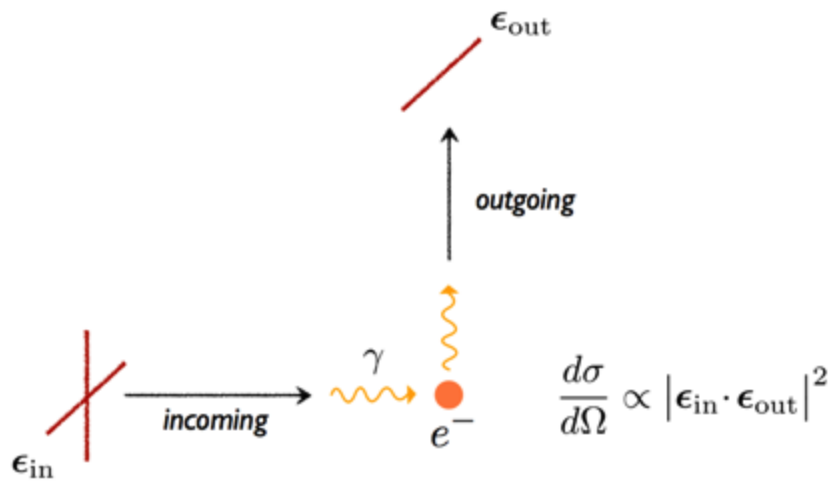
Inflationary Predictions

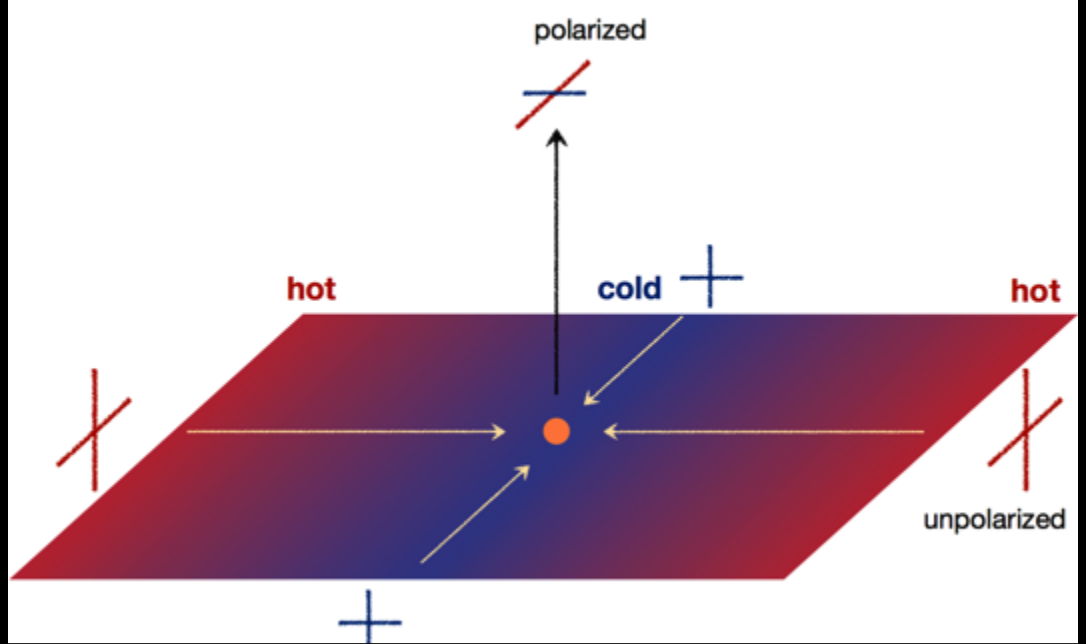
- ✓ Flat Universe
- ✓ Nearly Scale Invariant Fluctuations
- ✓ Gaussian Fluctuations
- ✓ Adiabatic Fluctuations
- ✓ Superhorizon Fluctuations
- ➢ ***Gravity Waves***

Thomson scattering is anisotropic:

