Planck, inflation and the future of inflationary constraints

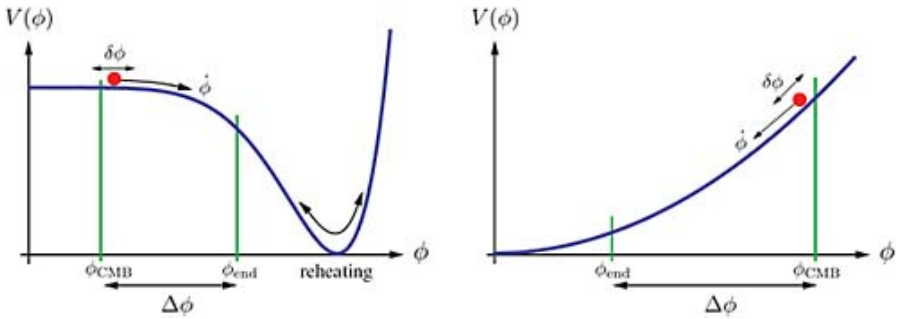
Consistency of Cosmological Datasets: Evidence for new Physics?

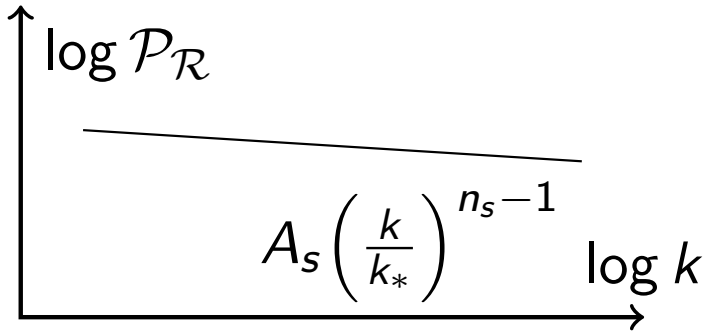
Will Handley
wh260@cam.ac.uk

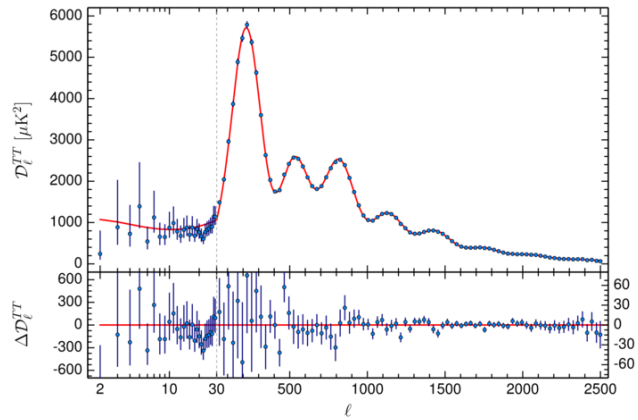
Astrophysics Group
Cavendish Laboratory
University of Cambridge

