Beam asymmetry in B-mode experiments

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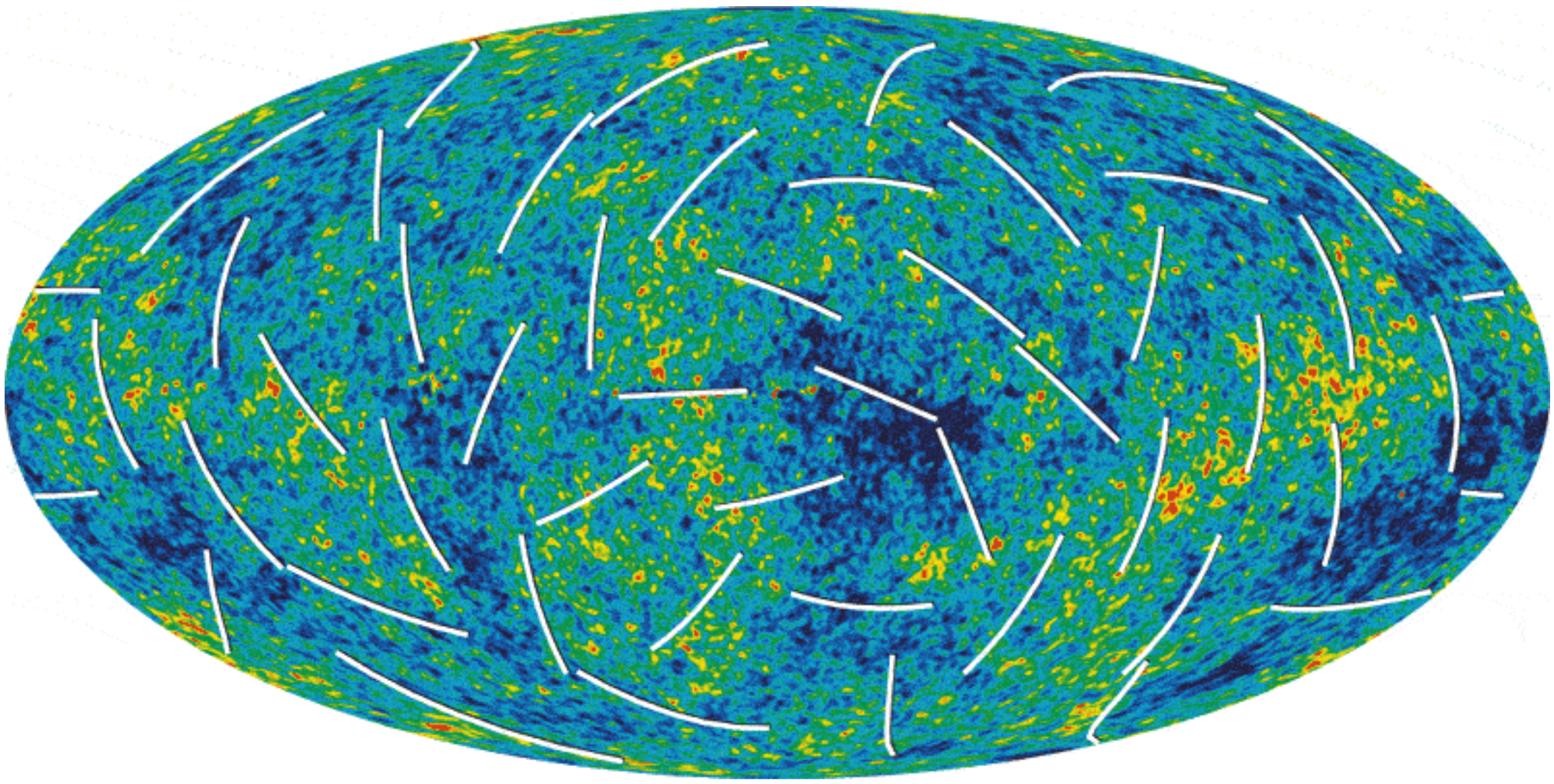
Outline

