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One of the major revelations in observational cosmology in recent times is the existence of “Dark Energy” in the energy budget of the Universe and late time acceleration in the expansion of the Universe. Together with “Dark Matter”, it constitutes around 95% of the energy budget of the Universe. The simplest candidate for such dark energy which can be formulated from a field theory is the “Vacuum Energy” or “Cosmological Constant” Λ. A Concordance ΛCDM model where the two dominant components are dark matter and Λ as dark energy, is consistent with majority of cosmological observations at present.

But recently, a major tension has emerged for ΛCDM as a viable model for expanding Universe. The model independent observation of the expansion rate of the Universe at present (H_0) as measured by nearby SnIa is at tension of more than 4σ with the same measurement by Planck for CMB assuming ΛCDM is the correct description of our Universe. This is termed as “Hubble Tension” in the literature. This puts a serious question mark for ΛCDM as a viable model for our Universe and motivates researchers to look for other alternatives that can not only describe different observational results but also at the same time, solves the Hubble tension. The present thesis deals with these aspects of our cosmological Universe.

The main findings of this thesis is three folds:

First, we consider different dark energy models that have been proposed in recent past and do a thorough study statistically to see whether they are preferred over ΛCDM model by the currently available cosmological data. We use the Bayesian statistical method to perform such study and find the Quintessence scalar field models are more preferred over ΛCDM model.

Next we do a model independent reconstruction of the expansion rate of the Universe at various redshifts and subsequently reconstruct the dark energy behaviour. Once done, we check whether the reconstructed behaviour is consistent with any theoretical model for dark energy that has been proposed so far.

Finally we study the Hubble tension in detail and look for alternatives of ΛCDM model that can solve this tension.