1st June 2018

The pipeline from inflation to the CMB



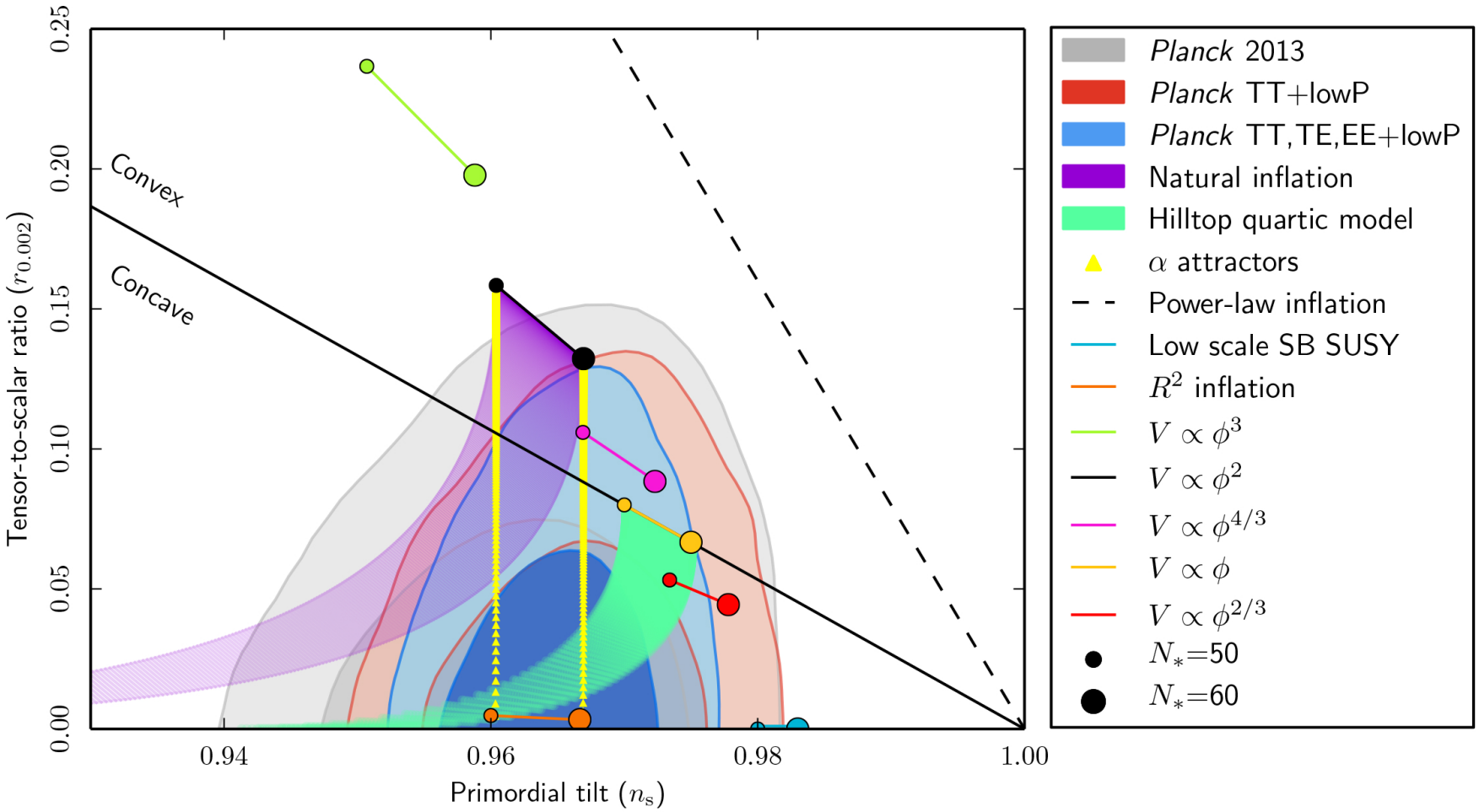




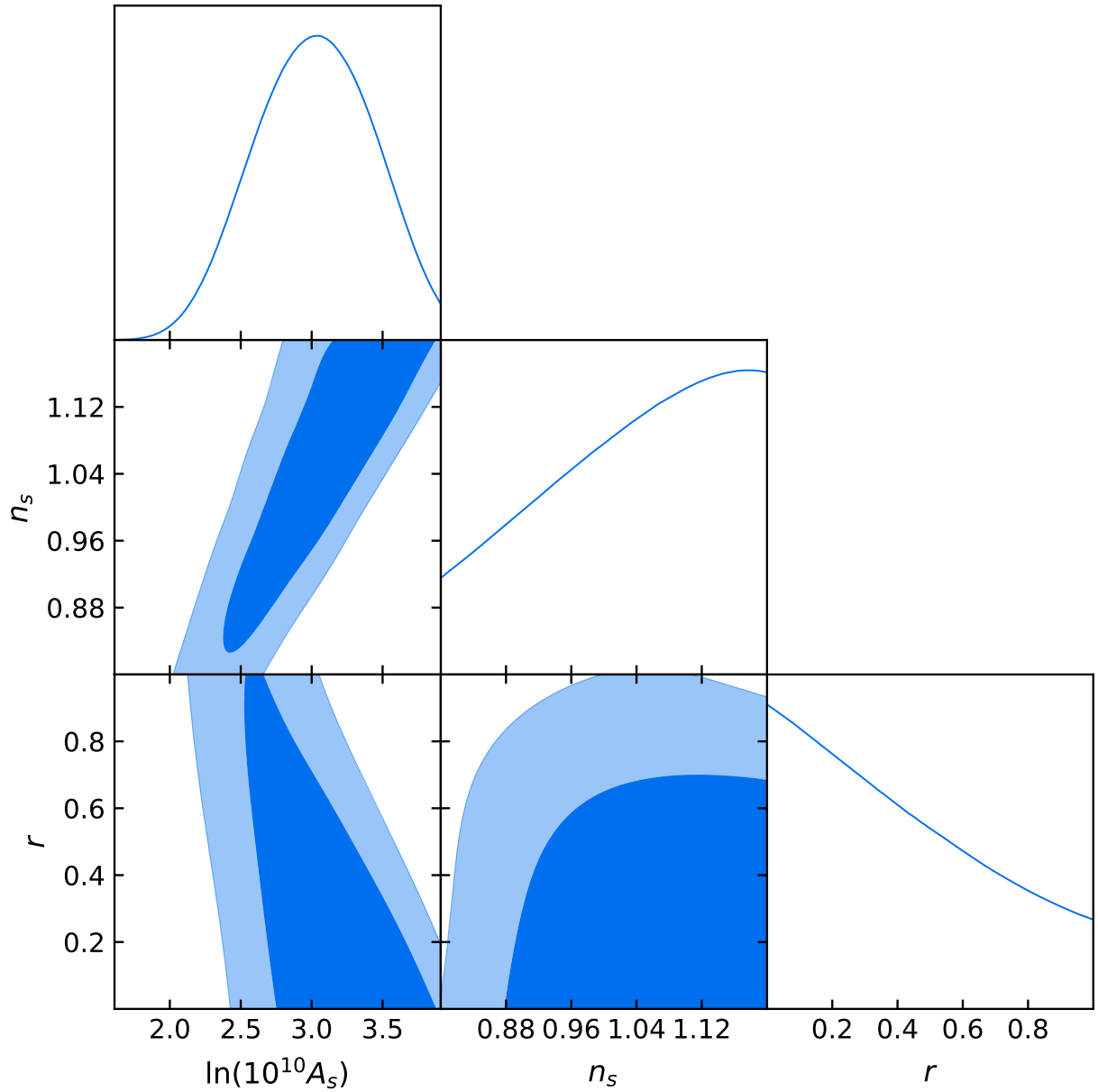
- Inflationary model
- Primordial power spectrum $\mathcal{P}_{\mathcal{R}}$
- (A_s, n_s, r)
- Boltzmann solver & line-of-site projection
- $(\Omega_b h^2, \Omega_c h^2, \theta_*, \tau)$
- CMB power spectrum C_ℓ

Constraining inflation (Planck 2015)

