Foreground Component Separation for SPIDER's Primordial B-mode Constraint

Johanna Nagy

Washington University in St. Louis

On behalf of the SPIDER Collaboration

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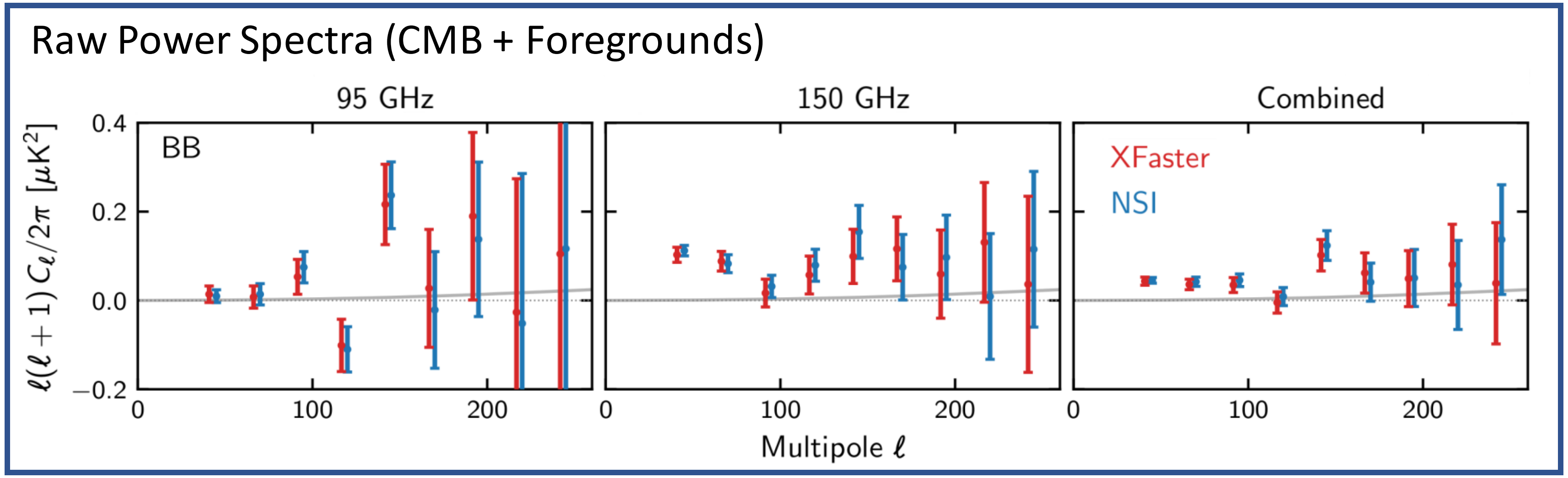
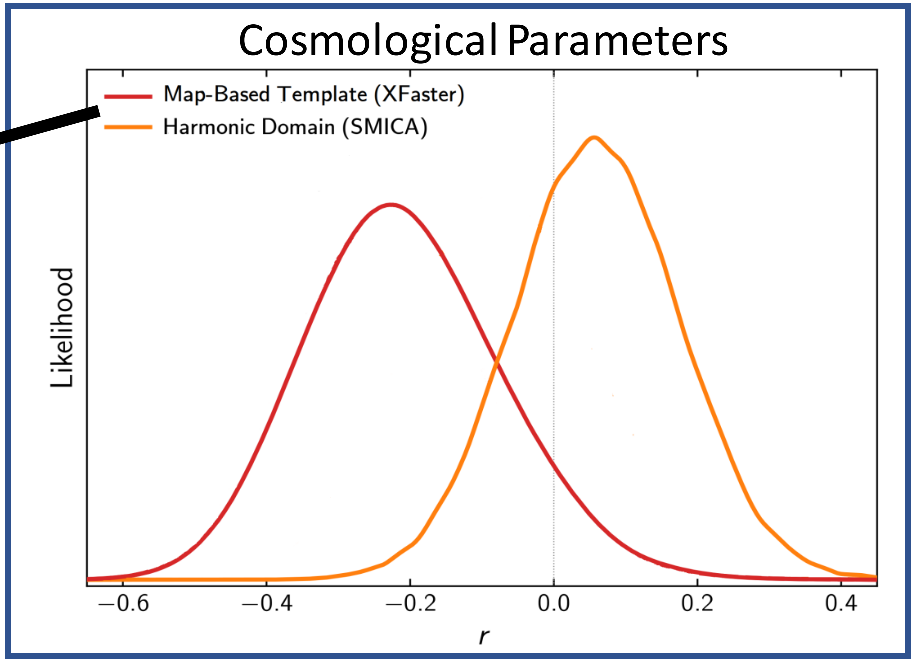
Motivation for Multiple Component Separation Techniques



