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Galactic Foregrounds and CMB Polarization with SPOrt

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Abstract. We discuss the expected polarization of the Galactic foregrounds at the SPOrt experiment frequencies 22–90 GHz. We also consider the problem of foreground separation and perform an analysis to estimate their impact on the detection of a cosmological signal.

1. Introduction

The SPOrt experiment is an Italian (ASI funded) program selected by ESA for the International Space Station. It will measure the linear polarization of the diffuse sky radiation at an angular resolution of 7° at 22, 32, 60, 90 GHz on $\sim$ 80% of the sky. The average pixel sensitivity (50% observing efficiency) is $\sigma_{pixel} = 5\ \mu$K, while including all pixels we expect $\sigma_{rms} = 0.2\ \mu$K. More details on the SPOrt project and its performance are presented by Carretti et al. (2000) (this volume).

2. Separation of foreground from CMB signal

Figure 1 plots the expected polarized component of Galactic foregrounds (synchrotron, free–free and dust) *vs.* frequency. The two different normalizations (specified in the figure caption) yield an upper limit and a more realistic value. These estimates are then used in our analysis below.

To separate the different polarized contributions we use the formalism by Dodelson (1995) that allows us to estimate all components, pixel by pixel, and their variance, once the spectral behaviours of foregrounds and CMB are known. In particular, our aim is to compute the SPOrt effective sensitivity for CMB signal, *i.e.* the rms variance on CMB polarization estimates $\sigma^2_{Prms} = (FDF)^2\sigma_0^2 + \sigma^2_{shape}$. Here σ_0 is the instrument sensitivity combining all four frequencies, FDF (Foreground Degradation Factor) measures the sensitivity degradation due to foreground subtraction and σ_{shape} is the contribution to the variance due to uncertainties in the spectral shapes of foregrounds. Table I reports updated values of FDF and σ_{shape} for different treatments of foregrounds and normalizations. The first column specifies the foregrounds removed, the third one shows the full–sky sensitivity after subtraction.

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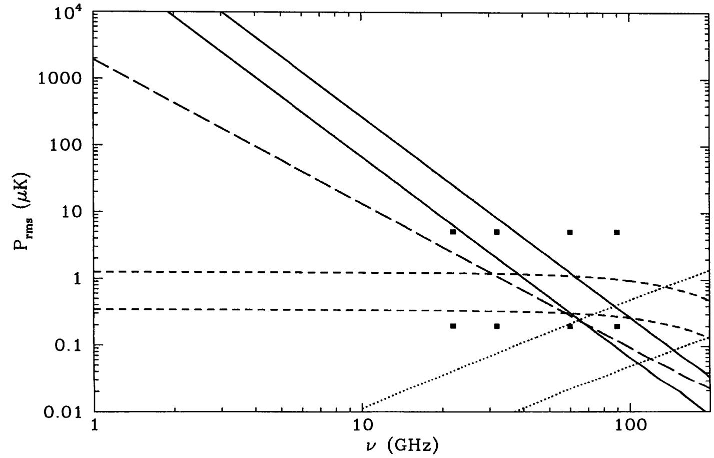

Figure 1. Plot of the rms polarization *vs* frequency. CMB (dashed lines): CDM models with optical depth 0.1, 0.5 on 7° angular scale. Synchrotron (solid): spectral index= −3, normalized to 5–20 mK at 2.4 GHz (Tucci et al. 2000). Free–Free (long dashed): s.i.= −2.15, normalized to 7.6 μK at 53 GHz (Kogut et al. 1996). Dust (dotted): normalized to 10 μK at 100 GHz (Kogut et al. 1996), 5–0.5% polarized. Large dots: pixel (upper) and full–sky (lower) SPOrt sensitivity.

As shown by the figure, at 22 and 32 GHz SPOrt will provide a nearly full–sky map of the polarized emission of the Galactic synchrotron. Moreover, at the higher frequencies, the presence of foregrounds does not affect considerably the SPOrt capability to detect the CMB polarization, as resulting from the effective sensitivity of 0.2–0.4 μK. That makes SPOrt able to detect the CMB component if the optical depth of the secondary ionization is $\tau \gtrsim 0.1$ (Carretti et al. 2000).

References

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Table 1. SPOrt sensitivity after foreground subtraction

Removed Foreground	FDF	FDF·σ_0	σ_{shape}(ff)		σ_{shape}(dust)	
normalized to (μK)			1.29	0.26	0.50	0.10
at frequencies			53 GHz		100 GHz	
sync	1.38	0.20	0.22	0.04	0.32	0.08
sync + ff	2.65	0.37	–	–	0.56	0.11
sync + dust	3.00	0.40	0.45	0.09	–	–

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