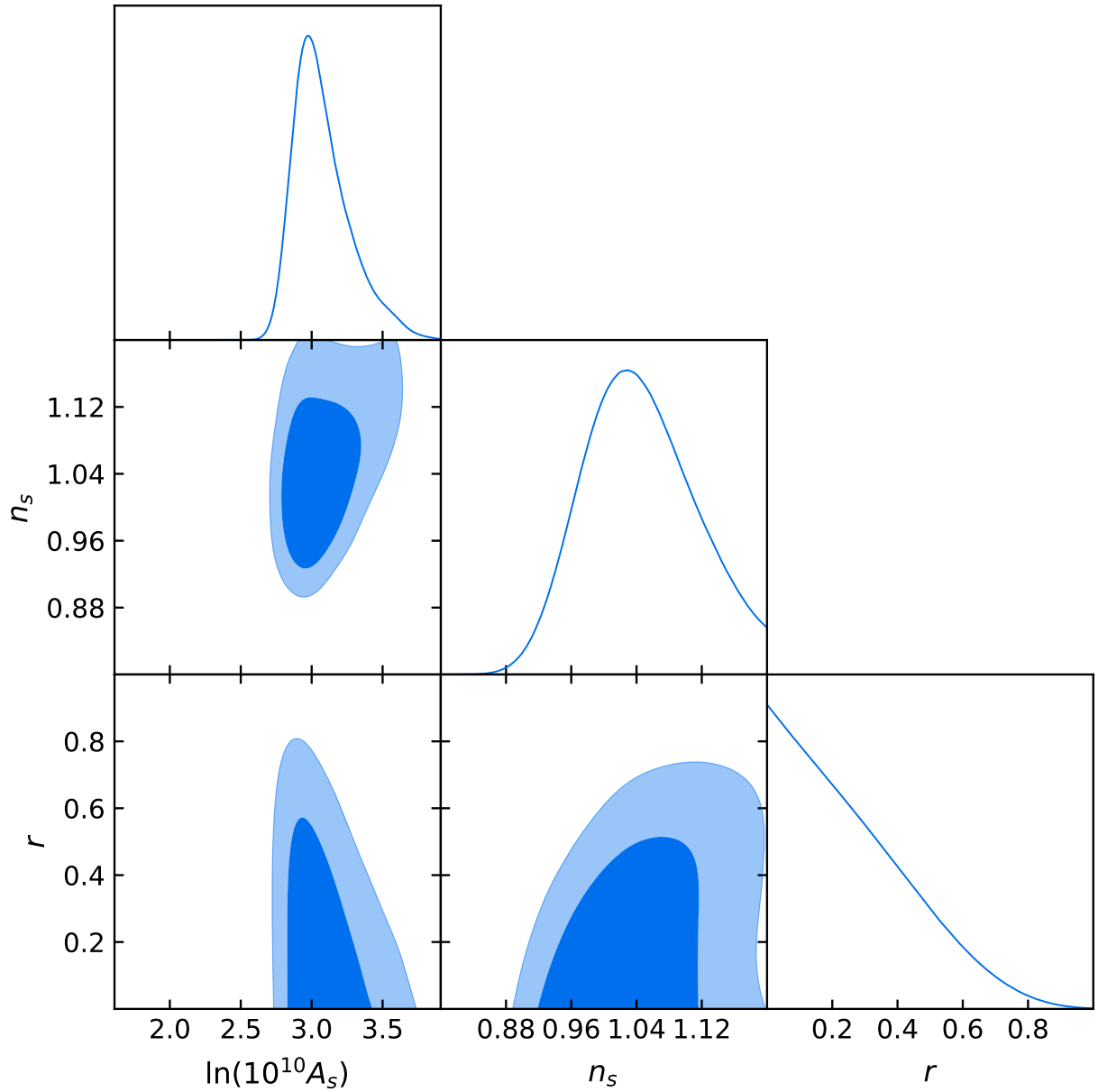
Linking theorists and observers



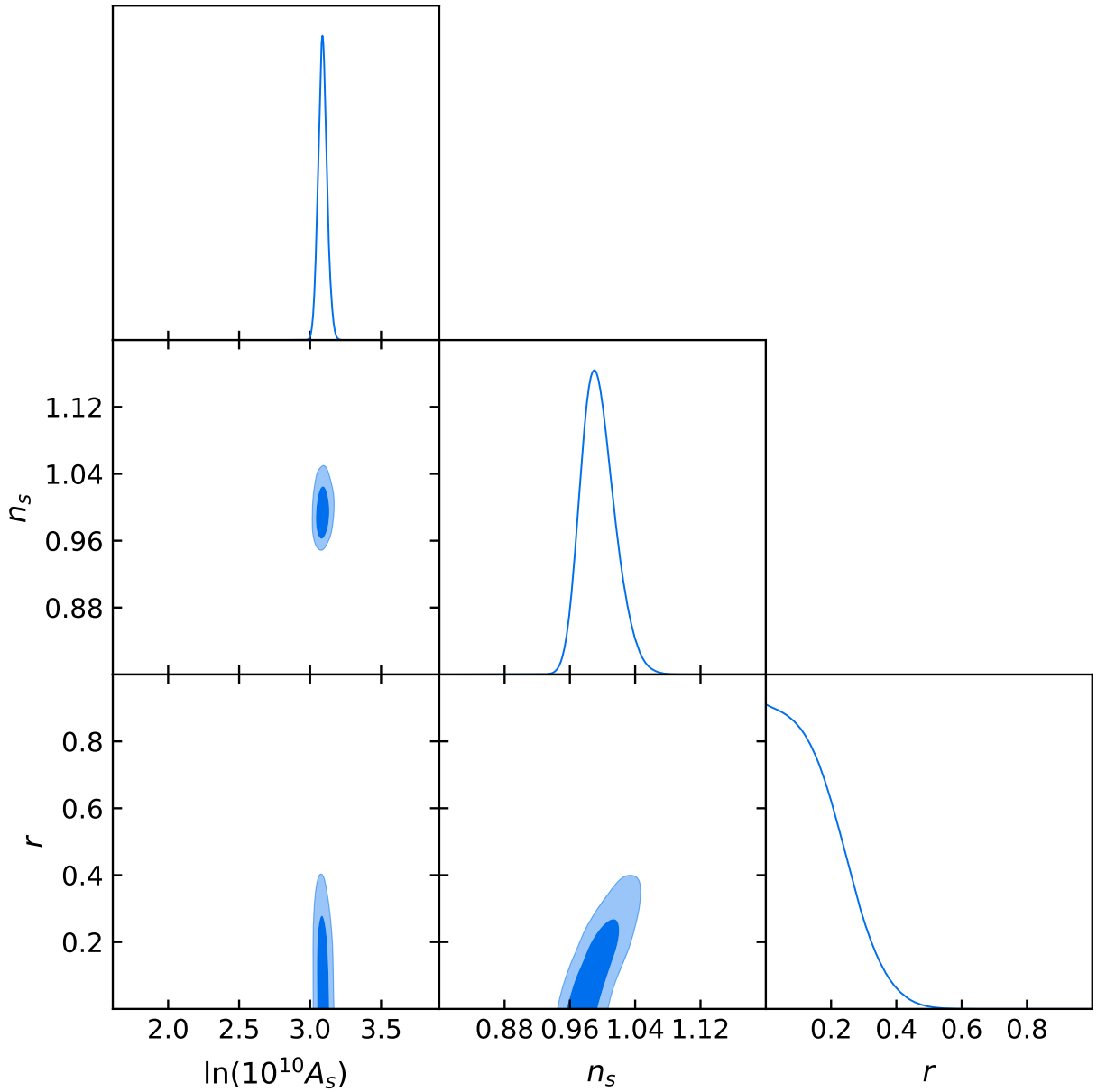
COBE


1.12
1.04
0.96
0.88
n_s
0.8
0.6
0.4
0.2
r
2.0
2.5
3.0
3.5
$\ln(10^{10}A_s)$
0.88
0.96
1.04
1.12
n_s
0.2
0.4
0.6
0.8
r

