International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 14 Issue 1 ǁ January 2026 ǁ PP. 87-95

Magnetized Bianchi Type-V Wet Dark Fluid Cosmological Model with Constant Deceleration Parameter in General Relativity

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ABSTRACT: *In this paper, we explored magnetized Bianchi type-V cosmological model with Wet dark fluid in general theory of relativity. A new equation of state for the dark energy component of the universe has been used. It is modeled on the equation of state $p = \gamma(\rho - \rho_*)$ which can describe a liquid, for example water. The exact solutions to the corresponding field equations are obtained in quadrature form. In this chapter, we have investigated Bianchi type-V cosmological model in presence of wet dark fluid with electro-magnetic field. By assuming F_{23} is the only non-vanishing component of electromagnetic field tensor F_{ij}. The physical and geometrical aspects of the models are also discussed.*
Keywords: ***Bianchi Type-V space-time, Magnetic permeability. Wet dark fluid (WDF), Electromagnetic field, deceleration parameter.***

Date of Submission: 05-01-2026 Date of acceptance: 15-01-2026

I. INTRODUCTION

Cosmology is the study of origin, current state and the future of the Universe. The Bianchi cosmologies which are spatially homogeneous and anisotropic play an important role in the theoretical cosmology and have been studied since 1960s. The simplest models of the expanding universe are those which are spatially homogeneous and isotropic at each instant of time. Bianchi type-V cosmological models have been studied by Farnsworth [1], Maartens et al. [2], Wainwright et al. [3], Collins [4], Coley et al. [5].

The occurrence of magnetic field on a galactic scale is well established fact today and their importance for a variety of astrophysical phenomenon is generally acknowledged by several authors. The renowned authors, Reiss et al. [6], Perlmutter et al. [7], Sahni [8] have studied the nature of the dark energy component of the universe as the one of the deepest mysteries of universe. We are motivated to use the wet dark fluid (WDF) as a model for a dark energy which stems from an empirical equation of state proposed by Hayward [9] and Tait [10] to treat water and aqueous solutions. Modification of the Friedmann equation such as Cardassion expansion referred by Freese et al.[11], Freese [12], Gondolo et al.[13] as well as what might be derived from brane cosmology given by Deffayet et al.[14], Dvali et al.[15], Dvali et al.[16] have also been used to explain the acceleration of the universe.

Harrison [17], Asseo and Sol [18] and Kim et al.[19] have pointed out the importance of magnetic field in the different context. Patil et al.[[20] has investigated Bianchi type-I Bianchi Type-I Cosmological Model in the Presence of Wet Dark Fluid with Magnetic Flux.

In this research article, we have introduced the magnetic flux in the system of wet dark fluid. This model is in the spirit of generalized Chaplygin gas (GCG) by Gorini et al.[21]. The equation of state for WDF is in the form

$$p_{WDF} = \gamma(\rho_{WDF} - \rho_*) \tag{1.1}$$

It is motivated by the fact that, a good approximation for many fluids, including water, in which the internal attraction of the molecules makes negative pressures. One of the virtues of this model is that the square of the sound speed c_s^2, which depends on $\frac{\partial p}{\partial \rho}$ can be positive, even while giving rise to cosmic acceleration in the current epoch. The parameters γ and ρ_* are taken to be positive and we restrict ourselves to $0 \leq \gamma \leq 1$. Note that if c_s denotes the adiabatic sound speed in WDF, then $\gamma = c_s^2$ (Babichev *et al.*[22]). To find the WDF energy density, we use the energy conservation equation as

$$\dot{\rho_{WDF}} + 3H(p_{WDF} + \rho_{WDF}) = 0 \tag{1.2}$$

where H is Hubble parameter.

From the equation of state (1.1) and using $3H = \frac{\dot{V}}{V}$ in the equation (1.2) and on solving we obtained

$$\rho_{WDF} = \frac{\gamma}{1+\gamma}\rho_* + \frac{D}{V^{1+\gamma}} \tag{1.3}$$

where D is the constant of integration and V is the volume expansion.WDF naturally includes two components: a piece that behaves as a cosmological constant as well as a standard fluid with an equation of state $p = \gamma\rho$, if we take $D > 0$, it confirm that the fluid will not violate the strong energy condition.

