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Bianchi Type–I model cosmic strings coupled with perfect fluid to in bimetric relativity

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ABSTRACT

Restricting to a particular type of background metric it is found that there is no contribution from cosmic string coupled with perfect fluid to the Bianchi type –I cosmological model in bimetric relativity.

Key worlds: Cosmic string, Perfect fluid, Singularity, Bimetric relativity.

AMS SUB. CODE: 83C05 (General Relativity)

INTRODUCTION

Rosen[6] (1973) proposed the bimetric theory of relativity to remove some of the unsatisfactory features of the general theory of relativity in which there exist two metric tensor at each point of space-time g_{ij}, which describes gravitation and background metric γ_{ij} , which enters into the field equations and interacts with g_{ij} but does not interact directly with matter. One can regard γ_{ij} as describing the geometry that exists if no matter were present.

Accordingly at each space-time point one has two line elements-

$$ds^2 = g_{ij}\, dx^i dx^j \qquad (1.1)$$

And $$d\sigma^2 = \gamma_{ij}\, dx^i dx^j \qquad (1.2)$$

where ds is the interval between two neighbouring events as measured by a clock and a measuring rod. The interval dσ is an abstract or a geometrical quantity not directly measurable, one can regard it as describing the geometry that exist if no matter were present.

In Rosen's bimetric theory of relativity, Mahurpawar [14, 15, 16] (2003-2008- 2001) has obtained nil contribution of cosmic strings in five, six and generalized n- dimensional static plane symmetric cosmological model. We extended work in Bianchi type- I as non-existence of Maxwell fields [17] (1997), cosmic strings coupled with Maxwell's fields [18] (2003) vacuum solutions [19] (2003-04) higher five and six dimensional axially symmetric [20, 21] (2004- 2004) in bimetric relativity. Rosen [7,8] (1975- 1980), Yilmaz [4] (1975), Karade[12](1980), Reddy et-al[2](1989), Mohanty et-al[3](2002), Deo[10,11](2004-2013), Adhav et-al[5](2005) have studied several; aspects of bimetric theory of relativity.

The string theory was developed to describe an event at early stages of evolution of the universe. Cosmic string arises during phase transition after the bigbang explosion as the temperature goes down below some critical temperature [Zel'dovitch [22] (1975), Kibble [13] (1976), Vilenkin [1] (1982), Latellier [9] (1983) has initiated the study of cosmic strings in general by solving the Einstein field equations and obtained various cosmological models with string dust sources.

In this paper we studied Bianchi type-I cosmological model with cosmic strings coupled with perfect fluid distribution and observed that there are no contributions of cosmic strings coupled with perfect fluid in this model. Only a vacuum model was found.

2. The Field Equations

The field equations of Rosen's bimetric theory of relativity read as –

$$N_{ij} - \frac{1}{2}N g_{ij} = -8\kappa T_{ij,} \tag{2.1}$$

where $N_j^i = \frac{1}{2}\gamma^{ab}\left(g^{hi}g_{hj|a}\right)_{|b}$

And $\kappa = \left(\frac{g}{\gamma}\right)^{1}/_{2}$,$N = N_i^j$, $g = det\left(g_{ij}\right)$, $\gamma = det\left(\gamma_{ij}\right)$ (2.2)

Summing over a and b from 1 to 4, a vertical bar (l) denotes the covariant differentiation with respect to γ_{ij}.

3. Bianchi type-I cosmological model for cosmic strings coupled with perfect fluid

We consider the non- static space-time described by the Bianchi type-I model

$$ds^2 = -dt^2 + A^2dx^2 + B^2dy^2 + C^2dz^2 \tag{3.1}$$

where A,B,C are function of time "t" only.

The flat metric corresponding to (3.1) is

$$ds^2 = -dt^2 + dx^2 + dy^2 + dz^2 \tag{3.2}$$

Signature of metric (3.1) is (-, +, +, +) i.e. +2

Assume that the space-time is filled with cosmic strings coupled with perfect fluid whose energy- moment tensor is given by-

$$T_i^j = T_{istring}^j + T_{iperfect\ fluid}^j \tag{3.3}$$

where $T_{is}^j = \rho v_i v^j - \lambda x_i x^j$ (3.4)

where ρ is the rest energy density for the cloud of strings with particle attached along the extension thus, $\rho = \rho_p + \lambda$

where ρ_p is the particle energy density, λ is the tension density of the strings and v^i the four velocity for the cloud of particle, x^i the flow of the matter the four vector which represents string direction which is essentially the direction of anisotropy.

$$v_i v^j = -1 = -x_i x^j$$

and $$v_i x_i = 0$$

$$T_{ip}^j = (\varepsilon + p)v_i v^j + p g_i^j \tag{3.5}$$

where ε being the matter density, p is the pressure

The components of energy tensor for a strings cloud field equations are-

$$-\left(\frac{A_4}{A}\right)_4+\left(\frac{B_4}{B}\right)_4+\left(\frac{C_4}{C}\right)_4=-16\pi\kappa(\lambda+\varepsilon) \quad (3.6)$$

$$\left(\frac{A_4}{A}\right)_4-\left(\frac{B_4}{B}\right)_4+\left(\frac{C_4}{C}\right)_4=-16\pi\kappa(p) \quad (3.7)$$

$$\left(\frac{A_4}{A}\right)_4+\left(\frac{B_4}{B}\right)_4-\left(\frac{C_4}{C}\right)_4=-16\pi\kappa(p) \quad (3.8)$$

$$\left(\frac{A_4}{A}\right)_4+\left(\frac{B_4}{B}\right)_4+\left(\frac{C_4}{C}\right)_4=32\pi\kappa\rho \quad (3.9)$$

where the suffix 4 follows an unknown function of A, Band C denotes ordinary differentiation with respect to time t.

Using equations (3.6) to (3.9), we get
$\lambda+2p+2\rho=0$ (3.10)

In view of reality conditions
i.e.$\lambda\geq 0$,$p\geq 0$ and $\varepsilon\geq 0$ equation (3.10) immediately implies that
$\lambda=0$, $p=0$ and $\varepsilon=0$ (3.11)

Which shows that the non- static Bianchi type- I model representing cosmic strings coupled with perfect fluid does not exist in bimetric theory of gravitation.

When $\lambda=0$, $p=0$ and $\varepsilon=0$ (vacuum) equations (3.6) to (3.9) admit the solution
$A=B=C=e^{ct}$ (3.12)

In view of equation (3.12), the line element (3.1) takes the form
$ds^2=-dt^2+e^{2ct}(dx^2+dy^2+dz^2)$ (3.13)

where c is the constant of integration.
It is interesting that this model (3.13) is free from the singularities and for c = 0 it reduces to flat one.

CONCLUSION

We conclude that non-static, describe by Bianchi type –I model, solutions of the field equation (2.1)with cosmic strings coupled with perfect fluid $A=B=C=e^{ct}$ where c is constant of integration ,i.e. there is no contribution of cosmic strings coupled with perfect fluid to non-static Bianchi type-I space-time in bimetric relativity can be reduced to the conformal space-time.

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