Abstract

This thesis is comprised primarily of work from three independent papers, [1], [2], and [3], written in collaboration with Sean Carroll, Tim Dulaney, and Heywood Tam. The original motivation for the projects undertaken came from revisiting the standard assumption of spatial isotropy during inflation. Each project relates to the spontaneous breaking of Lorentz symmetry—in early Universe cosmology or in the context of effective field theory, in general. Chapter 1 is an introductory chapter that provides context for the thesis. Chapter 2 is an investigation of the stability of theories in which Lorentz invariance is spontaneously broken by fixed-norm vector "æther" fields. It is shown that models with generic kinetic terms are plagued either by ghosts or by tachyons, and are therefore physically unacceptable. Chapter 3 is an investigation of the phenomenological properties of the one low-energy effective theory of spontaneous Lorentz symmetry breaking found in the previous chapter to have a globally bounded Hamiltonian and a perturbatively stable vacuum—the theory in which the Lagrangian takes the form of a sigma model. In chapter 4 cosmological perturbations in a dynamical theory of inflation in which an Abelian gauge field couples directly to the inflaton are examined. The dominant effects of a small, persistent anisotropy on the primordial gravitational wave and curvature perturbation power spectra are found using the "in-in" formalism of perturbation theory. It is found that the primordial power spectra of cosmological perturbations gain significant direction dependence and that the fractional direction dependence of the tensor power spectrum is suppressed in comparison to that of the scalar power spectrum.

Contents

List of Figures