

Findings of the Thesis

Title of the Thesis: **Dynamics of Dark Energy**

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Abstract

We study the $f(R)$ theory of gravity using metric approach. In particular we investigate the recently proposed model by Hu-Sawicki, Appleby-Battye and Starobinsky. In this model, the cosmological constant is zero in flat space time. The model passes both the Solar system and the laboratory tests. But the model parameters need to be fine tuned to avoid the finite time singularity recently pointed in the literature. We check the concordance of this model with the $H(z)$ and baryon acoustic oscillation data. We find that the model resembles the Lambda-CDM at high redshift. However, for some parameter values there are variations in the expansion history of the universe at low redshift.

In this thesis, we also investigate the curvature singularity in these models. We have found that the problem is generic but can be avoided provided that proper fine tuning is imposed on the evolution of scalaron in the high curvature regime. In principle, the problem can be circumvented by incorporating quadratic curvature correction in the Lagrangian though it might be quite challenging to probe the relevant region numerically.

We also consider stability of spherically symmetric solutions in $f(R)$ models. We find that the model suffers from a severe fine tuning problem when applied to compact objects like neutron stars. The problem can be remedied by introducing a cut off on the mass of the scalar degree of freedom present in the model. A new mass scale associated with neutron stars density is then required for the stabilities of $f(R)$ gravity solutions inside relativistic stars.

In the chapter 5, we investigate the possibility of a dark energy universe emerging from an action with higher-order string loop corrections to Einstein gravity in the presence of a massless dilaton. These curvature corrections (up to R^4 order) are different depending upon the type of (super)string model which is considered. We find in fact that Type II, heterotic, and bosonic strings respond differently to dark energy. A dark energy solution is shown to exist in

the case of the bosonic string, while the other two theories do not lead to realistic dark energy universes. We also investigate the cosmological dynamics of non-locally corrected gravity involving a function of the inverse d'Alembertian of the Ricci scalar. Casting the dynamical equations into local form, we derive the fixed points of the dynamics and demonstrate the existence and stability of a one parameter family of dark energy solutions for a simple choice of parameters. For a wide range of initial conditions, the system mimics dust like behavior before reaching the stable fixed point. The late time phantom phase is achieved without involving negative kinetic energy fields. A brief discussion on the entropy of de Sitter space in non-local model is included.