Matching WMAP 3-year results with the cosmological Slingshot primordial spectrum

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Abstract We consider a recently proposed scenario for the generation of primordial cosmological perturbations, the so called Cosmological Slingshot scenario. We first obtain a general expression for the Slingshot primordial power spectrum which extends previous results by including a blue pre-bounce residual contribution at large scales. Starting from this expression we numerically compute the CMB temperature and polarization power spectra arising from the Slingshot scenario and show that they excellently match the standard WMAP 3-year best-fit results. In particular, if the residual blue spectrum is far above the largest WMAP observed scale, the Slingshot primordial spectrum fits the data well by only fixing its amplitude and spectral index at the pivot scale $k_p = 10^{-3} \, h \, \text{Mpc}^{-1}$. We finally show that all possible distinctive Slingshot signatures in the CMB power spectra are confined to very low multipoles and thus very hard to detect due to large cosmic variance dominated error bars at these scales.

Keywords String cosmology · CMP

1 Introduction

It is well known that Standard (non-inflationary) Cosmology is afflicted by three severe problems [1]: homogeneity, isotropy and flatness. Inflation is the standard accepted
paradigm for the resolution of these problems. Nevertheless, as a fundamental origin of Inflation is as yet lacking, many attempts to alternatively solve the homogeneity, isotropy and flatness fine tunings have been recently put forward.

In this paper we consider one of these alternatives, namely the scenario developed in [2,3] so called the “Cosmological Slingshot Scenario”, or shortly the Slingshot.

In the Slingshot, our Universe is a probe $D3$-brane “orbiting” with an open trajectory in a IIB supergravity background, namely the Klebanov–Tseytlin (KT) metric [4] (the bulk). If the probe brane approach of [5] used in [2,3] can be used, the Slingshot trajectory results on an induced cosmological evolution on the brane. More precisely, a brane observer experiences a Friedman–Robertson–Walker non-singular bouncing universe. In the Slingshot, the problems that afflict standard cosmology are circumvented [2] by using similar mechanisms introduced in pre big-bang [6] and cyclic [7] scenarios. Besides, the Slingshot also predict a power spectrum of primordial perturbations. In [2,3], and in this letter, the primordial spectrum of scalar perturbations due to the fluctuation of the Slingshot brane on the KT background is indeed calculated under the approximation that the backreaction of the Slingshot brane into the bulk is negligible. The validity of this approximation is supported by the fact that the KT background, in which the Slingshot brane is moving, is produced by a large number of $D3$-branes having all the same tension (“mass”) as the Slingshot brane.

The plan of the paper is as follows. In Sect. 2 we will summarize the previous results of [2,3]. We will then extend those results in two ways. First of all we will consider a new blue contribution to the primordial power spectrum that was previously not accounted for. This will produce the general parametrization of the Slingshot primordial spectrum shown at the end of Sect.3.

As a second step, in Sect. 4, we will use this general parametrization in order to numerically compute the temperature and polarization CMB angular power spectra arising from the Slingshot and we will compare them to WMAP data [8]. In particular we will show that a suitable and natural choice of the Slingshot parameters allow to reproduce the standard WMAP 3-year best-fit power spectra. We will then try different choices for the Slingshot parameters and see if they can produce distinctive model-dependent signatures in the results. Finally we will draw our conclusions in Sect. 5.

We are now ready to conclude this section, but we would like to make a final remark first. In [3] an analytic expansion of the Slingshot spectrum for large multipoles ($\ell > 10$) had actually already been shown to match the WMAP best fit of a power law spectrum with spectral index $n_s \approx 0.95$. However, this result held only at a given pivot scale (chosen as $k_p \sim 10^{-3} \, \text{h Mpc}^{-1}$). Our numerical approach in this paper shows instead that the spectrum found in [3], matches the WMAP experimental results at all scales, and not only around the pivot scale. This is not an obvious result as the Slingshot primordial spectrum presents a non-trivial running of the spectral index.

2 The original Slingshot power spectrum

The Slingshot power spectrum of scalar perturbations is related to the quantum fluctuation of the Slingshot $D3$-brane. The way of producing this perturbation is similar