Abstract

The aim of this thesis is to contribute to the efforts made in recent years to improve the accuracy of theoretical expressions describing observables in cosmology. The high precision of upcoming surveys requires the theoretical predictions for cosmological observables to be more accurate than ever before in order to correctly interpret the physical information in the data. In the first part of this thesis we study the theoretical description of the cosmic microwave background (CMB) temperature anisotropies and clarify the ambiguity in regard of the monopole fluctuation. The background CMB temperature today is one of the fundamental cosmological parameters and there is no ambiguity in its definition. We show that once the cosmological parameters are set, i.e. the value of the background CMB temperature today is fixed, the angle average of the observed CMB temperature unambiguously determines the monopole fluctuation. Contrary to the gauge dependent standard expression used to describe the observed CMB temperature anisotropies, our expression is gauge-invariant. In the second part of this thesis we study the impact of a non-zero spatial curvature on cosmological observables, both theoretically and numerically. With the recent analysis of the Planck measurements allowing a non-zero spatial curvature, the interest in the spatial curvature and how a non-zero value affects observables has been revived in the past couple of years. We develop a theoretical framework to describe the propagation of light in a non-flat universe and derive theoretical expressions for cosmological observables. These expressions include scalar, vector and tensor contributions and are gauge invariant at linear order. To complement our theoretical study, we quantify the impact of a non-zero spatial curvature by numerical computations. The theoretical formalism presented in this thesis can be used to constrain the spatial curvature in the upcoming large-scale surveys.