$$p_{WDF} + \rho_{WDF} = (1+\gamma)\rho_{WDF} - \gamma\rho_*$$

$$= (1+\gamma)\frac{D}{V^{1+\gamma}} \geq 0 \tag{1.4}$$

According Holman and Naidu [23], the wet dark fluid has been used as dark energy in the homogeneous, isotropic FRW case and the early stage of expansion of the universe exhibits substantially non-Friedmannian behavior given by Zeldovich [24]. The author Singh et al.[25] has studied Bianchi type-I universe with wet dark fluid. Recently Patil et al. [26,27] has studied Non shearing LRS Bianchi type-III and Bianchi type-IX string cosmological model in presence of magnetic flux with bulk viscosity, also Patil et al. [28,29,30] has studied LRS Bianchi type-V cosmological model in presence of perfect fluid and magnetic flux with variable magnetic permeability and Bianchi type-IX and V cosmological model with two fluid in presence of magnetic flux.

In this paper, we have studied the Bianchi type-I cosmological model with matter term and dark energy treated as a dark fluid satisfying the equation of state (1.1) in presence of magnetic flux. The solution has been obtained in the quadrature form. The models with constant deceleration parameter have been studied in detail.

II. FUNDAMENTAL EQUATIONS AND GENERAL SOLUTIONS

We have considered Bianchi type-V space-time,

$$ds^2 = dt^2 - A^2dx^2 - e^{2ax}(B^2dy^2 + C^2dz^2) \tag{2.1}$$

in which A, B and C are cosmic scale functions of time t.

$$g = \det g_{ij} = -A^2B^2C^2e^{4ax}$$

Therefore, $\sqrt{-g} = ABC\, e^{2ax}$ (2.2)

The non vanishing christoffel symbols for metric (2.1) are,

$$\Gamma^0_{11} = A\dot{A},\quad \Gamma^1_{01} = \frac{\dot{A}}{A},\quad \Gamma^0_{22} = e^{2ax}B\dot{B},$$

$$\Gamma^2_{02} = \frac{\dot{B}}{B},\quad \Gamma^1_{22} = -\frac{B^2}{A^2}a\, e^{2ax}$$

$$\Gamma^2_{12} = a,\quad \Gamma^0_{33} = C\dot{C}e^{2ax},\quad \Gamma^3_{03} = \frac{\dot{C}}{C},$$

$$\Gamma^1_{33} = -\frac{C^2}{A^2}a\, e^{2ax},\quad \Gamma^3_{13} = a$$

The Einstein field equation for the space time (2.1) is,

$$R^i_j - \frac{1}{2}Rg^i_j = kT^i_j \tag{2.3}$$

The non vanishing components of Ricci tensor for metric (2.1) are

$$R^0_0 = \frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\ddot{C}}{C} \tag{2.4}$$

$$R^1_1 = \frac{\ddot{A}}{A} + \frac{\dot{A}}{A}\frac{\dot{B}}{B} + \frac{\dot{A}}{A}\frac{\dot{C}}{C} - \frac{2a^2}{A^2} \tag{2.5}$$

$$R^2_2 = \frac{\ddot{B}}{B} + \frac{\dot{B}}{B}\frac{\dot{A}}{A} + \frac{\dot{B}}{B}\frac{\dot{C}}{C} - \frac{\dot{B}^2}{B^2} - \frac{2a^2}{A^2} \tag{2.6}$$

$$R^3_3 = \frac{\ddot{C}}{C} + \frac{\dot{C}}{C}\frac{\dot{A}}{A} + \frac{\dot{C}}{C}\frac{\dot{B}}{B} - \frac{2a^2}{A^2} \tag{2.7}$$

$$R^0_1 = 2\frac{\dot{A}}{A} - \frac{\dot{B}}{B} - \frac{\dot{C}}{C} \tag{2.8}$$

and Ricci Scalar $R = R^0_0 + R^1_1 + R^2_2 + R^3_3$,

$$R = 2\left(\frac{\ddot{A}}{A} + \frac{\ddot{B}}{B} + \frac{\ddot{C}}{C}\right) + 2\left(\frac{\dot{A}}{A}\frac{\dot{B}}{B} + \frac{\dot{A}}{A}\frac{\dot{C}}{C} + \frac{\dot{B}}{B}\frac{\dot{C}}{C}\right) - \frac{6a^2}{A^2} \tag{2.9}$$