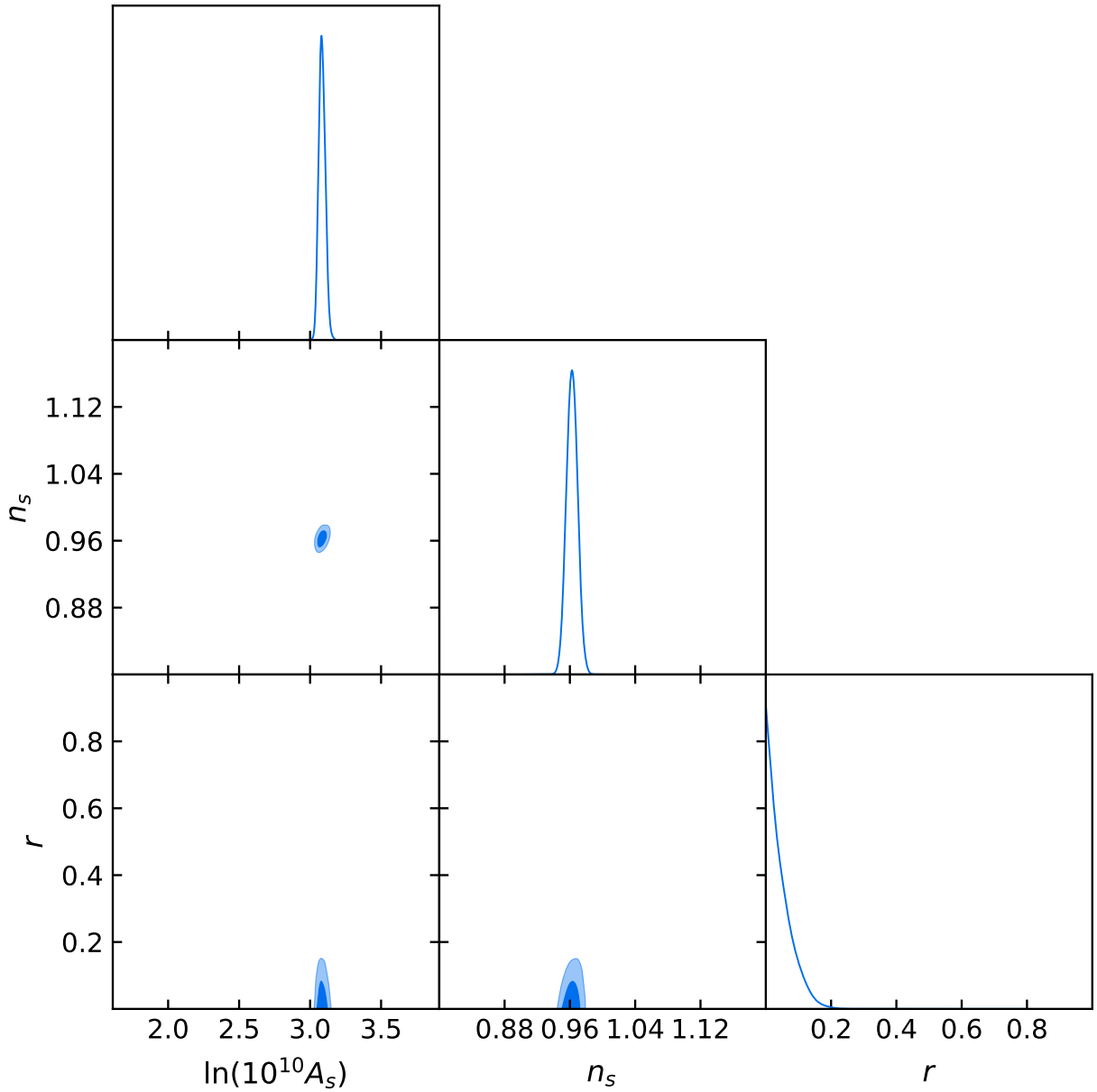
COBE, MAXIMA, BOOMERANG, VSA, DASI, CBI



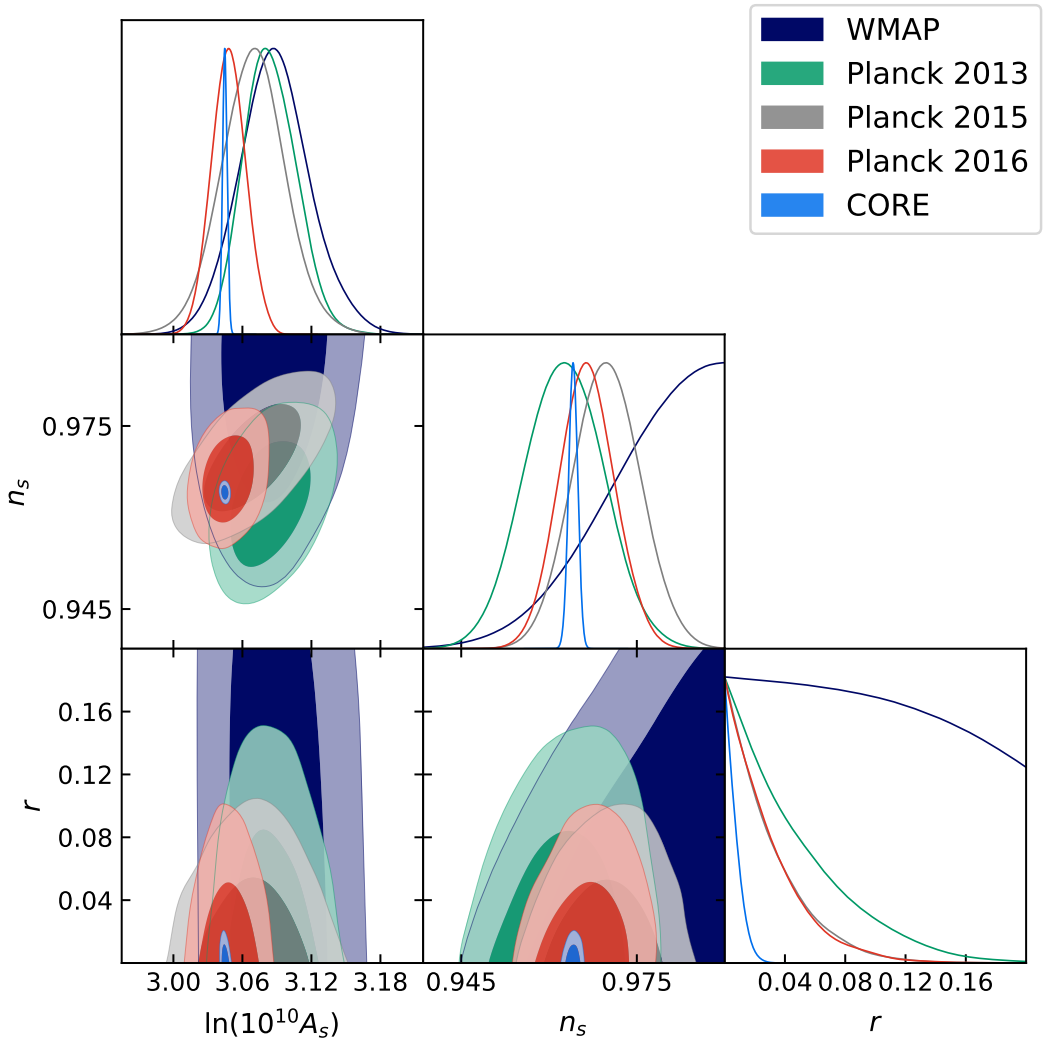
WMAP


1.12
1.04
0.96
0.88
n_s
0.8
0.6
0.4
0.2
r
2.0
2.5
3.0
3.5
$\ln(10^{10}A_s)$
0.88
0.96
1.04
1.12
n_s
0.2
0.4
0.6
0.8
r