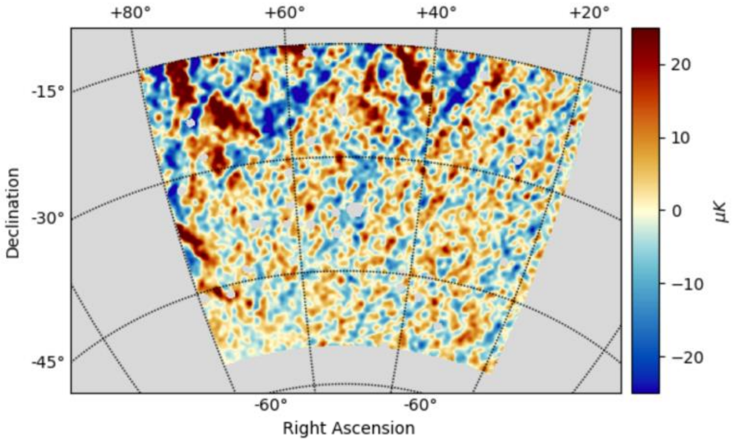


Different Component Separation Techniques Make Different Assumptions

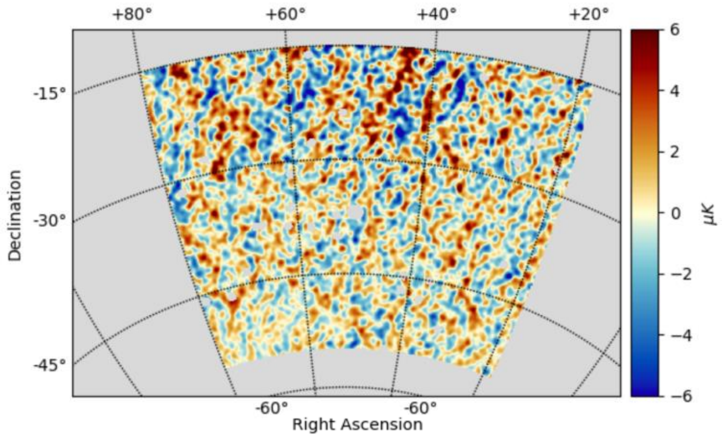
Template Subtraction Procedure

Use high frequency Planck maps as a template for the dust.

353-100 GHz U Template



217-100 GHz U Template



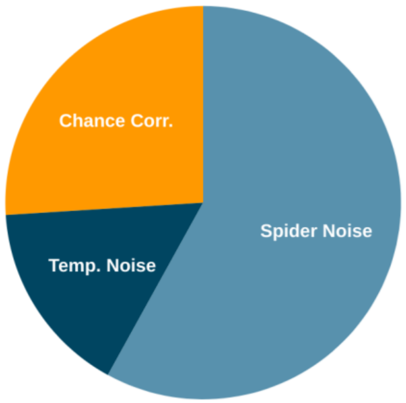
Generate clean maps for each Stokes parameter S

