

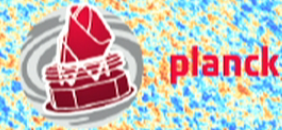
Title: Results from Planck 2015

Date: Apr 26, 2016 04:00 PM

URL: <http://pirsa.org/16040056>

Abstract: <p>Planck's full-mission data, released in 2015, provides a high-resolution whole-sky polarization and temperature maps of the CMB and astrophysical components. I will talk about implications of Planck 2015 results for inflation, why cosmic dust is important, and what we are currently doing to study it. I will also highlight some tests of the statistical isotropy and Gaussianity of the cosmic microwave background (CMB) anisotropies we have done with observations made by the Planck satellite. I will show how simple map stacking can be used as a powerful statistical tool for studying polarized CMB and dust emission maps.</p>

Outline



- 1 Instrument and Mission Overview**
- 2 Foregrounds and Component Separation**
- 3 CMB Maps and Spectra**
- 4 B-Modes and Dust**
- 5 Implications for Inflation**
- 6 Variance Asymmetry**
- 7 Peak Statistics & Cold Spot**
- 8 Stacking & Polarization**



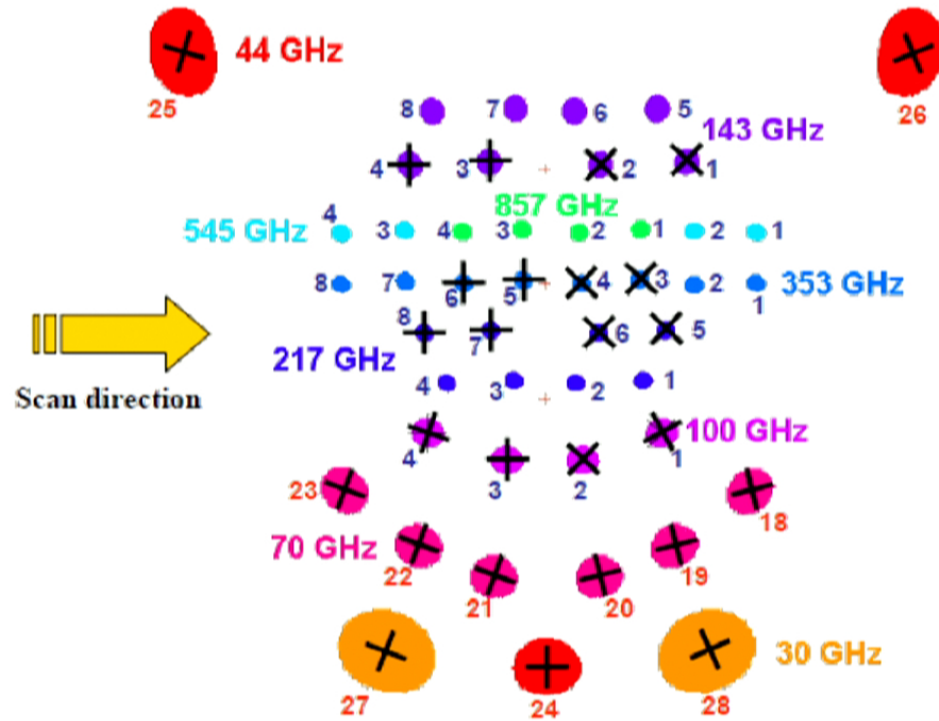
Planck before Launch



planck



Planck Focal Plane Schematics

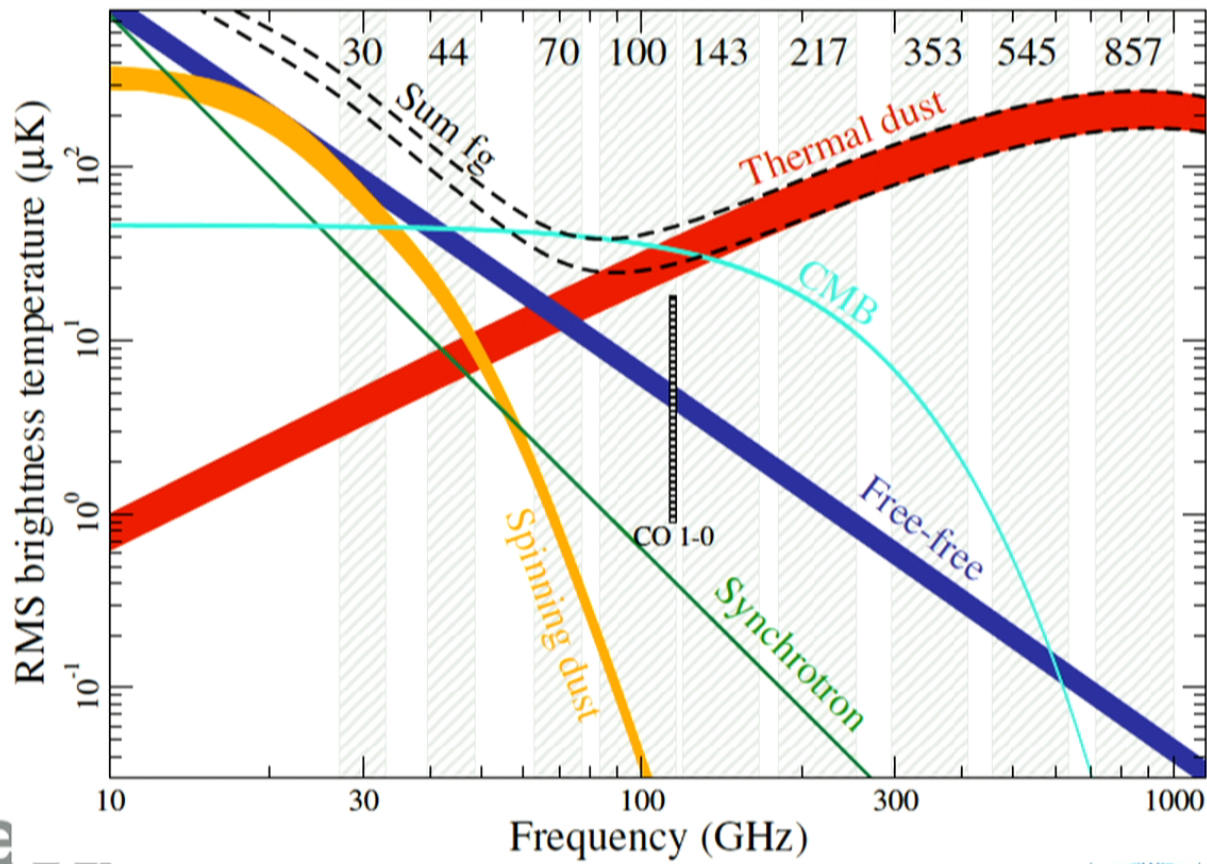


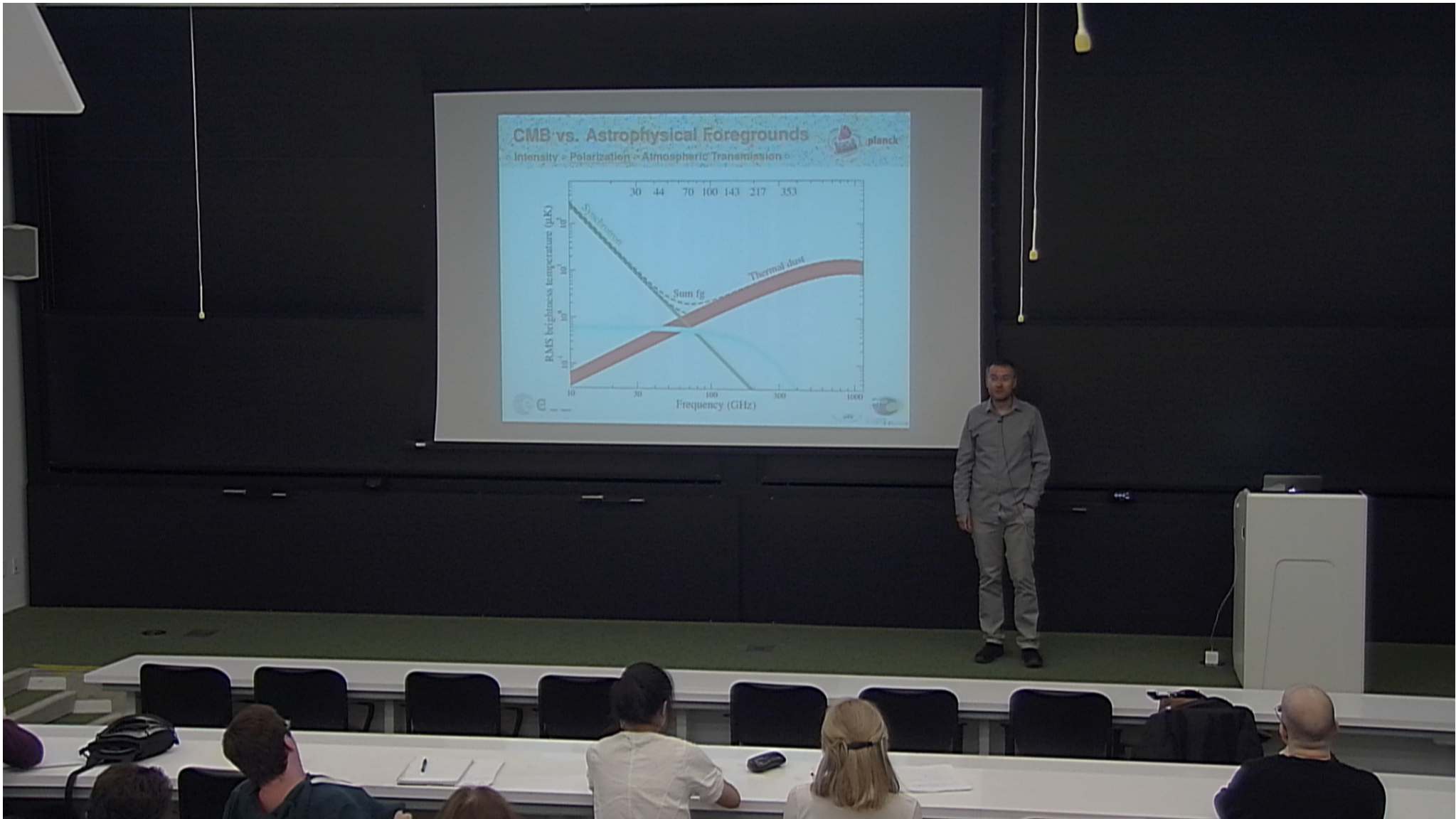
CMB vs. Astrophysical Foregrounds



planck

◦ Intensity ◦ Polarization ◦ Atmospheric Transmission ◦