Using equations (2.4) to (2.9) to the L.H.S. of equation (2.3), we have

$$R^0_0 - \frac{1}{2}g^0_0\, R = -\frac{\dot{A}}{A}\frac{\dot{B}}{B} - \frac{\dot{A}}{A}\frac{\dot{C}}{C} - \frac{\dot{B}}{B}\frac{\dot{C}}{C} + \frac{6a^2}{A^2} \tag{2.10}$$

$$R^1_1 - \frac{1}{2}g^1_1\, R = -\frac{\ddot{B}}{B} - \frac{\ddot{C}}{C} - \frac{\dot{B}}{B}\frac{\dot{C}}{C} + \frac{a^2}{A^2} \tag{2.11}$$

$$R^2_2 - \frac{1}{2}\, g^2_2\, R = -\frac{\ddot{A}}{A} - \frac{\ddot{C}}{C} - \frac{\dot{A}}{A}\frac{\dot{C}}{C} + \frac{a^2}{A} \tag{2.12}$$

$$R^3_3 - \frac{1}{2}\, g^3_3\, R = -\frac{\ddot{A}}{A} - \frac{\ddot{B}}{B} - \frac{\dot{A}}{A}\frac{\dot{B}}{B} + \frac{a^2}{A^2} \tag{2.13}$$

$$R^0_1 - \frac{1}{2}\, g^0_1\, R = 2\frac{\dot{A}}{A} - \frac{\dot{B}}{B} - \frac{\dot{C}}{C} \tag{2.14}$$

The energy momentum tensor for system of wet dark fluid and magnetic field is

$$T_j^i = (\rho_{WDF} + p_{WDF})u_j u^i - p_{WDF}\,\delta_j^i + E_j^i \qquad (2.15)$$

in which u^i is the flow vector satisfying the relation
$g_{ij}u^i u^j = 1$
The electromagnetic field E_j^i is defined as,
$E_j^i = \frac{1}{4\pi}\left[-F_{jl}F^{il} + \frac{1}{4}g_j^i F_{lm}F^{lm}\right]$
with the Maxwell's equation,
$\frac{\partial}{\partial x^j}\left(F^{ij}\sqrt{-g}\right) = 0$, which leads to, $F_{23} = I$

$$\Rightarrow E_0^0 = E_1^1 = -E_2^2 = -E_3^3 = \frac{I^2}{8\pi B^2 C^2} \qquad (2.16)$$

Using co-moving system of co-ordinate and equation (2.16) in equation (2.15) we have obtain the energy momentum tensors as

$$T_0^0 = \rho_{WDF} + \frac{I^2}{8\pi B^2 C^2} \qquad (2.17)$$

$$T_1^1 = -p_{WDF} + \frac{I^2}{8\pi B^2 C^2} \qquad (2.18)$$

$$T_2^2 = -p_{WDF} - \frac{I^2}{8\pi B^2 C^2} \qquad (2.19)$$

$$T_3^3 = -p_{WDF} - \frac{I^2}{8\pi B^2 C^2} \qquad (2.20)$$

Using equations (2.10)-(2.14) and (2.17)-(2.20) in equation (2.3), we have

$$-\frac{\dot A}{A}\frac{\dot B}{B} - \frac{\dot A}{A}\frac{\dot C}{C} - \frac{\dot B}{B}\frac{\dot C}{C} + \frac{6a^2}{A^2} = k\left(\rho_{WDF} + \frac{I^2}{8\pi B^2 C^2}\right) \qquad (2.21)$$

$$-\frac{\ddot B}{B} - \frac{\ddot C}{C} - \frac{\dot B}{B}\frac{\dot C}{C} + \frac{a^2}{A^2} = k\left(-p_{WDF} + \frac{I^2}{8\pi B^2 C^2}\right) \qquad (2.22)$$

$$-\frac{\ddot A}{A} - \frac{\ddot C}{C} - \frac{\dot A}{A}\frac{\dot C}{C} + \frac{a^2}{A} = k\left(-p_{WDF} - \frac{I^2}{8\pi B^2 C^2}\right) \qquad (2.23)$$

$$-\frac{\ddot A}{A} - \frac{\ddot B}{B} - \frac{\dot A}{A}\frac{\dot B}{B} + \frac{a^2}{A^2} = k\left(-p_{WDF} - \frac{I^2}{8\pi B^2 C^2}\right) \qquad (2.24)$$

$$2\frac{\dot A}{A} - \frac{\dot B}{B} - \frac{\dot C}{C} = 0 \;,\; 2\frac{\dot A}{A} = \frac{\dot B}{B} + \frac{\dot C}{C} \qquad (2.25)$$

