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ORIGINAL ARTICLE

Five dimensional bulk viscous cosmological model with wet dark fluid in general relativity

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Abstract In this paper, we have constructed a five dimensional LRS Bianchi type I cosmological model with wet dark fluid (WDF) in general relativity with the matter field described as bulk viscosity. It is found that in presence of bulk viscosity an inflationary effective stiff fluid cosmological model is obtained, whereas in absence of bulk viscosity the wet dark fluid degenerate to stiff fluid. Some physical and geometrical properties of the model are also discussed.

Keywords Bulk viscous fluid · Wet dark fluid · Cosmological model · General relativity

1 Introduction

The unification of gravitational forces in nature is not possible in usual four dimensional space times. So, higher dimension theory might be useful at very early stages of the evolution of the universe. In fact, as time evolves, the standard dimensions expand while the extra dimensions shrink to the Planckian dimension, which is beyond of our ability to detect with the currently available experimental facilities (Chatterjee et al. 1990; Chatterjee 1992a, 1992b). This fact has attracted many researchers to investigate the problems in the field of higher dimension (Witten 1984). Subsequently Adhav et al. (2008), Reddy and Naidu (2009), Mohanty et al. (2009), Tade and Sambhe (2012) have constructed five dimensional cosmological models in various aspects.

The large scale distribution of galaxies in our universe shows that the matter is satisfactorily described by a perfect fluid. However, it is conjectured that material distributions behaves like a viscous fluid in early phase of the evolution of the universe when galaxies were formed (Ellis and Sachs 1971). It is well known, that in several circumstances during cosmic evolution in which viscosity could arise (Misner 1968; Ellis and Sachs 1979; Hu 1983) and lead to an effective mechanism of entropy production. Murphy (1973) constructed homogeneous isotropic spatially flat cosmological models with bulk viscous fluid alone because the shear viscosity cannot exist due to the assumption of isotropy and showed that the big bang singularity can be avoided by the introduction of bulk viscosity. Heller and Klimek (1975) also investigated viscous universe without initial singularity and they showed that, the introduction of bulk viscosity effectively removes the initial singularity in certain class of cosmological models. Roy and Prakash (1976, 1977) constructed viscous fluid cosmological models of Petrove type ID and non-degenerate Petrove type I with constant shear viscosity. Banarjee et al. (1985) studied Bianchi type-I cosmological models for viscous fluid consisting of bulk and shear viscosity. Santos et al. (1985) obtained exact solutions of field equations representing isotropic homogeneous cosmological models with bulk viscosity assuming a condition that bulk viscous coefficient as power function of mass density. Bali and Jain (1987, 1988) obtained some expanding and shearing viscous fluid cosmological models in which coefficient of shear viscosity is proportional to the rate of expansion of the model. Roy and Singh (1983) constructed LRS Bianchi type V cosmological model involving viscosity. Bali and Yadav (2002) investigated an

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