Planck 2013

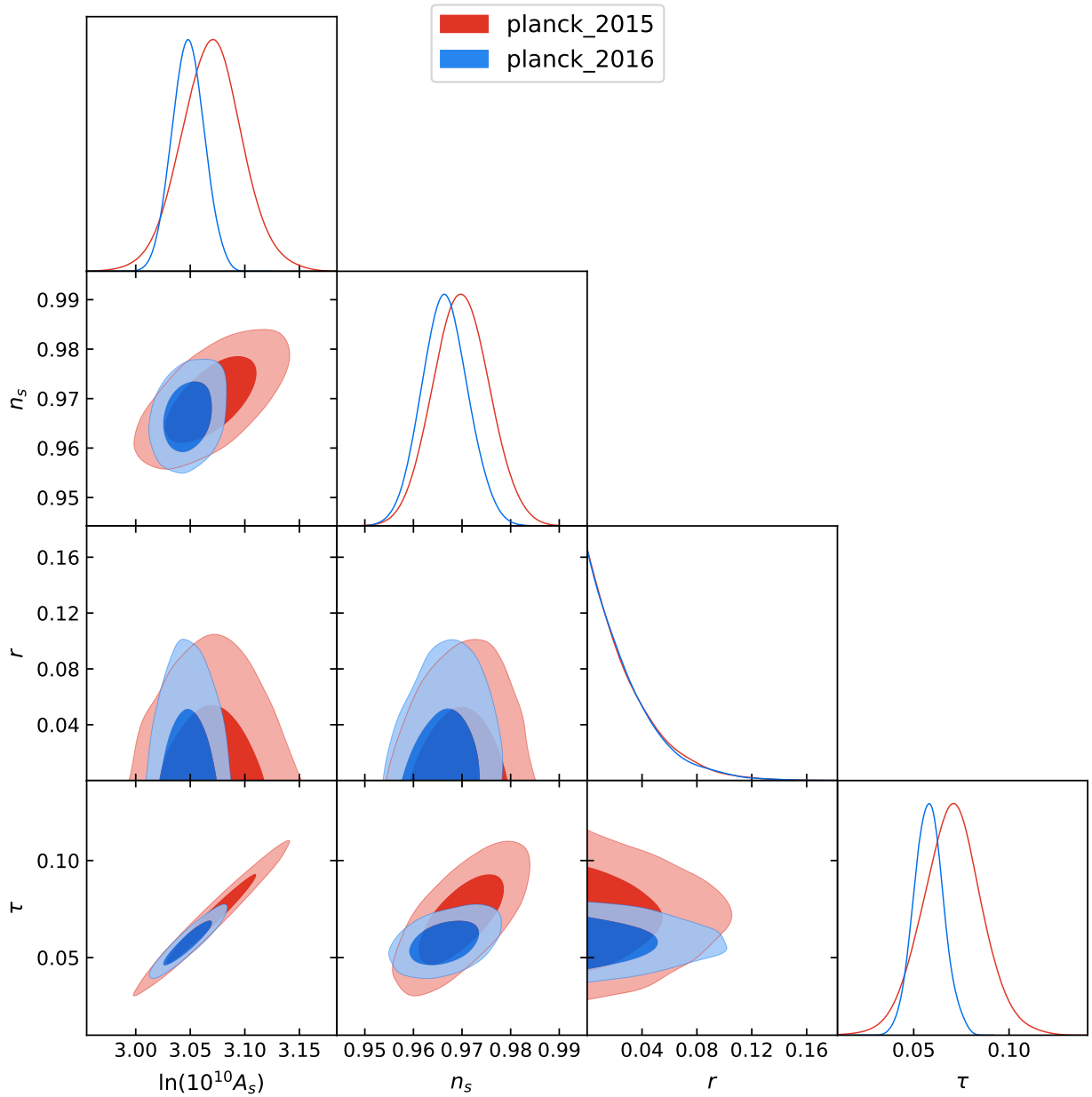

1.12
1.04
0.96
0.88
n_s
0.8
0.6
0.4
0.2
r
2.0
2.5
3.0
3.5
$\ln(10^{10}A_s)$
0.88
0.96
1.04
1.12
n_s
0.2
0.4
0.6
0.8
r