Subtracting equation (1.3) from equation (1.1), we have

$$p_{WDF} - \rho_{WDF} = \frac{-2\gamma}{1+\gamma}\rho_* + \frac{D(\gamma-1)}{V^{(1+\gamma)}}\,. \qquad (2.26)$$

Solving equation (2.25), we have

$$A^2 = BC \qquad (2.27)$$

To obtain more general solution, we use the metric potential relation

$$B = C^{\,n} \qquad (2.28)$$

Volume scale factor is $V = ABCe^{2ax}$ (2.29)

III. THE GEOMETRICAL AND PHYSICAL SIGNIFICANCE

Adding equations (2.22)-(2.24) and three times equation (2.21) and using equations (1.4), (2.27), (2.28),(2.29) we obtain,

$$\frac{\ddot V}{V} = -\frac{kI^2}{4\pi B^2 C^2} - \frac{3k}{2}\frac{D(1+\gamma)}{V^{1+\gamma}} + \frac{21a^2}{2A^2} \qquad (3.1)$$

On simplifying and solving equation (2.29), we have

$$\dot V = \sqrt{\frac{-\chi V^{-\gamma+1}}{-\gamma+1} + 3\eta V^{-1/3} + \frac{3}{4}\omega V^{4/3}} \qquad (3.2)$$

Where $\chi = -\frac{3}{2}k(1+\gamma)$, $\eta = \frac{I^2}{4\pi}e^{8ax/3}$, $\omega = \frac{21}{2}e^{4ax}$

On simplifying above equation, we have

$$dt = \left(\frac{-\chi V^{-\gamma+1}}{-\gamma+1} + 3\eta V^{-1/3} + \frac{3}{4}\omega V^{4/3}\right)^{-1/2} dV \qquad (3.3)$$

Using equations (2.27),(2.28) and (2.29) we have

$$A^2 = \frac{V^{2/3}}{e^{4ax/3}} \qquad (3.4)$$

$$B^2 = \frac{V^{4n/3n+3}}{e^{8axn/3n+3}} \qquad (3.5)$$

$$C^2 = \frac{V^{4/3n+3}}{e^{8ax/3n+3}} \tag{3.6}$$

The line element of Bianchi type-V space-time,

$$ds^2 = \left(\frac{-\chi V^{-\gamma+1}}{-\gamma+1} + 3\eta V^{-1/3} + \frac{3}{4}\omega V^{4/3}\right)^{-1/2} dV^2 - \frac{V^{2/3}}{e^{4ax/3}} dx^2$$
$$-e^{2ax}\left(\frac{V^{4n/3n+3}}{e^{8axn/3n+3}} dy^2 + \frac{V^{4/3n+3}}{e^{8ax/3n+3}} dz^2\right) \tag{3.7}$$

Using equations (2.29) and (3.2) in Scalar expansion θ, we have

$$\text{Scalar expansion } \theta = \frac{\dot V}{V} = \sqrt{\frac{-\chi V^{-\gamma-1}}{-\gamma+1} + 3\eta V^{-7/3} + \frac{3}{4}\omega V^{-2/3}} \tag{3.8}$$

Shear scalar is as follows,

$$\sigma_{ij} = \frac{1}{2}\{u_{i;j} - u_{j;i}\} + \frac{1}{2}\{u_{i,k}u^k u_j - u_i u_{j,k}u^k\} - \frac{1}{3}\theta\{g_{ij} - u_i u_j\}$$

Using co-moving system of co-ordinate and equation (3.8) in above equation, we have,

$$\sigma^2 = \frac{4}{27}\sqrt{\frac{-\chi V^{-\gamma-1}}{-\gamma+1} + 3\eta V^{-7/3} + \frac{3}{4}\omega V^{-2/3}} \tag{3.9}$$

Here H is Hubble parameter defined as $H = \frac{1}{3}\left\{\frac{\dot A}{A} + \frac{\dot B}{B} + \frac{\dot C}{C}\right\} = \frac{1}{3}\frac{\dot V}{V}$

$$H = \frac{1}{3}\frac{\dot V}{V} = \frac{1}{3}\sqrt{\frac{-\chi V^{-\gamma-1}}{-\gamma+1} + 3\eta V^{-7/3} + \frac{3}{4}\omega V^{-2/3}} \tag{3.10}$$