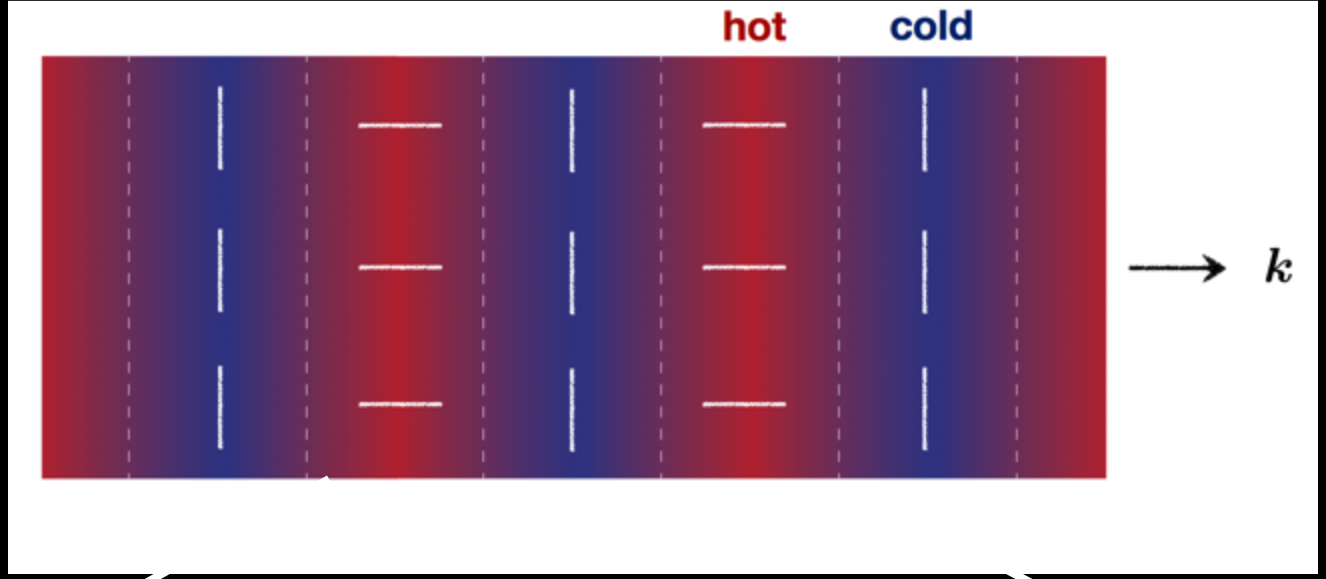


$$\frac{d\sigma}{d\Omega} \propto \left|\epsilon_{\rm in} \cdot \epsilon_{\rm out}\right|^2$$

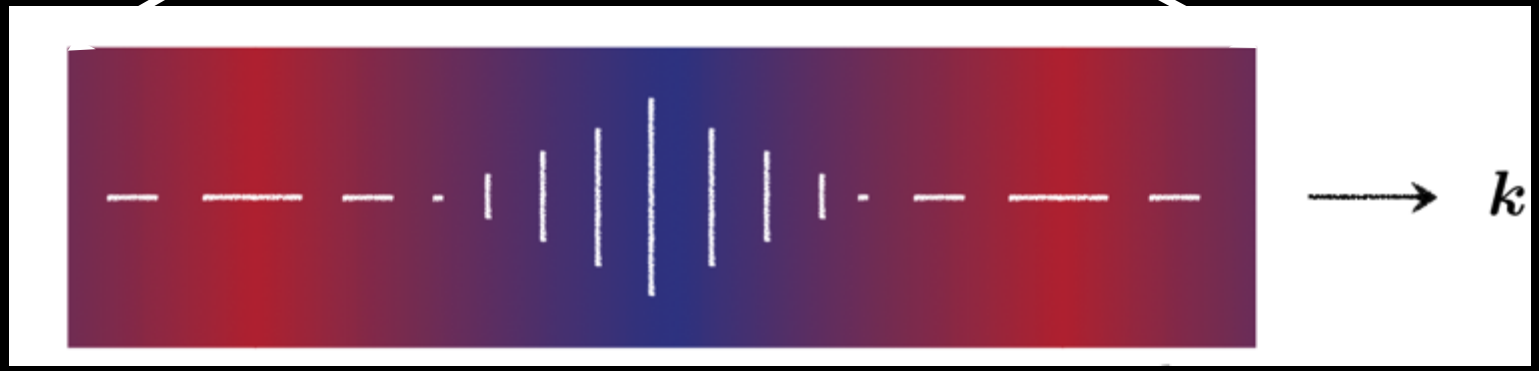
Quadrupolar temperature anisotropy leads to linear polarization:



