Bianchi Type-1 Cosmological Model of Two-Fluid in General Relativity

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Abstract:

This paper deals with study of Anisotropic Homologous Two-fluid Cosmological Models using Bianchi Type-1. Also physical and kinematical properties with reference to space-time and energy. Here one fluid represent Matter content and another as radiation of the universe.

Keywords Bianchi type-1, Space time, Two-Fluid.

Introduction

The Cosmic Microwave Background (CMB) is the important part of the Different Cosmological model like Homogeneous, Isotropic and Anisotropies. Minor perturbation in CMB, which is superimposed on ideal smooth background. Provide information of Galaxy and huge structure in the universe. Different scientists and researchers have studied and contributed important information and data on above Topic. Some of the them are given below

i) Dunn & Coley [3] calculated Model of Bianchi type VI_0 source of two fluid .

ii) Oli and Pant [6] calculated above model using space time coordinates.

iii) Oli [15] calculated Homogenous two fluid Anisotropic models in Bianchi type-I space time using Gravity, cosmological constant G and Λ respectively.

Numbers of scientists have calculated the Friedmann-Robertson-Walker (FRW) Models using Two-Fluids as source of energy.

i) Tupper & Coley [2] calculated 2 different fluids acting as gravity field denoted by the FRW Material.

ii) Belinski & Khalatnikov [5], using viscosity one cannot remove singularity (cosmological) but one can study new behavior of singularity of fluid.

iii) Verma [1] Perform Analysis of two fluids cosmological model.

iv) GR. Venkateswarlu [14], calculated Kaluza-klein mesonic cosmology models using two fluids.

v) Pawar [9] Cosmological models with conduction of Heat and radiation disorders calculated by.

vi) Katore et al. [16], calculated acceleration & deceleration of cosmos models with ideal fluid and dark Matter.

The invention CMBR Propel authors to research FRW model with two fluid as Energy source.

i) P Sandin [13] has examined cosmological model with two fluid.

ii) Patil et. al [12, 17] has investigated magnetic Two fluid Anisotropic Bianchi type-9 and 5 model for two fluids.

We motivated the above research for further investigation on Bianchi type cosmological model using two fluids as energy source.

Field Equation

The spatial homogeneous anisotropic Bianchi-Type-1 Metric in the form,

$$ds^2 = dt^2 - A^2dx^2 - B^2dy^2 - C^2dz^2 \tag{2.1}$$

Where the coefficient of dx, dy, dz are constants and functions of t alone.

The Equations of field of two fluid with energy as source in gravitational field

$$R_{ij} - \frac{1}{2}g_{ij}R = -8\pi G T_{ij} \tag{2.2}$$

Also the The Enery momentum tensor (EMT) of two fluid is

$$T_{ij} = \left(T_{ij}\right)^m + \left(T_{ij}\right)^r \tag{2.3}$$

Where

i) $\left(T_{ij}\right)^m$ Denote EMT for matter field with

$\rho_m -$ density,

$P_m -$ pressure and

ii) $\left(T_{ij}\right)^r$ Denote EMT for radiation field with

$\rho_m -$density,

$P_r = \frac{1}{2}\rho_r -$ pressure

and $(U_i)^m = (U_i)^r = (1, 0, 0, 0)$ —Velocities of matter & radiation

$$\left(T_{ij}\right)^m = (P_m + \rho_m)(u_i)^m\left(u_j\right)^m - P_m g_{ij} \tag{2.4}$$

$$\left(T_{ij}\right)^r = \frac{4}{3}\rho_r(u_i)^r\left(u_j\right)^r - \frac{1}{3}\rho_r g_{ij} \tag{2.5}$$

Using equation (2.3), (2.4) and (2.5). (2.2) becomes,

$$\frac{\ddot{B}}{B} + \frac{\ddot{C}}{C} + \frac{\dot{B}\dot{C}}{BC} = -8\pi G\left(P_m + \frac{1}{3}\rho_r\right) \tag{26}$$

$$\frac{\ddot{A}}{A} + \frac{\ddot{C}}{C} + \frac{\dot{A}\dot{C}}{AC} = -8\pi G\left(P_m + \frac{1}{3}\rho_r\right) \tag{2.7}$$

$$\frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\dot{A}\dot{B}}{AB} = -8\pi G\left(P_m + \frac{1}{3}\rho_r\right) \tag{2.8}$$

$$\frac{\dot{A}\dot{B}}{AB} + \frac{\dot{B}\dot{C}}{BC} + \frac{\dot{A}\dot{C}}{AC} = -8\pi G\left(P_m + \rho_r\right) \tag{2.9}$$

comparing (2.6), (2.7) and (2.8), we obtain

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$$\frac{\dot{A}}{A}=\frac{\dot{B}}{B}=\frac{\dot{C}}{C}=a(const), \tag{2.10}$$

On Integrating, we have,

$$A=B=C=at+n \tag{2.11}$$

Where

a-any constant and

n –integration constant.