From equation (2.29), we have

$$\frac{\ddot V}{V} = 2\left\{\frac{\dot A}{A}\frac{\dot B}{B} + \frac{\dot C}{C}\frac{\dot B}{B} + \frac{\dot C}{C}\frac{\dot A}{A}\right\} + \left\{\frac{\ddot A}{A} + \frac{\ddot B}{B} + \frac{\ddot C}{C}\right\}$$

The deceleration parameter q is given by

$$q = \frac{d}{dt}\left(\frac{1}{H}\right) - 1$$

Where H is Hubble parameter and

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

Using equation (2.29) (3.1) and (3.2) in above equation, we have

$$q = \frac{V^{-\gamma+1}\left(\frac{-2\chi}{-\gamma+1} - 3\chi\right) + 3\eta\left(3V^{-1/3} + V^{-4/3}\right) + \omega\left(\frac{3}{2}V^{4/3} - V^{1/3}\right)}{\frac{-\chi V^{-\gamma+1}}{-\gamma+1} + 3\eta V^{-1/3} + \frac{3}{4}\omega V^{4/3}} \tag{3.11}$$

SOME SPECIAL CASES

Case I : $\gamma = 1$ and $N = 1$

From equations (3.4), (3.5), (3.6), (3.7), (3.8),(3.9),(3.10) and (3.11) are yields,

$$A^2 = \frac{V^{2/3}}{e^{4ax/3}}$$

$$B^2 = \frac{V^{4n/3n+3}}{e^{8axn/3n+3}}$$

$$C^2 = \frac{V^{4/3n+3}}{e^{8ax/3n+3}}$$

$$\rho_{WDF} = \left(\frac{1}{2}\rho_* + \frac{c}{V^2}\right)$$

$$p_{WDF} = \frac{c}{V^2} - \frac{1}{2}\rho_*$$

$$ds^2 = \frac{V^{2/3}}{e^{4ax/3}} dx^2 - e^{2ax}\left(\frac{V^{4n/3n+3}}{e^{8axn/3n+3}} dy^2 + \frac{V^{4/3n+3}}{e^{8ax/3n+3}} dz^2\right)$$

θ *tends to infinity*

q *tends to infinity*

σ *tends to infinity*

Graphical Representation:-For $\gamma = 1$ and $N = 1$

$$\rho_{WDF} = \left(\frac{1}{2}\rho_* + \frac{C}{V^2}\right)$$

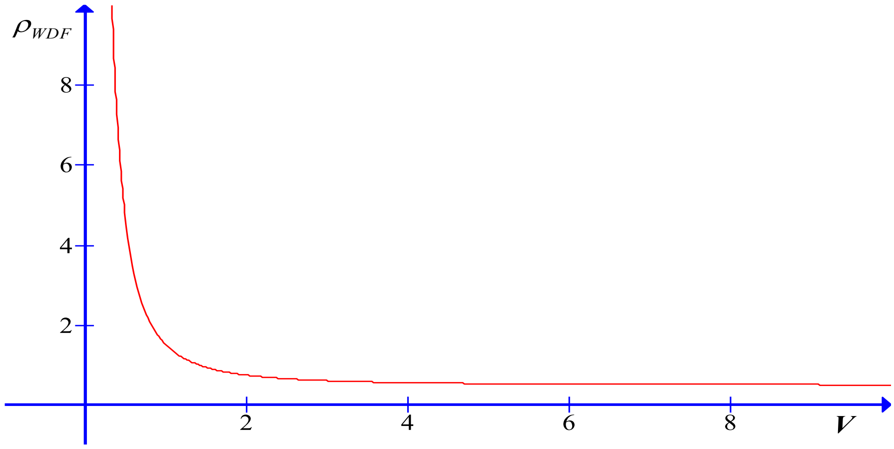

Fig. 1

From fig.-1, it clears that as volume increases, density decreases suddenly and after a stage, it is stable.