Thanks to Dan Baumann

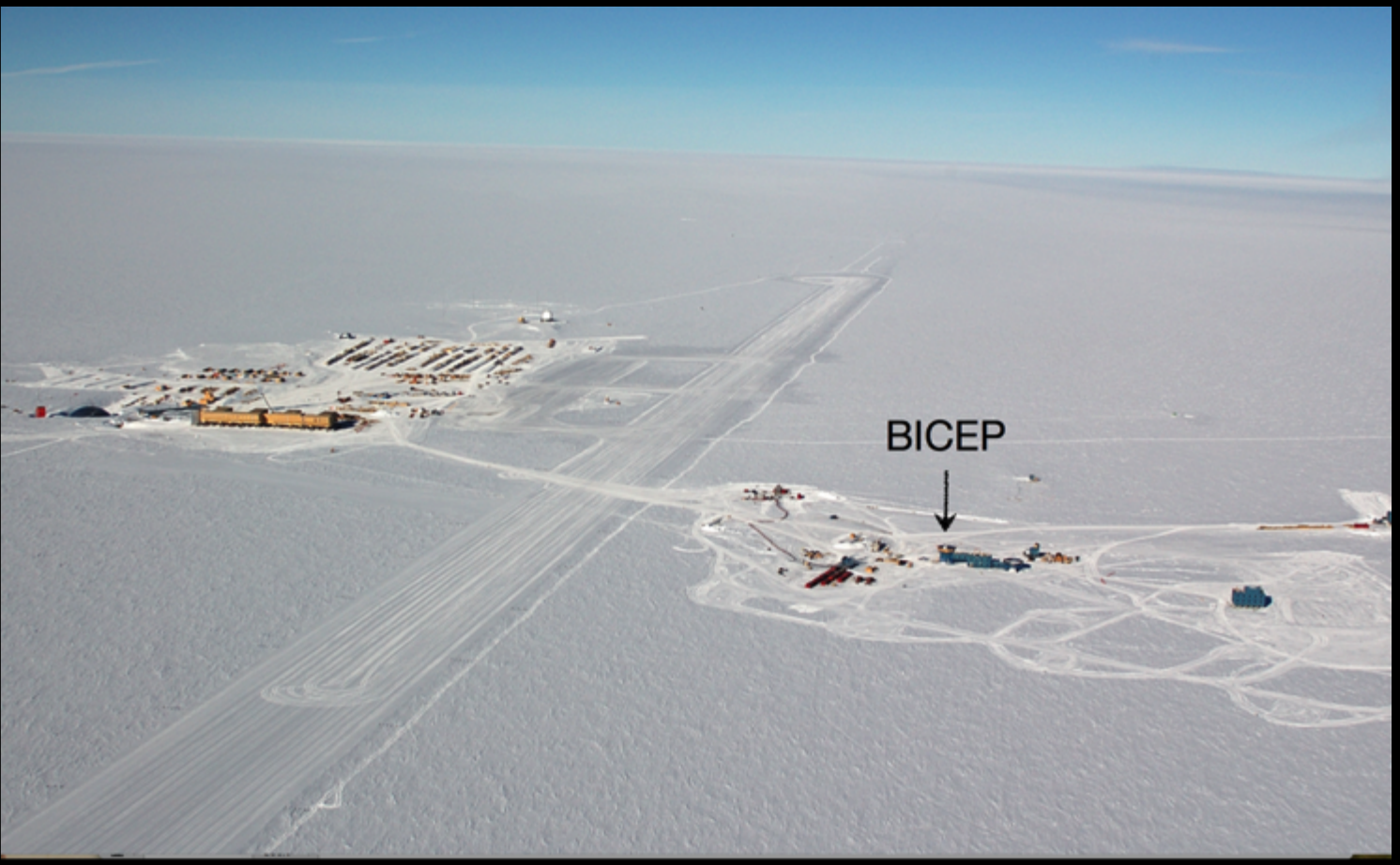


E

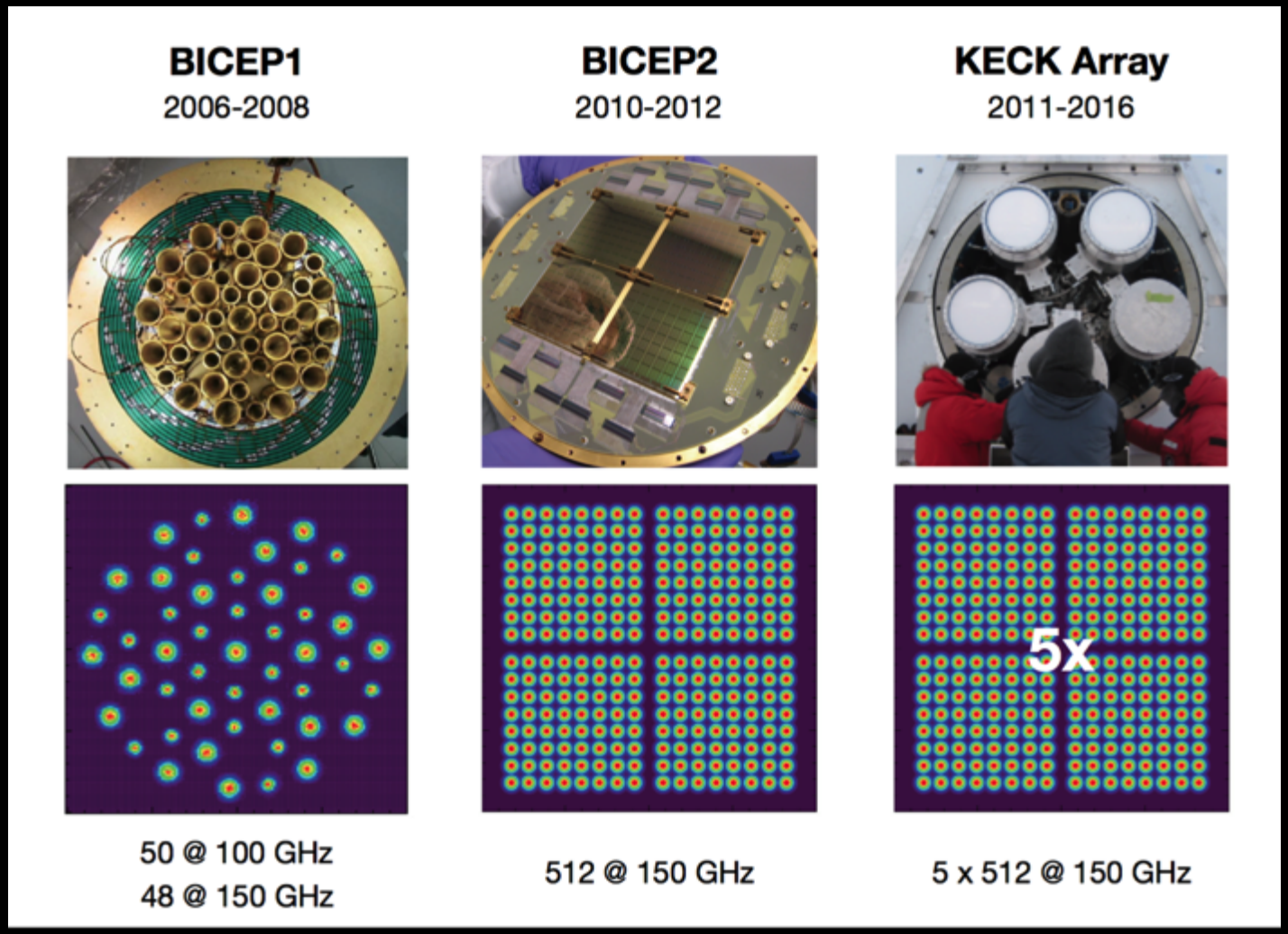


B

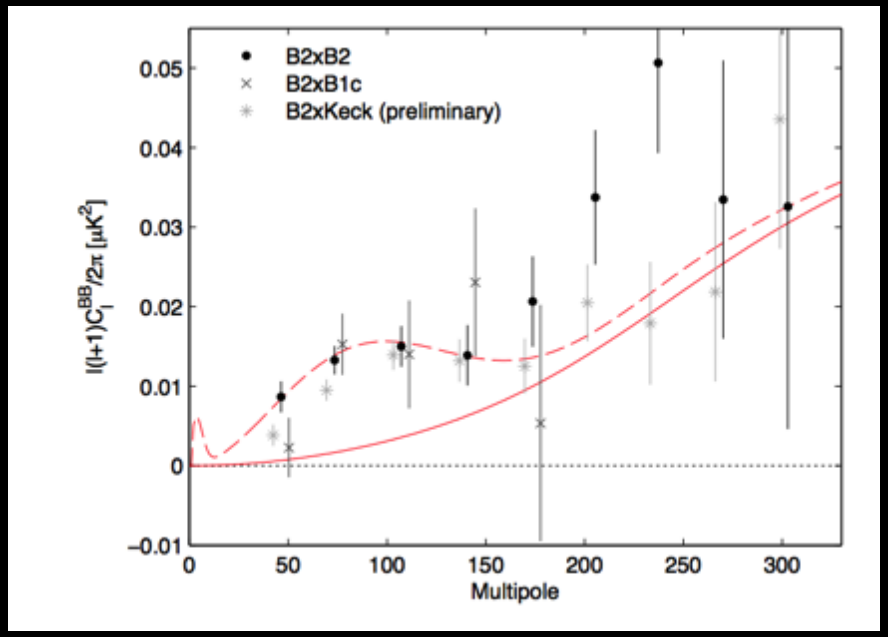
Heroic Science



BICEP Family

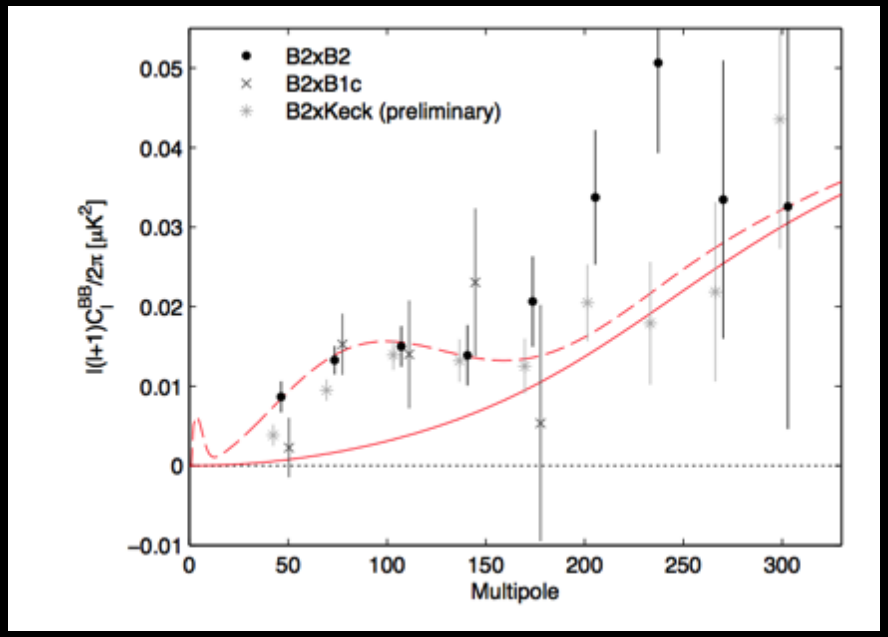


WOW!



- Signature of inflation!
- GR + quantum fluctuations near the Planck scale
- Large field inflation
- Profound implications for fundamental physics and cosmology

Important Results Deserve Careful Scrutiny



Is the signal on the sky?

Is the signal due to CMB?

Systematics

- The B-mode polarization signal is more than 10 time weaker than E mode signal, 1000 times weaker than the CMB temperature signal and 10^9 weaker than the atmospheric signal

E to B Mixing

- Due to sky cut, time filtering
- Iteratively corrected in map-making
- Seen in their BICEP1 paper but amplitude is too small to account for detected signal