The Future

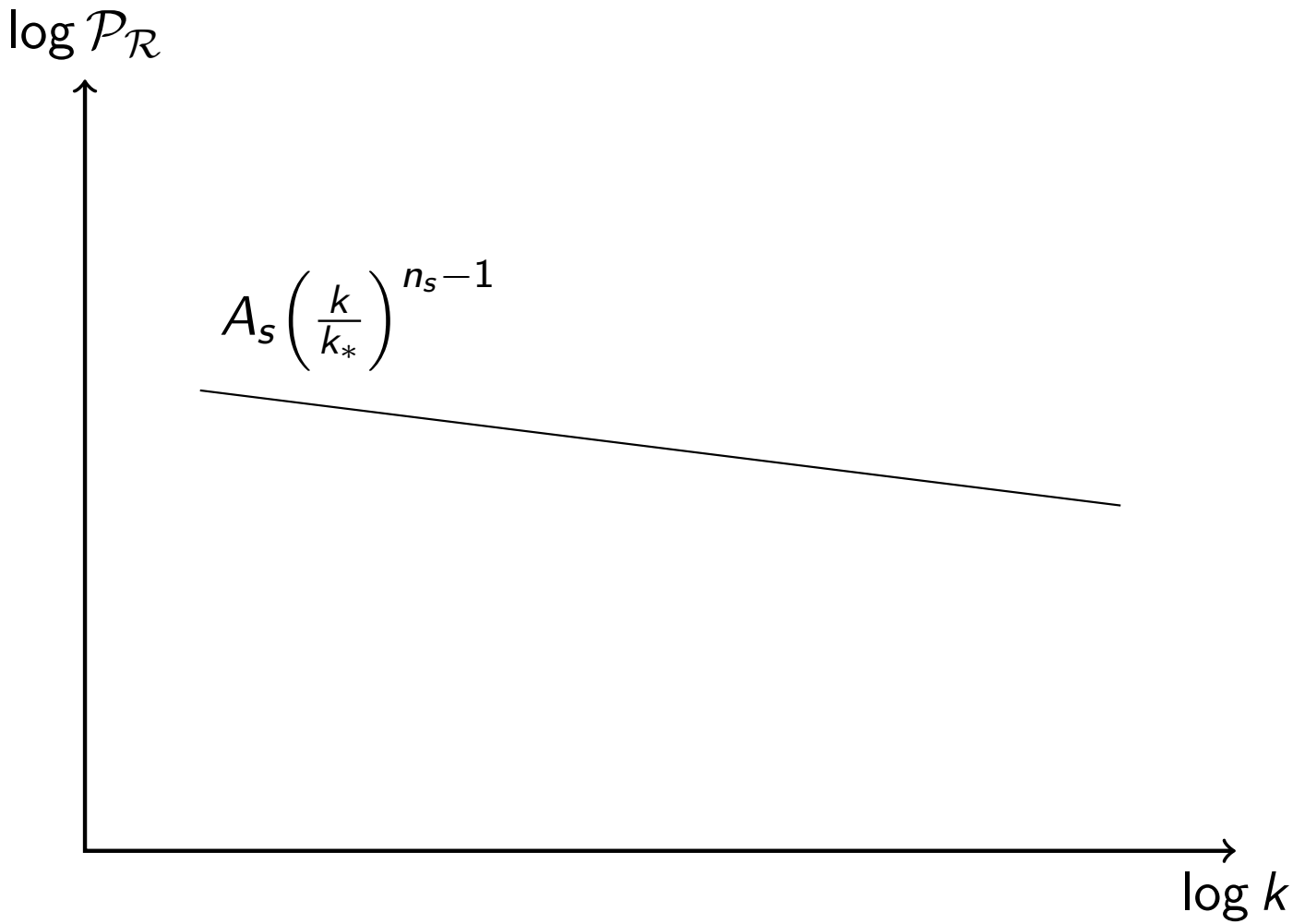


- Lyth bound:
  $r > 0.01 \Rightarrow \Delta\phi > M_{\mathrm{p}}$
- LiteBird: $r \sim \mathcal{O}(10^{-3})$,
  $r \sim \mathcal{O}(N^{-2})$ $50 < N < 60$
- Compare specific inflationary models.

