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A search for transient reductions in the inflaton speed of sound in cosmological data, and other topics

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The cover shows a triangular section of Planck’s 2013 CMB sky (★), reflected several times along its sides to form a 2-dimensional orbifold with the symmetry of a hexagonal lattice, gathering both of the topics of this thesis (but bearing no physical meaning).

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*To my parents, thanks to whom I am not just a physicist,
but a person in all its dimensions.*

*And to Berenice, who walked along the valley with me –
without your support this thesis would have never been possible.*

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Foreword

This thesis consists of two different parts, separating research projects carried out in two different groups.

In the first and longest part of this thesis, we attempt to fit the signal for a reduction in the speed of sound of the inflaton. In chapter 1, we shortly introduce the topics discussed in this thesis, namely Λ CDM cosmology, transient reduction in the speed of sound during inflation, and Bayesian statistical inference. Afterwards, we attempt to fit a particular hypothesis for the speed of sound reduction using Cosmic Microwave Background data (chapter 2) and later adding Large Scale Structure data to the search (chapter 3). Finally, in chapter 4 we present two pieces of code that were elaborated for the research in this thesis, and later released to the community.

In the second part, consisting solely of chapter 5, we present a classification of all possible 6-dimensional symmetric toroidal orbifolds over which Heterotic String Theory leads to a supersymmetric model. To do that, we made use of standard crystallographic tools.

Abbreviations

CMB Cosmic Microwave Background radiation

(C)DM (Cold) Dark Matter

Λ CDM Dark Energy, Cold Dark Matter cosmological model

EFT Effective Field Theory

FLRW Friedmann-Lemaître-Robertson-Walker, either meaning simply the so-called metric, or the full homogeneous and isotropic cosmology

GR General Relativity

GSR Generalised Slow-Roll

GUT Grand Unification Theory

LSS Large Scale Structure

MCMC Markov chain Monte Carlo

pdf Probability Density Function (often in low caps)

QFT Quantum Field Theory

SRFT Slow-Roll Fourier Transform

SUSY Super-symmetry

WMAP($\#$) The Wilkinson Microwave Anisotropy Probe; a number $\#$ after it refers to the data release corresponding to the $\#$ -th year of the survey.

WP WMAP low- ℓ polarisation likelihood.