Using (2.11), (2.1) yields,

$$ds^2=dt^2-(at+n)^2(dx^2+dy^2+dz^2)$$

3. Physical and Kinematical Properties

We know that " gamma law"

$$P_m=(\gamma-)\rho_r\,, 1\ 1\leq\ \gamma\ \leq\ 2 \tag{3.1}$$

where

$$\rho_m=\frac{6a^2}{(4-3\gamma)(at+n)^2} \tag{3.2}$$

$$\rho_r=\frac{3a^2(2-3\gamma)}{(4-3\gamma)(at+n)^2} \tag{3.3}$$

$$\rho=\frac{a^2(12-9\gamma)}{(4-3\gamma)(at+n)^2} \tag{3.4}$$

Hubble generalized parameter is given by

$$H=\frac{1}{3}(H_1+H_2+H_3) \tag{3.4}$$

In which $H_1=\frac{\dot{A}}{A}, H_2=\frac{\dot{B}}{B},\ H_3=\frac{\dot{C}}{C}$

***Model-1:* $\gamma=1$**

Consider shear scalar, scalar expansion, deceleration & density

$$\theta=3H=\frac{3a}{(at+n)}$$

$$\sigma^2=\frac{3}{2}\frac{a^2}{(at+n)^2}$$

$$q=0$$

$$\Omega_m=2,\ \Omega_r=-1, \Omega_0=1 \tag{3.6}$$

***Model-2:* $\gamma=\frac{4}{3}$**

Scalar expansion, shear scalar, deceleration & density as follows,

$$\theta=3H=\frac{3a}{(at+n)}$$

$$\sigma^2=\frac{3}{2}\frac{a^2}{(at+n)^2}$$

$$q = 0$$
$$\Omega_m = \Omega_r = \Omega_0 = \infty \qquad (3.6)$$

Model-3 : $\boldsymbol{\gamma = \frac{5}{3}}$

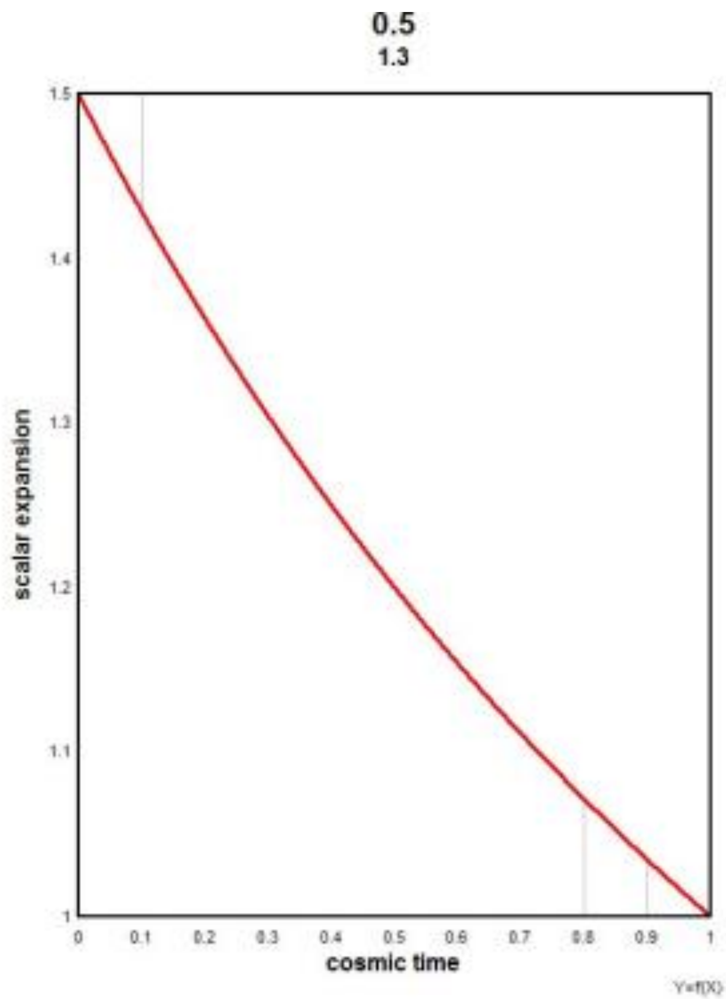
Expansion and shear scalar respectively, deceleration and density as follows,

$$\theta = 3H = \frac{3a}{(at+n)}$$
$$\sigma^2 = \frac{3}{2}\frac{a^2}{(at+n)^2}$$
$$q = 0$$
$$\Omega_m = -2, \Omega_r = 3, \Omega_0 = 1 \qquad (3.6)$$

Model-4: γ = 2

Scalar expansion, shear scalar, deceleration and density

$$\theta = 3H = \frac{3a}{(at+n)}$$
$$\sigma^2 = \frac{3}{2}\frac{a^2}{(at+n)^2}$$
$$q = 0$$
$$\Omega_m = -1, \Omega_r = 2, \Omega_0 = 1 \qquad (3.6)$$