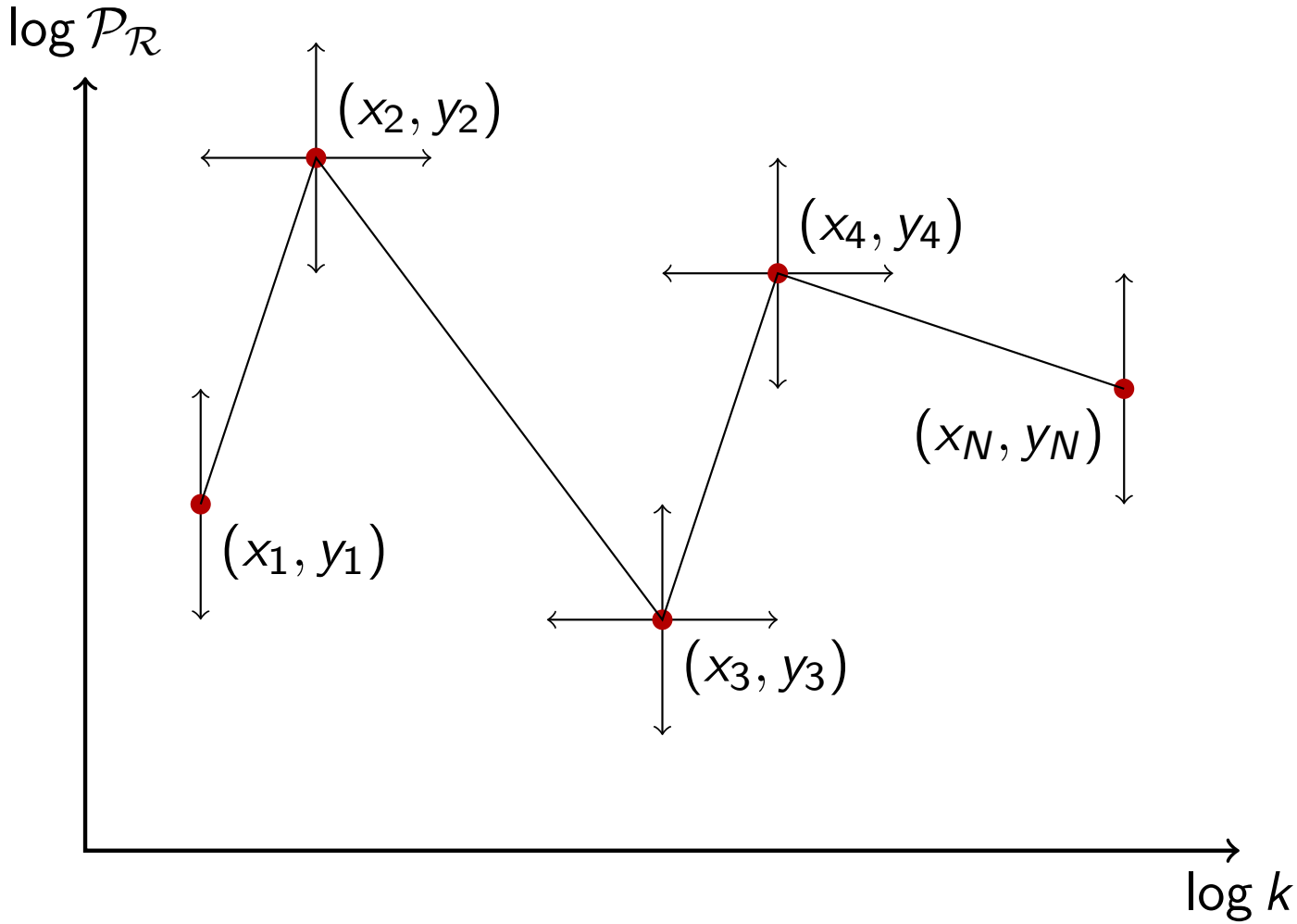
The importance of τ



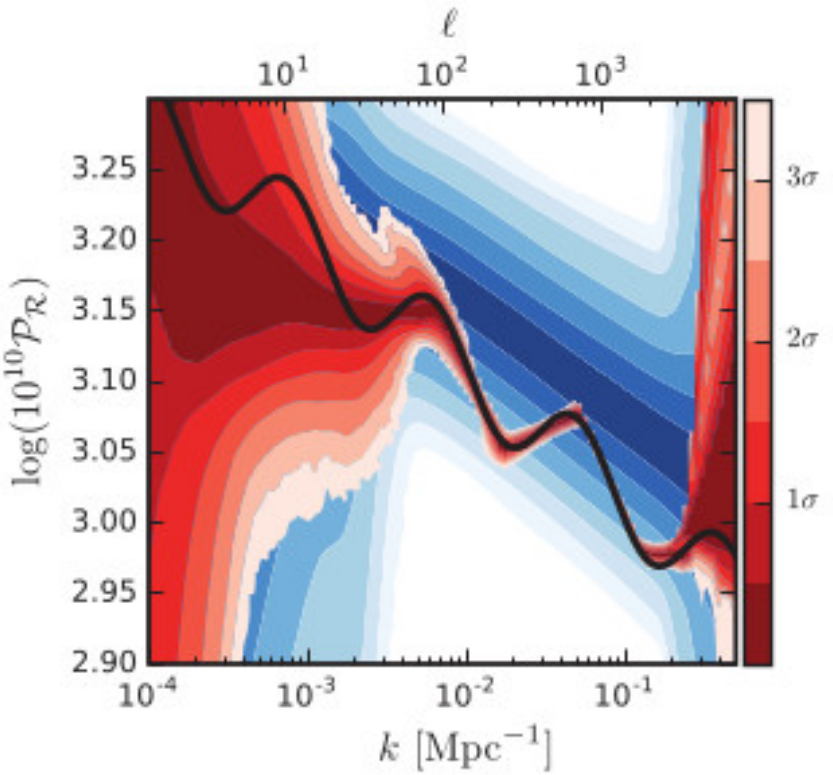
Primordial power spectrum reconstruction