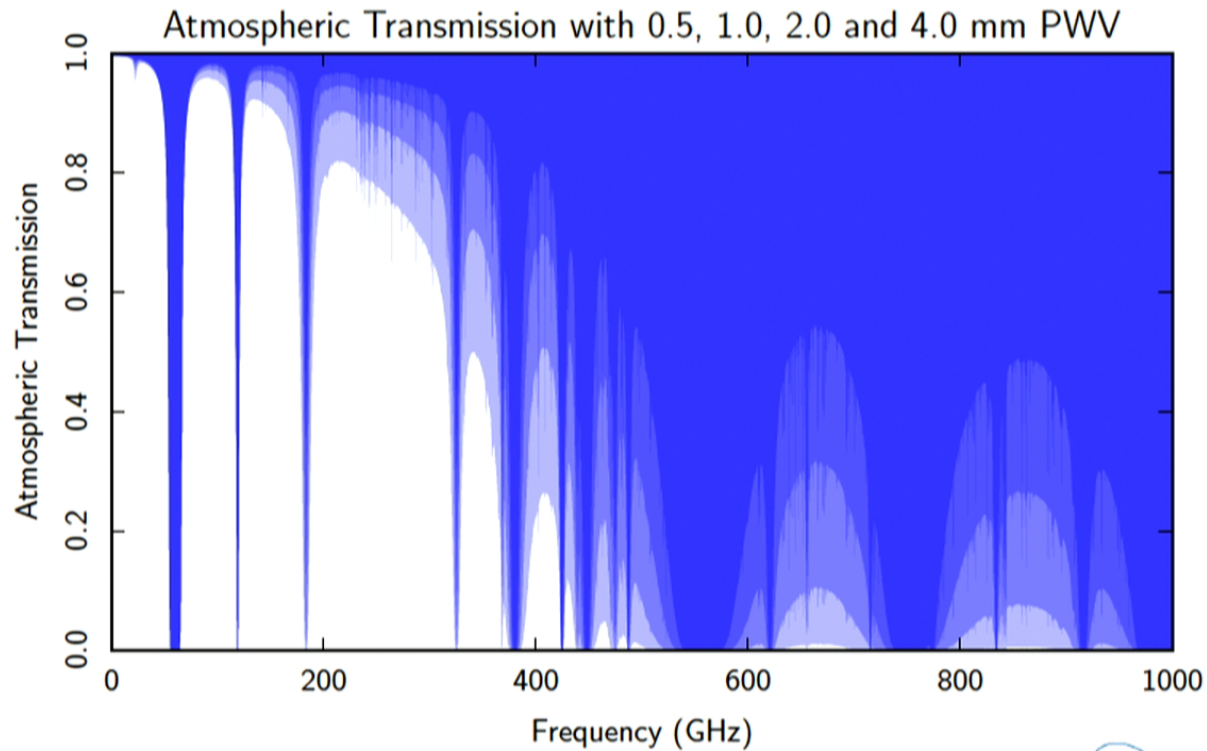


CMB vs. Astrophysical Foregrounds

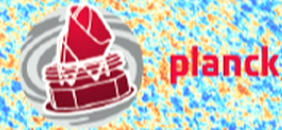
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planck



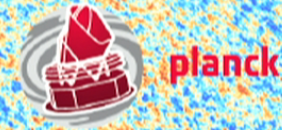
Component Separation Methods



Like in 2013, three CMB cleaning methods (SMICA, SEVEM, NILC) & 1 explicit Component Separation method (Commander).



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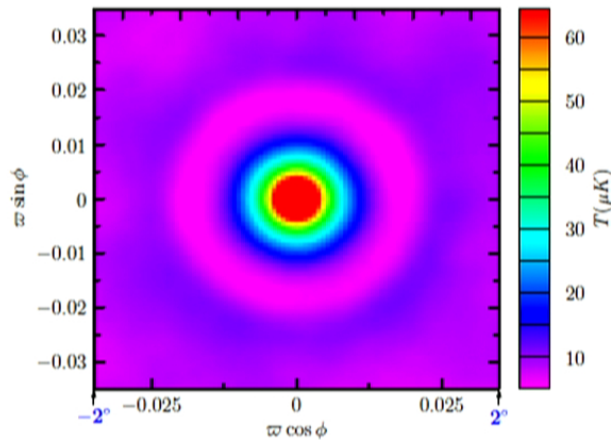


Planck 2015: Stacking T & Q



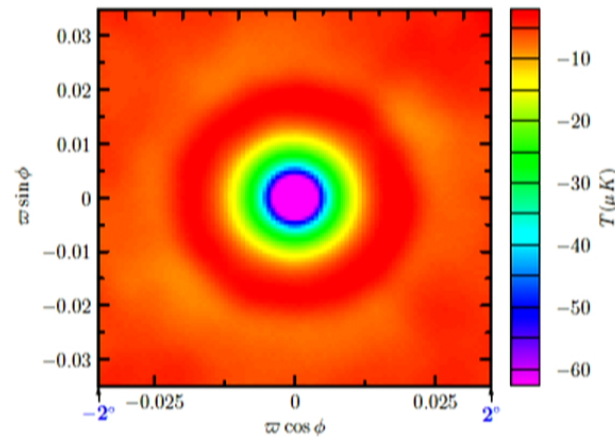
T on hot spots

24645 patches on T maxima, random orientation, threshold $\nu=0$



T on cold spots

24582 patches on T minima, random orientation, threshold $\nu=0$



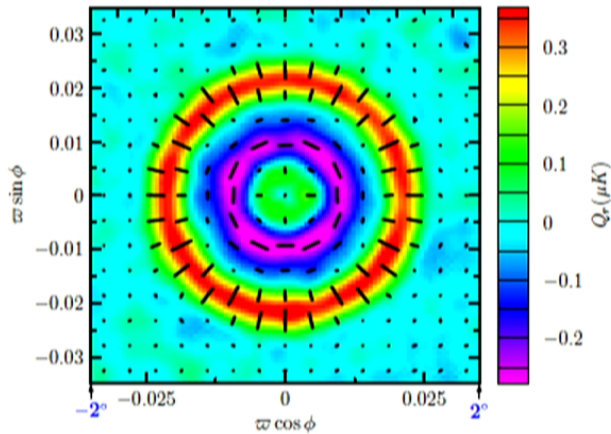
resolution: FWHM 15 arcmin

Peaks are selected above a threshold $|T_{\text{peak}}| > \nu \sqrt{\langle T^2 \rangle}$ ($\nu = 0$ here).



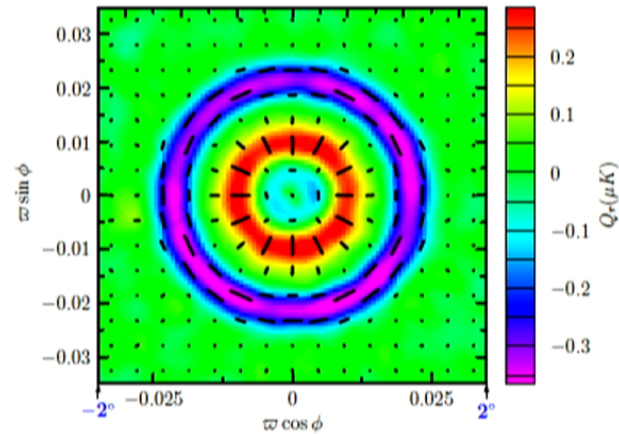
Q_r on hot spots

33214 patches on T maxima, random orientation, threshold $\nu=0$



Q_r on cold spots

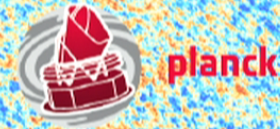
33126 patches on T minima, random orientation, threshold $\nu=0$



resolution: FWHM 15 arcmin

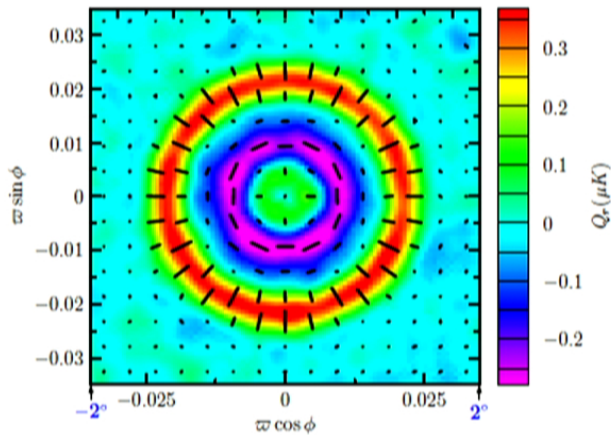
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Planck 2015: Stacking T & Q_r



