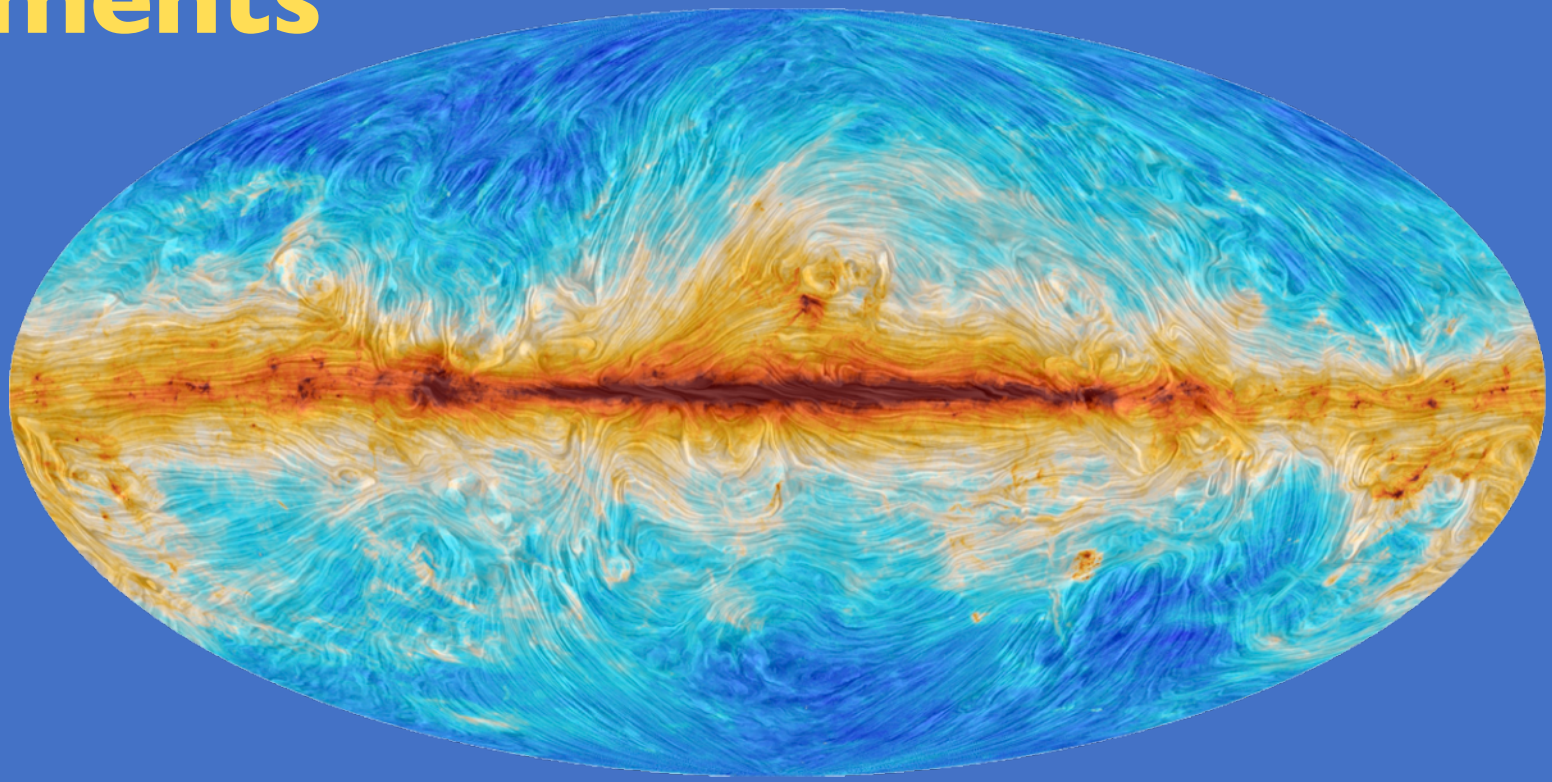
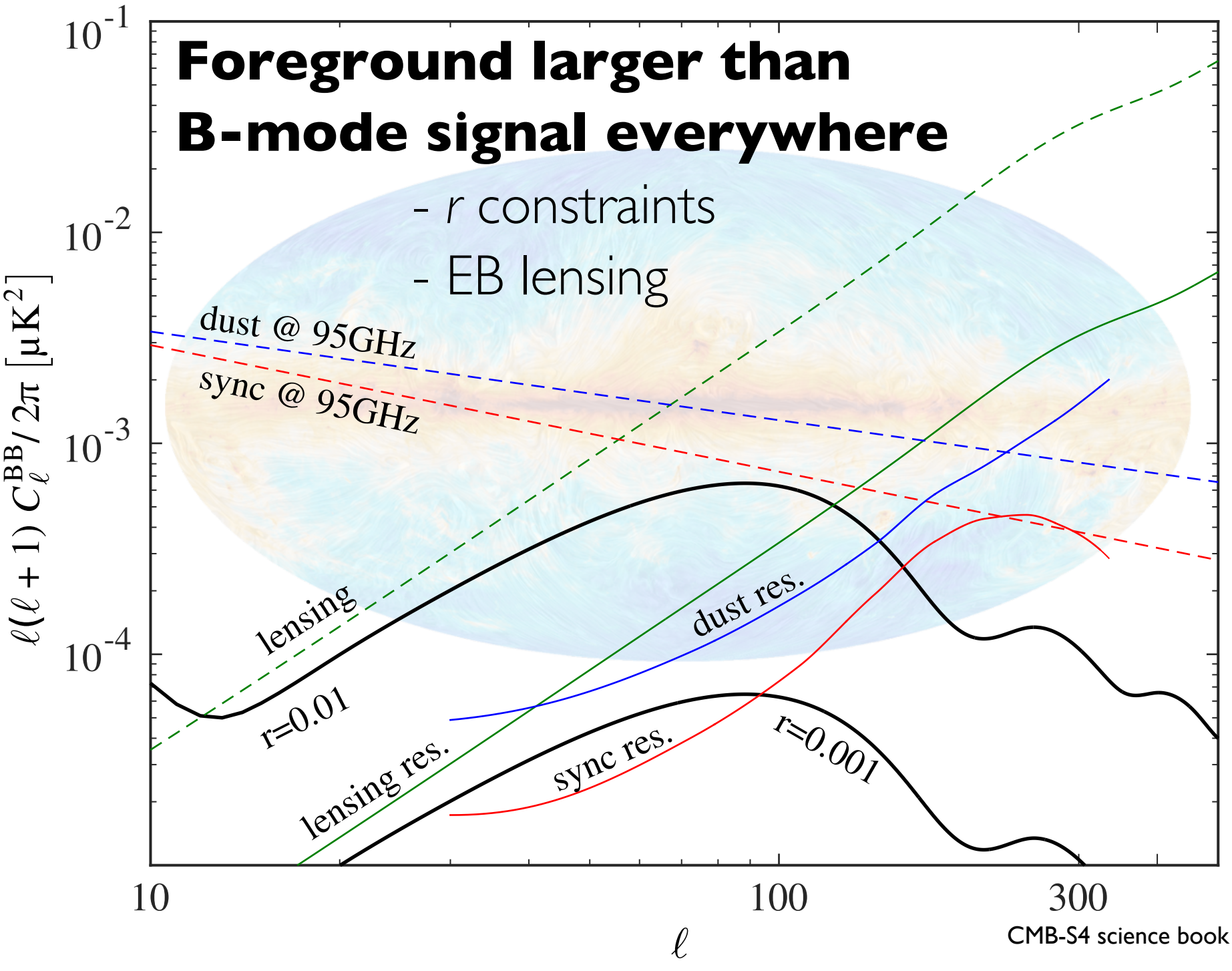
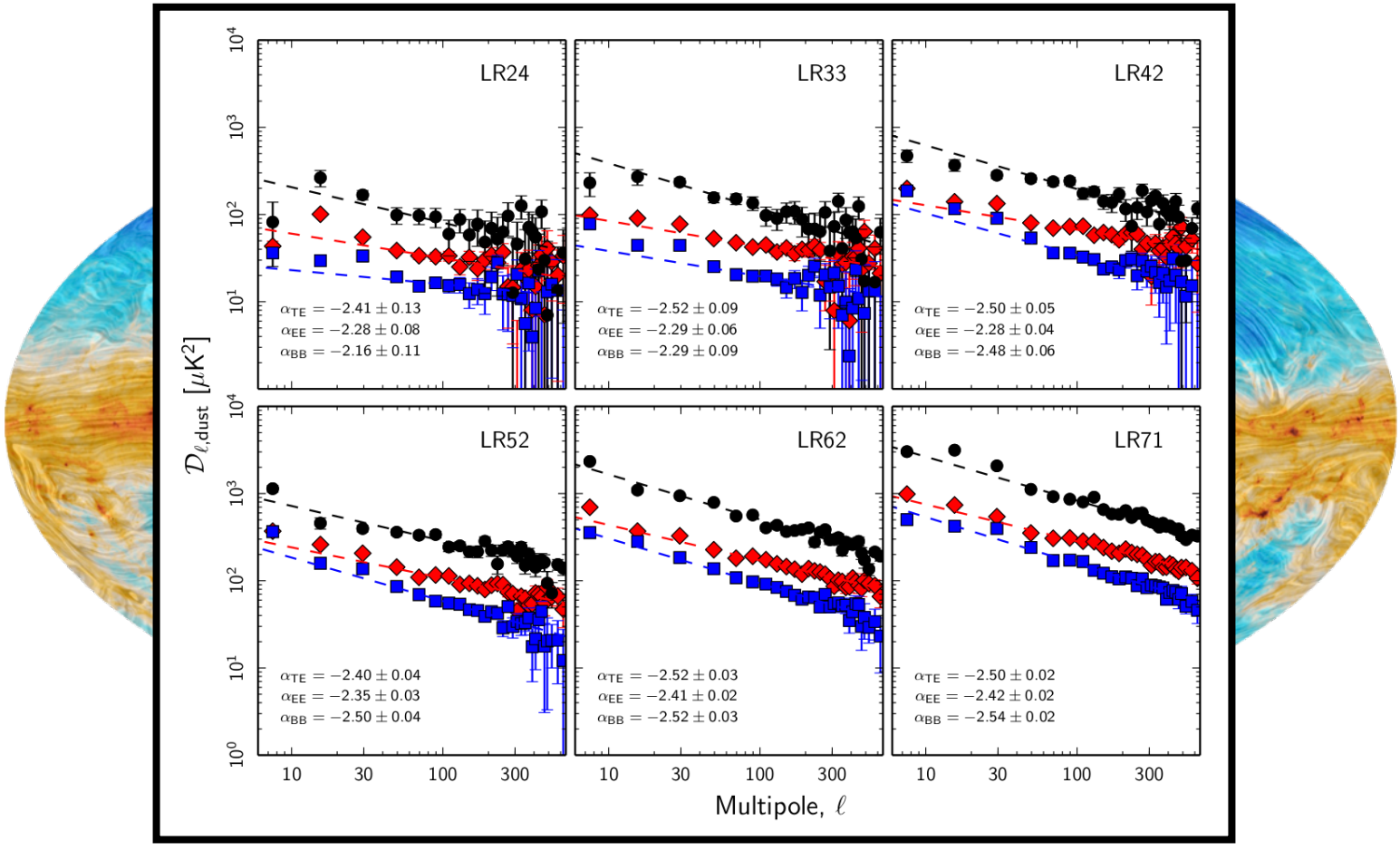
The power spectra of polarized filaments