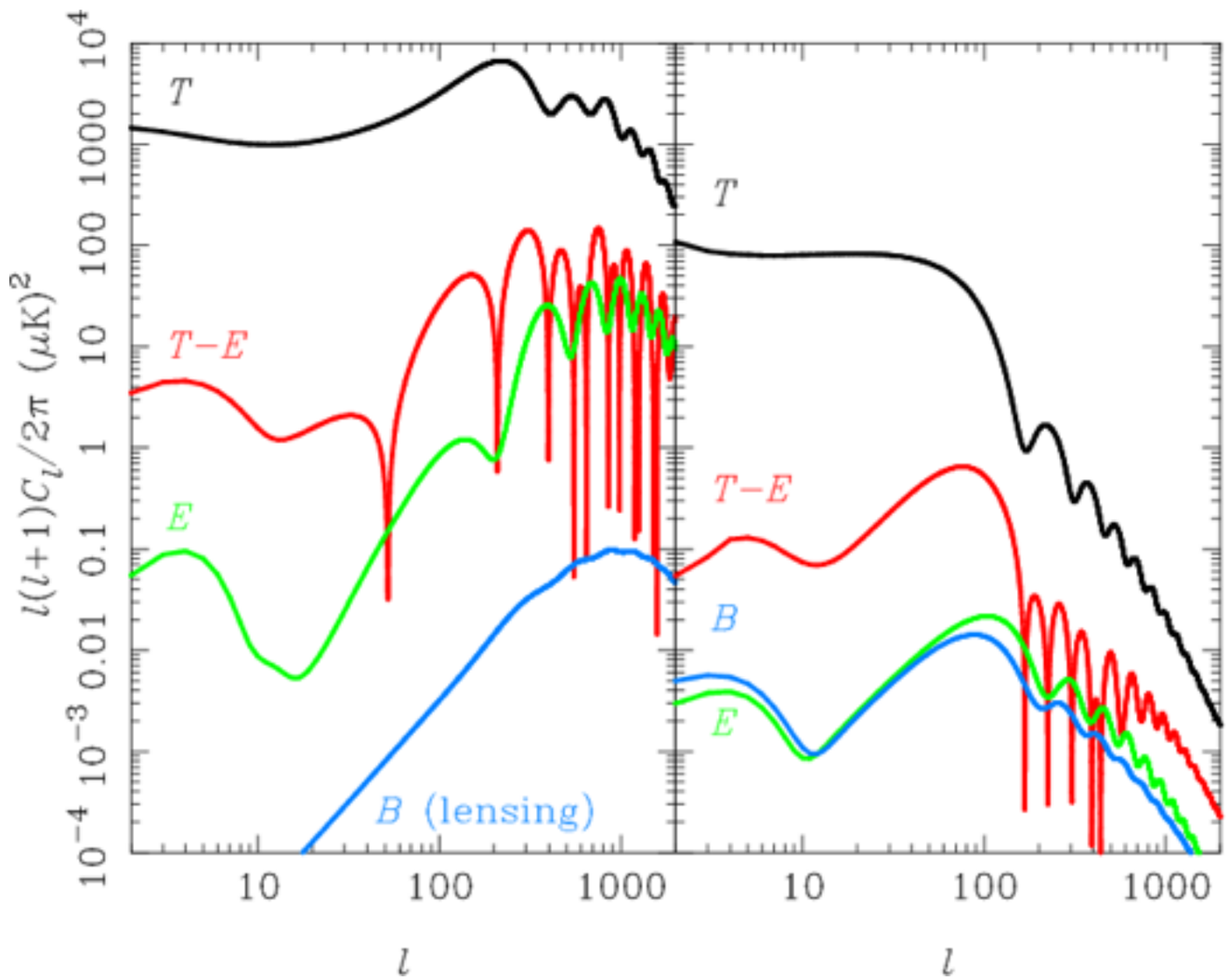
- CMB polarisation and the importance of detecting B-modes
- Motivation for new method to clean asymmetry bias from CMB experiments
- Brief description of new map making algorithm

CMB observables



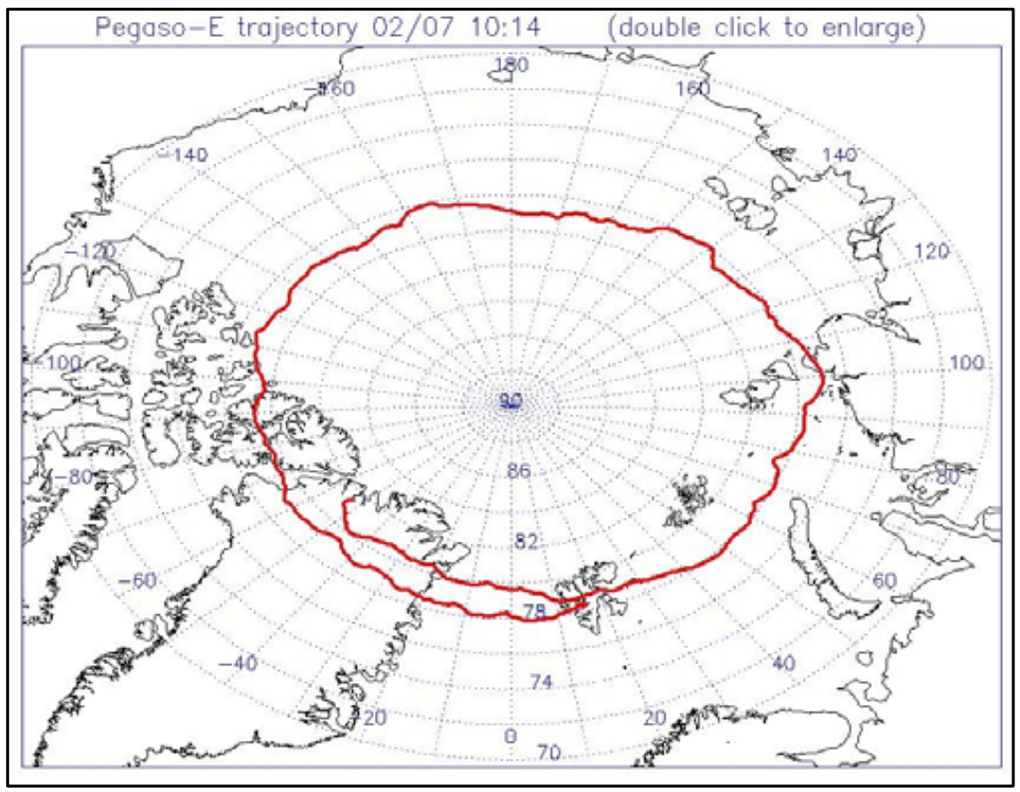
Scalar and Tenser perturbations

$$C_\ell^{XY} = \frac{1}{2\ell+1} \sum_{m=-\ell}^{\ell} a_{\ell m}^{X} a_{\ell m}^{Y*}$$