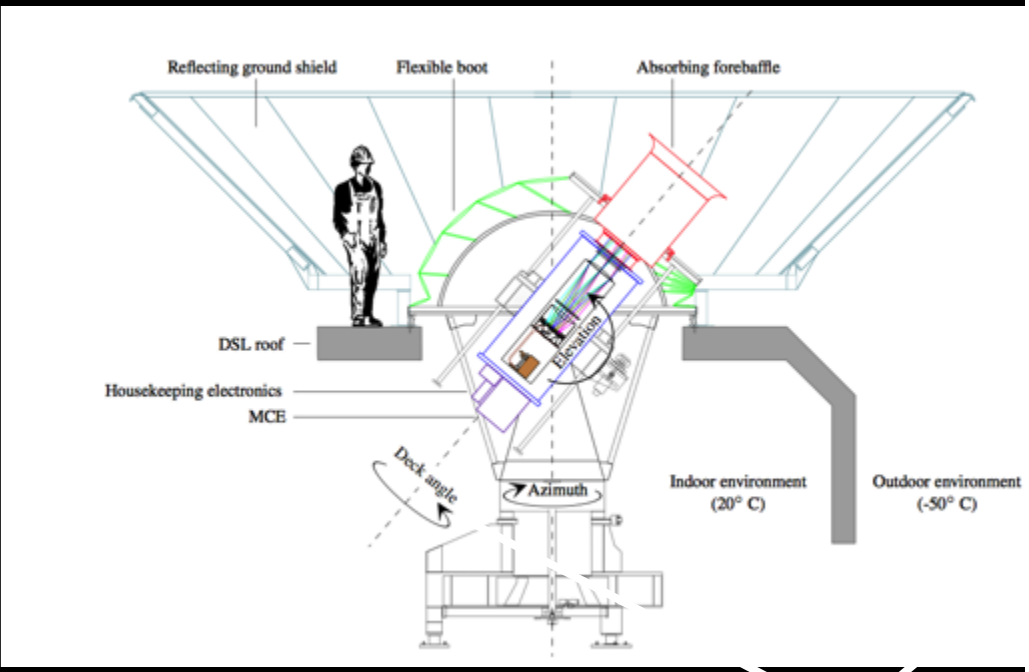


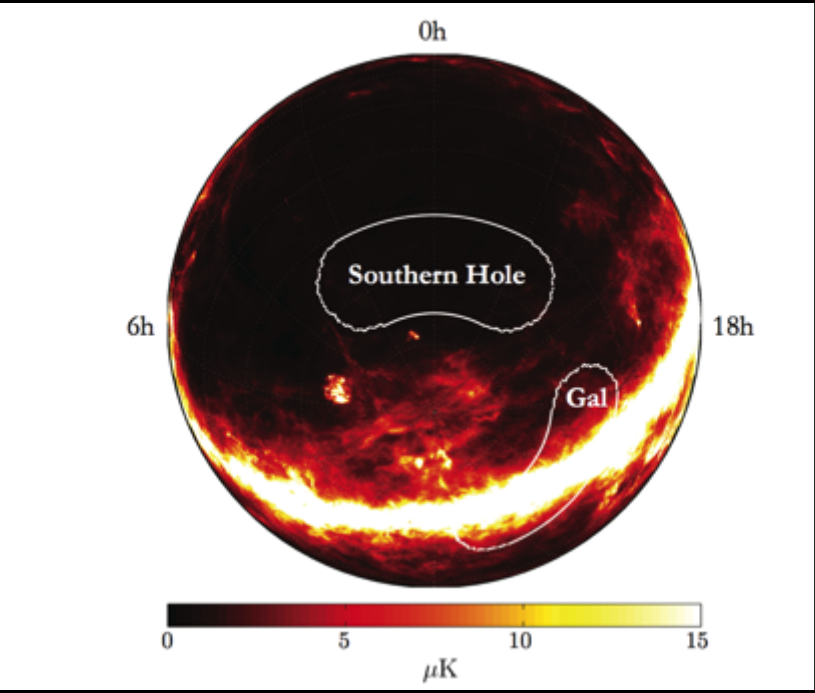
TABLE 1
JACKKNIFE PTE VALUES FROM χ^2 AND χ (SUM-OF-DEVIATION) TESTS

Jackknife	Bandpowers 1–5 χ^2	Bandpowers 1–9 χ^2	Bandpowers 1–5 χ	Bandpowers 1–9 χ
Deck jackknife				
EE	0.046	0.030	0.164	0.299
BB	0.774	0.329	0.240	0.082
EB	0.337	0.643	0.204	0.267
Scan Dir jackknife				
EE	0.483	0.762	0.978	0.938
BB	0.531	0.573	0.896	0.551
EB	0.898	0.806	0.725	0.890
Temporal Split jackknife				
EE	0.541	0.377	0.916	0.938
BB	0.902	0.992	0.449	0.585
EB	0.477	0.689	0.856	0.615
Tile jackknife				
EE	0.004	0.010	0.000	0.002
BB	0.794	0.752	0.565	0.331
EB	0.172	0.419	0.962	0.790
Azimuth jackknife				
EE	0.673	0.409	0.126	0.339
BB	0.591	0.739	0.842	0.944
EB	0.529	0.577	0.840	0.659
Mux Col jackknife				
EE	0.812	0.587	0.196	0.204
BB	0.826	0.972	0.293	0.283
EB	0.866	0.968	0.876	0.697
Alt Deck jackknife				
EE	0.004	0.004	0.070	0.236
BB	0.397	0.176	0.381	0.086
EB	0.150	0.060	0.170	0.291
Mux Row jackknife				
EE	0.052	0.178	0.653	0.739
BB	0.345	0.361	0.032	0.008
EB	0.529	0.226	0.024	0.048
Tile/Deck jackknife				
EE	0.048	0.088	0.144	0.132
BB	0.908	0.840	0.629	0.269
EB	0.050	0.154	0.591	0.591
Focal Plane inner/outer jackknife				
EE	0.230	0.597	0.022	0.090
BB	0.216	0.531	0.046	0.092
EB	0.036	0.042	0.850	0.838
Tile top/bottom jackknife				