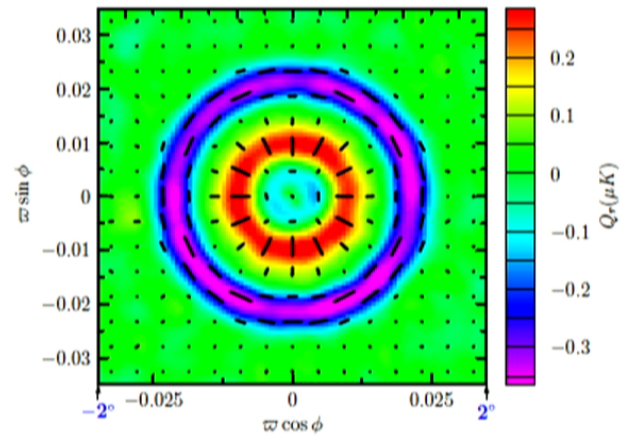
Q_r on hot spots

33214 patches on T maxima, random orientation, threshold $\nu=0$



Q_r on cold spots

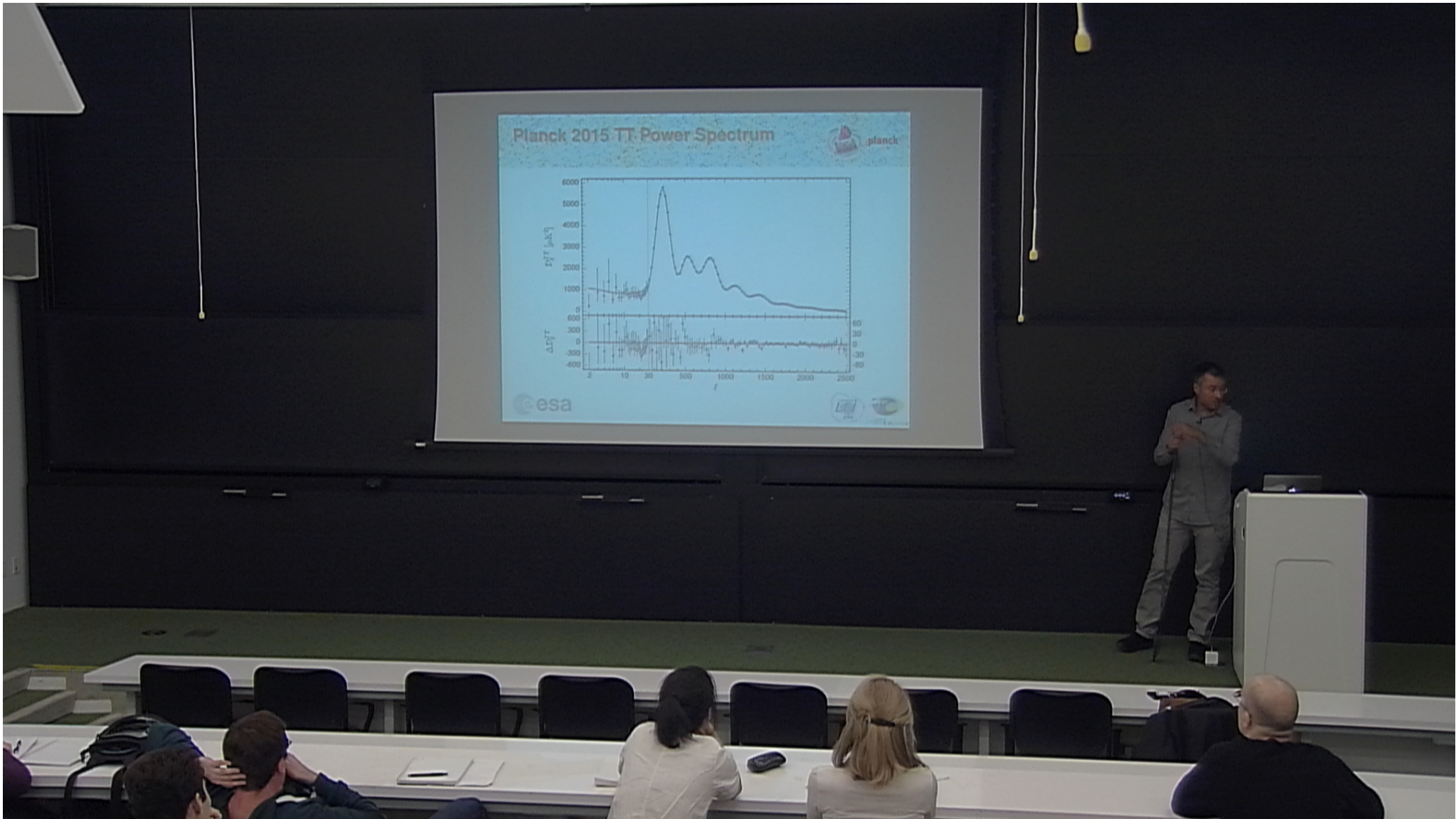
33126 patches on T minima, random orientation, threshold $\nu=0$



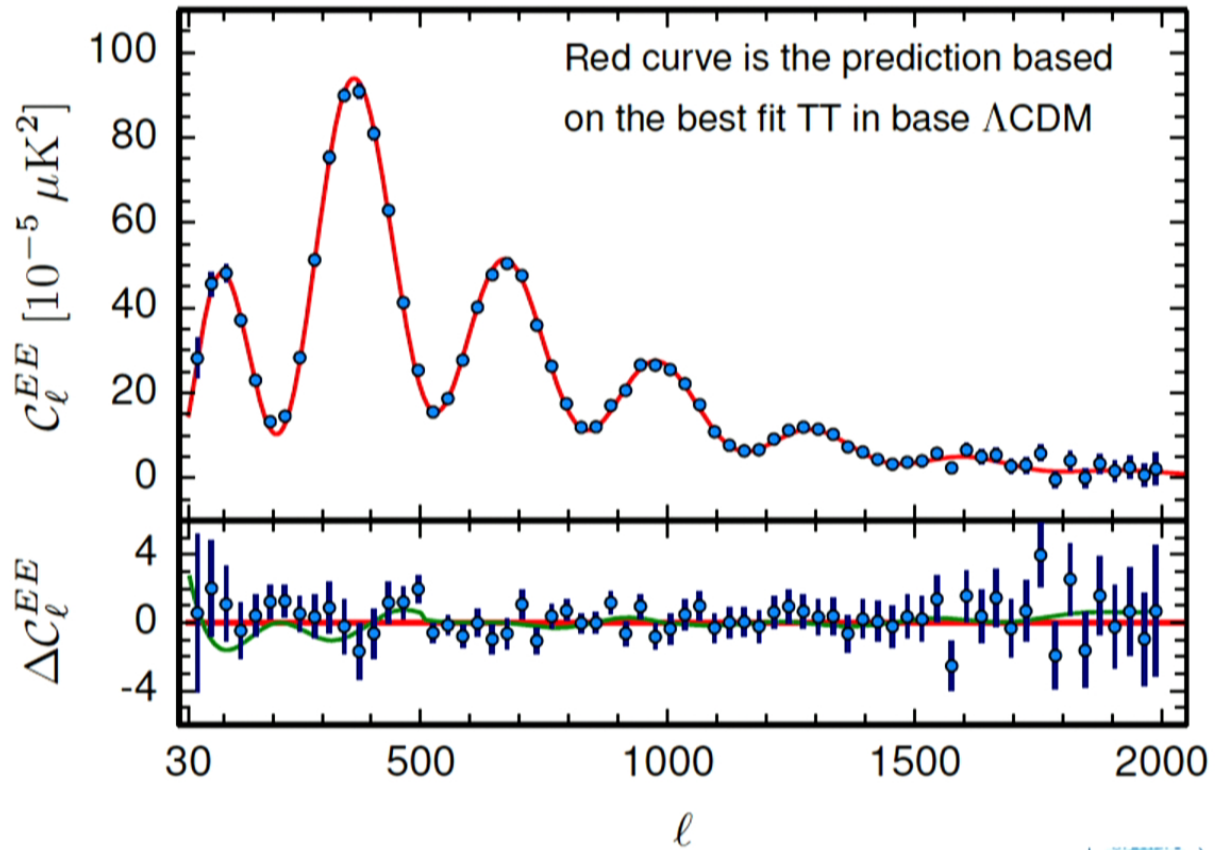
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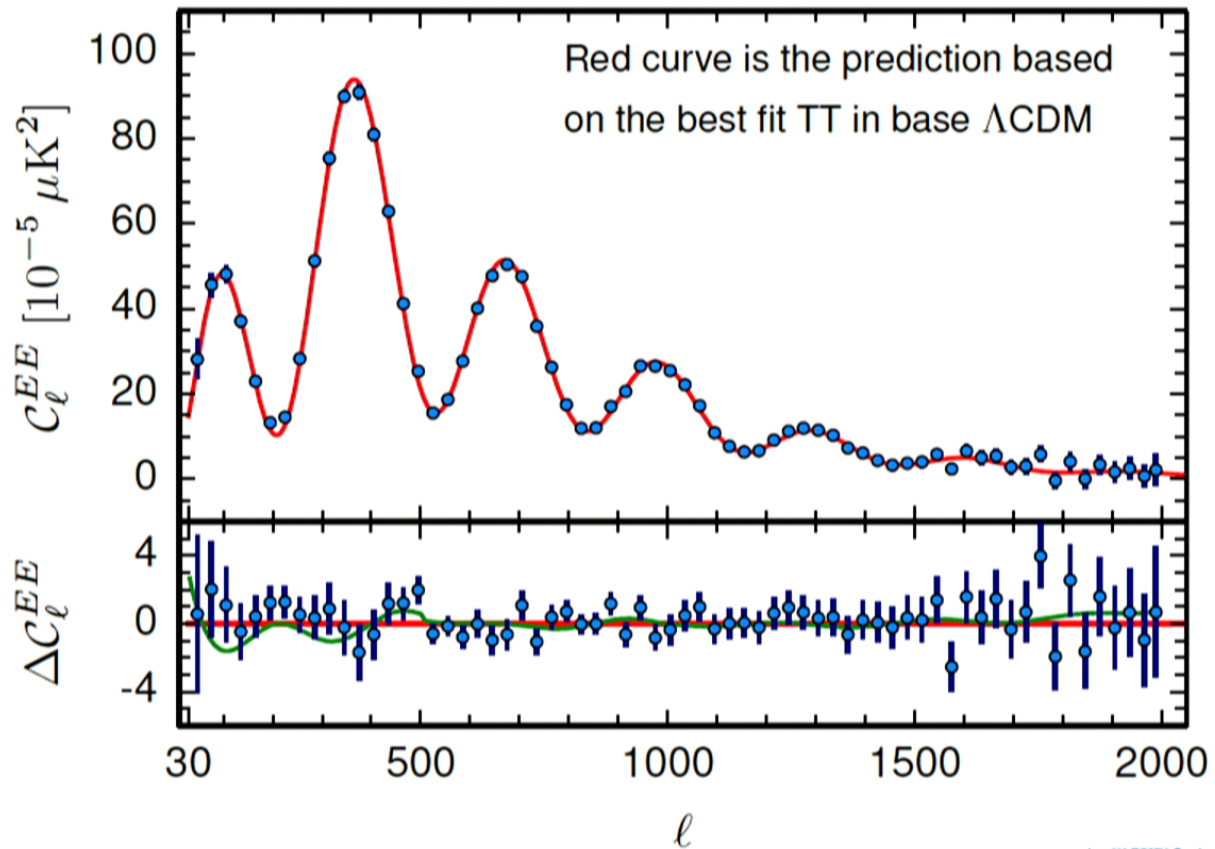
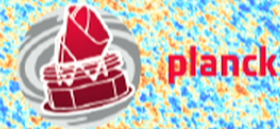