$p_{WDF} = \frac{C}{V^2} - \frac{1}{2}\rho_*$

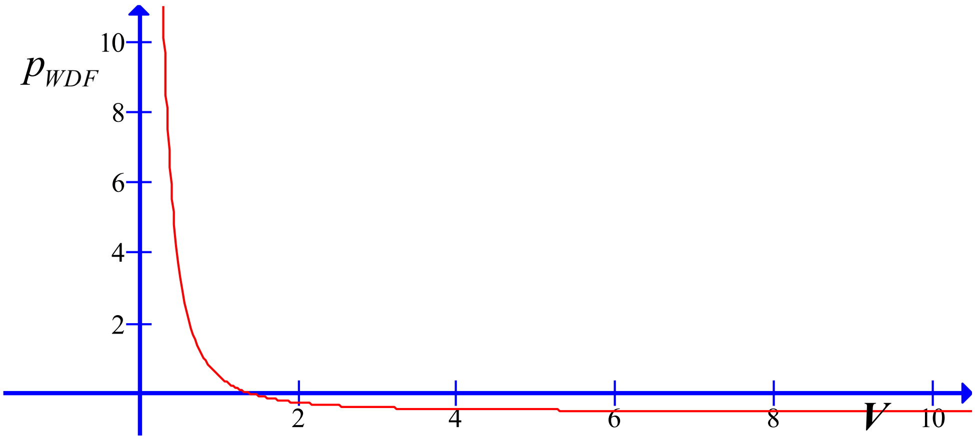

Fig. 2

From fig.-2, it shows that as volume increase, pressure decreases and it goes to negative.

Case II: $\gamma = 0$ And $N = 1$

From equations (3.4), (3.5), (3.6), (3.7), (3.8),(3.9),(3.10) and (3.11) are yields,

$a_1 = V^{1/2}$

$a_2 = V^{(1/4)}\sqrt{D}\,\exp\left[\frac{1}{2}\left(X\int\frac{dt}{V}\right)\right]$

$a_3 = V^{(1/4)}\,\frac{1}{\sqrt{D}}\,\exp\left[-\frac{1}{2}\left(X\int\frac{dt}{V}\right)\right]$

$\rho_{WDF} = \frac{C}{V}$,

$p_{WDF} = 0$

$$ds^2 = \left(-\chi V + 3\eta V^{-1/3} + \frac{3}{4}\omega V^{4/3}\right)^{-1/2} dV^2 - \frac{V^{2/3}}{e^{4ax/3}}dx^2$$
$$-e^{2ax}\left(\frac{V^{4n/3n+3}}{e^{8axn/3n+3}}dy^2 + \frac{V^{4/3n+3}}{e^{8ax/3n+3}}dz^2\right)$$

$$\theta = \frac{\dot{V}}{V} = \sqrt{\frac{-\chi V^{-1}}{1} + 3\eta V^{-7/3} + \frac{3}{4}\omega V^{-2/3}}$$

$$q = \frac{-5\chi V + 3\eta\left(3V^{-1/3} + V^{-4/3}\right) + \omega\left(\frac{3}{2}V^{4/3} - V^{1/3}\right)}{-\chi V + 3\eta V^{-1/3} + \frac{3}{4}\omega V^{4/3}}$$

$$\sigma^2 = \frac{4}{27}\sqrt{\frac{-\chi V^{-\gamma-1}}{-\gamma+1} + 3\eta V^{-7/3} + \frac{3}{4}\omega V^{-2/3}}$$

Graphical Representation:- For $\gamma = 0$ and $N = 1$

$\rho_{WDF} = \frac{C}{V}$, $p_{WDF} = 0$

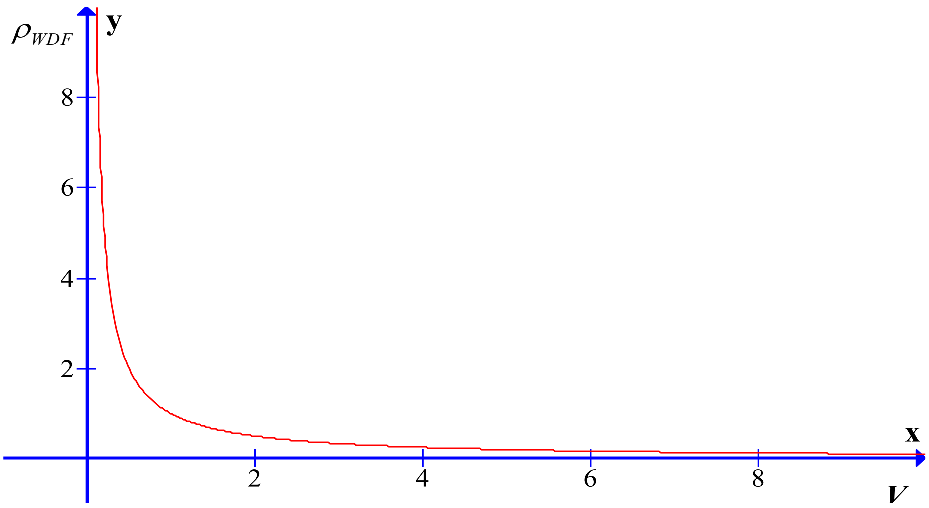

Fig.3

From fig.3, as volume increases density decrease gradually.