Kevin M. Huffenberger (FSU)
Aditya Rotti (Manchester)
David C. Collins (FSU)


Foreground larger than
B-mode signal everywhere
- r constraints
- EB lensing
dust @ 95GHz
sync @ 95GHz
lensing
r=0.01
lensing res.
dust res.
sync res.
r=0.001
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$\ell(\ell+1)\,C_\ell^{BB}/2\pi\ [\mu K^2]$
10
100
300
ℓ
CMB-S4 science book

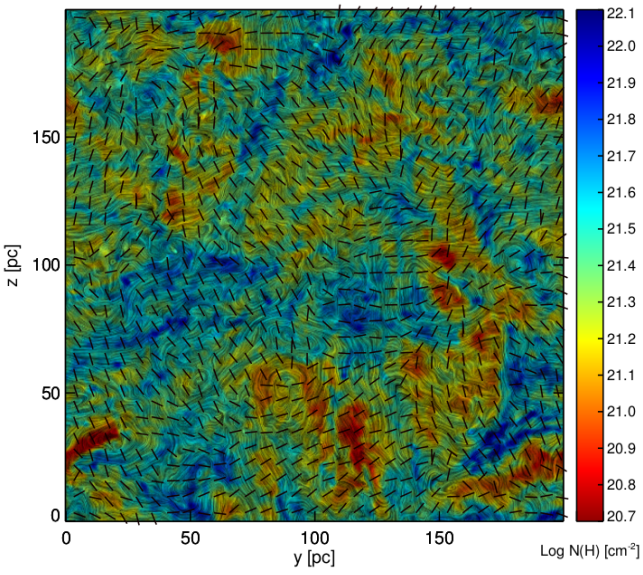
Dust power spectrum properties

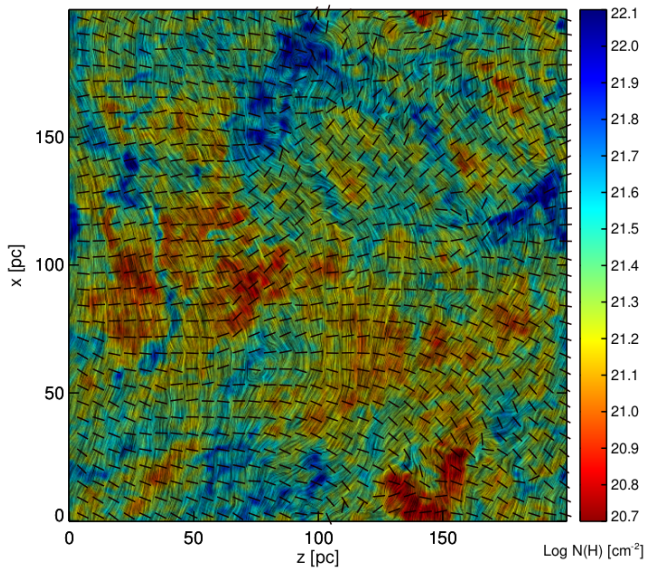


$C_l^{BB} \propto l^{-2.42}$ $\quad C_l^{BB} / C_l^{EE} = 0.5$ $\quad r^{TE} = 0.36$

