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ORIGINAL ARTICLE

LRS Bianchi type-II bulk viscous cosmic string model in a scale covariant theory of gravitation

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Abstract A locally rotationally symmetric(LRS) Bianchi type-II space-time is considered in the frame work of a modified theory of gravitation proposed by Canuto et al. (Phys. Rev. Lett. 39:429, 1977) when the source for energy momentum tensor is a bulk viscous fluid containing one dimensional cosmic strings. A special law of variation for Hubble's parameter proposed by Bermann (Nuovo Cimento B 74:182, 1983) is used to obtain determinate solution of the field equations. We have also used the barotropic equation of state and the bulk viscous pressure is assumed to be proportional to the energy density. The physical and kinematical properties of the model are also discussed.

Keywords Scale covariant theory · Cosmic string · Bulk viscosity · Bianchi type-II model

1 Introduction

Several modifications of Einstein's theory have been proposed from time to time. Noteworthy among them are the scalar-tensor theories of gravitation formulated by Brans and Dicke (1961), Nordtvedt (1970), Sen (1957), Sen and Dunn (1971) and Saez and Ballester (1986). In particular, Brans-Dicke and Saez-Ballester scalar-tensor theories are attracting more and more attention because of their applications in cosmology. In these theories gravity is mediated by a long range scalar field in addition to the usual tensor fields present in Einstein's theory. Brans-Dicke scalar-tensor theory of gravitation introduces an additional scalar field ϕ interacting equally with all forms of matter (with the exception of electromagnetism) besides the metric g_{ij} and a dimensionless coupling constant ω. In Saez-Ballester scalar-tensor theory of gravitation the metric is coupled with a dimensionless scalar field in a simple manner. This coupling gives a satisfactory description of the weak fields. One particularly interesting result of this theory is appearance of antigravity regime, which suggests a possible connection to the missing matter problem in non-flat FRW cosmologies. Canuto et al. (1977) have proposed a scale covariant theory of gravitation which is another viable alternative to general relativity (Wesson 1980; Will 1984). In this theory Einstein's field equations are valid in gravitational units where as the physical quantities are measured in atomic units. The metric tensor in the two systems of units are related by a conformal transformation

$$\overline{g_{ij}} = \phi^2\big(x^k\big)g_{ij} \tag{1}$$

where Latin indices take the values 1, 2, 3, 4, bar denotes gravitational units and unbar denotes atomic units. The gauge scalar function ϕ $(0 < \phi < \infty)$ in its most general formulation is a function of all space-time coordinates. Thus, using the conformal transformation of the type given by Eq. (1) Canuto et al. (1977) transformed the usual Einstein's equations into

$$R_{ij} - \frac{1}{2}Rg_{ij} + f_{ij}(\phi) = -8\pi G(\phi)T_{ij} + \Lambda(\phi)g_{ij} \tag{2}$$

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