$$S_\nu^{\mathrm{cleaned}} = S_\nu - \alpha S_{\nu_0}^{\mathrm{t}}$$

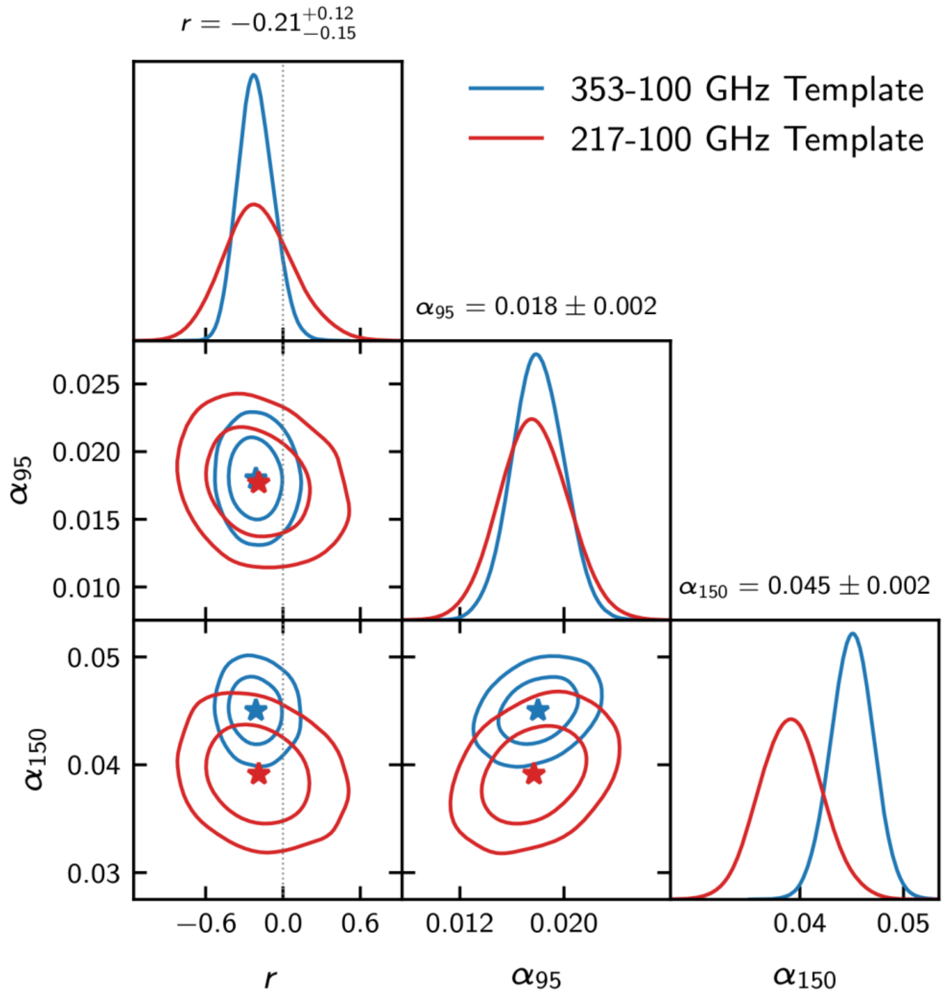
Find the template scaling factor α that minimizes the amplitude of the EE and BB power spectra.

Template Subtraction Results

- 353 and 217 templates give consistent r likelihoods
- Error breakdown for α_{150} from 353 template



