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SOME PHYSICAL AND GEOMETRICAL FEATURES

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ABSTRACT

In this paper we have obtained a magnetized cylindrically symmetric universe with two degrees of freedom in general relativity in which free gravitational field is of Petrov type I degenerate. The magnetic field is due to an electric current along x- axis. The distribution consists of an electrically neutral perfect fluid with an infinite electrical conductivity.

Keywords *: Eigenvalue, Magnetofluid, Relativity, Pressure and Density etc.*

Introduction :

Recently several applications of the general theory of relativity have shown growing interest in different fields of mathematics. Stewart [1] investigated the models as more stable if the matter is supposed to be anisotropic. Ellis and MacCallum [2] obtained a class of homogeneous models for perfect fluid distribution. The anisotropic magnetic fluid models have significant contribution in the evolution of galaxies and stellar bodies. Primordial magnetic fields of cosmological origin have been speculated by Asseo and Sol [3]. FRW models are approximately valid as present day magnetic field strength is very small. In early universe the strength must have been appreciable. The breakdown of isotropy is due to magnetic field. Thorne [4] investigated as LRS Bianchi type-I cosmological models containing a magnetic field. Jacobs [5,6] investigated Bianchi type I cosmological models with magnetic field satisfying barotropic equation of state. Collins [7] gave a qualitative analysis of Bianchi type I models with magnetic field. Roy et al [8] obtained Bianchi type I cosmological model with perfect fluid and magnetic field introducing space-like unit vector field orthogonal to the coordinate time. Recently, Bali [9] investigated a magnetized cosmological model in which expansion θ in the model is proportional to σ_1^1, the eigenvalue of shear tensor σ_i^j for perfect fluid distribution. Bali and Tyagi [10] investigated stiff magnetofluid cosmological model for perfect fluid distribution. Bali and Ali [11], to appear in IJTP obtained magnetized cosmological model with two degrees of freedom for perfect fluid distribution in general relativity. Roy and Prakash [12] obtained a plane symmetric cosmological model with an incident magnetic field for perfect fluid distribution in which the gravitational field is of Petrov type-I degenerate. Roy *et al.* [13] investigated a cylindrically symmetric universe with two degrees of freedom in general relativity in which free gravitational field is Petrov type degenerate.

The pressure and density for the model (1.31a) are given by :

$$8\pi p = \frac{1}{\alpha^2 T^2}\left(\frac{1}{4}\log T - \frac{9}{16} + \frac{\alpha}{8}\right) - \Lambda, \qquad (1.1)$$

$$8\pi\varepsilon = \frac{1}{\alpha^2 T^2}\left(\frac{1}{4}\log T - \frac{1}{16} - \frac{\alpha}{8}\right) + \Lambda \qquad (1.2)$$

The model has to satisfy the reality condition (i) $\varepsilon+p > 0$ and (ii) $\varepsilon+3p > 0$.

The condition (i) leads to

$$T^{1/2} > \exp\left(\frac{5}{8}\right). \qquad (1.3)$$

The condition (ii) leads to

$$T > \exp\left(\frac{7}{4} - \frac{\alpha}{4} + 16\pi\Lambda\alpha^2 T^2\right) \qquad (1.4)$$

which gives condition on Λ. From (1.3) and (1.4), we find that reality conditions are satisfied.

The scalar of expansion θ calculated for flow vector v^i is given by

$$\theta = \frac{1}{\alpha T}\left(\log T\right)^{1/2} \qquad (1.5)$$

The rotation ω is identically zero and the components of shear tensor is given by :

$$\sigma_1^1 = \frac{1}{3\alpha T}\left(\log T\right)^{1/2}, \qquad (1.6)$$

$$\sigma_2^{\ 2} = \frac{1}{\alpha T}\left[\frac{1}{6}(\log T)^{1/2} - LR\right], \tag{1.7}$$

$$\sigma_3^{\ 3} = \frac{1}{\alpha T}\left[\frac{1}{6}(\log T)^{1/2} + LR\right], \tag{1.8}$$

$$\sigma_3^{\ 2} = \frac{1}{2\alpha T} \tag{1.9}$$

The non-banishing components of the conformal curvature tensor are

$$C_{12}^{\ \ 12} = C_{13}^{\ \ 13} = -\tfrac{1}{2} C_{23}^{\ \ 23}$$

$$= \quad \frac{1}{6\alpha^2 T^2}\left(\frac{1}{2}\log T - \frac{3}{8}\right) \tag{1.10}$$