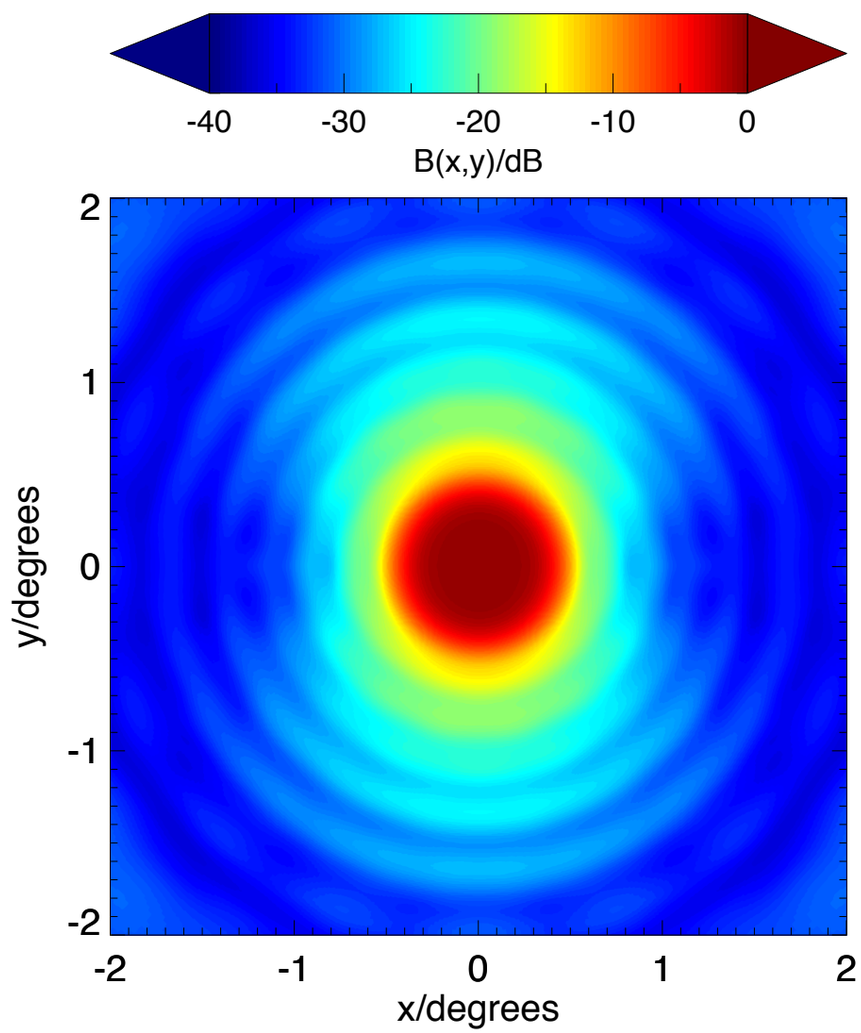


Scalar perturbations Tensor perturbations

Large Scale Polarization Explorer (LSPE)



