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ORIGINAL ARTICLE

Bianchi type-V bulk viscous string cosmological model in $f(R,T)$ gravity

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Abstract In this paper, we investigate a spatially homogeneous and anisotropic Bianchi type-V cosmological model in a scalar-tensor theory of gravitation proposed by Harko et al. (Phys. Rev. D 84:024020, 2011) when the source for energy momentum tensor is a bulk viscous fluid containing one dimensional cosmic strings. To obtain a determinate solution, a special law of variation proposed by Berman (Nuovo Cimento B 74:182, 1983) is used. We have also used the barotropic equation of state for the pressure and density and bulk viscous pressure is assumed to be proportional to energy density. It is interesting to note that the strings in this model do not survive. Also the model does not remain anisotropic throughout the evolution of the universe. Some physical and kinematical properties of the model are also discussed.

Keywords Bianchi-V model · $f(R,T)$ gravity · Bulk viscous model · String model

1 Introduction

It is well known that the late time accelerated expansion of the universe has been confirmed by the high red shift supernovae experiments (Reiss et al. 1998; Perlmutter et al. 1999; Bennett et al. 2003) and by the observations such as cosmic microwave background radiation (Spergel et al. 2003, 2007). In view of this it is now believed that the energy composition of universe has 4 % ordinary matter and 20 % dark matter and 76 % dark energy. Modifications of Einstein's theory are attracting more and more attention, in recent years, to explain the late time acceleration and dark energy. Among the various modifications of Einstein's theory, $f(R)$ gravity (Akbar and Cai 2006) and $f(R,T)$ gravity (Harko et al. 2011) theories are attracting more and more attention during the last decade because these theories are supposed to provide natural gravitational alternatives to dark energy. It has been suggested that cosmic acceleration can be achieved by replacing Einstein-Hilbert action of general relativity with a general function $f(R)$ where R is a Ricci scalar. Chiba et al. (2007), Nojiri and Odintsov (2007, 2010), Multamaki and Vilja (2006, 2007) are some of the authors who have investigated several aspects of $f(R)$ gravity models which show early time inflation and late time acceleration. A comprehensive review on $f(R)$ gravity is given by Copeland et al. (2006). Another modification of standard general relativity is $f(R,T)$ gravity proposed by Harko et al. (2011) wherein the gravitational Lagrangian is given by an arbitrary function of the Ricci scalar R and of the trace of the stress energy tensor T. The gravitational field equations have been derived from the Hilbert-Einstein type variational principle

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

where $f(R,T)$ is an arbitrary function of the Ricci scalar, R, T is the trace of stress-energy tensor of the matter, T_{ij} and L_m is the matter Lagrangian density. We define the stress-energy tensor of matter as

$$T_{ij}=\frac{-2}{\sqrt{-g}}\frac{\delta(\sqrt{-g}L_m)}{\delta g^{ij}} \quad (2)$$

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