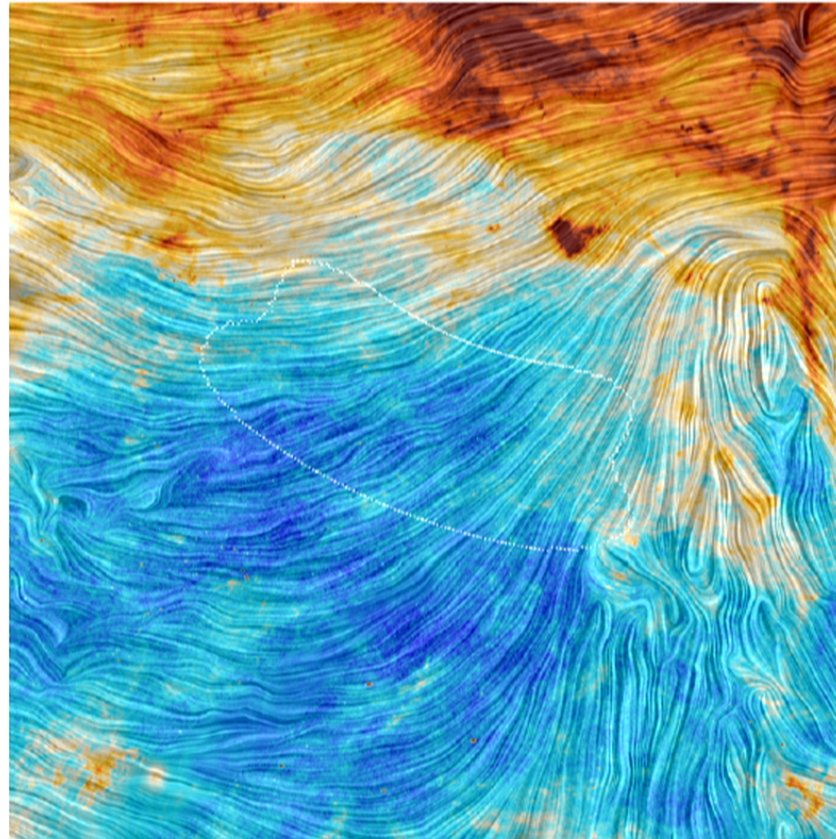
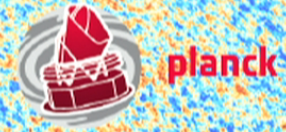
Planck 2015 EE Power Spectrum



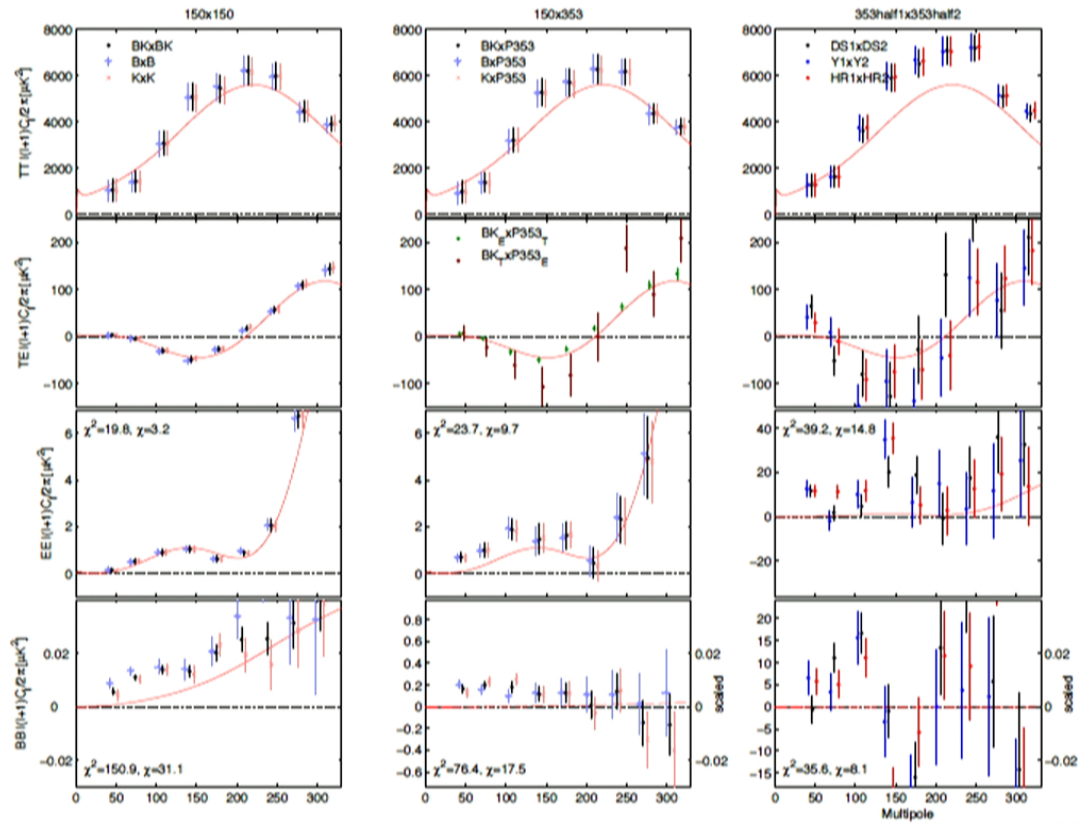
Planck 2015 EE Power Spectrum



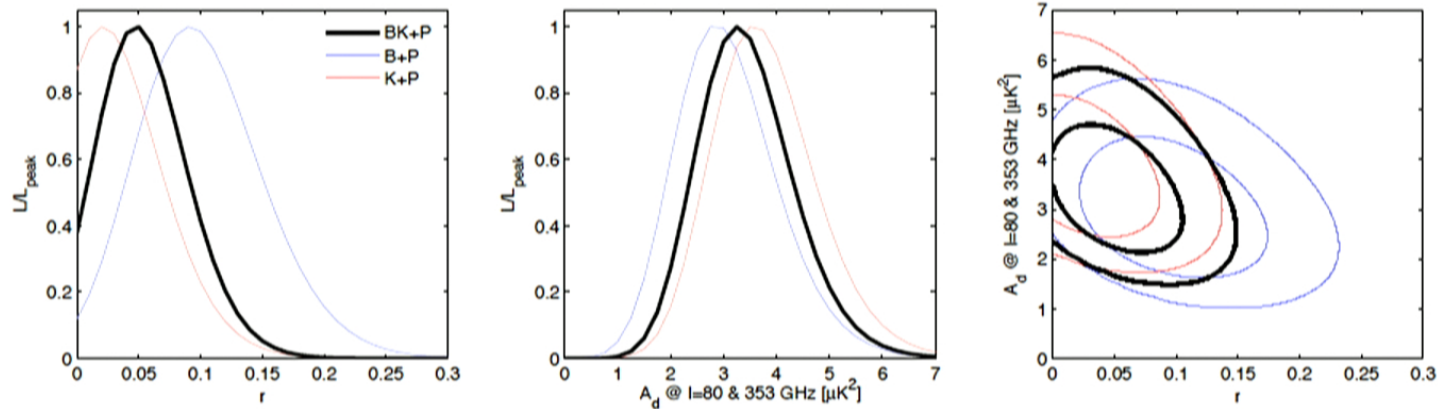
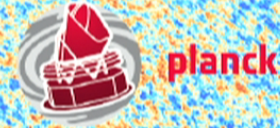
Planck View of BICEP2 Field



Planck x BICEP2/Keck Cross-Spectra



Planck x BICEP2 Joint Likelihood

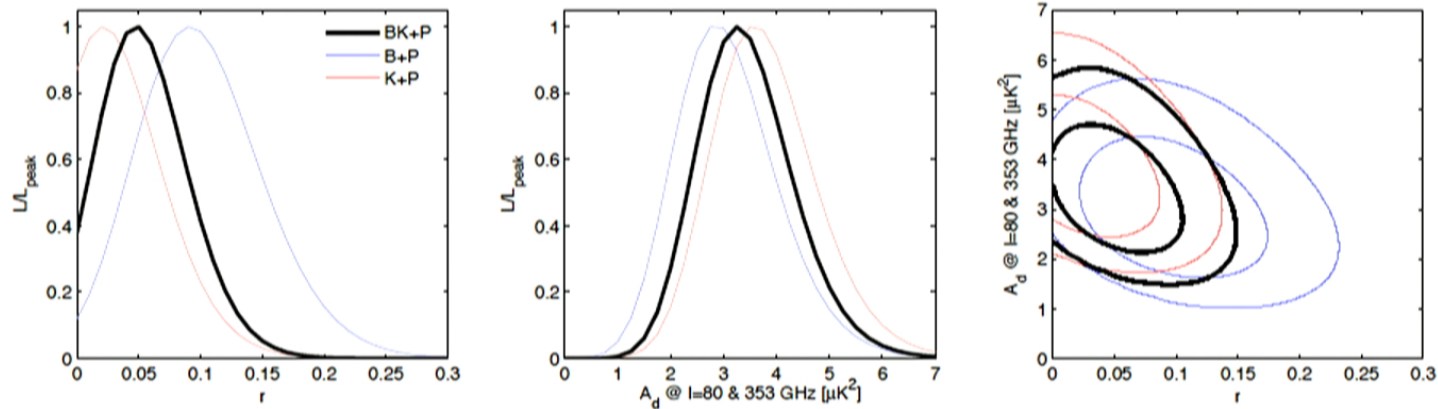
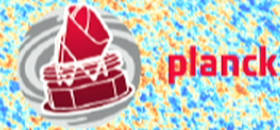


Likelihood results from a basic lensed- Λ CDM+ r +dust model, fitting BB auto- and cross-spectra taken between maps at 150 (BICEP2/Keck) and 217 and 353 GHz (Planck).

A Gaussian prior is placed on the dust frequency spectrum parameter $\beta_d = 1.59 \pm 0.11$.