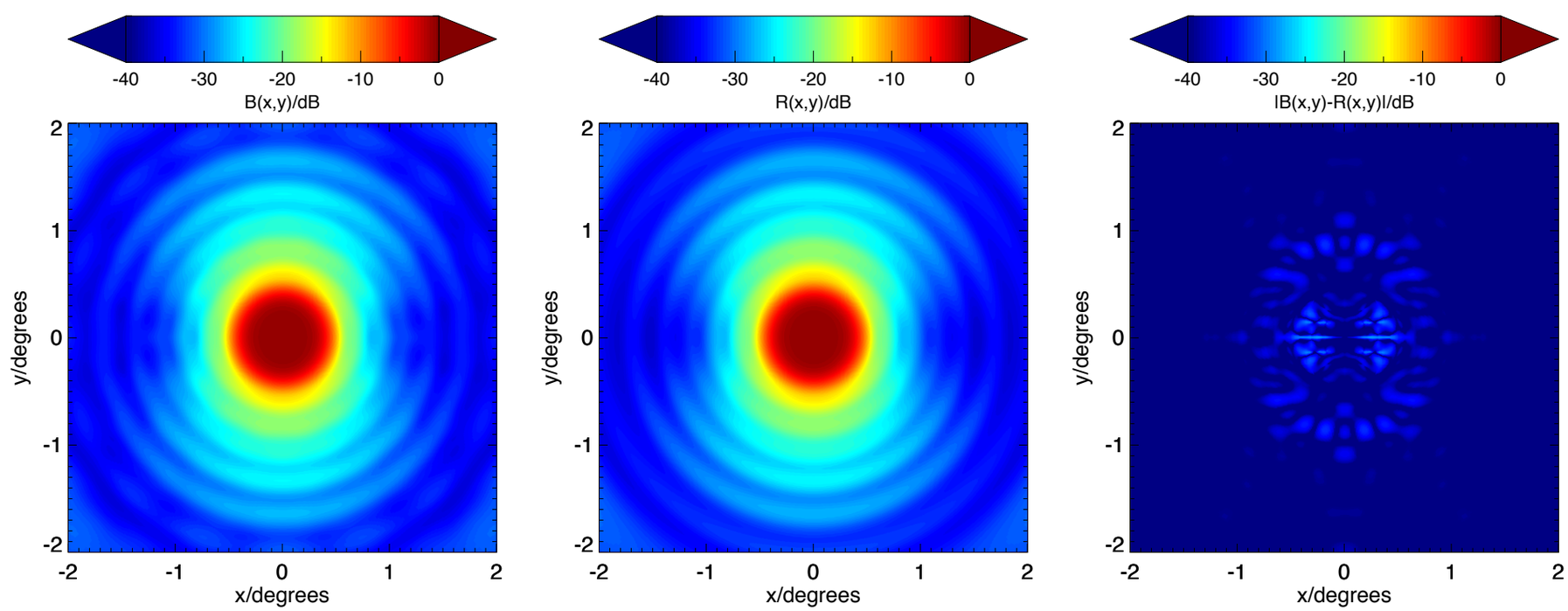
LSPE beam



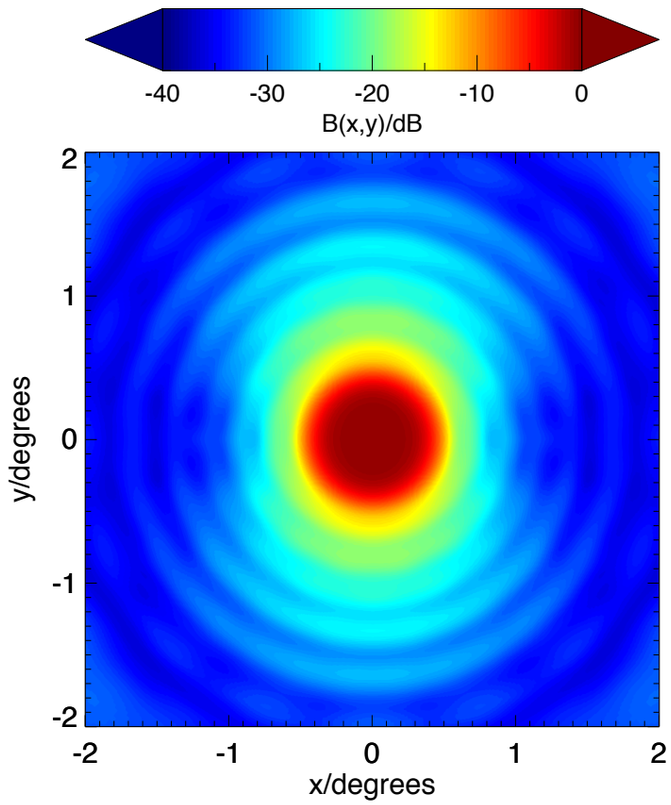
- 17 wave guide modes
- Each mode coupled to the bolometer
- maximum sensitivity
- Asymmetric beam

LSPE beam decomposition

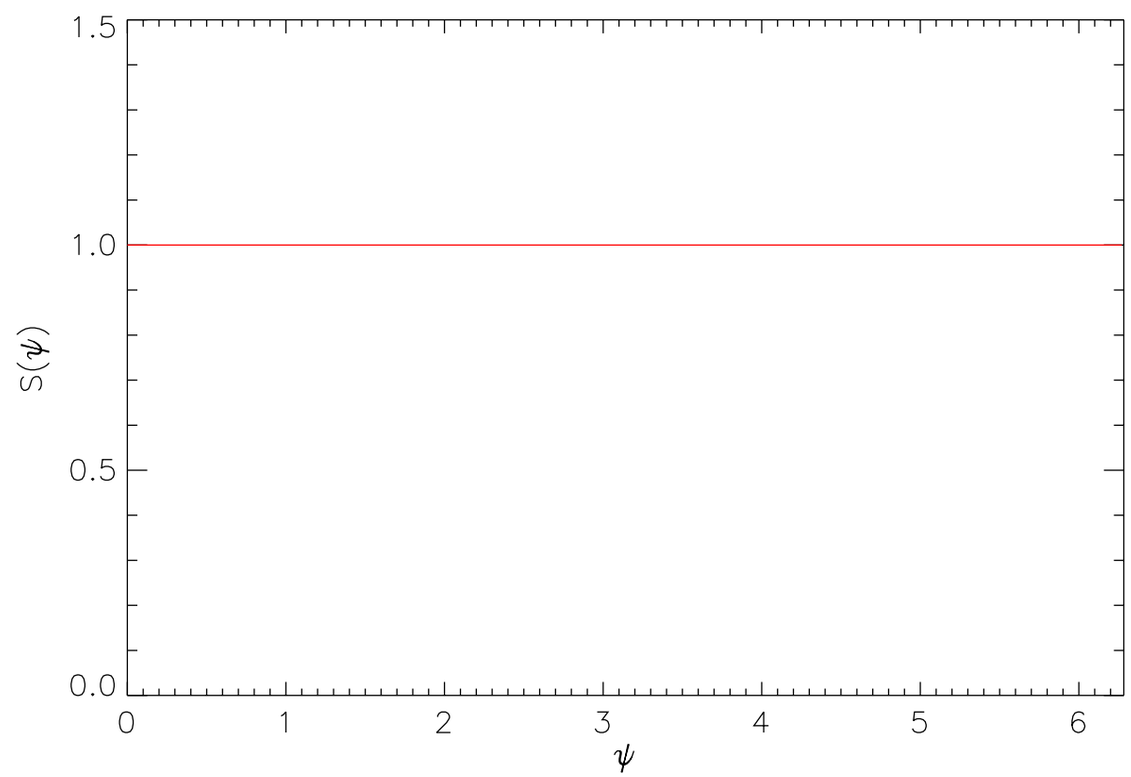
$$
\begin{aligned}
b_{0\ell k} &= \int d\Omega \, {}_0Y^*_{\ell k}(\Omega)\tilde{T}(\Omega) \\
b_{\pm 2\ell k} &= \int d\Omega \, {}_{\pm 2}Y^*_{\ell k}(\Omega)[\tilde{Q}(\Omega) \mp i\tilde{U}(\Omega)],
\end{aligned}
$$