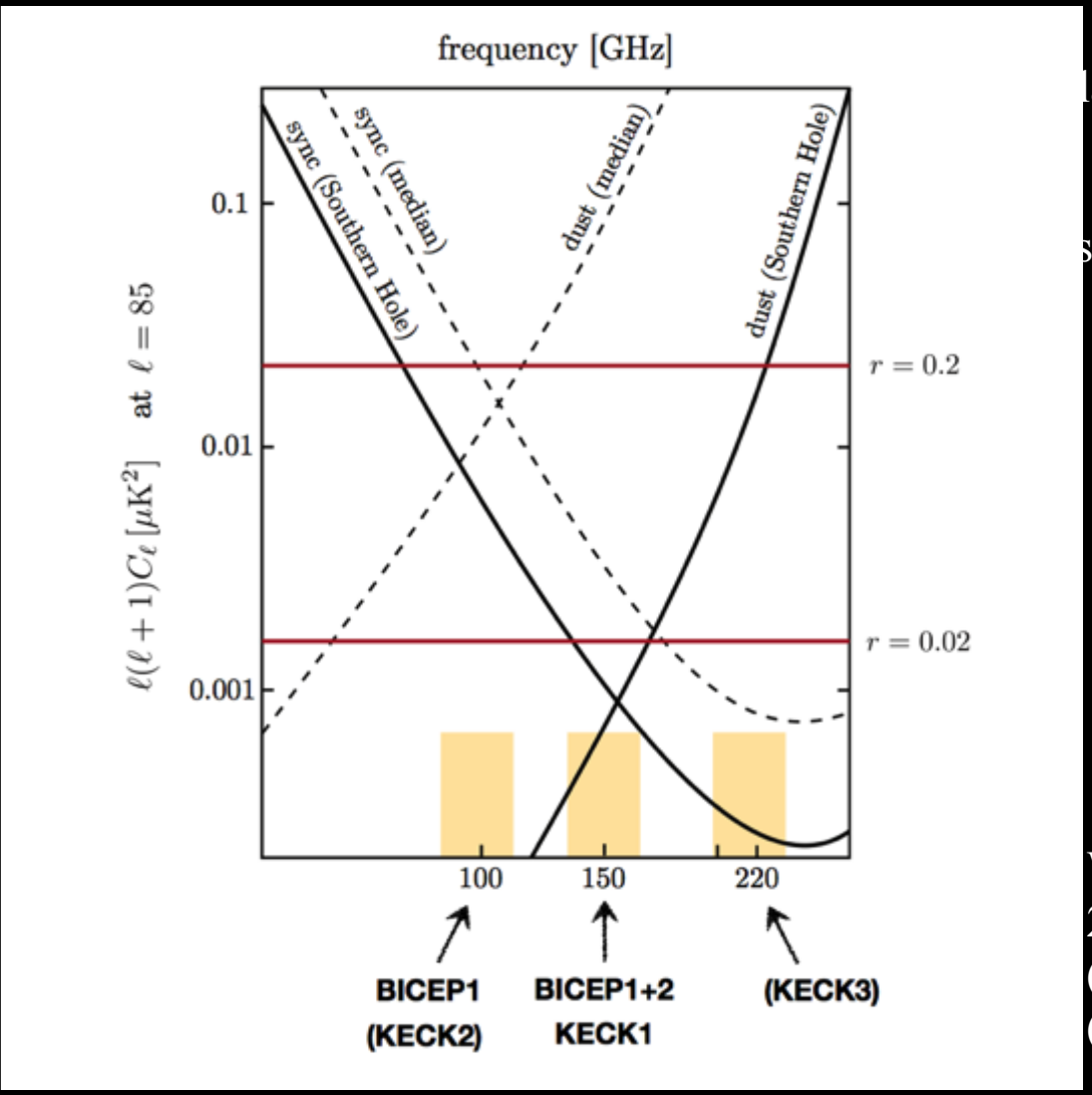
Fails high S/N EE jackknifes but not BB

Foregrounds

- Synchrotron
- Thermal Dust
- Spinning Dust, Iron dust grains
- Very clean region

