Understanding The Accelerating Universe: Model Building and Observational Signatures

Abstract
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Abstract

The main objective of this thesis is to study the accelerating expansion of the Universe. It is believed that there are two accelerating epochs in the evolution of the Universe. One is at early times. It is called inflation. Another one is the late time cosmic acceleration. The dynamics of the cosmic acceleration can be explained in two ways. One corresponds to the introduction of an exotic matter which has large negative pressure. Another one corresponds to the modification of the Einstein's general theory of relativity. The detailed discussion about inflation and late time cosmic acceleration is presented in the first chapter.

In the second chapter, we discuss different dark energy and modified gravity models to explain the late-time cosmic acceleration.

The third chapter contains a brief discussion on different probes for late-time cosmic acceleration. The probes are distance ruler, the growth of structures, matter power spectrum, bispectrum, observed galaxy power spectrum, and weak lensing.

In the fourth chapter, we study an inflationary scenario in the presence of Generalized Chaplygin Gas (GCG). We show that in Einstein gravity, GCG is not a suitable candidate for inflation; but in a five-dimensional braneworld scenario, it can work as a viable inflationary model.

In the fifth chapter, we study the effects of general relativistic corrections on the observed galaxy power spectrum in thawing class of

quintessence and cubic Galileon models. We consider linear, squared and inverse-squared potentials. For the Galileon model, only the linear potential preserves the shift symmetry. Other potentials are considered phenomenologically. We show that the observed galaxy power spectrum differs from the standard matter power spectrum mainly due to redshift space distortion (RSD) factor and relativistic effects.

In the sixth chapter, we study the signatures of particular dark energy (CPL and GCG parametrizations and quintessence) and modified gravity models (cubic Galileon) on weak lensing convergence power spectrum and bispectrum. When we compare with the ΛCDM model, for all the models, the deviations in the convergence power spectrum is larger compared to the deviations in the matter power spectrum (at any redshift). Similar behavior is present in the convergence bispectrum. Only the amplitude of the deviations increase. We show that the cubic Galileon model can be significantly distinguished from quintessence for the higher values of λ_i (initial slope of potential).

In the seventh chapter, we study the nonlinear effects of the clustering and smooth quintessence beyond the Baryon Acoustic Oscillations (BAO) scale. The results of this scheme allow us for the prediction of the nonlinear power spectrum in the mildly nonlinear regime up to few percentage accuracies compared to the other available tools (e.g. HMCode and Coyote Emulator). The accuracies increase with increasing redshifts.

Finally, in the eighth chapter, we summarize the results of all the papers.