Detected Signal Depends on Orientation



$$S(\psi) \quad = \quad a_0$$



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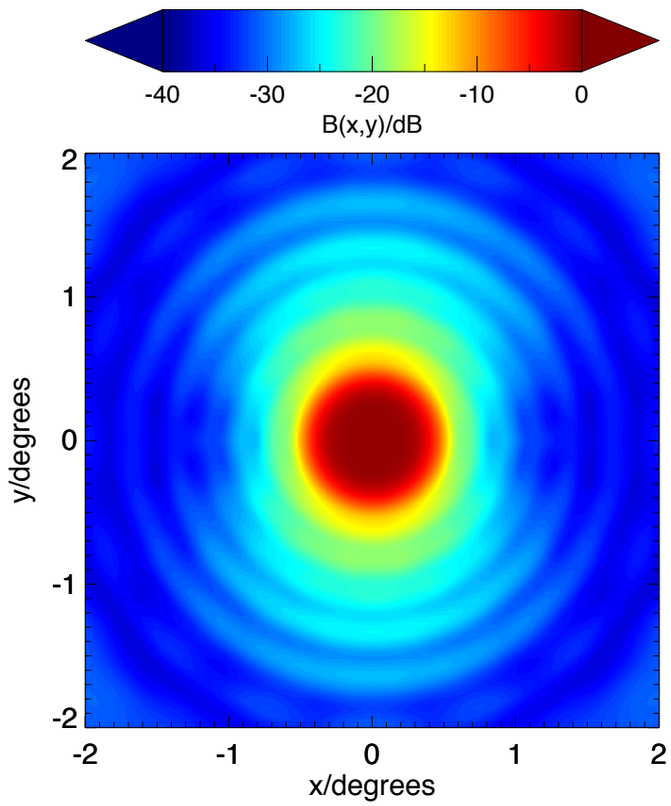
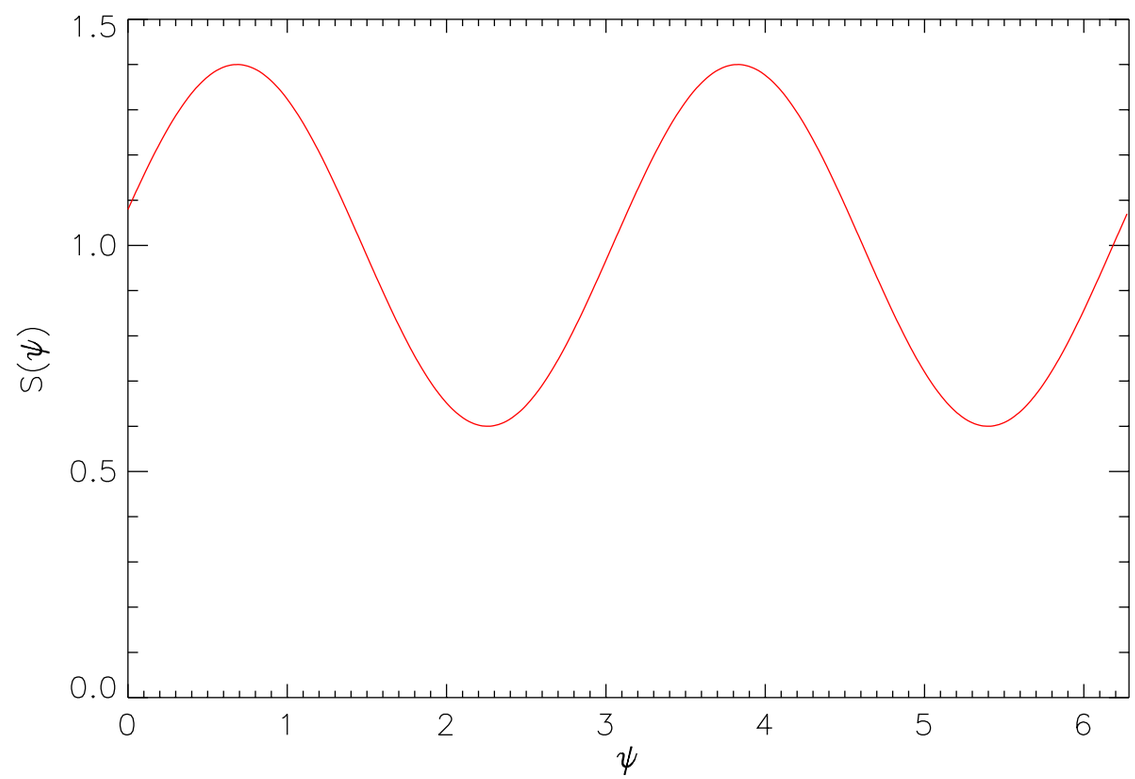
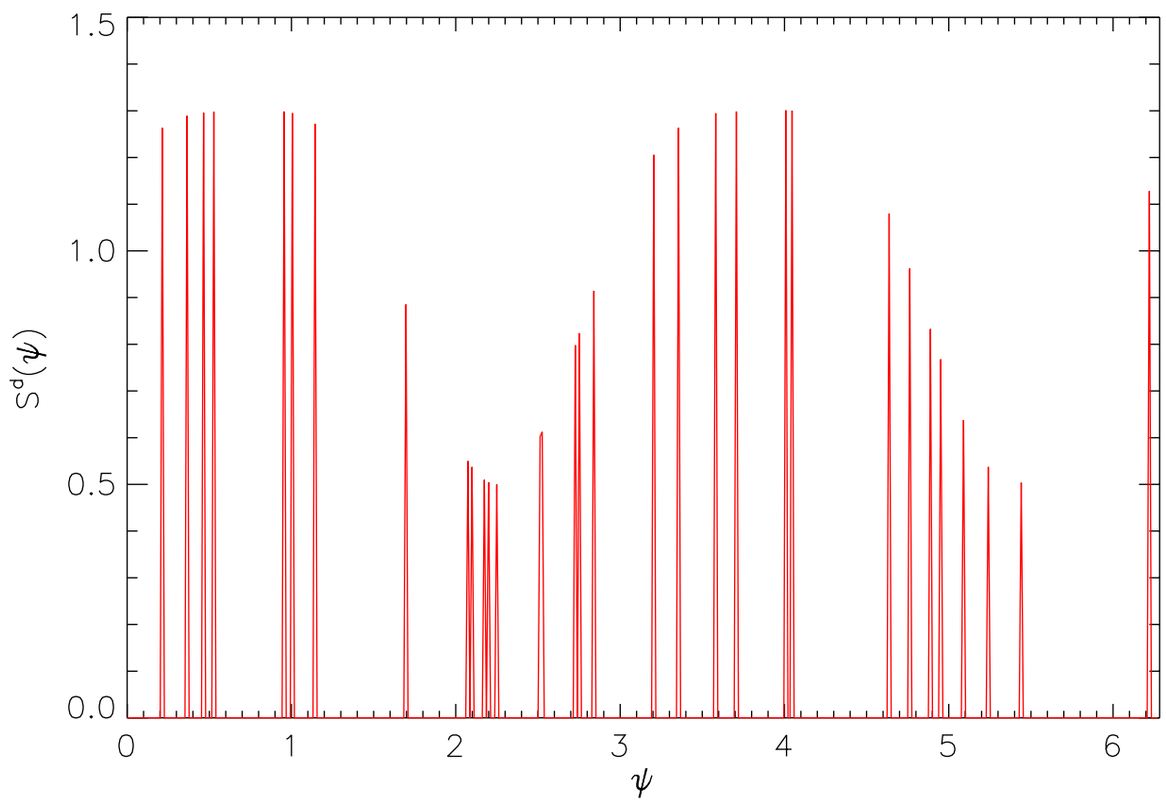


