

On the Detection of Primordial CMB B-modes from the Ground at Low Frequency

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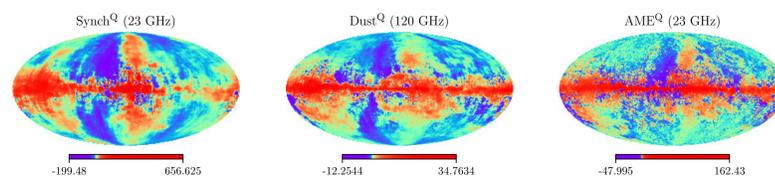
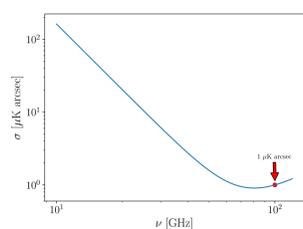
Introduction

The detection of primordial B-modes would constitute a proof of inflationary physics and open a way to test fundamental physics. However, the detection of this signal is challenging from the data analysis point of view, due to the relative low amplitude compared to foregrounds, the lensing contamination coming from the leakage of E-modes, and the instrumental sensitivity. In this work we explore the viability of the detection of the primordial polarization B-mode of the cosmic microwave background (CMB) from the ground, but operating on the microwave low-frequency range (e.g., from 10 GHz-120 GHz). The reason to choose this frequency range is twofold: on the one hand, the instrumental cost is, in principle, lower than at higher frequencies and, on the other hand, it could serve as a complement to future satellite missions like LiteBIRD, which cover frequencies above 40 GHz.

Simulations

We have generated simulations of the observed sky under different experimental configurations. The simulations contain the following components:

- CMB: generated using C_ℓ from [4] employing the latest parameters from [1].
- Instrumental sensitivity:
- Foregrounds: Simulations include galactic emission from synchrotron and dust (which are the main foreground contaminants to the polarized CMB). Some also incorporate the anomalous microwave emission (AME). Foreground components are generated using [5].



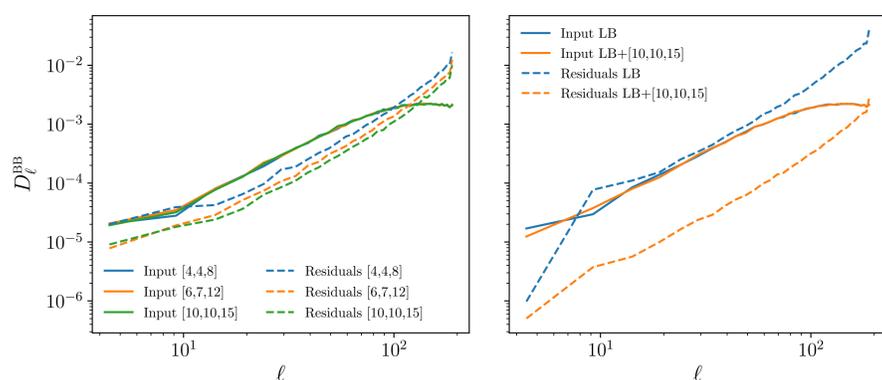
Component Separation

Our approach grounds on a full-parametric pixel-based maximum likelihood method, which relies on an affine-invariant ensemble sampler for Markov chain Monte Carlo (MCMC) [3], to retrieve the polarized CMB, as well as the foregrounds' parameters. The foreground parametric models used are:

Foreground	Model
Synchrotron	Powerlaw + Curvature
Dust	Modified Black-body
AME	Powerlaw + Curvature

Results

We have studied the ability of a ground-based telescope (GT) to detect primordial gravitational waves under different scenarios, mainly: i) different GT configurations, i.e., the distribution of frequency channels, ii) the value of r , iii) the foreground components, iv) joint performance with LiteBIRD, etc. The GT channels are distributed in the following frequency bands: [10-20], [26-46], [75-120] GHz.



Results of the GT under different configurations and models.

$r_{in} \times 10^3$	model	configuration	$f_{del}(\%)$	$r \times 10^3$	$\sigma_r \times 10^3$	(r/σ_r)
1	SD	[4,4,8]	75	1.05	0.45	2.32
1	SD	[10,10,15]	75	1.07	0.28	3.75
2	SD	[4,4,8]	50	1.81	0.57	3.20
2	SD	[6,7,12]	25	2.20	0.58	3.76
2	SD	[10,10,15]	0	2.28	0.68	3.33
2	SDA	[10,10,15]	25	2.44	0.69	3.51

Results for the LiteBIRD experiment combined with the GT.

$r_{in} \times 10^3$	model	configuration	$f_{del}(\%)$	$r \times 10^3$	$\sigma_r \times 10^3$	(r/σ_r)
2	SD	[10,10,15]	0	2.31	0.50	4.63
2	SDA	[10,10,15]	0	2.44	0.59	4.12

SD: foregrounds include only synchrotron and dust.

SDA: foregrounds include synchrotron, dust, and AME.

Masked Sky

A complete sky coverage is not available from a single location on the ground. The mask shown is the intersection between QUIJOTE and Planck 90% masks and has been used in the analysis of the GT, at Teide Observatory.

To correct the leakage from E to B modes due to incomplete coverage, we have applied a pseudo- C_ℓ algorithm to estimate the true power spectra [2].



References

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Conclusions

It has been proved that a ground-based utility operating in the low-frequency range is capable of detecting $r \simeq 2 \times 10^{-3}$ even with a simple telescope configuration when delensing is performed. $r \simeq 1 \times 10^{-3}$ is also detectable if the instrument has a more complex (and also sensitive) configuration.

This facility have also been shown to be a complement to LiteBIRD's data, improving significantly the results. Note, unlike LiteBIRD, GT covers the AME part of the spectrum. Therefore, if polarized AME is sufficiently important, a joint analysis will be mandatory.