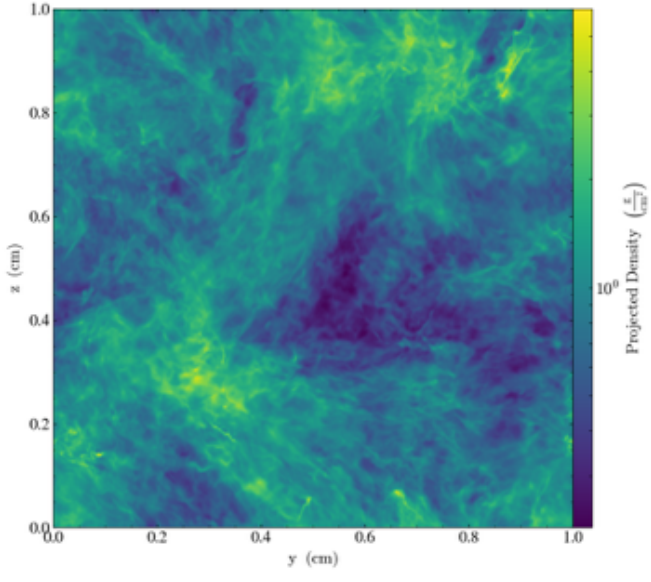
Planck 2016, 2018

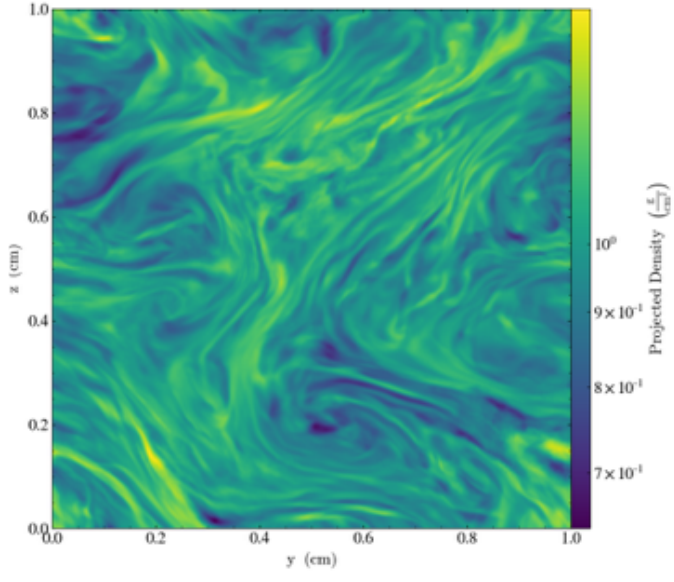
MHD simulations





Kritsuk et al 2017

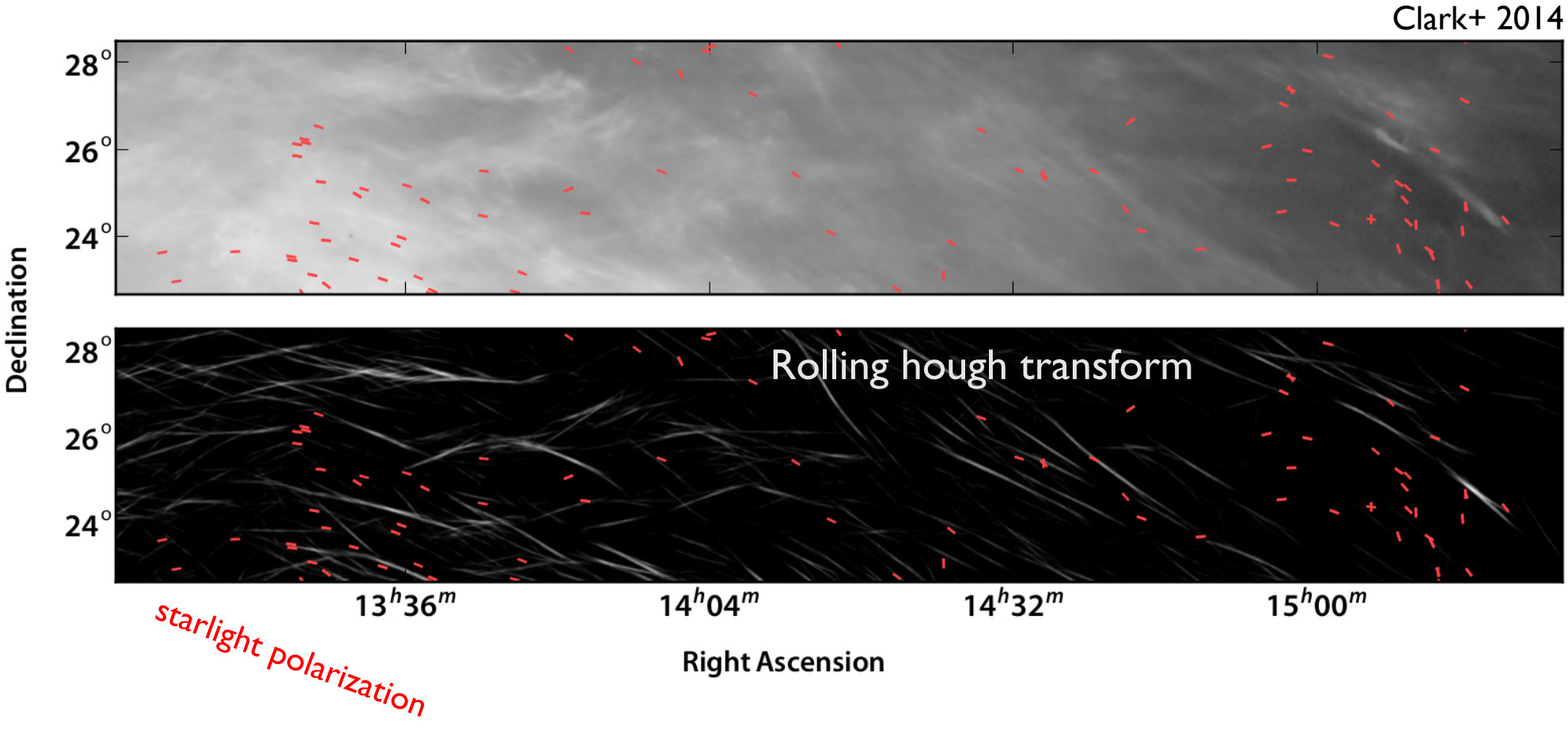




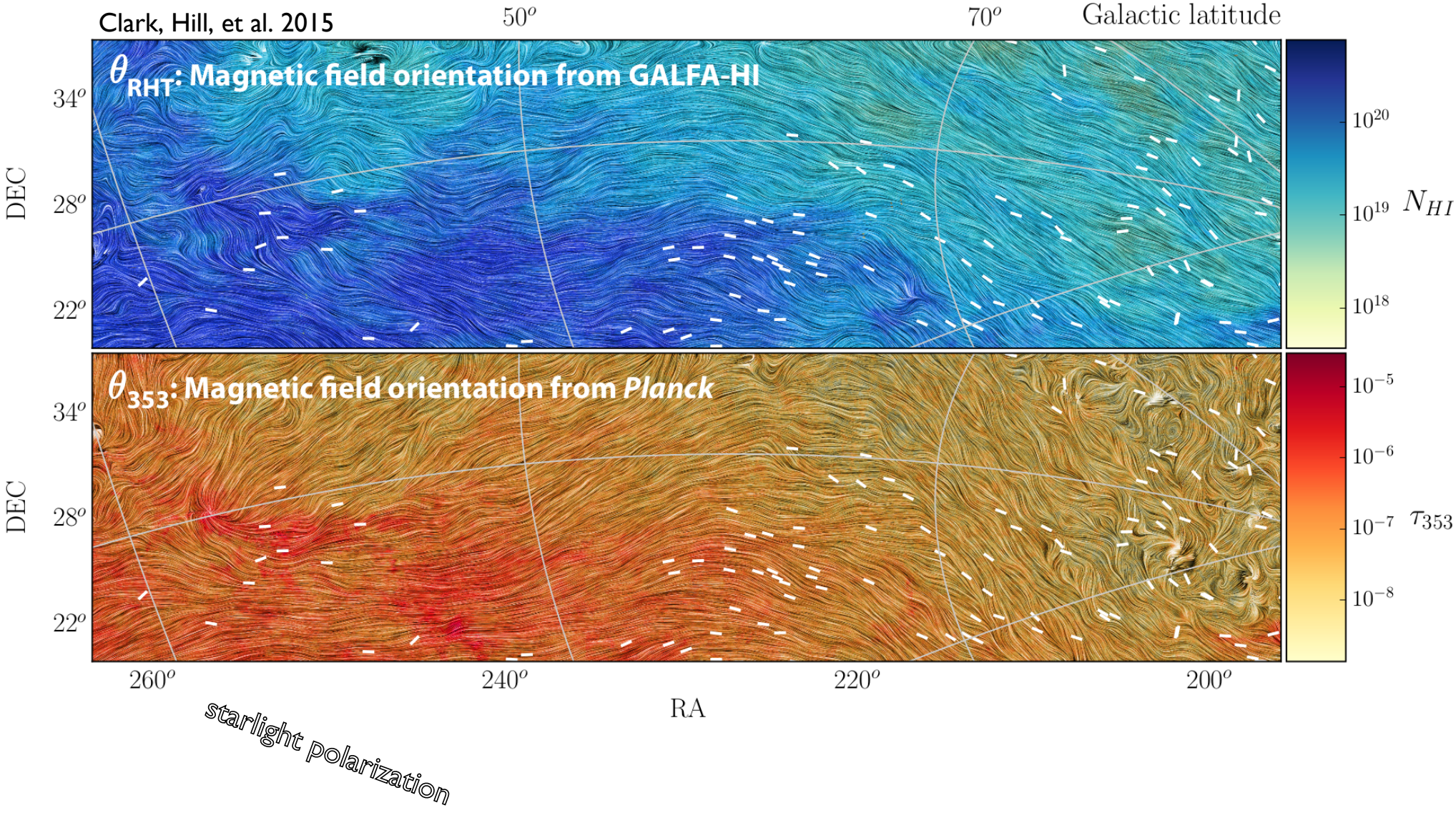
David Collins

Can we gain insight with simpler models?