$$S(\psi) \quad = \quad a_0 + a_2 \cos(2\psi + \phi_2)$$



How we recover the temperature of the pixel



$$
\begin{aligned}
S^d(\psi) &= h(\psi)S(\psi) \\
\tilde{S}^d_k &= \sum_{k'=-\infty}^{\infty} H_{kk'}\tilde{S}_{k'}
\end{aligned}
$$

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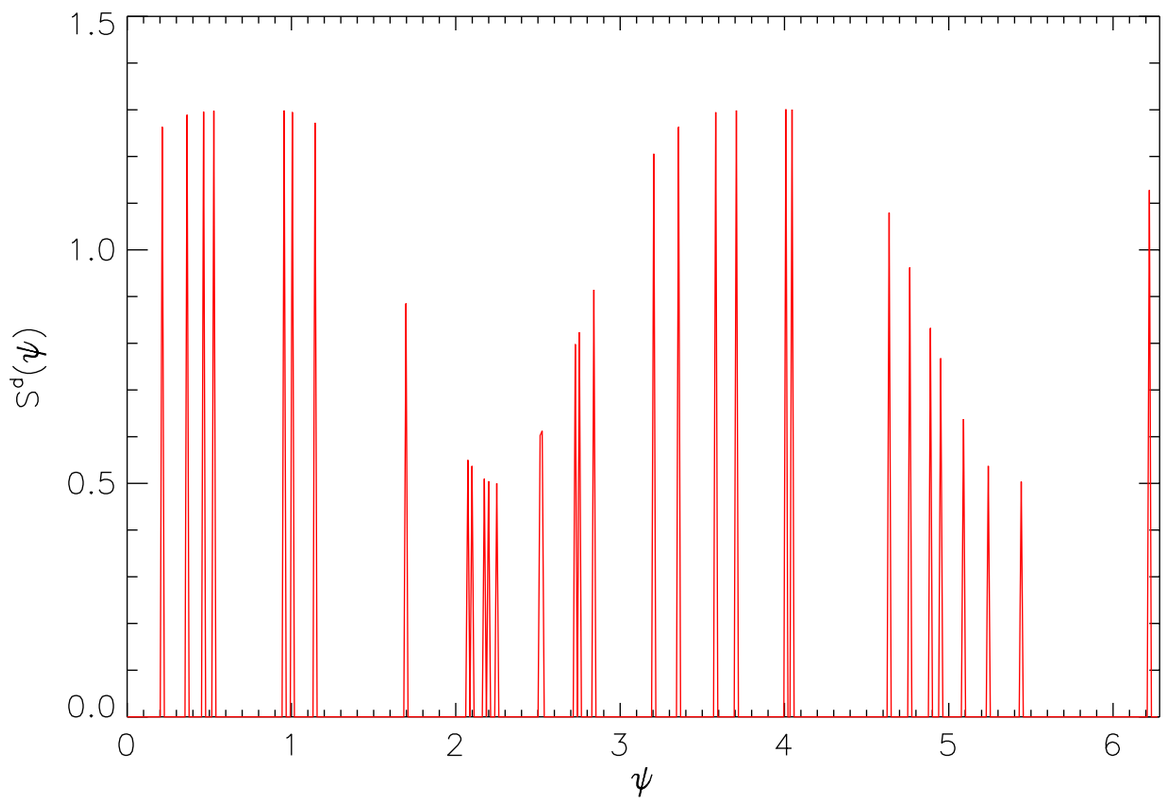