Planck x BICEP2 Joint Likelihood

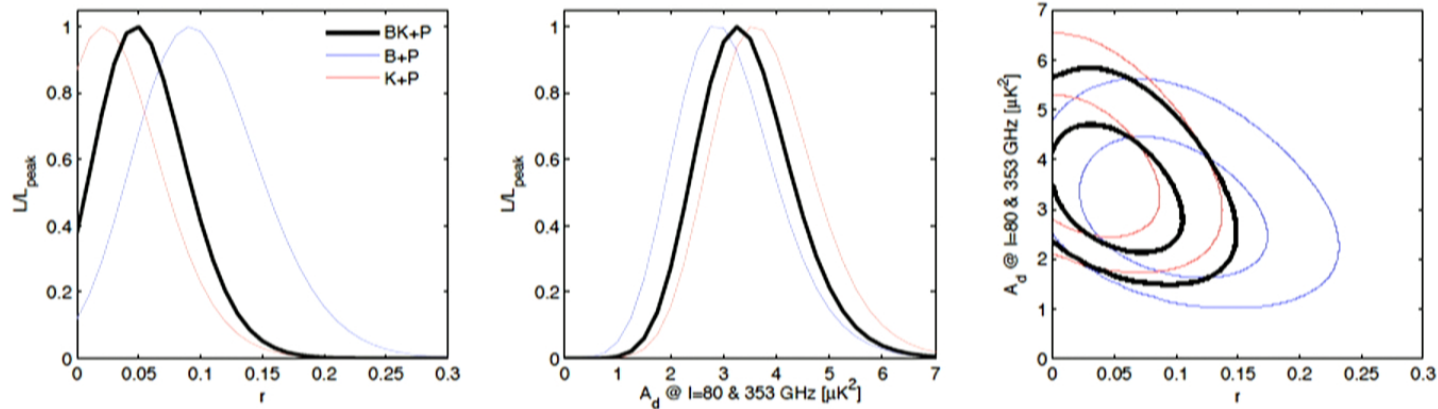


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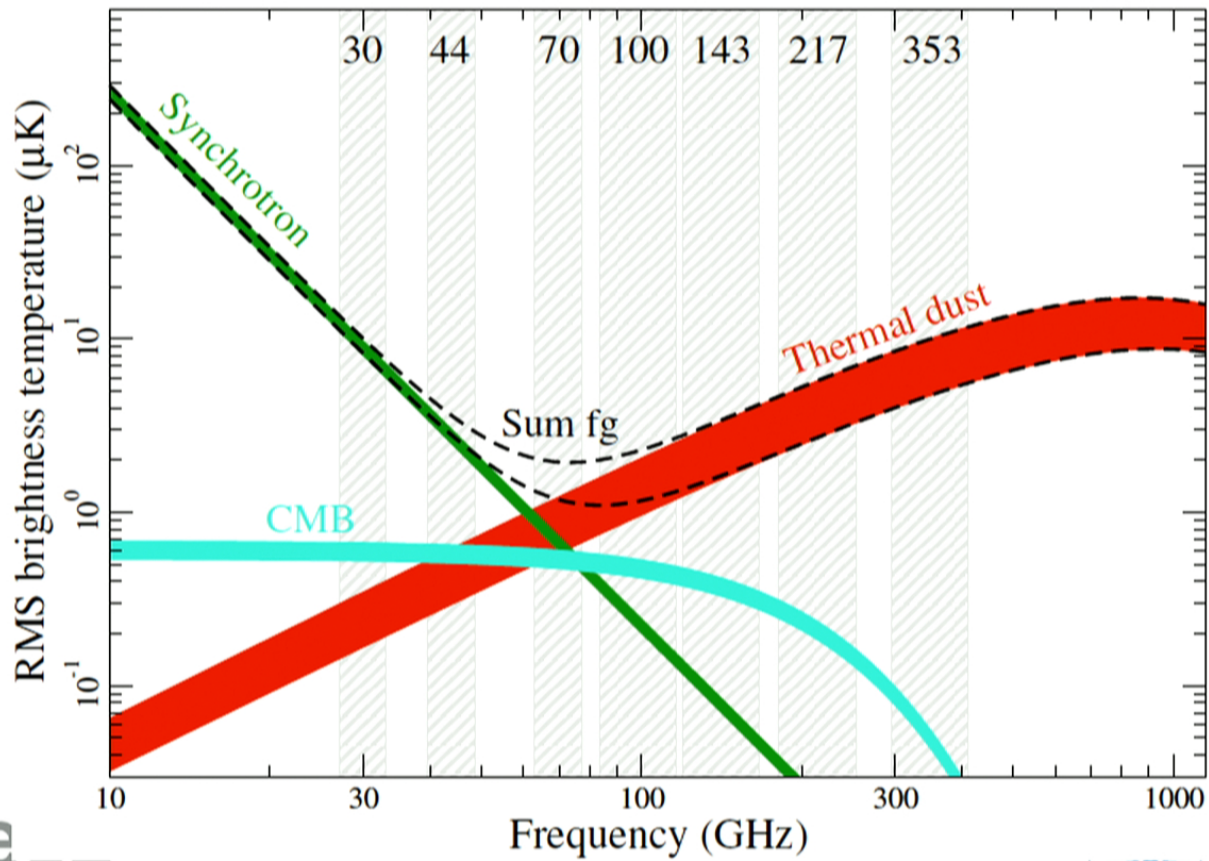
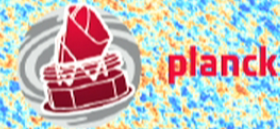
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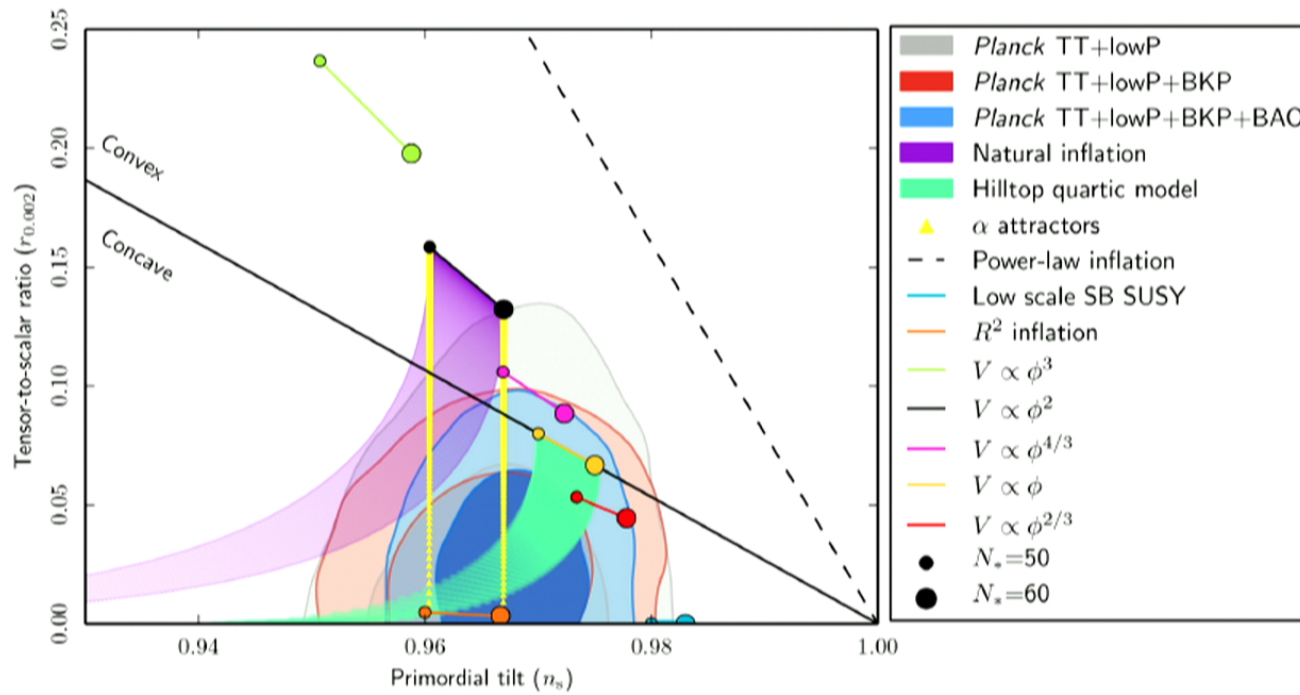
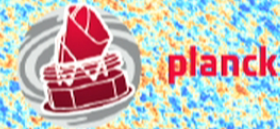