Fibers in neutral hydrogen

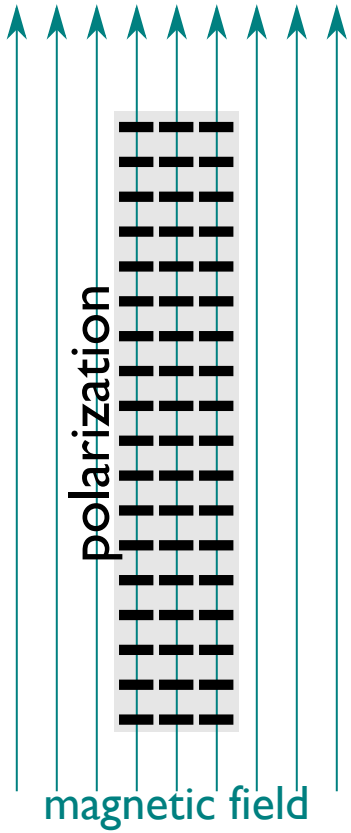


Filament orientation correlates to Planck dust polarization



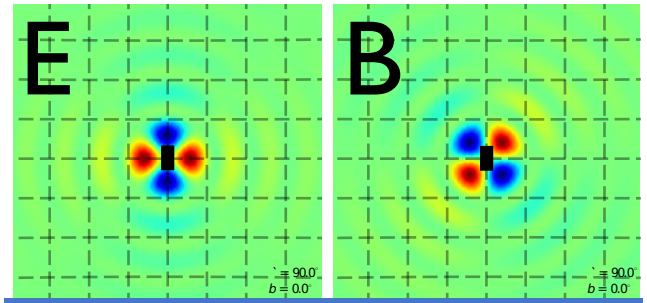
If the foreground was all filaments, what properties reproduce the power spectra?