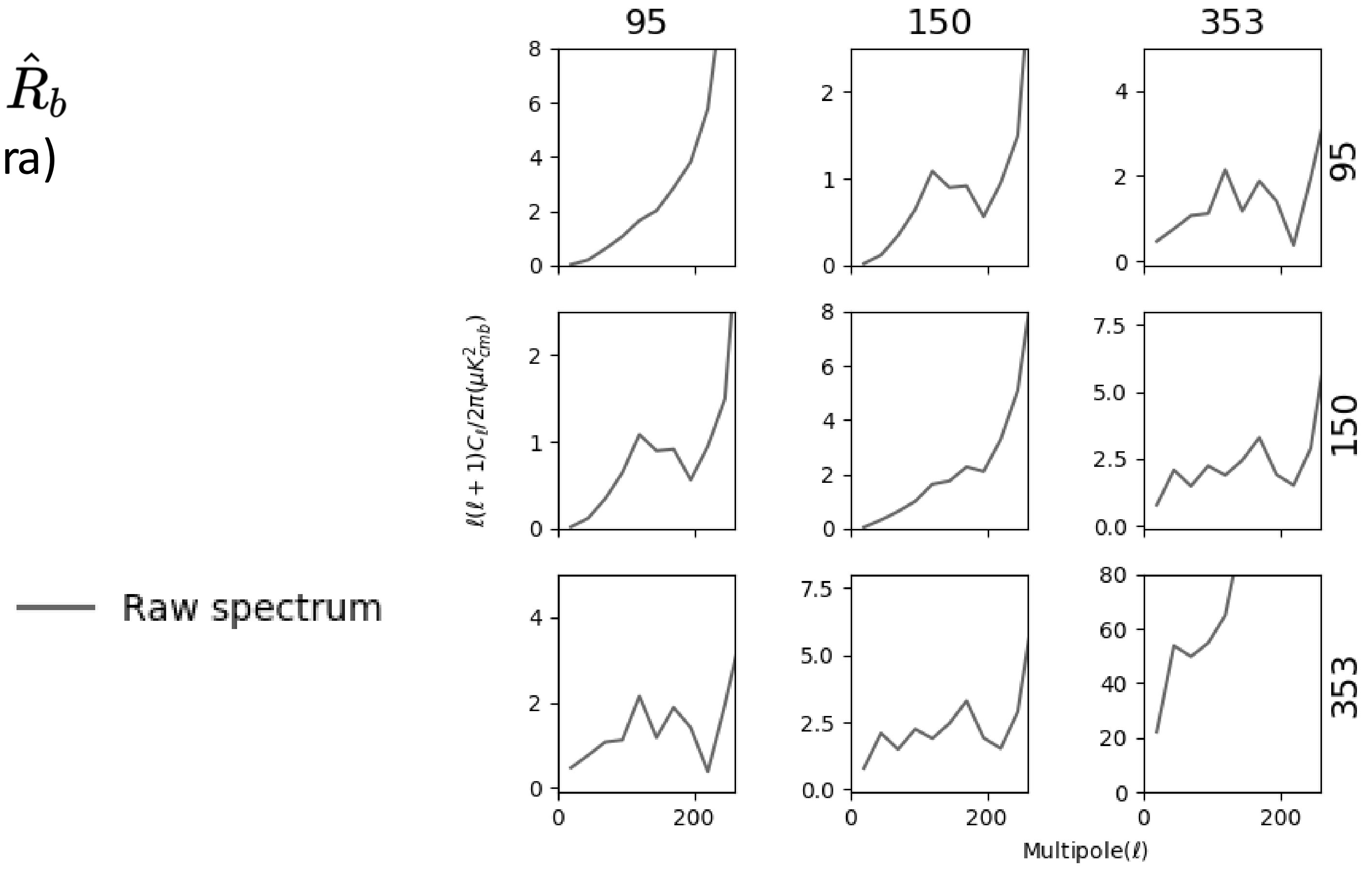
- Explicit assumptions
  - Dust scales linearly from high frequencies
  - No spatial scaling variation (f_{sky} = 4.8%)
  - Template accurately represents the true dust



Using XFaster pipeline, 2104.01172

SMICA Procedure
(Spectral Matching Independent Component Analysis)

- Compute a spectral covariance matrix $\hat{R}_b$ from N input maps (all EE and BB spectra)



Simplified Example, EE only

SMICA Procedure

(Spectral Matching Independent Component Analysis)

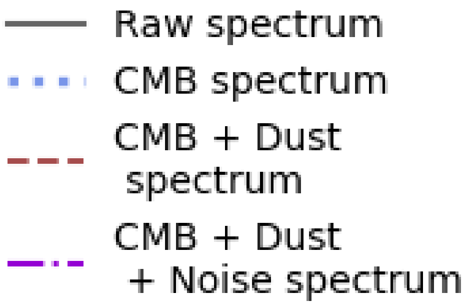
- Compute a spectral covariance matrix $\hat{R}_b$ from N input maps (all EE and BB spectra)
- Fit the model