CMB vs. Astrophysical Foregrounds

◦ Intensity ◦ Polarization ◦ Atmospheric Transmission ◦



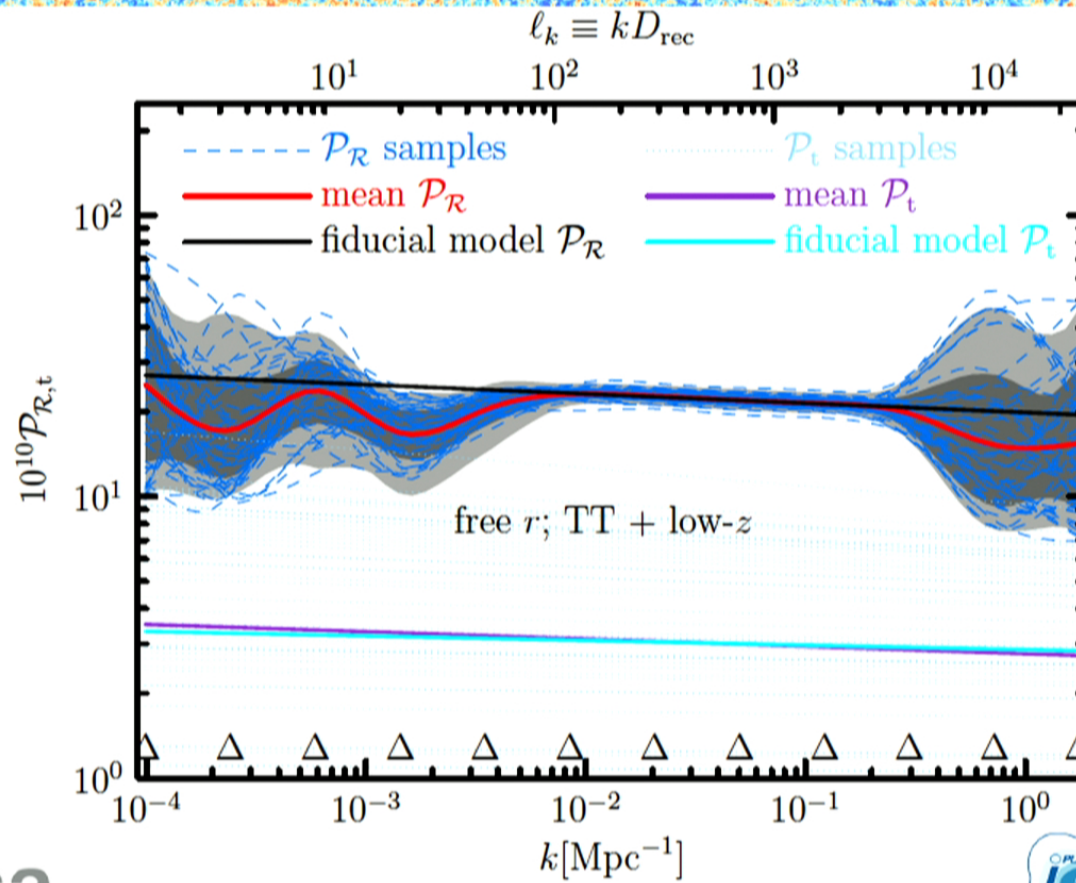
Planck + BICEP2 Constraints



Primordial Spectrum Reconstruction



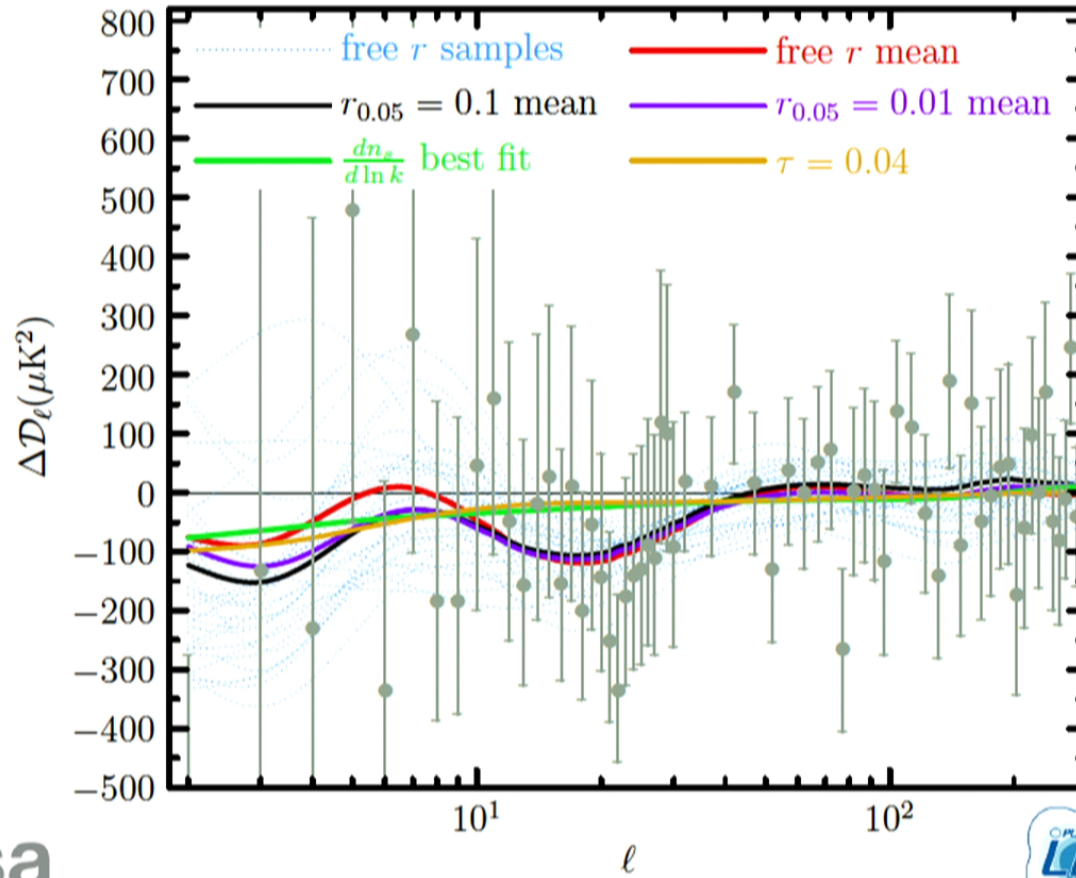
planck



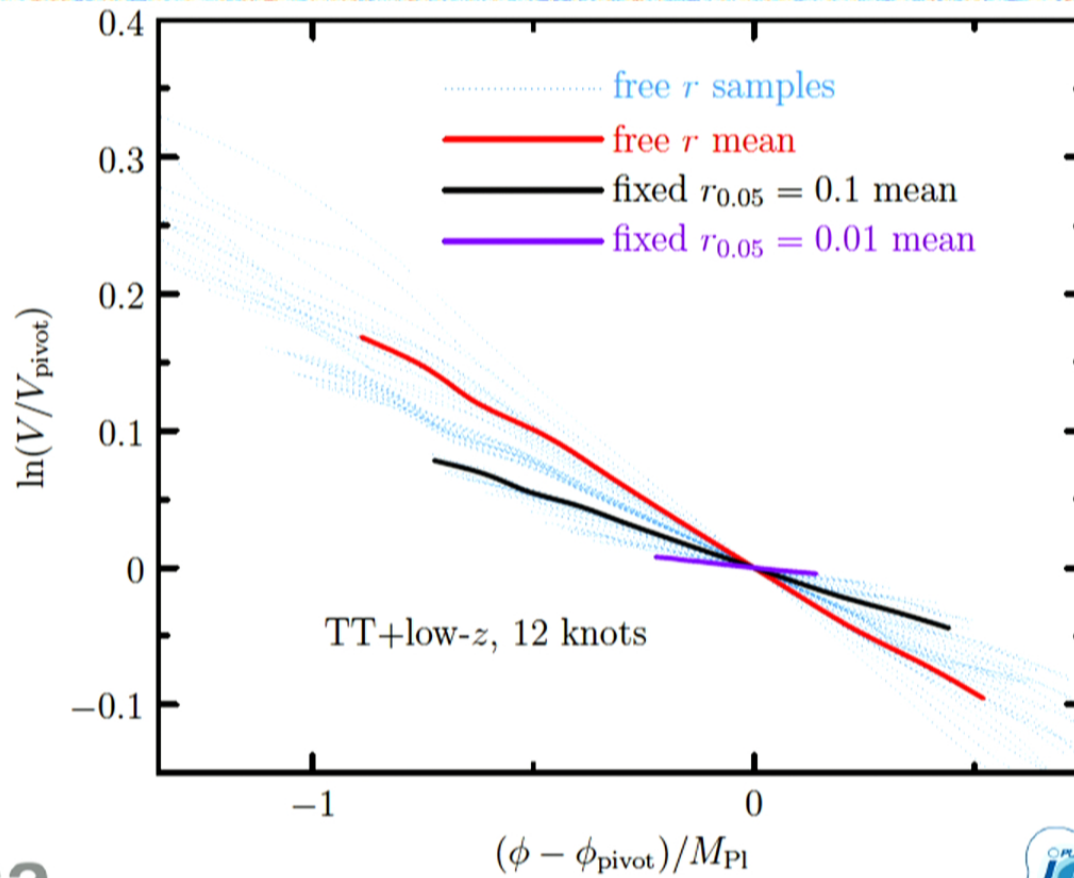
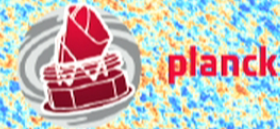
Running Spectral Index is Not a Good Fit



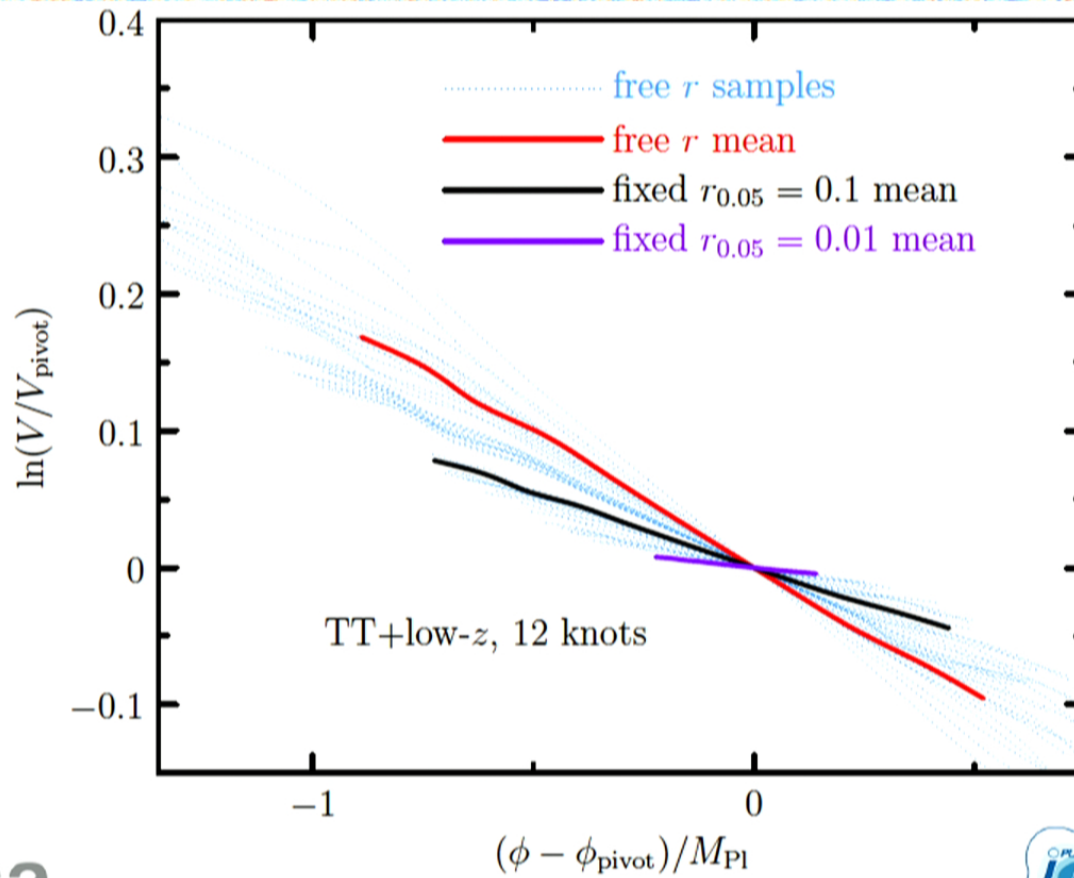
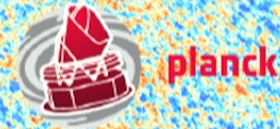
planck

