SCALAR PERTURBATIONS IN f(R)-COSMOLOGIES

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ABSTRACT. We take first steps to generalizing the recently developed mechanical (non-hydrodynamical), or discrete (discontinuous), approach to cosmological problems on intermediate, semiastrophysical semicosmological, scales to the case of nonlinear gravity. In the framework of the f(R) theory we study the scalar perturbations in the flat space and derive the corresponding gravitational potentials.

Key words: alternative theories of gravity: f(R) nonlinear theories; cosmological perturbation theory: scalar perturbations; scalaron; Yukawa potential

1. Introduction

Observations of the Ia supernovae and cosmic microwave background have revealed that the Universe is undergoing an accelerating phase in its expansion. The explanation of this acceleration in the context of general relativity has stimulated a lot of ideas, the most notable of which is the introduction of mysterious cosmic fluid, the so called dark energy. In more recent times, modified theories of gravity, constructed by adding correction terms to the usual Einstein-Hilbert action, have opened a new window to study accelerated expansion of the universe where it has been shown that such correction terms could give rise to accelerating solutions of the field equations without having the invoke concepts such as dark energy.

2. Scalar cosmological perturbations

In our work we do a scalar cosmological perturbation. The background metric is the flat FRLW metric. We divide our analysis of perturbed equations to two cases: the scalaron's mass is large enough and then we reproduce the standard General Relativity; or we don't neglect the scalaron's contribution (but we neglect the influence of cosmological background) and then we find that scalar perturbations - we have two variables Ψ and Φ in conformal Newtonian gauge - represent the mix of the standard potential and the additional Yukawa term:

$$\Psi = \frac{F'}{2F}\left[\frac{\kappa^2 m}{12\pi a F'}\frac{\exp\left(-\sqrt{\frac{a^2F}{3F'}}r\right)}{r} - \frac{\kappa^2}{Fa^3}\bar{\rho}_c\right] + \frac{\varphi}{a}\,,$$

$$\Phi = -\frac{F'}{2F}\left[\frac{\kappa^2 m}{12\pi a F'}\frac{\exp\left(-\sqrt{\frac{a^2F}{3F'}}r\right)}{r} - \frac{\kappa^2}{Fa^3}\bar{\rho}_c\right] + \frac{\varphi}{a}\,,$$

where $F = \frac{df}{dR}$, $\varphi = -\frac{G_N m_0}{r} - \frac{G_N m_0}{2r_0^3}r^2 + \frac{3G_N m_0}{2r_0}$, a is a scale factor and ρ_c is the rest mass density in comoving coordinates $(\delta\rho_c = \rho_c - \bar{\rho}_c)$.

3. Next future work

We will try to reproduce our results in computations in NP-formalism.

References

De Felice A., Tsujikawa S.: 2010, *Living Reviews Relativity 13,* **arXiv:1002.4928**, f(R)-theories.