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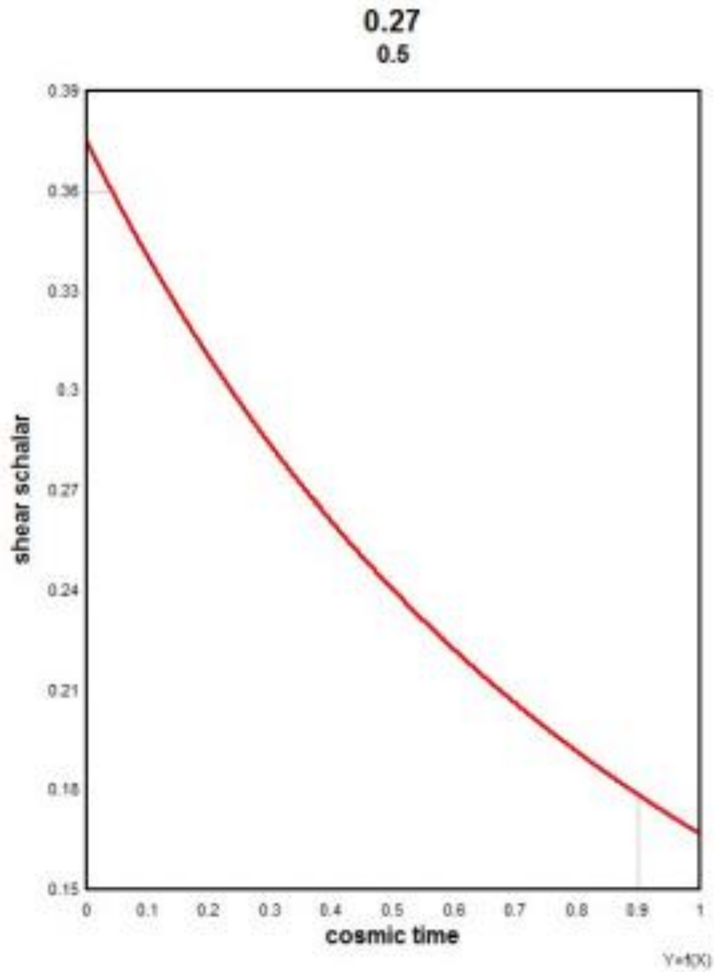
The above graphical representation shows that has time increases, scalar expansion θ decreases.



The above graphical representation shows that has time increase, scalar expansion σ decreases.

Conclusion :

In this research paper we have a deceleration parameter $q = 0$ corresponds to the universe with two fluid model is expand with fix velocity.

Also, in all above cases, the

i) Ratio $\left(\frac{\sigma}{\theta}\right)^2 = \frac{3a^2}{2(at+n)^2} \times \frac{(at+n)^2}{3a^2} = \frac{1}{2} \neq 0$

ii) Models are expanding and rotating with time .

ii) $S \propto T$ i.e Stability (S)of model is directly proportional to Time(T),

iii) $E \propto \frac{1}{T}$ i.e Expansion rate (E) is inversely proportion to time

all of the above property suggest that model is realistic

The result obtained by Adhav et.al (2011) is acquiesce with our result for $m = 0$ in Bianchi type –v model. i.e our result is a special case.

REFERENCES:

[1] A. K. Verma (2009), Astrophysics. Space Sci., 321, 73-77.

[2] A. A. Coley and B. O. J. Tupper (1985), J. Math. Phys., Vol. 27,

[3] A. A. Coley, K. Dunn (1990), Astrophysics. J. 26, 348.

[4] B. Mishra, P. P. Ray, S. K. J. Pacif (2018), Advance in High Energy Physics, Vol. 2018, Article 6306848, 9 pages.

[5] Belinsky V A, Khalatnikov I M (1975),zh.Eksp.TeorFiz 631121.

[6] D. N. Pant, S. Oli (2002), Astrophysics. Space Sci. 281,623.

[7] D. D. Pawar, V. R. Patil (2013), Prespacetime Journal, 4-3, 312-320.

[8] D.D.Pawar, V.J.Dagwal (2013), IJ. of science & Engg. Research 4,4,689-693.

[9] D.D.Pawar, S.W.Bhaware, A. G. Deshmukh (2009), Rom. J. Phys.,54,187- 194.

[10] K.S.Adhav, S.M.Borikar, M.S.Desale, R.B.Raut (2011),EJTP8,No.25;319-326.

[11] K. S. Adhav, S. M. Borikar, R. B. Raut (2011), Int. Theor. Phys.50,1846-1851. [12] Patil V R, Bhojne Sarika A (2016), IJPRET, VOL 4(9): 179-186.

[13] Pratik Sandin (2009), Gen Reiatv Gravit 49; 2707-2724.

[14] R.Venkateswarlu-2013,Prespacetime Journal,4,8 pp.801-806

[15] S. Oli (2008), Astrophysics. Space Sci.89-94, 314.

[16] S. D. Katore, B. B. Chopade, S. H. Shekh, S. A. Bhaskar (2012), IJMA, P. 1283-1291.

[17] V. R. Patil, S. A. Bhojne, G. U. Khapekar, N. S. Bayaskar (2017), IOSR-JM, Vol. 13, Issue 6 Ver. II, PP 12-17.

[18] V. V. Mete, V. M. Umarkar, A. M. Pund (2012), Prespacetime Journal Vol. 3 Issue 2 PP : 170-177.