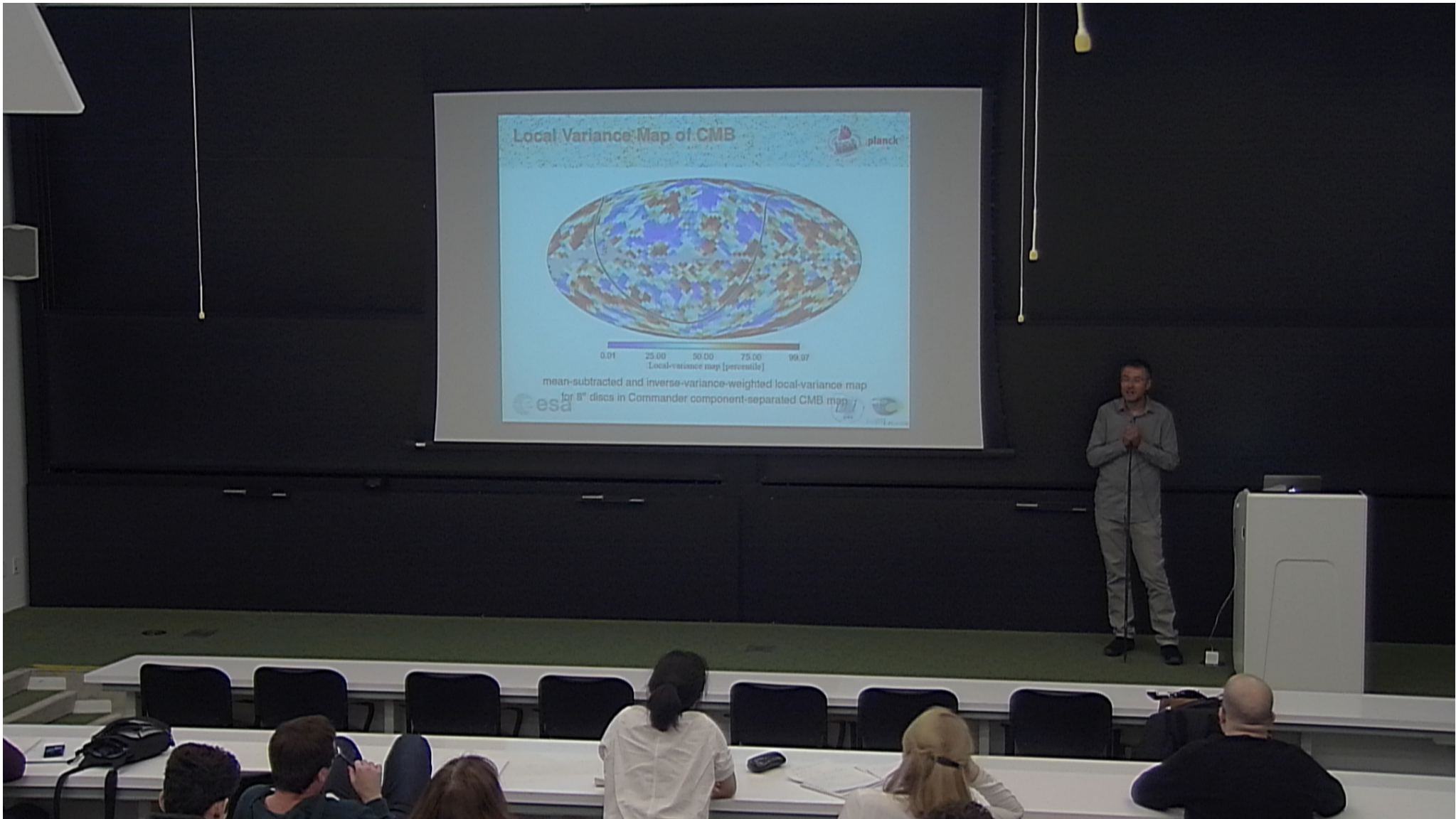


Primordial Potential Reconstruction

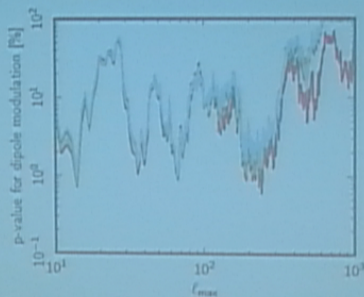
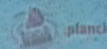


Primordial Potential Reconstruction

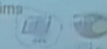




QML Estimator of Dipole Modulation



Go after $\delta C_{\ell\ell+1}$ in $2 < \ell < l_{max}$ range, compare to sims





Going after localized anomalies...

Let's look at peaks!

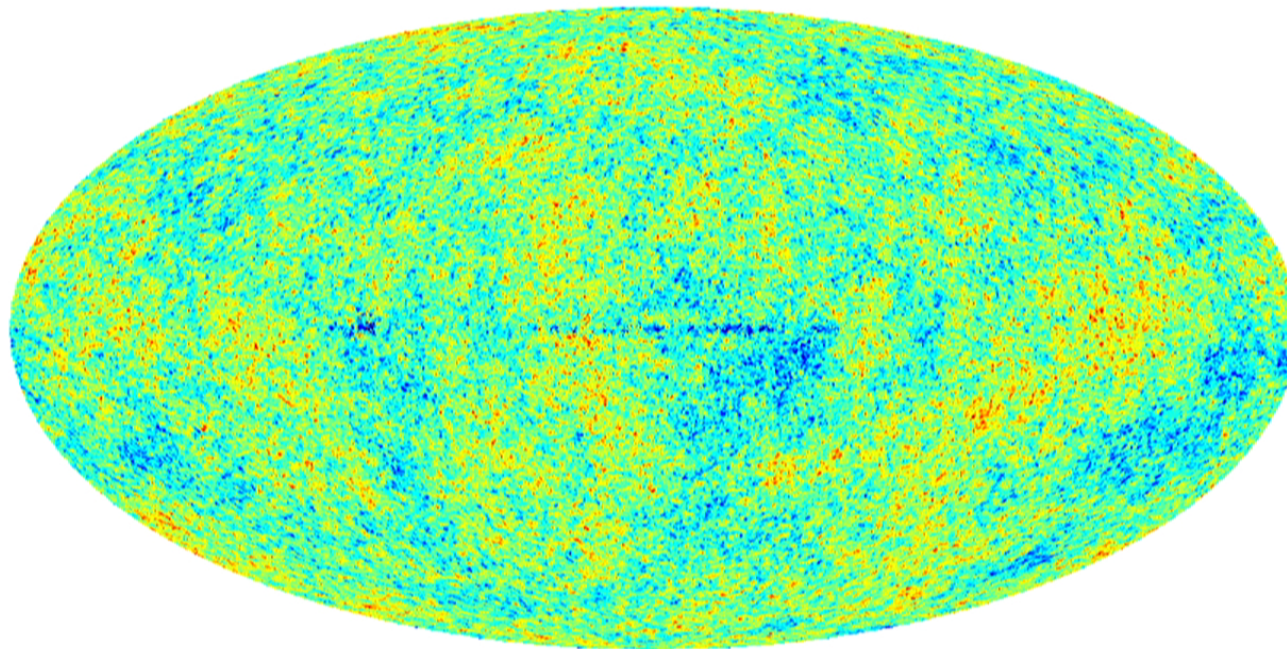


CMB Data Analysis Pipeline

◦ SMICA ◦ Whiten ◦ Mask ◦ Filter ◦ Find Peaks ◦



planck



-4.500E-04



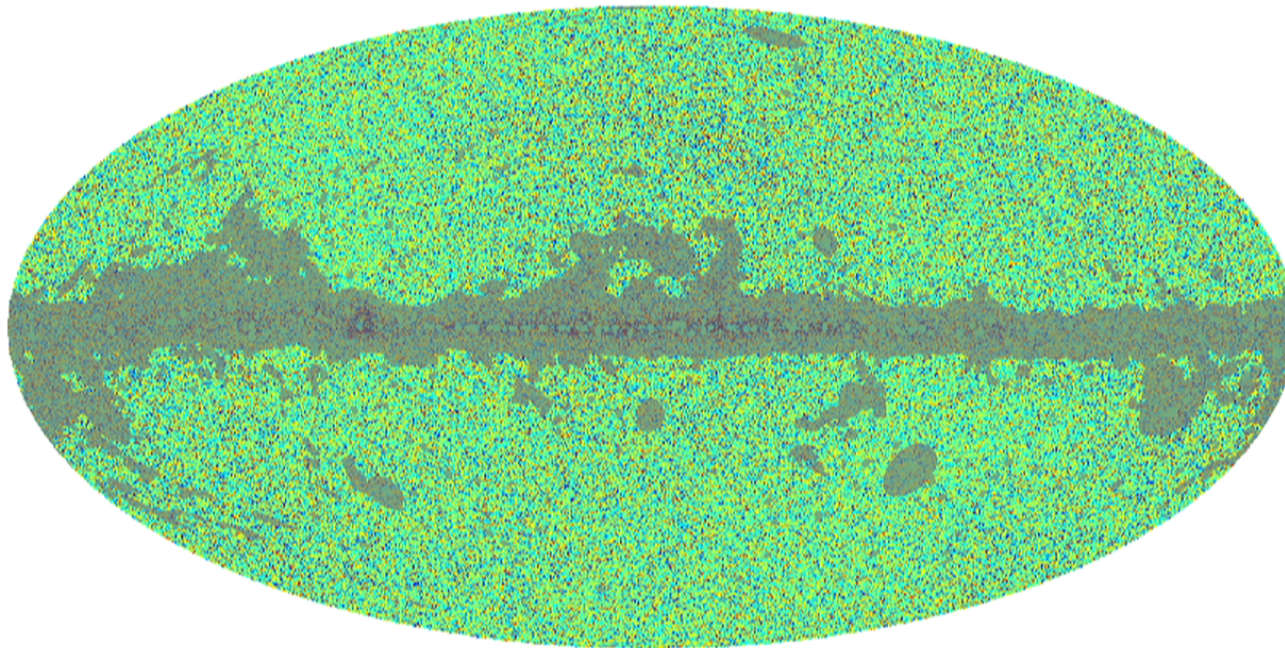
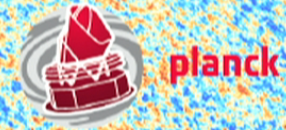
+4.500E-04

Planck 2015 release [SSG84 filter at $240'$ FWHM]



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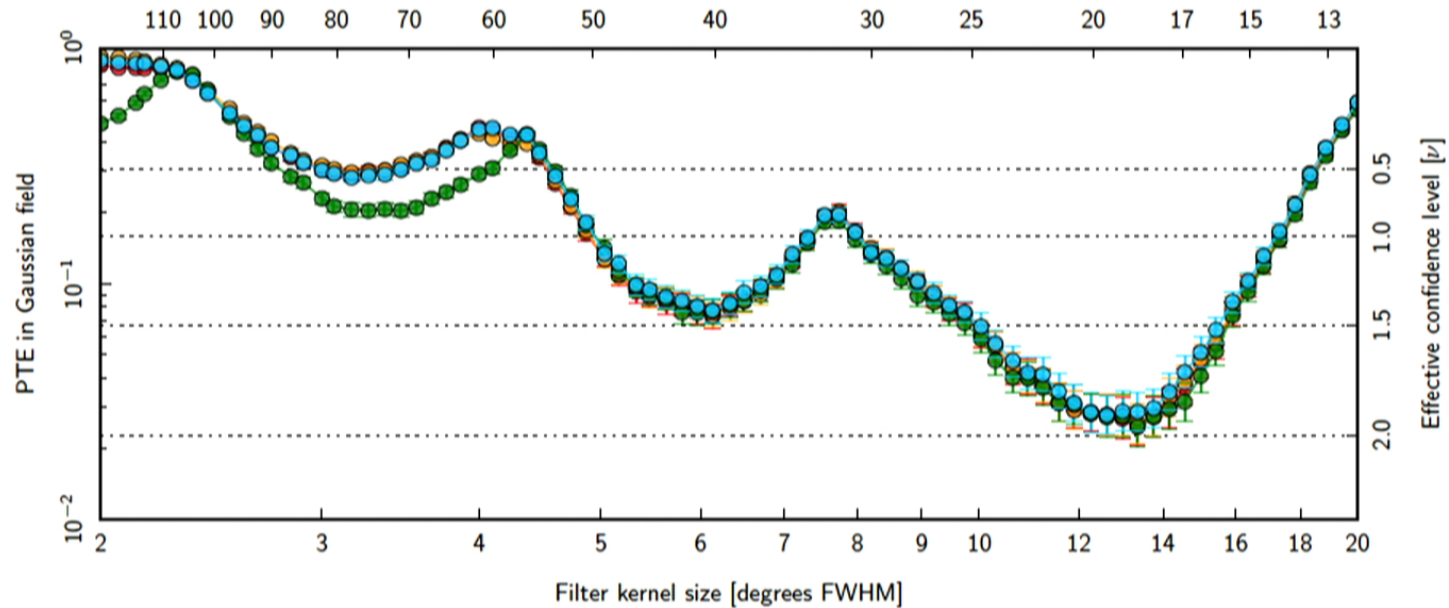
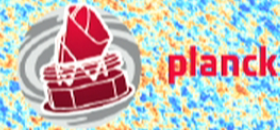
-1.200E+03  +1.200E+03