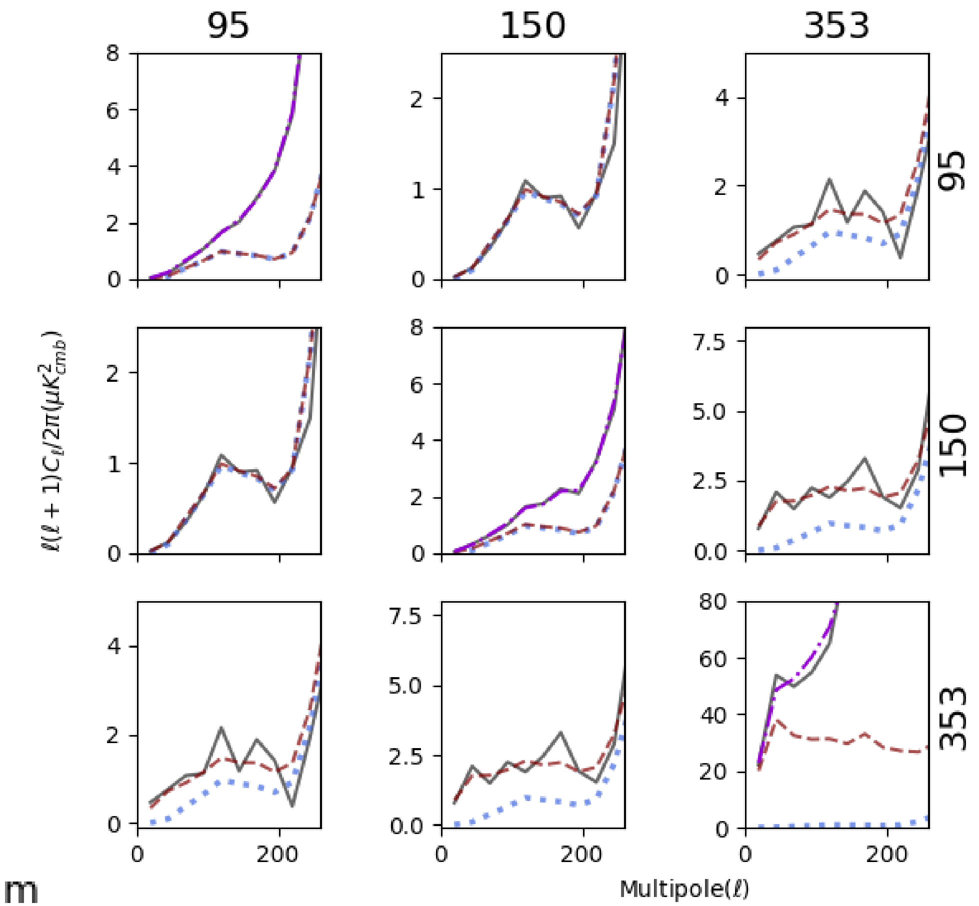
Transfer Matrix

$$\tilde{R}_b(\theta) = \underbrace{\tilde{N}_b}_{\textbf{Noise}} + \sum_{b'} J_{b,b'} \left[\underbrace{f_{b'} P_{b'} f_{b'}^T}_{\textbf{Dust}} + \underbrace{C_{b'}}_{\textbf{CMB}} \right]$$

- Dust model is a modified blackbody

$$\mathbf{f} \sim \left(\frac{\nu}{\nu_0}\right)^{\beta_\mathrm{d}} \left(\frac{\mathbf{B}(\nu, \mathbf{T})}{\mathbf{B}(\nu_0, \mathbf{T})}\right)$$

