

Some plane symmetric inhomogeneous cosmological models in the scalar-tensor theory of gravitation

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Abstract The present study deals with the inhomogeneous plane symmetric models in scalar-tensor theory of gravitation. We used symmetry group analysis method to solve the field equations analytically. A new class of similarity solutions have been obtained by considering the inhomogeneous nature of metric potential. The physical behavior and geometrical aspects of the derived models are also discussed.

Keywords Similarity solutions · Inhomogeneous plane symmetric model · Scalar-tensor theory

1 Introduction

In recent years, modifications of general relativity are attracting more attention to explain the late time cosmic acceleration of universe. This late time cosmic accelerated expansion of universe has been confirmed by high red-shift supernovae experiments (Riess et al. 1998; Perlmutter et al. 1999;

Bennet et al. 2003). Broadly, the model building undertaken in the literature to capture the alternative theory of gravitation can be classified into two categories: dimensional scalar field and non dimensional scalar field model. Brans and Dicke (1961) formulated the scalar-tensor theories of gravitation on the basis of coupling between an adequate tensor field and scalar field ϕ . The scalar field has a dimension of G^{-1} where G is the gravitational constant. Therefore ϕ^{-1} play the role of $G(t)$. This theory successfully describes the Mach's principle but fails to explain the missing matter problems and absolute properties of space. Later on Saez and Ballester (1985) developed a scalar-tensor theory in which the metric is coupled with a dimensionless scalar field in a simple manner. This coupling gives a satisfactory description of weak fields. The SB theory of gravitation solves missing matter problem in non flat FRW cosmologies and removes the graceful exist problem in inflation era. In the literature, Singh and Agarwal (1991), Reddy et al. (2006), Socorro et al. (2010), Jamil et al. (2012) and recently Yadav (2013) have studied the some aspects of SB theory of gravitation in different physical contexts.

The recent observations suggest that the matter distribution in the present universe is on the whole isotropic and homogeneous. But on the theoretical ground, the universe could have not had such smoothed out picture. Close to big bang singularity, the assumption of spherically symmetric and isotropy can not be strictly valid. Therefore inhomogeneous cosmological models play an important role to study the essential features of universe such as process of homogenization and formation of galaxies at early stage of evolution. So in literature, many authors consider plane symmetry, which is less restrictive than spherical symmetry and provides an avenue to study inhomogeneities in early universe. Rendall (1995), Da Silva and Wang (1998), Anguige (2000), Nouri-Zonoz and Tavanfar (2001), Pradhan

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