Planck 2015 release [SSG84 filter at 240' FWHM]



Significance of Cold Spot

◦ Whitened Savitzky-Golay ◦ Mexican Hat Wavelet ◦

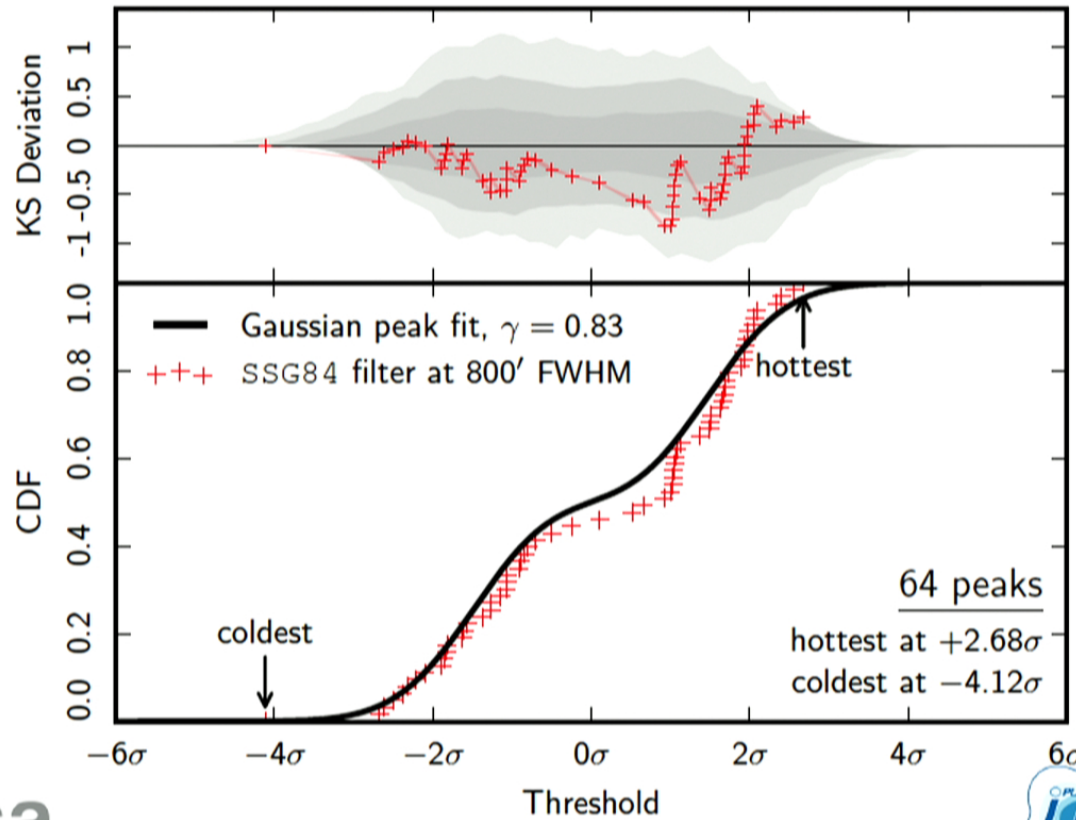


Significance evaluated by counting simulations which exceed observed value –

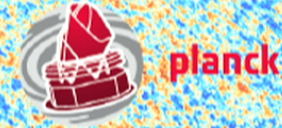
[For full details see Isotropy and Statistics paper.](#)



Cold Spot is Fairly Cold!



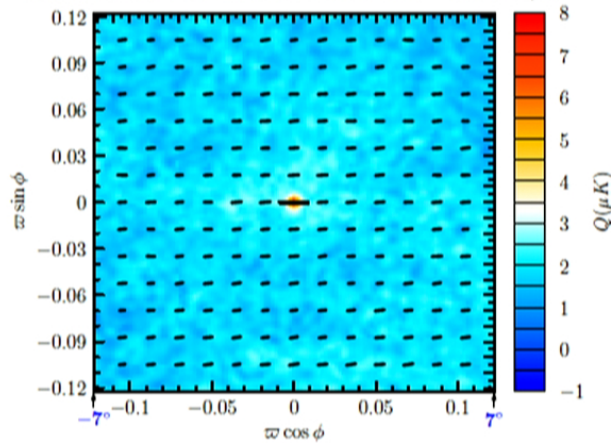
Stacking Polarized Dust



Planck 2015 Component Separated Commander Dust Map

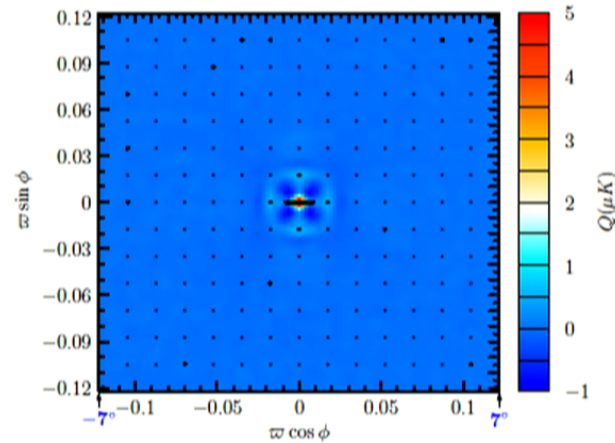
Dust Component, $T < 25\mu K$

43 patches on P maxima, oriented, threshold $\nu = 1$, $I \leq 25\mu K$



CMB Component

33536 patches on P maxima, oriented, threshold $\nu = 1$

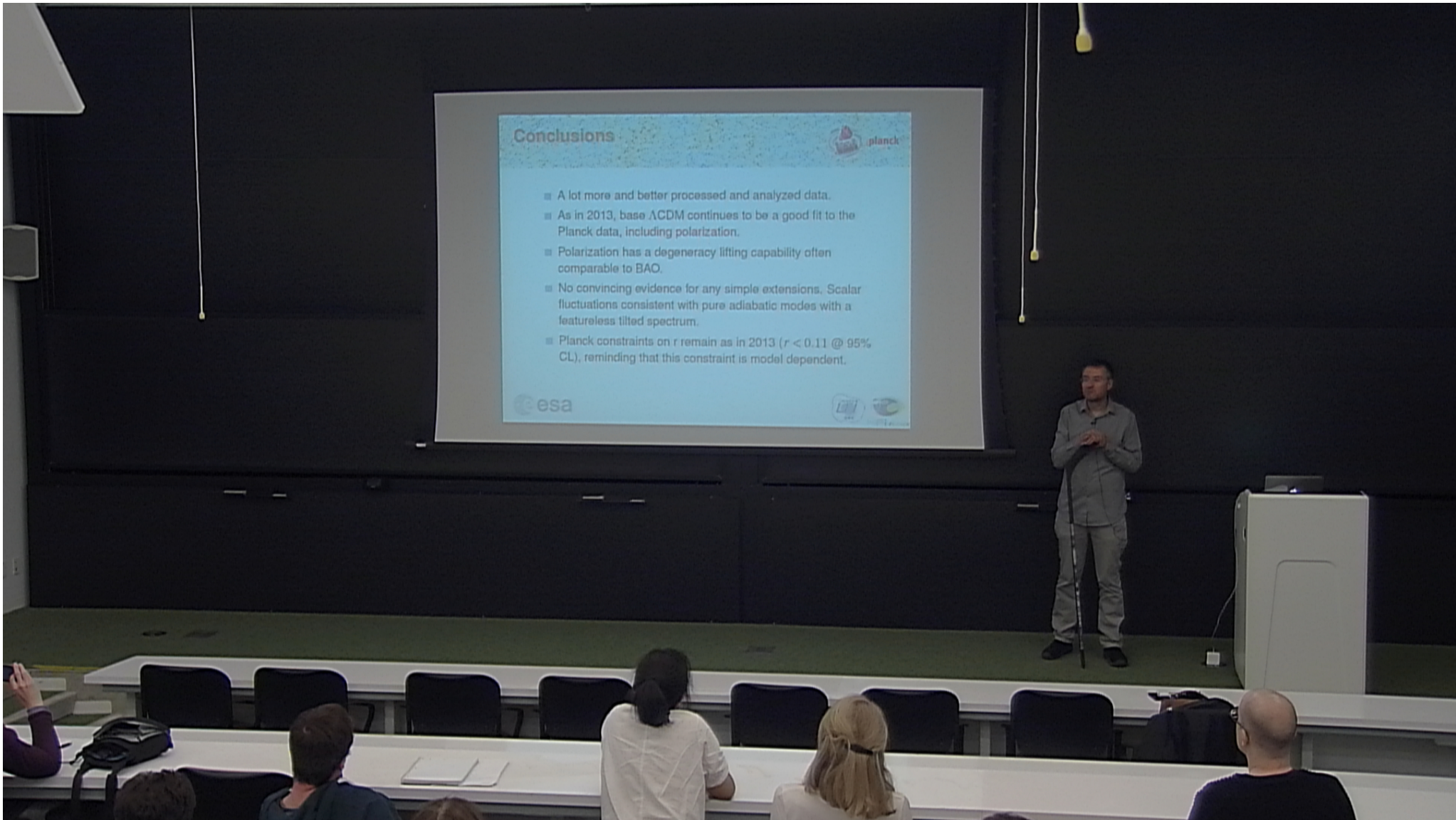


Q stacked on $Q^2 + U^2$ oriented peaks (oriented s.t. U vanishes in the centre).

Patch size: $\varpi \leq 7^\circ$; threshold $\nu = 1$

T map FWHM 2° ; Q, U maps FWHM 15 arcmin.

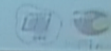




Conclusions



- A lot more and better processed and analyzed data.
- As in 2013, base Λ CDM continues to be a good fit to the Planck data, including polarization.
- Polarization has a degeneracy lifting capability often comparable to BAO.
- No convincing evidence for any simple extensions. Scalar fluctuations consistent with pure adiabatic modes with a featureless tilted spectrum.
- Planck constraints on r remain as in 2013 ($r < 0.11$ @ 95% CL), reminding that this constraint is model dependent.



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