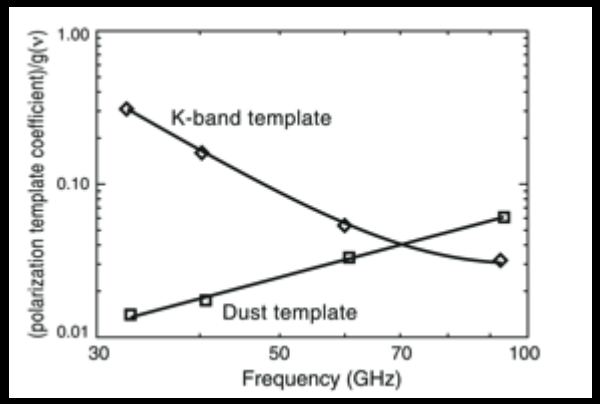


Expected signal low

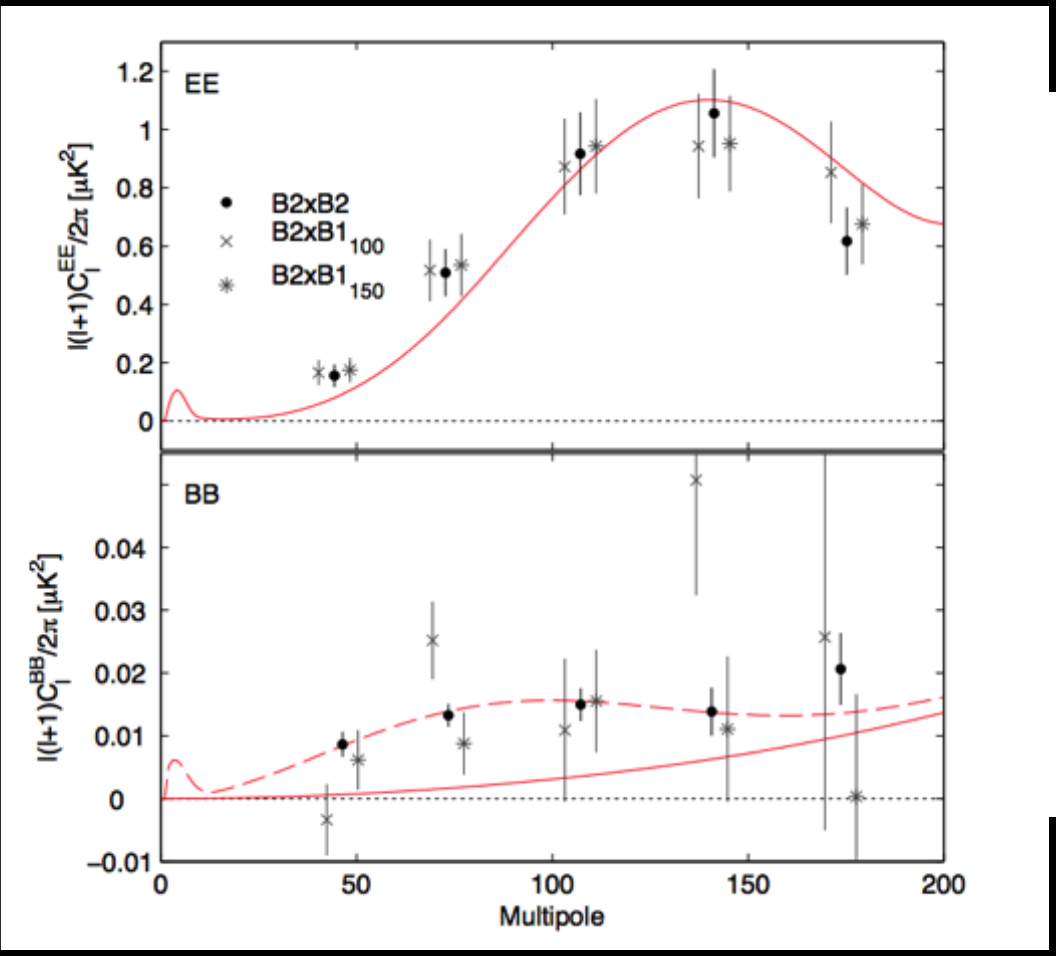


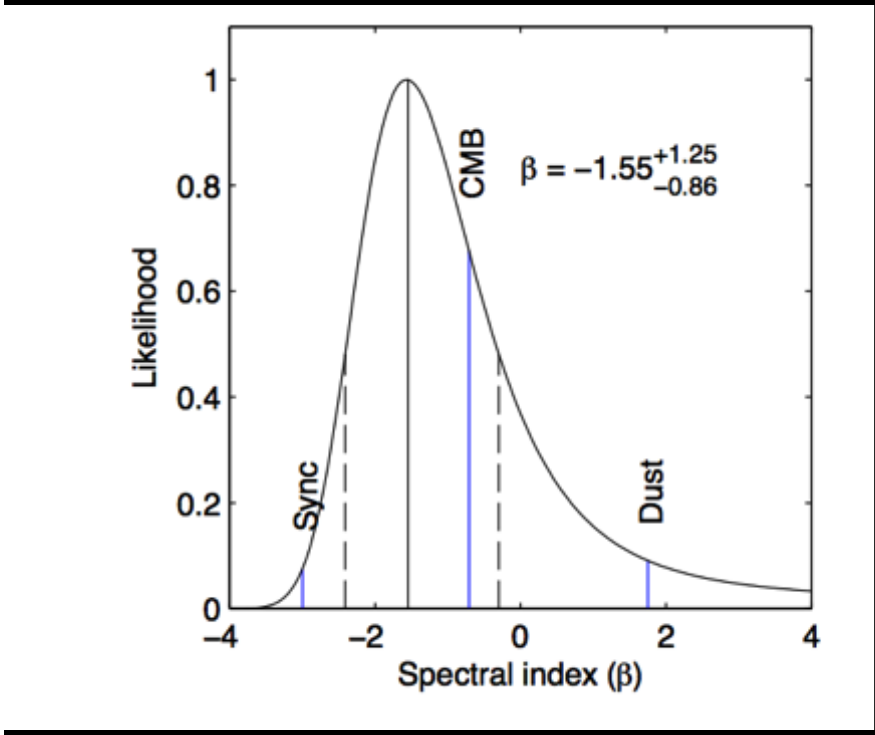
lation from WMAP 30

s $\nu^{-6.6}$ extrapolation



WMAP best fit cross-correlationbetwen 22 and 94 GHz has a shallower slope ($\nu^{-4.8}$)
(Bennett et al. 2013)