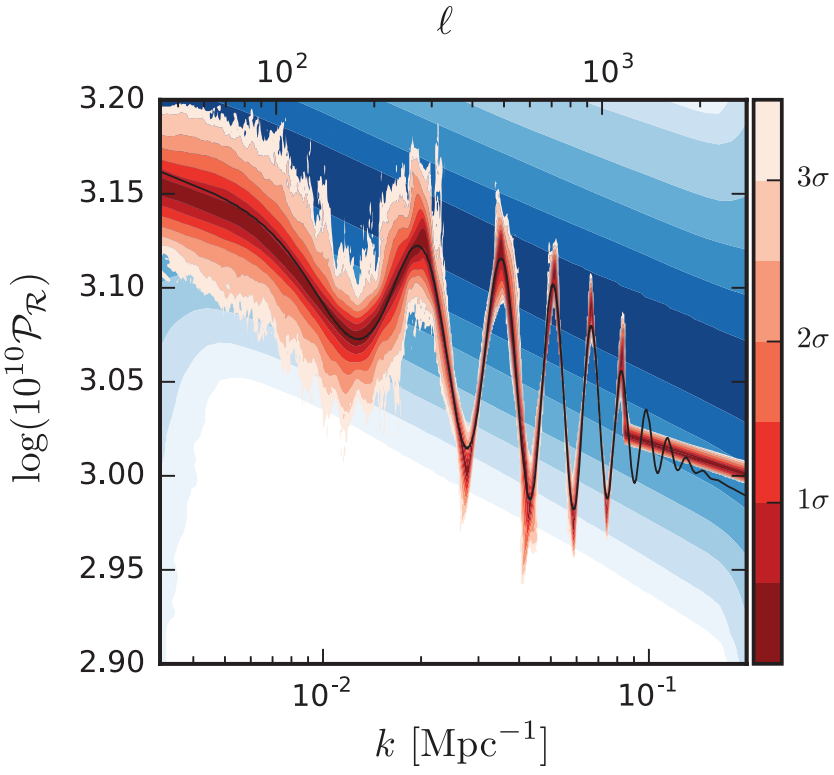


Primordial power spectrum reconstruction

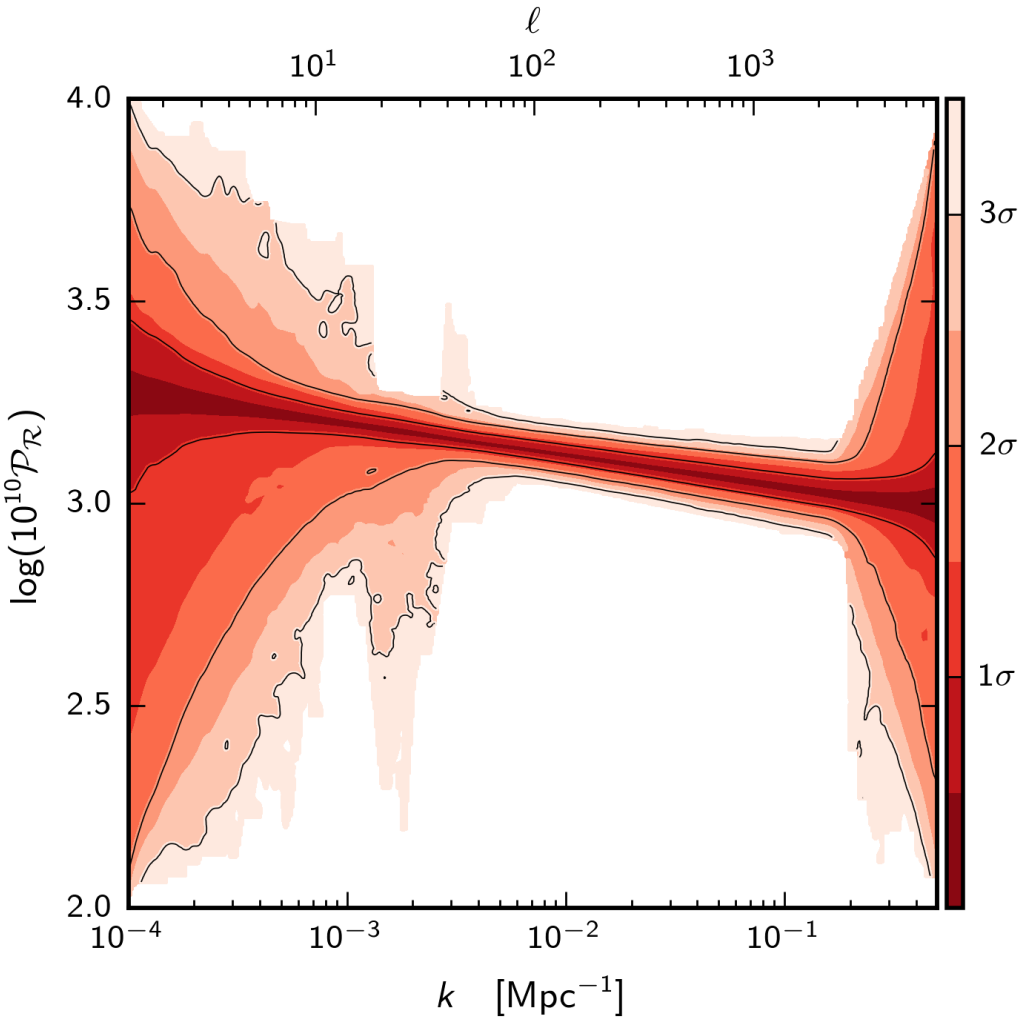


Primordial power spectrum reconstruction with CORE





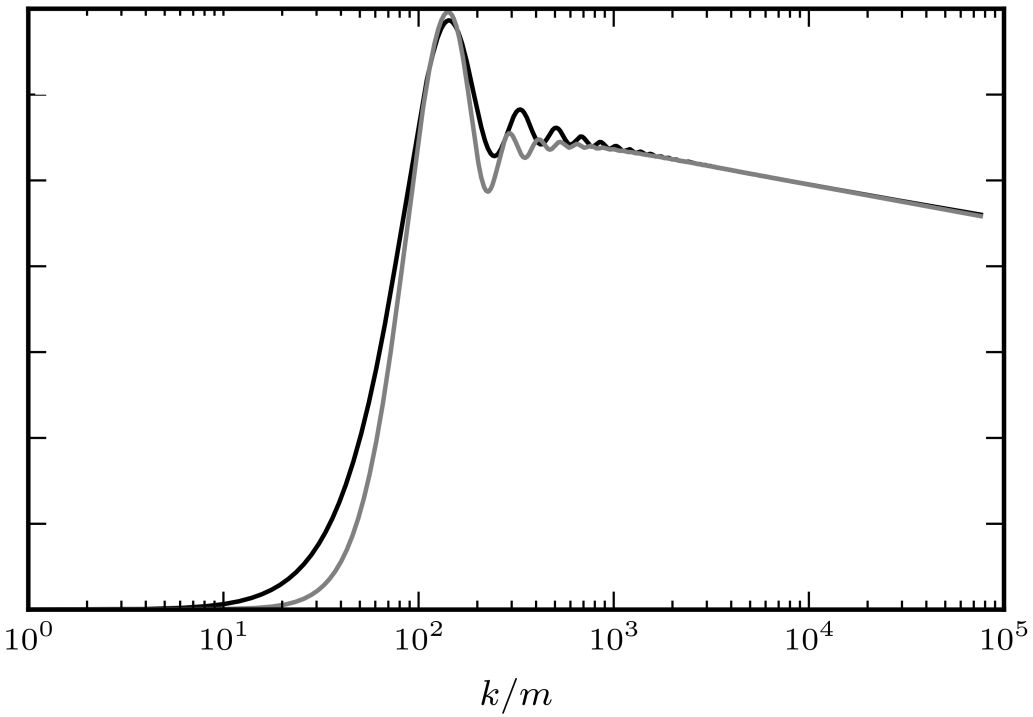
The future of inflation observation



- $r \overset{?}{\neq} 0$ — LiteBird
- better $\tau \Rightarrow$ feature finding
  — CORE (CMB Bharat?)
  — PICO?
- Spectral distortions — PRISTINE?
- Alternative models to relieve tensions?

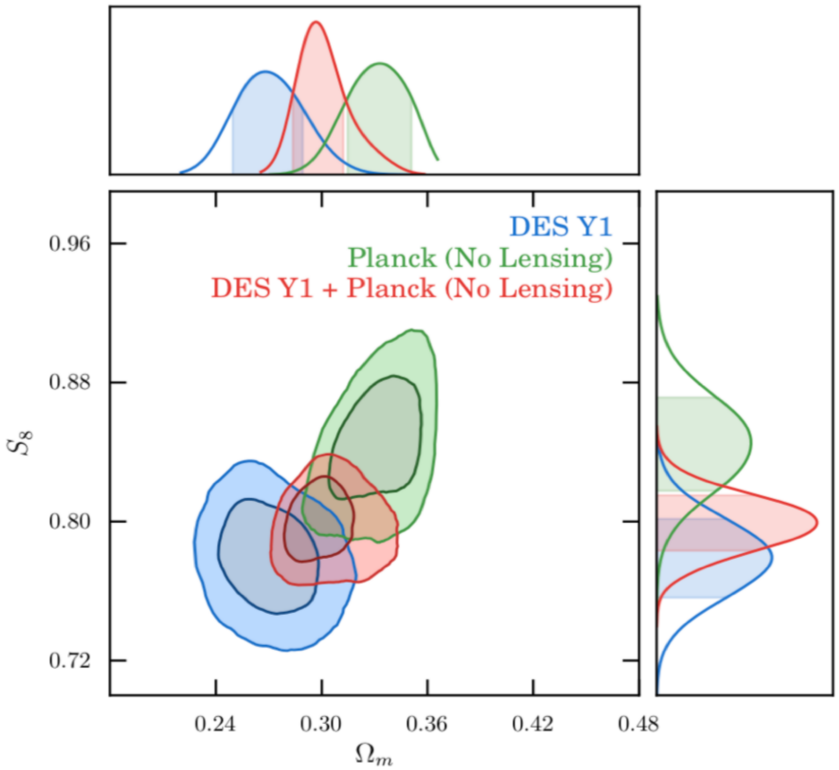
Alternative models: Kinetic dominance

"Just enough inflation"



- Only $\sim \mathcal{O}(60)$ efolds of total inflation
- Preceded by generic phase of $\dot{\phi}^2 \gg V(\phi)$
- Natural mechanism for generating low-ℓ supression
- Possibility of fitting $\ell \sim 30$ feature
- Spatial curvature provides stronger justification.

The DES Bayes factor



- Contains everything it should, in a dimensionally consistent way:

$$R = \frac{P(D_{pl}, D_{des}|M)}{P(D_{pl}|M)P(D_{des}|M)}$$

- $R \sim 10$ default prior, $R \sim 0.1$ for narrower prior.

$$R = \frac{P(D_{pl}|D_{des}, M)}{P(D_{pl}|M)} = \frac{P(D_{pl}|M_{OL})}{P(D_{pl}|M_{GPE})}$$

- Represents Bayesian confidence in ability to combine the data
- The fact that there are physically reasonable priors which make $R < 1$ means that as a Bayesian I am very suspicious of this combination.
- Conditioned on ΛCDM, these data are inconsistent.