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ORIGINAL ARTICLE

Bianchi type-VI_0 perfect fluid cosmological model in a modified theory of gravity

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Abstract A spatially homogeneous and anisotropic Bianchi type-VI_0 space-time filled with perfect fluid in general relativity and also in the framework of $f(R,T)$ gravity proposed by Harko et al. (in arXiv:1104.2669 [gr-qc], 2011) has been studied with an appropriate choice of the function $f(R,T)$. The field equations have been solved by using the anisotropy feature of the universe in Bianchi type-VI_0 space time. Some important features of the models, thus obtained, have been discussed. We noticed that the involvement of new function $f(R,T)$ doesn't affect the geometry of the space-time but slightly changes the matter distribution.

Keywords Bianchi type-VI_0 · $f(R,T)$ gravity · Perfect fluid · General relativity

1 Introduction

In recent years, there has been a lot of interest in alternative theories of gravitation. In view of the late time acceleration of the universe and the existence of the dark matter and dark energy, very recently, modified theories of gravity have been developed. Noteworthy amongst them are $f(R)$ theory of gravity formulated by Nojiri and Odintsov (2003a) and $f(R,T)$ theory of gravity proposed by Harko et al. (2011). Carroll et al. (2004) explained the presence of a late time cosmic acceleration of the universe in $f(R)$ gravity. Nojiri and Odintsov (2003b) demonstrated that phantom scalar in many respects looks like strange effective quantum field theory by introducing a non-minimal coupling of phantom field with gravity. Recently, Harko et al. (2011) developed $f(R,T)$ modified theory of gravity, where the gravitational Lagrangian is given by an arbitrary function of the Ricci scalar R and of the trace T of the stress-energy tensor. They have obtained the gravitational field equations in the metric formalism, as well as, the equations of motion for test particles, which follow from the covariant divergence of the stress-energy tensor. The $f(R,T)$ gravity model depends on a source term, representing the variation of the matter stress energy tensor with respect to the metric. A general expression for this source term is obtained as a function of the matter Lagrangian L_m so that each choice of L_m would generate a specific set of field equations. Some particular models corresponding to specific choices of the function $f(R,T)$ are also presented, they have also demonstrated the possibility of reconstruction of arbitrary FRW cosmologies by an appropriate choice of a function $f(T)$. In the present model the covariant divergence of the stress energy tensor is nonzero. Hence the motion of test particles is non-geodesic and an extra acceleration due to the coupling between matter and geometry is always present.

In $f(R,T)$ gravity, the field equations are obtained from the Hilbert-Einstein type variational principle.

The action principle for this modified theory of gravity is given by

$$S=\frac{1}{16\pi G}\int f(R,T)\sqrt{-g}d^4x+\int L_m\sqrt{-g}d^4x \tag{1.1}$$

where $f(R,T)$ is an arbitrary function of the Ricci scalar R and of the trace T of the stress energy tensor of matter and L_m is the matter Lagrangian.

The stress energy tensor of matter is

$$T_{ij}=-\frac{2}{\sqrt{-g}}\frac{\partial(\sqrt{-g})}{\partial g^{ij}}L_m, \qquad \Theta_{ij}=-2T_{ij}-pg_{ij} \tag{1.2}$$

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