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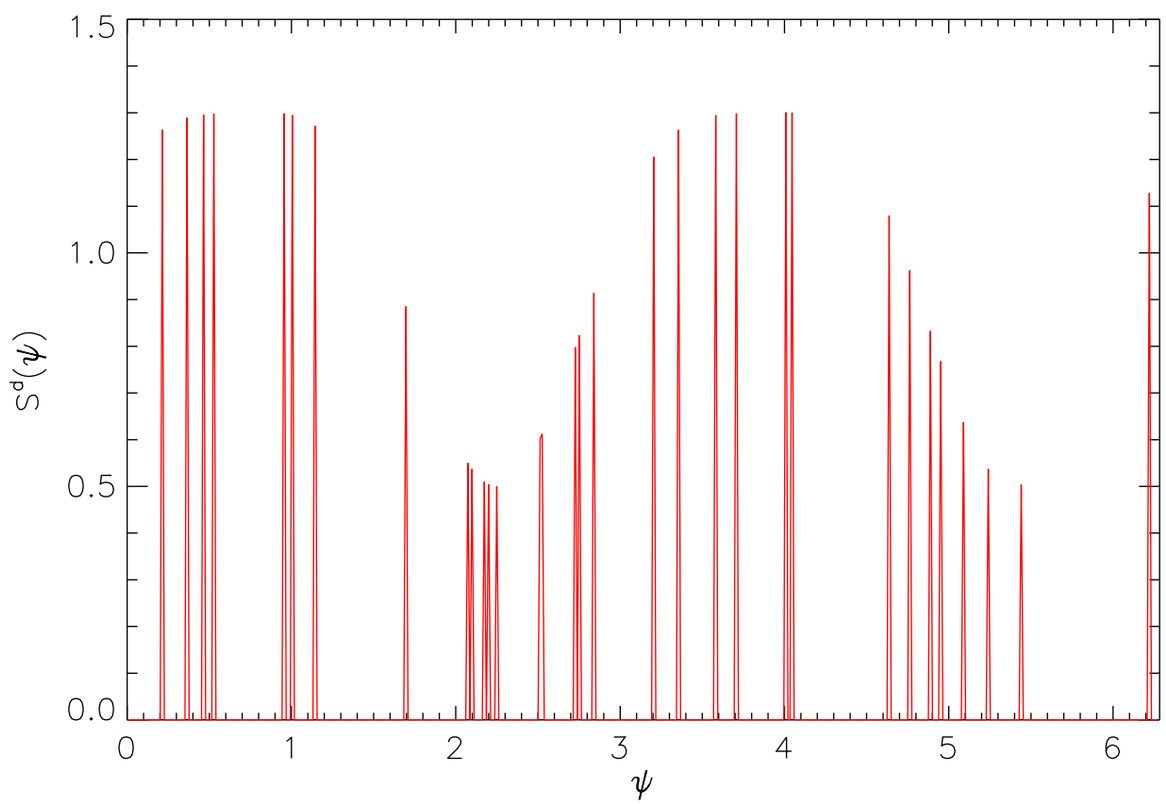

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TOD $\longrightarrow$ Map of sky smoothed with axisymmetric component of the beam

Test on simulations

- Elliptical Gaussian beam FWHM
  = 7 arcmin
- Ratio of axis = 1.5
- Experimental Probe for
  Inflationary Cosmology (EPIC)

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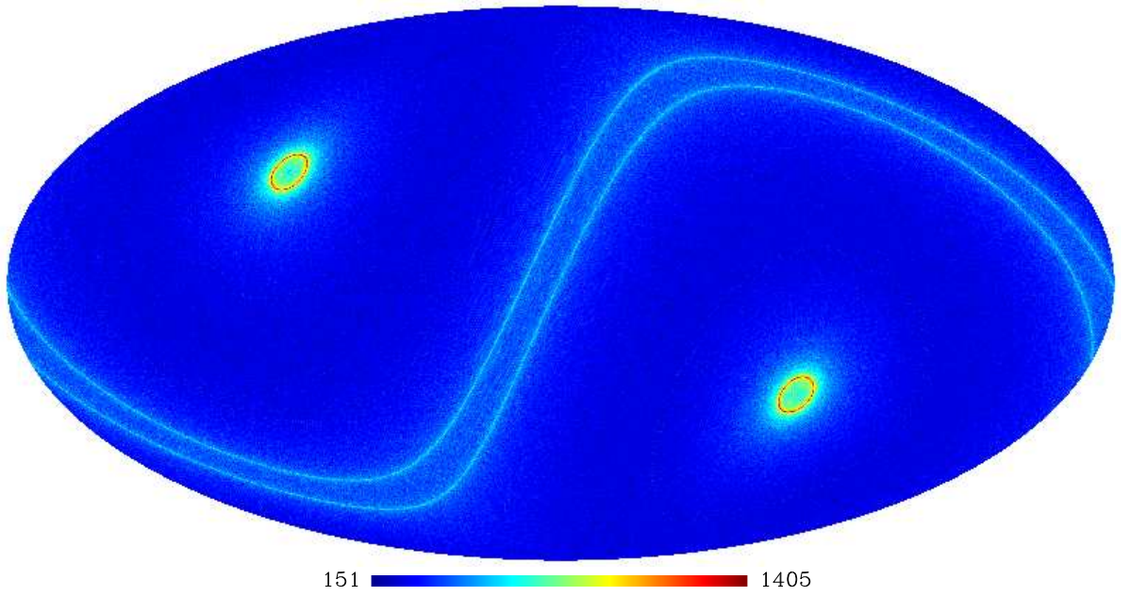

Test on simulations

TOD $\longrightarrow$ Map of sky smoothed with axisymmetric component of the beam

Test on simulations

TOD $\longrightarrow$ Map of sky smoothed with axisymmetric component of the beam