Polarization of magnetized filament

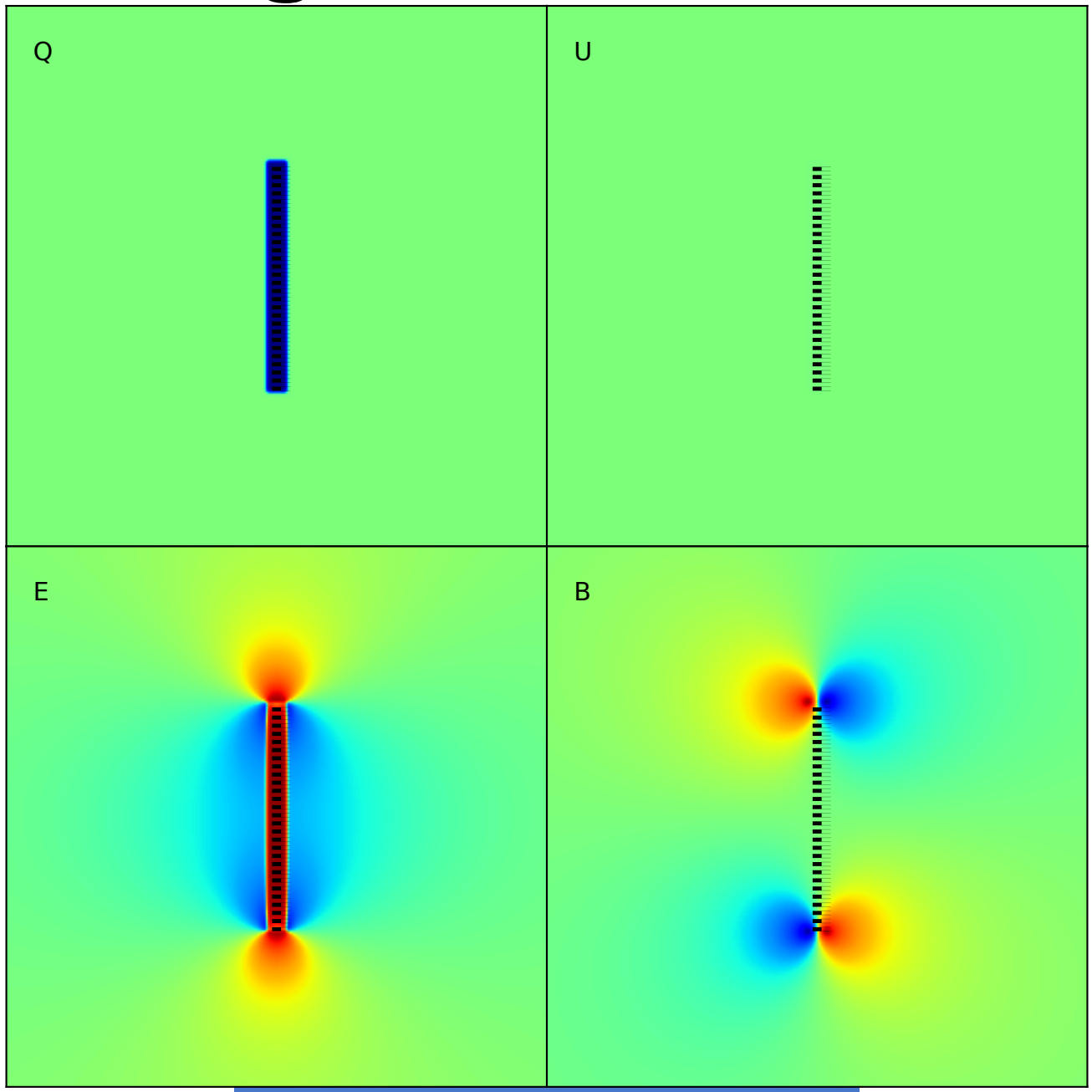


Rotti & Huffenberger

arxiv:1807.11940

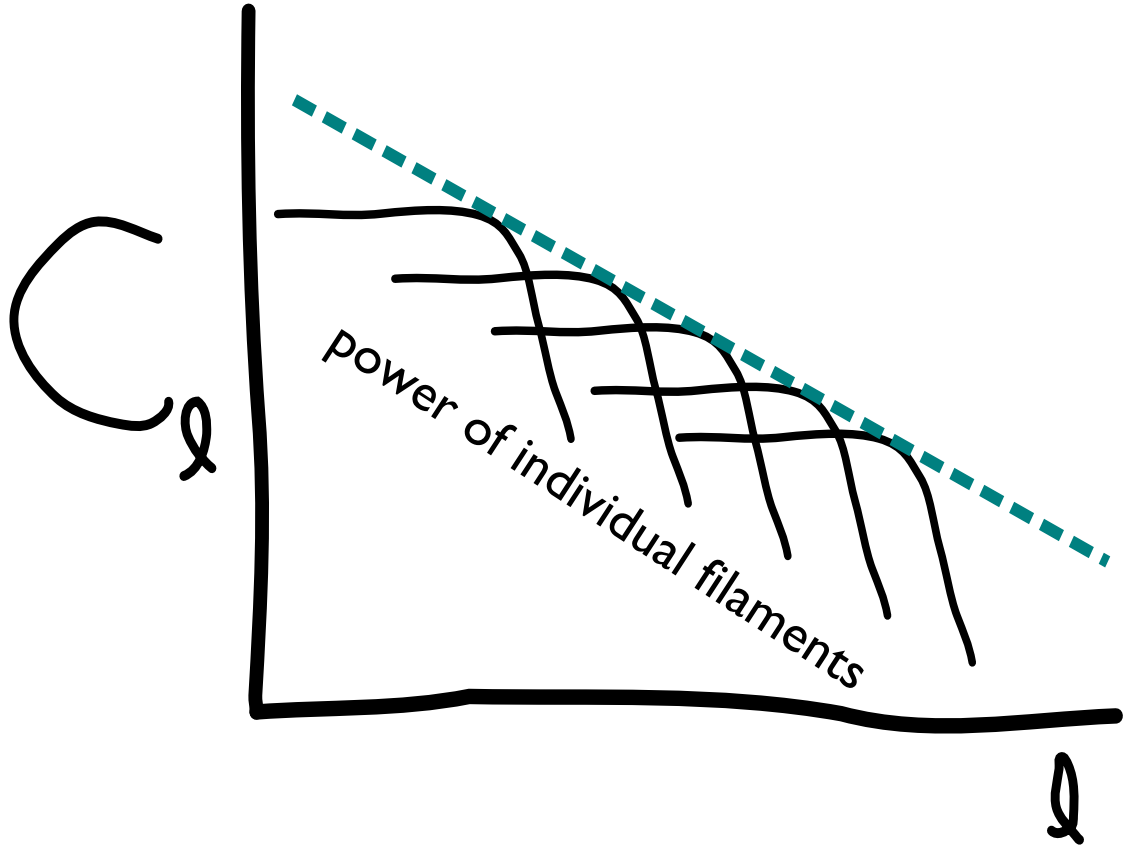


Green's Function pol→EB



Polarized Filament

Filament (halo) model



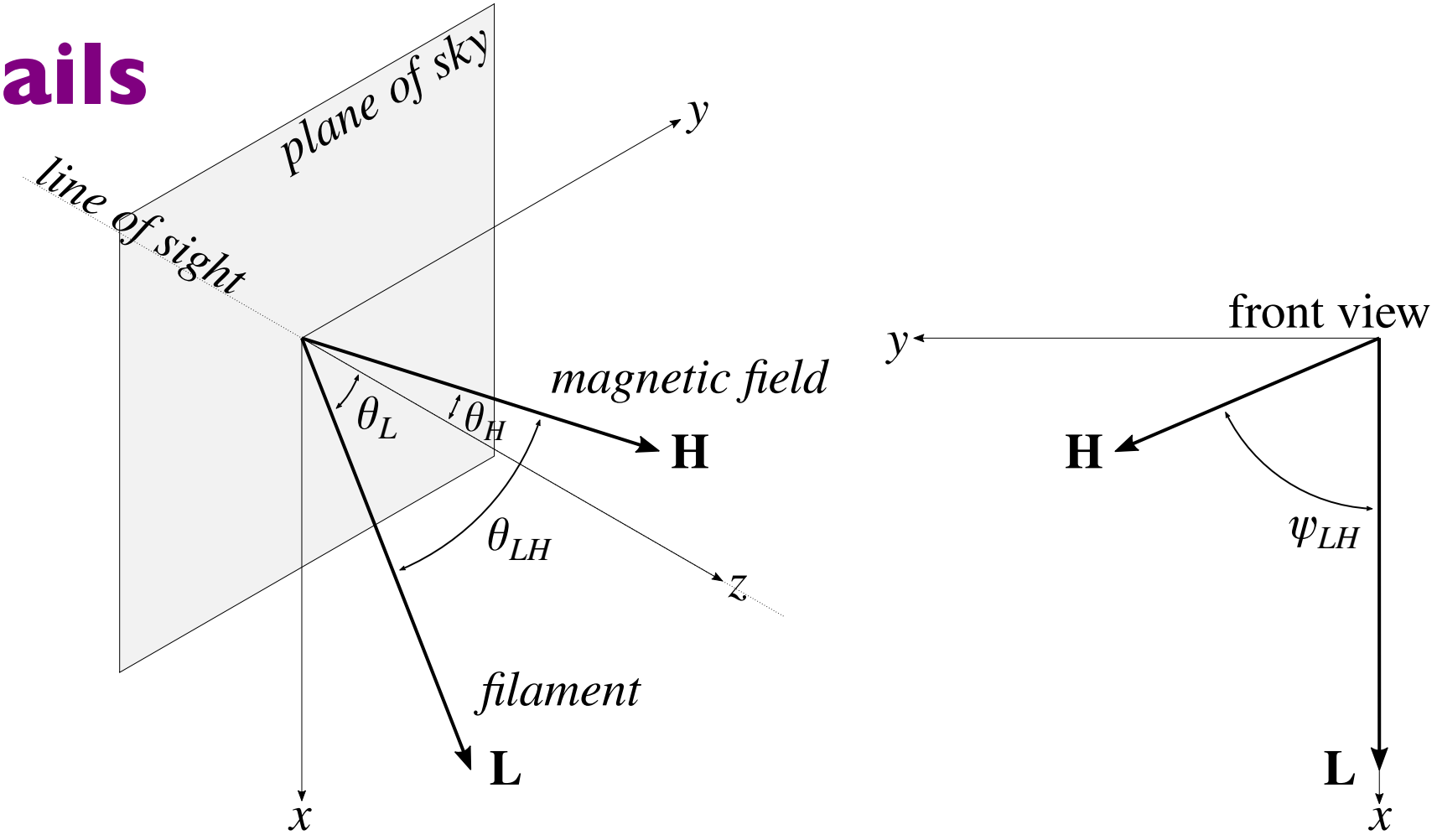
$$C_\ell^{EE} = \frac{1}{2\pi} \int d\phi_\ell \int d\alpha \; n(\alpha) \; |E(\boldsymbol{\ell}, \alpha)|^2,$$

$$C_\ell^{BB} = \frac{1}{2\pi} \int d\phi_\ell \int d\alpha \; n(\alpha) \; |B(\boldsymbol{\ell}, \alpha)|^2,$$

$$C_\ell^{TE} = \frac{1}{2\pi} \int d\phi_\ell \int d\alpha \; n(\alpha) \; T(\boldsymbol{\ell}, \alpha) E(\boldsymbol{\ell}, \alpha)^*$$

integrate over population of filaments

Details



- Filaments in all orientations
  - Column density
  - Polarization fraction
- Magnetic field angular separation (Gaussian)