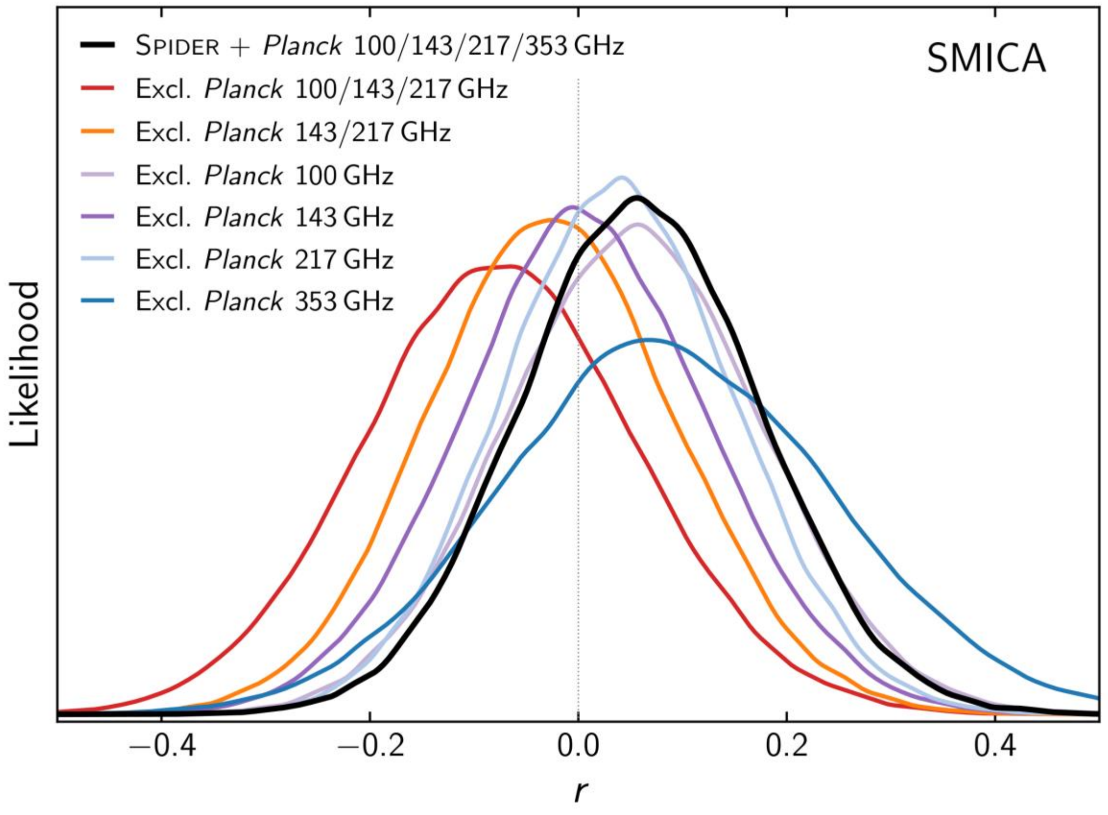




Simplified Example, EE only

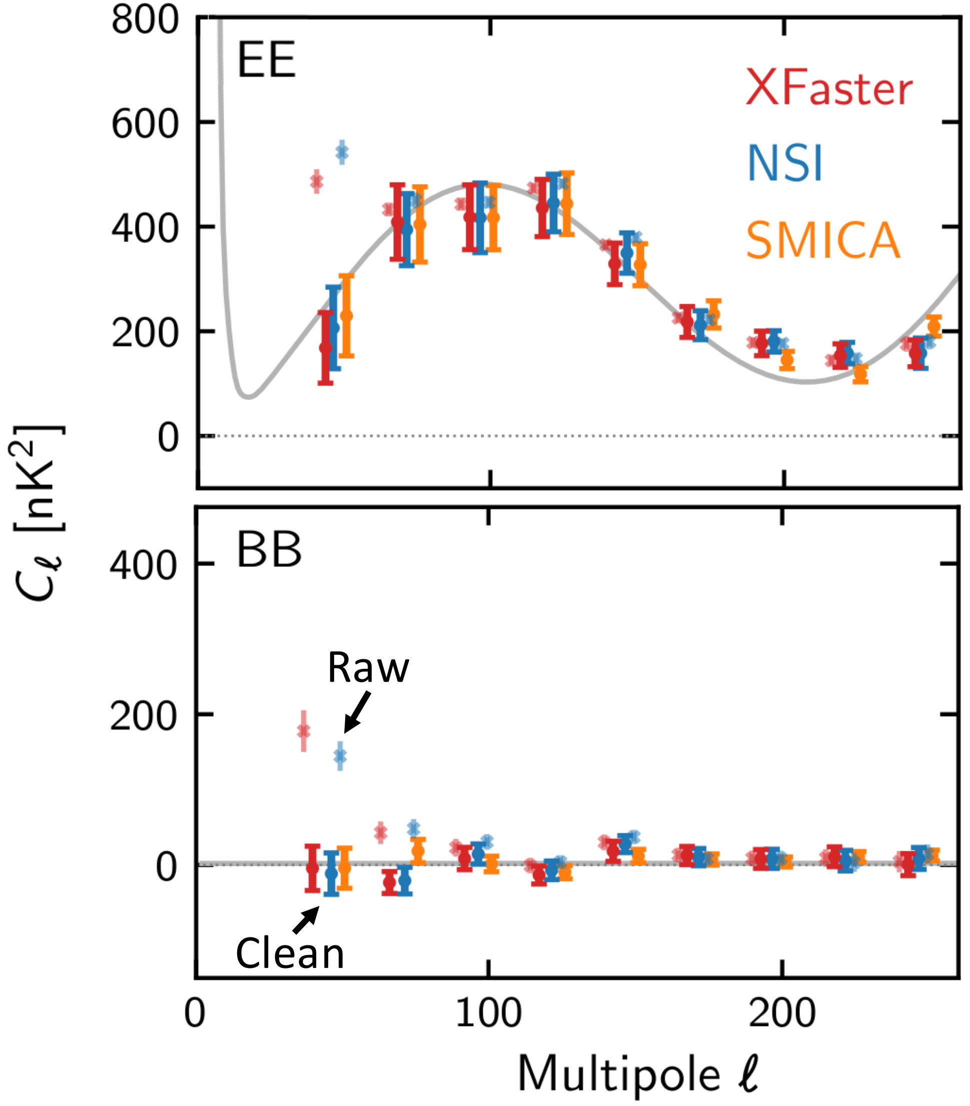
SMICA Results

- Explore how different information impacts r likelihood
- Some degeneracy between dust and noise due to similar spectral shape
  - Negligible effect on CMB component
- Explicit assumptions
  - Dust is a modified blackbody
  - Index is scale independent
  - Same index in EE and BB



Comparing the Methods

Power Spectra

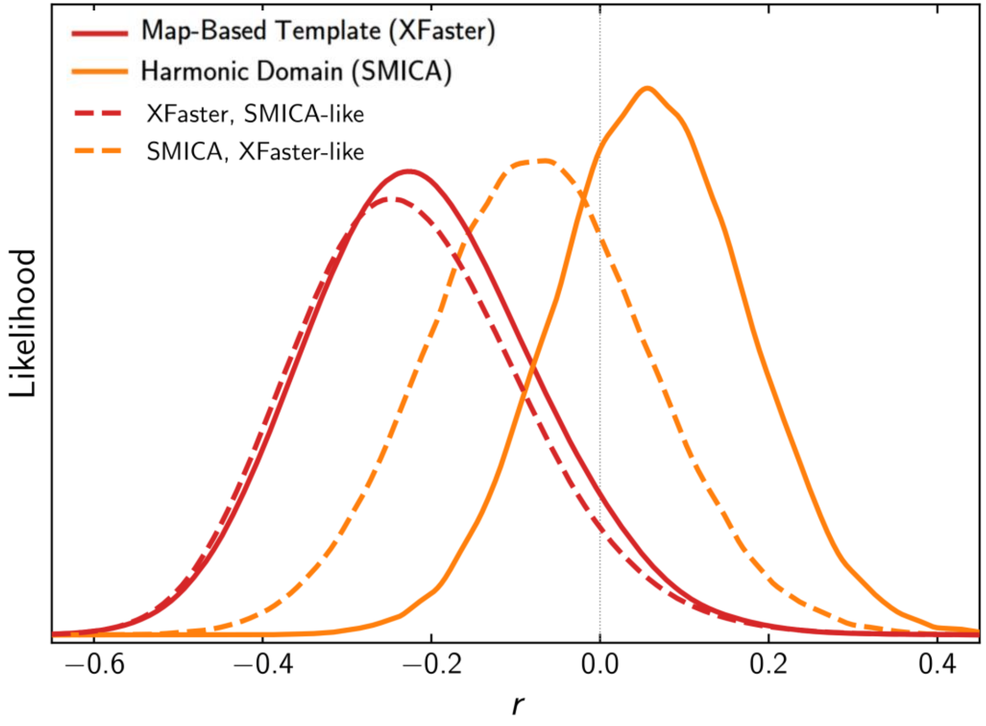


Inferred Dust Spectral Index

Measurement	β_d (95, 150 GHz)
Planck	1.53 ± 0.02
SPIDER, 353 Temp.	$1.49\pm^{0.07}_{0.09}$, 1.52 ± 0.05
SPIDER, 217 Temp.	$1.51\pm^{0.10}_{0.12}$, $1.68\pm^{0.08}_{0.09}$
SPIDER, SMICA	1.43± 0.04, 1.50± 0.04

FFP10, Auto-Cross

Cosmological Parameter Estimation



Conclusions

- Mutiple component separation techniques with different underlying assumptions provide a valuable check on cosmological results
- Can be applied to both Galactic dust and synchrotron
- SPIDER found good agreement between both methods, but more sensitive measurements may reveal where assumptions break down