

ISOCURVATURE FORECASTS FOR PLANCK, CMB S4, AND PIXIE, AND MAYBE CONSTRAINTS FOR ACTPOL

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ABSTRACT

We provide forecasts of cold dark matter isocurvature (CDI) constraints for combinations of Planck, CMB S4, and PIXIE. Using MCMC methods on fiducial power spectra, we find substantial improvements in the measurement of the large scale isocurvature power.

1. INTRODUCTION

- broad motivations for what produces isocurvature. axions / inflation
- heuristic description of isocurvature effects on CMB power spectra. maybe I include something like the dD_l/dP_{II}^j plots.
- previous CMB measurements: Planck 2015, WMAP (Komatsu et al, Bean et al, Moodley 2004)
- maybe discuss some European cosmological future projects (CoRE? LiteBird?)
- other forecasting papers? Do these exist?

2. METHODS

2.1. Perturbations and Power Spectra

I should include the description of PII and PRI.

For a set of the standard cosmological parameters with the additional isocurvature parameters, we compute a theoretical power spectrum with CLASS, a fast Boltzmann code written in C (citation). The adiabatic and isocurvature are contained in three functions, $\mathcal{P}_{\mathcal{R}\mathcal{R}}(k)$, $\mathcal{P}_{II}(k)$, and $\mathcal{P}_{RI}(k)$, the curvature, isocurvature, and cross-correlation power spectra, respectively (cite Planck 2015 XX). Like Planck, we specify these power spectra through two scales, $k_1 = 0.002 \text{ Mpc}^{-1}$ and $k_2 = 0.100 \text{ Mpc}^{-1}$. We use the same uniform priors as Planck,

$$\mathcal{P}_{\mathcal{R}\mathcal{R}}^{(1)}, \mathcal{P}_{\mathcal{R}\mathcal{R}}^{(2)} \in (10^{-9}, 10^{-8}), \quad (1)$$

$$\mathcal{P}_{II}^{(1)}, \mathcal{P}_{II}^{(2)} \in (0, 10^{-8}), \quad (2)$$

$$\mathcal{P}_{RI}^{(1)} \in (-10^{-8}, 10^{-8}). \quad (3)$$

We follow Planck 2015 XX's convention of fixing $\mathcal{P}_{RI}^{(2)}$ from these parameters. Then we sample over the Λ CDM scenario, but replace A_s and n_s with $\mathcal{P}_{\mathcal{R}\mathcal{R}}^{(1)}$, $\mathcal{P}_{\mathcal{R}\mathcal{R}}^{(2)}$ and add the three isocurvature parameters $\mathcal{P}_{II}^{(1)}$, $\mathcal{P}_{II}^{(2)}$, $\mathcal{P}_{RI}^{(1)}$.

$$\{\Omega_b h^2, \Omega_c h^2, \theta_A, \tau_{reio}, \mathcal{P}_{\mathcal{R}\mathcal{R}}^{(1)}, \mathcal{P}_{\mathcal{R}\mathcal{R}}^{(2)} \quad (4)$$

$$\mathcal{P}_{II}^{(1)}, \mathcal{P}_{II}^{(2)}, \mathcal{P}_{RI}^{(1)} \} \quad (5)$$

Should I describe the perturbation stuff of how the CLASS isocurvature code works?

2.2. Forecasting

- explanation of how we got these numbers in Table 1
- how do you turn the numbers in Table 1 into a likelihood
- atmospheric noise model
- choosing a fiducial power spectrum.
- comparing the fiducial power spectrum Planck parameter estimates with real Planck (do we we need this?)

2.3. ACTPol Likelihood

We use the same methods as in Louis et al. 2016 for the ACT likelihood, marginalizing the ACTPol spectrum from $350 < l < 4000$ to construct a Gaussian likelihood function with an overall calibration parameter. We produce our parameter constraints by summing this with the Planck 2015 log-likelihood. We use the public CMB-marginalized 'plik-lite' Planck 2015 likelihood which uses TT for $30 \leq l \leq 2508$, a likelihood generated from CMB lensing, and a joint TT, EE, BB, and TE likelihood for the range $2 \leq l < 30$.

$$-2 \ln L = -2 \ln L(\text{ACTPol}) \quad (6)$$

$$-2 \ln L(\text{Planck TT}_{30 < l < 2508}) \quad (7)$$

$$-2 \ln L(\text{Planck TEB}_{2 \leq l < 30}) \quad (8)$$

$$-2 \ln L(\text{Planck Lensing}) \quad (9)$$

In addition to the Λ CDM and isocurvature parameters, we need two nuisance parameters coming from the normalizations of the two instruments we use data from (Planck and ACT),

$$\{A_{\text{planck}}, Y_p\}. \quad (10)$$

3. RESULTS

- a triangle plot with all of the forecasts
- derived parameters plot, overplot all forecasts
- ACTPol measurements

4. CONCLUSION

TABLE 1
FORECASTING PARAMETERS

Experiment	$l_{min} - l_{max}$	f_{sky}	θ FWHM	σ_T ($\mu\text{K arcmin}$)	σ_P ($\mu\text{K arcmin}$)
CMB S4	30-3000	0.40	3.0	1.0	1.4
PIXIE	2 - 150	0.8	120	2.9	4.0
Planck 2017 high.L	30 - 2500	0.65	10,7.1,5.0	65.0, 43.0, 66.0	103.0, 81.0, 134.0

NOTE. — These forecasts are based on [blahblahblah](#).