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The Cosmology of Gravitational Scalar-Tensor Theories

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Recent developments in observational cosmology and astronomy (such as
the apparent discovery of the accelerated expansion of the Universe and the
existence of dark matter) have put theoretical physics in general and cosmology in particular into crisis. In this thesis, we introduce a detailed review of Einstein's theory of general relativity by which standard cosmology based on.
We present the challenges to Einstein theory of gravity and the difficulties of the current theoretical cosmology in explaining the accelerated expansion of the
Universe. Although General Relativity Theory (GR) is a generalization of Newtonian Gravity in the presence of strong gravitational fields, there is no properly defined Newtonian limit of (GR) on cosmological scales. Recently, general relativistic quasi-Newtonian cosmologies have been studied in the context of large scale structure formation and nonlinear gravitational collapse in the late-time
Universe. This despite the general covariant inconsistency of these cosmological models except in some special cases such as the spatially homogeneous and isotropic, spherically symmetric, expanding (FLRW) spacetimes. Higher-order
gravitational theories, such as f (R) models, have been shown to exhibit more shared properties with Newtonian gravitation than does GR. In this work, we study the existence and integrability conditions of quasi-Newtonian cosmological spacetimes in Scalar-Tensor theories of gravitation. We will also derive the
covariant density and velocity perturbations of such models and analyze the corresponding solutions.

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