The model does not exist between $T = 0$ and $T = 1$. At $T = 1$, $\theta = 0$. Hence, it starts from rest and goes on expanding till $T = \infty$ when θ is zero again. The model in general represents expanding, shearing and non-rotating universe since lim $T_{\to\infty}, \phi/\theta \neq 0$. Hence the model does not approach isotropy for large values of T. The ratio of magnetic energy to material energy is given by :

$$\frac{E_4^{\ 4}}{\varepsilon} = \frac{\sqrt{2}L^{3/2}\alpha T}{4\left[\frac{1}{2}\log T - \frac{L}{8} - \frac{L\alpha}{4} + 8\pi\Lambda\alpha^2 T^2\right]} \tag{1.11}$$

Since $\lim_{T\to 0}, E_4^{\ 4}/\varepsilon \to 0,$, the material energy is more dominant than magnetic energy.

In the absence of magnetic field, the pressure and density for the model are given by :

$$8\pi p = \frac{1}{\alpha^2 T^2}\left(\frac{1}{4}\log T + \frac{\alpha}{8} - \frac{9}{16}\right) - \Lambda, \tag{1.12}$$

$$8\pi\varepsilon = \frac{1}{\alpha^2 T^2}\left(\frac{1}{4}\log T - \frac{\alpha}{8} - \frac{1}{16}\right) + \Lambda, \tag{1.13}$$

The expansion 0, the components of shear tensor and non- vanishing components of conformal curvature tensor in the absence of magnetic field are given by :

$$\theta = \frac{1}{\alpha T}(\log T)^{1/2}, \tag{1.14}$$

$$\sigma_1^{\ 1} = \frac{1}{3\alpha T}\left(\log T\right)^{1/2}, \tag{1.15}$$

$$\sigma_2^{\ 2} = \frac{1}{6\alpha T}\left(\log T\right)^{1/2}, \tag{1.16}$$

$$\sigma_3^{\ 3} = \frac{1}{6\alpha T}\left(\log T\right)^{1/2}, \tag{1.17}$$

$$\sigma_3^{\ 2} = \frac{1}{2\alpha T} \tag{1.18}$$

and

$$C_{12}^{\ 12} = C_{13}^{\ 13} = -\tfrac{1}{2} C_{23}^{\ 23}$$

$$= \quad \frac{1}{6\alpha^2 T^2}\left(\frac{1}{2}\log T - \frac{3}{8}\right). \tag{1.19}$$

The reality condition (ε + p) > 0 leads to

$$T^{1/2} > \exp\left(\frac{5}{8}\right).$$

The condition (ε + 3p) > 0 leads to

$$T > \exp\left(\frac{7}{4} - \frac{\alpha}{4} + 16\pi\Lambda\alpha^2 T^2\right)$$

which gives condition on Λ. Thus reality conditions are satisfied for *T*.

Conclusion:

A magnetized cylindrically symmetric universe with two degrees of freedom in which the free gravitational field is Petrov type-I degenerate has been presented. The magnetic field is due to an electric current production along the x-axis. The distribution consists of an electrically neutral perfect fluid with an infinite electrical conductivity. The behaviour of the model when magnetic field tends to zero and other physical aspects of the model has also been discussed. The model in the absence of magnetic field starts expanding with a big bang at $T = 0$ and it stops at $T = 1$. In the absence of magnetic field, the model in general represents expanding, shearing, non-rotating and Petrov type I degenerate universe in general. Since $\lim_{T\to\infty} \sigma/\theta$ does not tend to zero, the model does not approach isotropy for large values of *T*.

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