Slope scaling relation

$$C_\ell = \int d\alpha_0 \; n(\alpha_0)\alpha_0^q F(\alpha_0^r \ell)$$

$$n(\alpha_0) \propto \alpha_0^p$$

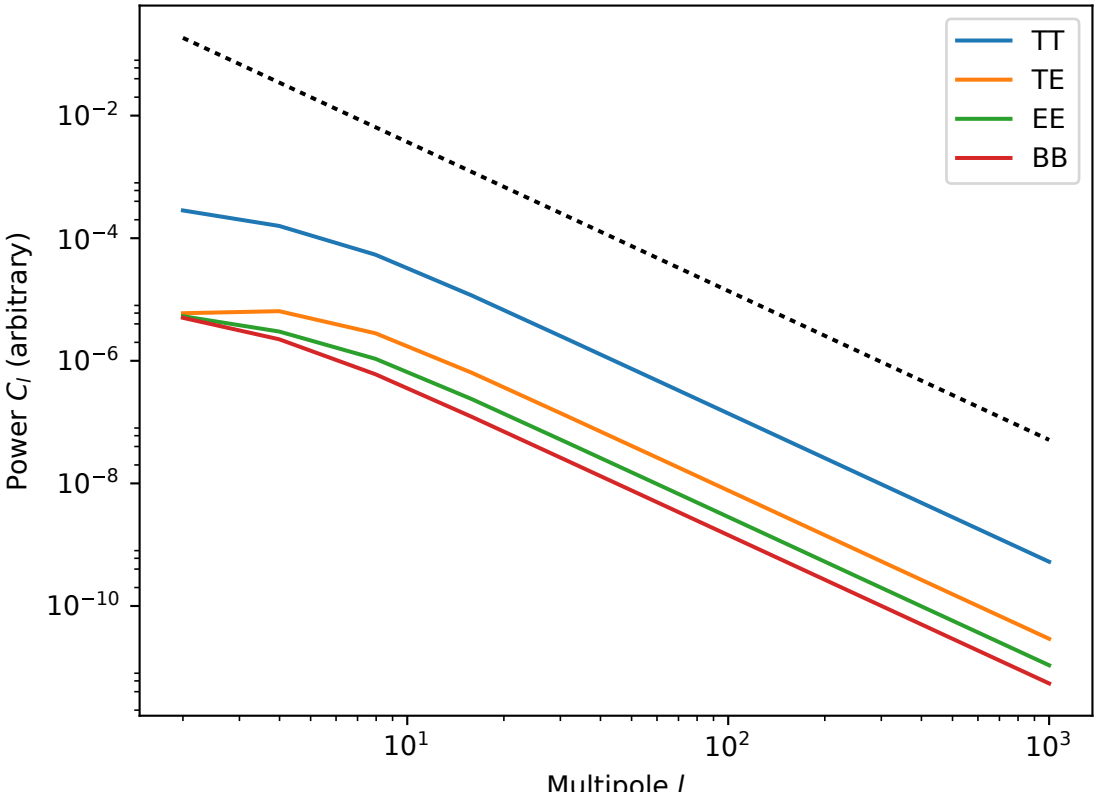
$$\Big\} \quad C_\ell \propto \ell^{-(p+q+1)/r}$$

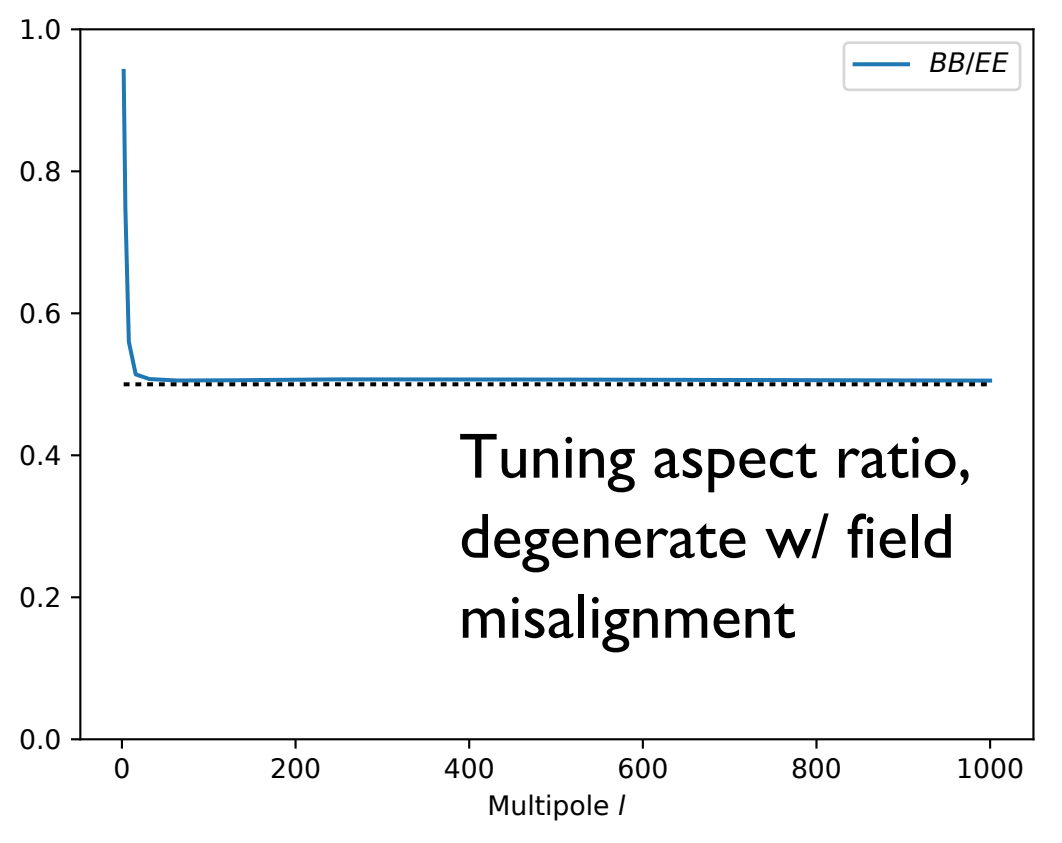
For the size of filament:

