only [SD et al. '14]



Next:

- Planck data including polarization
- Cross-checks with LSS reconstructions
- Inference of inflationary (recombinational) parameters
- Morphology/Symmetry investigations