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Plane Symmetric Cosmological Model with Wet Dark Fluid in Bimetric Theory of Gravitation

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(1)INTRODUCTION:-

Some investigation of plane symmetric cosmological relativity Qureshi and Deo A.J.M.M.vol.(1)2012-13 page no.1-5[23]

The purpose of this chapter is to investigate the role of wet dark fluid in plane- symmetric cosmological model within the frame work of bimetric theory of gravitation proposed by Rosen[16]. In this theory, it is observed that there is no contribution from wet dark fluid.

(3.1) $$ds^2 = A^2(dt^2 - dx^2) - B^2dy^2 - C^2dz^2$$

where *A*, *B* and *C* are functions of *x* and *t* .

$$g_{11} = -A^2, g_{22} = -B^2, g_{33} = -C^2, g_{44=}A^2$$

$$g^{11} = -A^{-2}, g^{22} = -B^{-2}, g^{33} = -C^{-2}, g^{44} = A^{-2}$$

His metric represents the anisotropic homogeneous universe (Aygun *et al* , [3]).

The background flat metric corresponding to equation (1) is

The field equations in bimetric theory of gravitation proposed by Rosen [16] are

(3.2) $$d\sigma^2 = (dt^2 - dx^2) - dy^2 - dz^2$$

where *A*, *B* and *C* are functions of time *t* alone.

$$\gamma_{11} = \gamma_{22} = \gamma_{33} = -1, \gamma_{44} = 1$$

$$\gamma^{11} = \gamma^{22} = \gamma^{33} = -1, \gamma^{44} = 1$$

The field equations of the rosen's biometric theory of gravitation are

(3.3) $$K_j^i = N_j^i - \frac{1}{2} N g_j^i = -8kT_j^i$$

Where,

(3.4) $$N_j^i = \frac{1}{2}\gamma^{\alpha\beta}(g^{hi} g_{hj|4})_{|4}$$

And $$k = \left(\frac{g}{r}\right)^{\frac{1}{2}}$$

Together with $g = \det(g_{ij})$ and $\gamma = \det(\gamma_{ij})$

Here the vertical bar $(|)$ denotes covariant differentiation with respect to γ_{ij} and T_j^i is the energy momentum tensor of the matter fields.

The Rosen's fields equations in biometric theory for the metric (2) are written in the form

(3.5) $$N_1^1 = \left(\frac{\ddot{A}}{A} - \frac{\dot{A}^2}{A^2}\right)$$

$$N_2^2 = \left(\frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} \right)$$

(3.6)

$$N_3^3 = \left(\frac{\ddot{C}}{C} - \frac{\dot{C}^2}{C^2} \right)$$

(3.7)

$$N_4^4 = \left(\frac{\ddot{A}}{A} - \frac{\dot{A}^2}{A^2} \right)$$

(3.8)

Now,

(3.9) $$N = N_1^1 + N_2^2 + N_3^3 + N_4^4$$

We get,

$$N = \left(\frac{\ddot{A}}{A} - \frac{\dot{A}^2}{A^2} + \frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} + \frac{\ddot{C}}{C} - \frac{\dot{C}^2}{C} + \frac{\ddot{A}}{A} - \frac{\dot{A}^2}{A^2} \right) = -16\pi\pi kp$$

(**3.10)**

$$K_1^1 = \left(\frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} + \frac{\ddot{C}}{C} - \frac{\dot{C}^2}{C^2} \right) = -16\pi kp$$

(3.11)

$$K_2^2 = \left(\frac{2\dot{A}^2}{A^2} - \frac{2\ddot{A}}{A} + \frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} - \frac{\ddot{C}}{C} + \frac{\dot{C}^2}{C^2} \right) = -16\pi kp$$

(3.12) **(3.13)**

$$K_3^3 = \left(\frac{2\dot{A}^2}{A^2} - \frac{2\ddot{A}}{A} + \frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} - \frac{\ddot{C}}{C} + \frac{\dot{C}^2}{C^2} \right) = -16\pi kTp$$

$$K_4^4 = \left(\frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} - \frac{\ddot{C}}{C} + \frac{\dot{C}^2}{C^2} \right) = -16\pi k T_4^4$$

(3.14)

Now we consider the momentum tensor for the perfect fluid

$$T_j^i = (p+\rho)u_i u^j + p g_i^j$$

Where, ρ =density and p =proper pressure

$$T_1^1 = T_2^2 = T_3^3 = p \text{ And } T_4^4 = -\rho$$

Now using equation (1) to (14) we get

$$K_1^1 = \left(\frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} + \frac{\ddot{C}}{C} - \frac{\dot{C}^2}{C^2} \right) = -16\pi k p$$

(3.15)

$$K_2^2 = \left(\frac{2\dot{A}^2}{A^2} - \frac{2\ddot{A}}{A} + \frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} - \frac{\ddot{C}}{C} + \frac{\dot{C}^2}{C^2} \right) = -16\pi k p$$

(3.16)

$$K_3^3 = \left(\frac{2\dot{A}^2}{A^2} - \frac{2\ddot{A}}{A} + \frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} - \frac{\ddot{C}}{C} + \frac{\dot{C}^2}{C^2} \right) = -16\pi k T p$$

(3.17)

$$K_4^4 = \left(\frac{\ddot{B}}{B} - \frac{\dot{B}^2}{B^2} - \frac{\ddot{C}}{C} + \frac{\dot{C}^2}{C^2} \right) = 16\pi k \rho$$

(3.18)

Equation (15) and (17) .we finds the solution in the form of

$$p + \rho = 0$$

(3.19)

For reality $p \geq 0$ and $\rho \geq 0$.thus in this model perfect fluid does not exist

For vacuum case $(p = \rho = 0)$, the field equations admit the solution of the form

(3.20) $A = \exp(m_1 t + m_2), B = \exp(m_3 + m_4), C = \exp(m_5 t + m_6)$

m_1, m_2, m_3, m_4, m_5 and m_6 are the constants of integration.

Thus, in view of equation (19),the metric (1) takes the form

$$ds^2 = e^{(m_1 t + m_2)}(dt^2 - dx^2) - e^{(m_3 t + m_4)}dy^2 - e^{(m_5 t + m_6)}dz^2$$

Which [for $m_1 = m_3 = m_5 = \alpha$ and $m_2 = m_4 = m_6 = \beta$] reduced to

$$ds^2 = e^{(\alpha t + \beta)}\left(dt^2 - dx^2 - dy^2 - dz^2\right)$$

(3.21) **(3.22)**

$$ds^2 = e^T\left(dt^2 - dx^2 - dy^2 - dz^2\right)$$

It is interesting to note that, the model is conformably flat and free and free from singularity. At T=0, the model to flat one.

Conclusion:-

Here, we have constructed a plane symmetric cosmological model in Rosen[16] bimetric theory of gravitation with a new equation of state for the dark energy component of the universe(known as Wet Dark Fluid). It is observed that the plane symmetric cosmological model does not exists in Bimetric theory of gravitation with wet dark fluid as a source of gravitation and hence only vacuum model is obtained.

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922 ***Kishor S. Adhav et al***

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