Power Spectrum $\longrightarrow$ Simulated CMB

Test on simulations

TOD → Map of sky smoothed with axisymmetric component of the beam

Power Spectrum → Simulated CMB

Simulated CMB → Smoothed map

Simulated CMB → TOD

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COMPARE → Smoothed map

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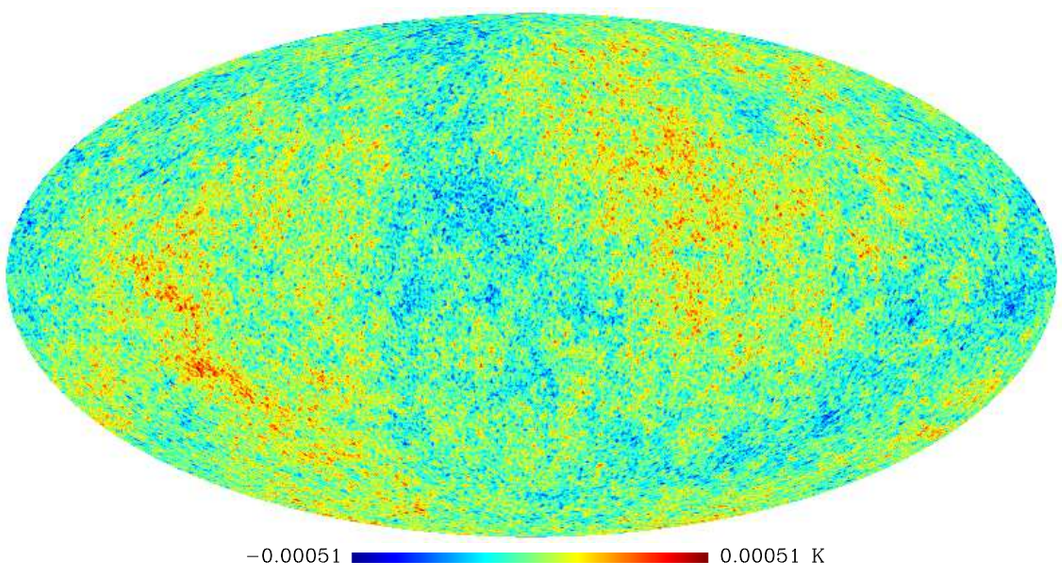
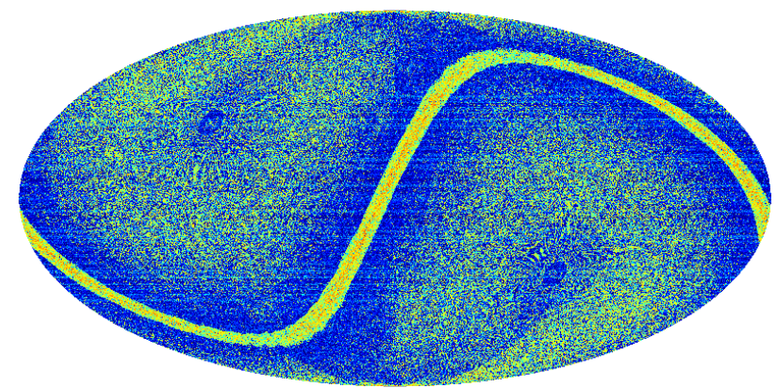
Test on simulations

smoothed CMB

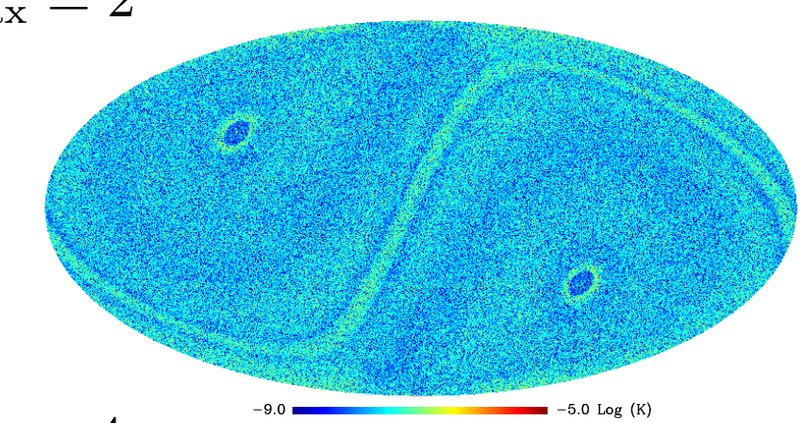


|map - smoothed CMB|

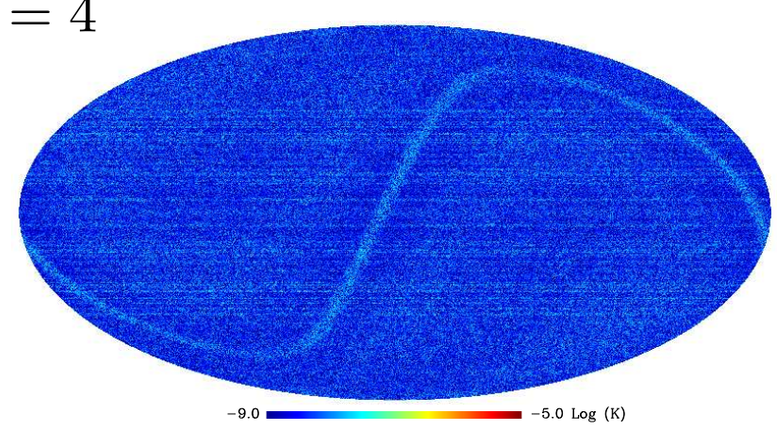
$k_{\max} = 0$



$k_{\max} = 2$



$k_{\max} = 4$



Summary

- New map making algorithm to create maps clean of asymmetry bias.
- For full description see Wallis et al. 2014 on the arXive 1401.2075