EE
B2xB2
B2xB1100
B2xB1150
BB
Multipole

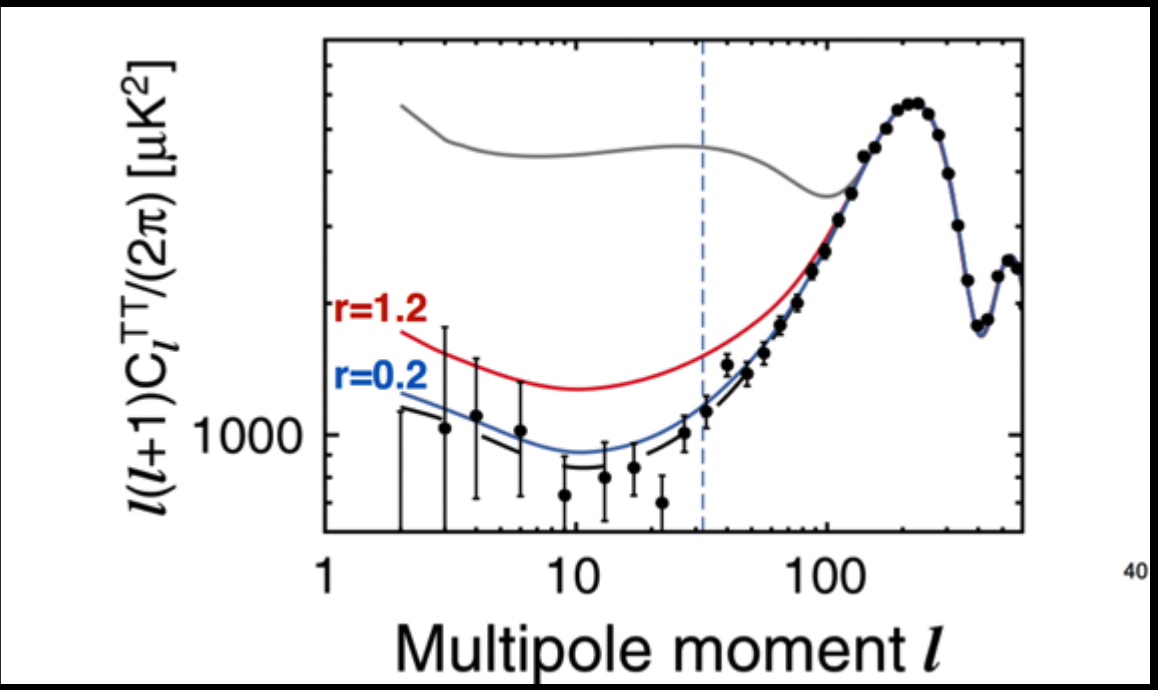

Likelihood
CMB
Sync
Dust
β = −1.55+1.25−0.86
Spectral index (β)

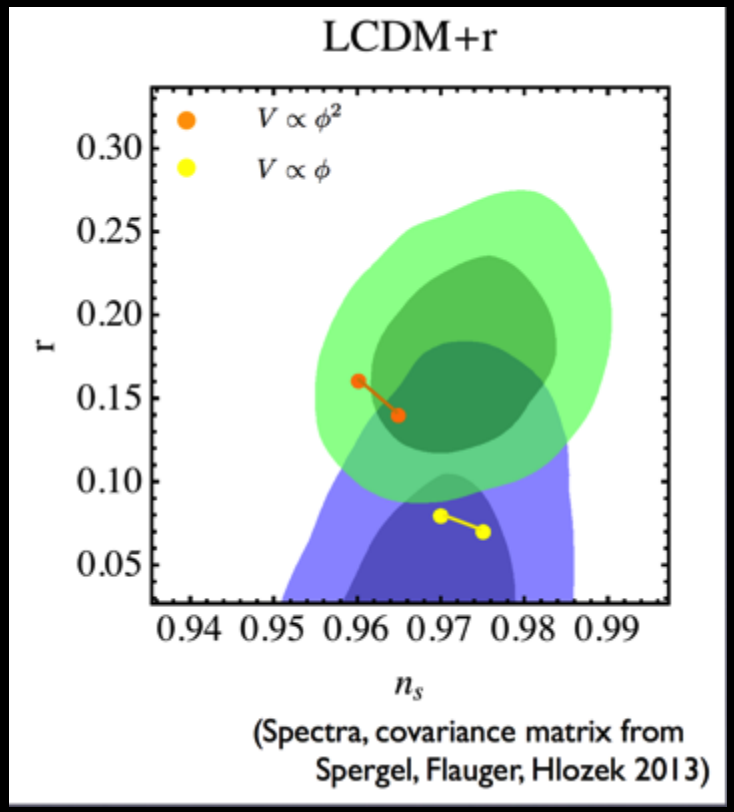
Tests I would like to see..

- Bicep100 x Bicep100
- Keck x (Bicep1-100)
- (Keck-Bicep2) x Bicep2
- EB lensing x Planck CIB
- Correlate polarization with Planck (143-100) GHz intensity maps, 353 GHz maps, and WMAP 22 GHz maps
- Systematics paper and discussion of null tests

Implications

- r = 0.2 is marginally incompatible with power law models and temperature data



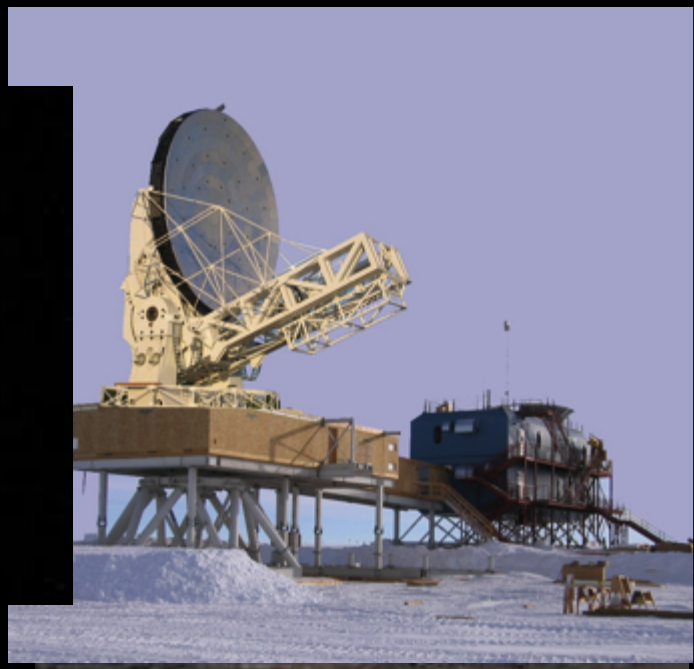


Need to change assumptions

- Running of spectral index
- Anticorrelated isocurvature modes
- Break in spectrum

$\Delta\chi^2_{\rm eff}$	running	broken power law
CAMspec	6	12
CrossSpec	4	10

Testing the BICEP Result



Tests I would like to see..

- Detection of deviations from w = -1 might be "just around corner"
- Lack of large scale power in temperature measurements could be signature of cutoff in the power spectrum
- Strongly motivates measurements of curvature
- Systematics!