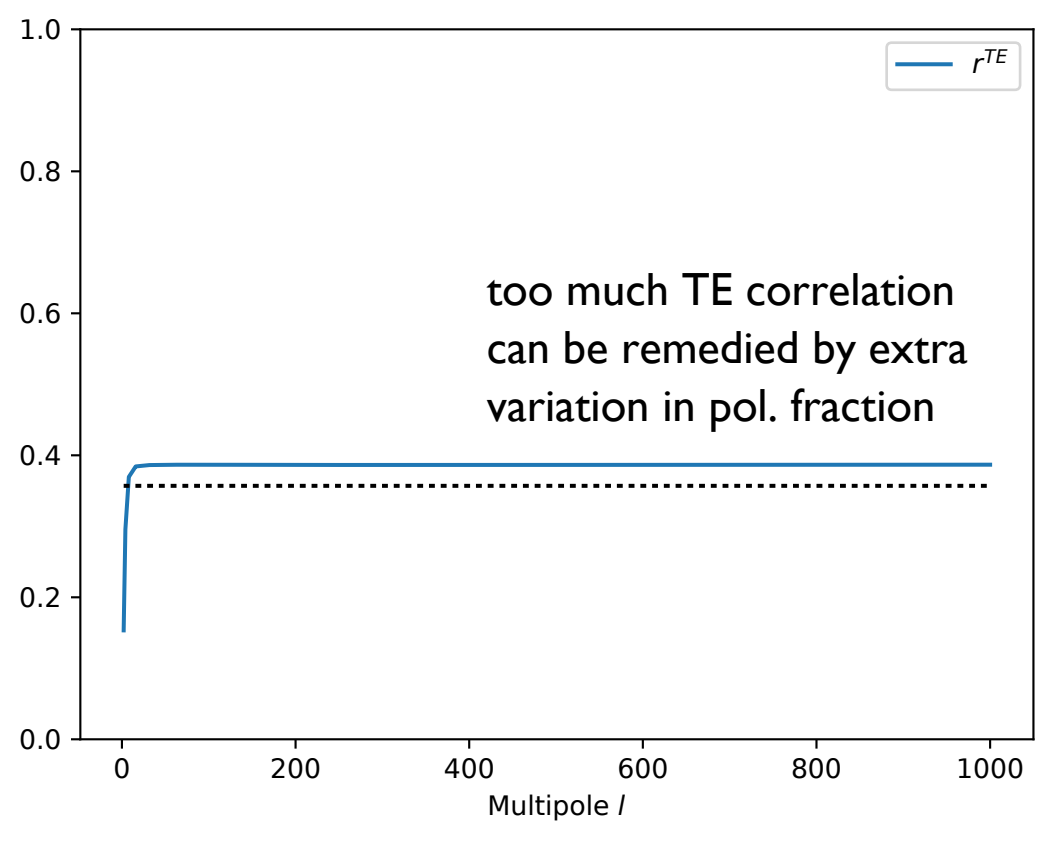
q = 6 (solid angle, column density)

r = 1 (trigonometry)

$C_l \propto l^{-2.42}$ implies $n(L) \propto L^{-4.58}$


TT
TE
EE
BB
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
Power C_l (arbitrary)
10^1
10^2
10^3
Multipole l


BB/EE
Tuning aspect ratio, degenerate w/ field misalignment
1.0
0.8
0.6
0.4
0.2
0.0
0
200
400
600
800
1000
Multipole l


r^{TE}
too much TE correlation
can be remedied by extra
variation in pol. fraction
1.0
0.8
0.6
0.4
0.2
0.0
0
200
400
600
800
1000
Multipole l

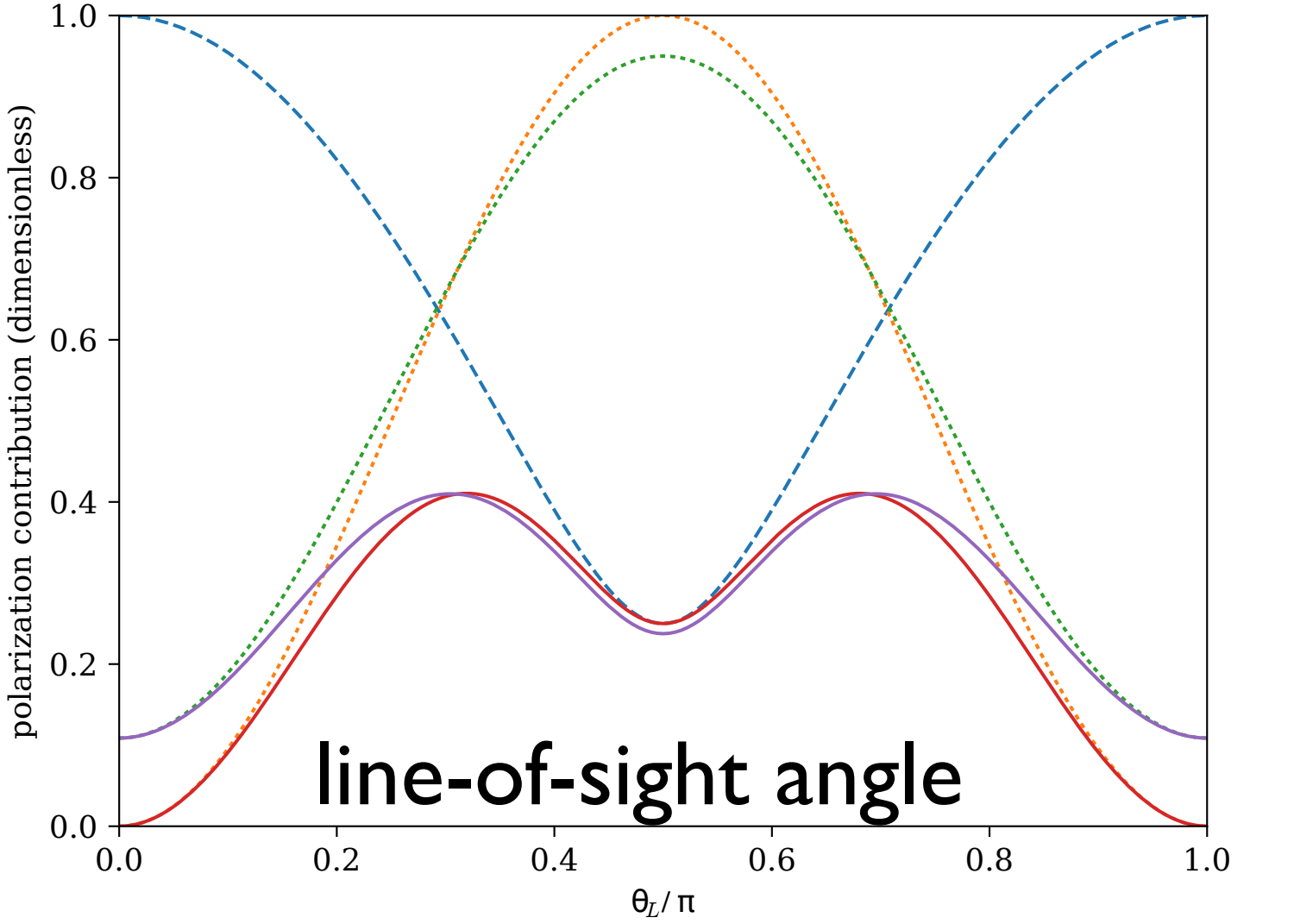
Conclusions

Filament models provides intuition about the possible structure of pol. foregrounds.

Concrete relationships exist between power spectrum observables and the filament population.

Future:

1. Paper coming soon
2. Examine off-diag. (lensing, FG diagnostic)



$T_0 / \max(T_0)$

$f_{\mathrm{pol}} / \max(f_{\mathrm{pol}})$ (perfect alignment)

$f_{\mathrm{pol}} / \max(f_{\mathrm{pol}})$ (20° misalignment)

product $\propto$ pol. amp. (perfect)

product $\propto$ pol. amp. (20° misalignment)