IV. MODELS WITH CONSTANT DECELERATION PARAMETER

Case I: Power law ($N = 1$, $\gamma = 1$)

We take the power law,

$V = at^b$

where a and b are constant.

From equations (3.4), (3.5), (3.6), (3.7), (3.8),(3.9),(3.10) and (3.11) are yields,

$a_1 = a^{(1/2)}\, t^{(b/2)}$

$a_2 = a^{(1/4)} t^{(b/4)} \sqrt{D} \exp\left(\frac{X}{2}\int \frac{dt}{V}\right)$

$a_3 = a^{(1/4)}\, t^{(b/4)} \frac{1}{\sqrt{D}} \exp\left(-\frac{X}{2}\int \frac{dt}{V}\right)$

$\rho_{WDF} = \left(\frac{\rho_*}{2} + \frac{C}{at^{2b}}\right)$

$p_{WDF} = \frac{C}{at^{2b}} - \frac{\rho_*}{2}$

$$ds^2 = dt^2 - at^b (dx^1)^2 - a^{(1/2)} t^{(b/2)} D \exp\left(X\int \frac{dt}{V}\right)(dx^2)^2$$
$$-a^{(1/2)} t^{(b/2)} D^{-1} \exp\left(-X\int \frac{dt}{V}\right)(dx^3)^2$$

$\theta = \frac{b}{t}$

$q = \frac{3}{b} - 1$

$\sigma^2 = \frac{1}{3}\left\{\left(\frac{b}{t}\right)^2 \left(\frac{1}{16}\right) + \frac{3X}{4t^{2b}a^2}\right\}$

Graphical Representation:- Power Law, $V = at^b$

$\rho_{WDF} = \left(\frac{\gamma}{1+\gamma}\rho_* + \frac{\gamma C}{at^{b(1+\gamma)}}\right)$ for $\gamma = 1$, $\rho_{WDF} = \left(\frac{\rho_*}{2} + \frac{C}{at^{2b}}\right)$

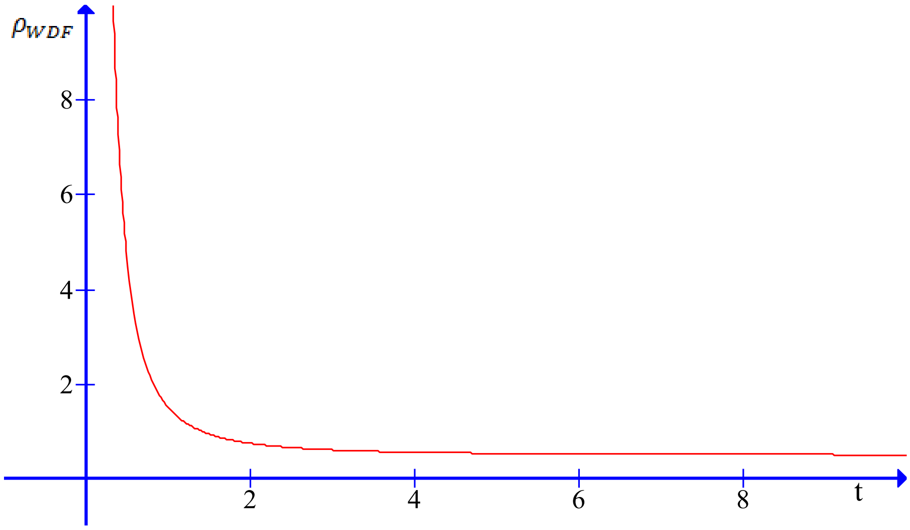

Fig.4

As time increases density decreases gradually.

$p_{WDF} = \frac{\gamma C}{a t^{b(1+\gamma)}} - \frac{\gamma}{1+\gamma} \rho_* ,$

For $\gamma = 1$, $p_{WDF} = \frac{C}{a t^{2b}} - \frac{\rho_*}{2}$

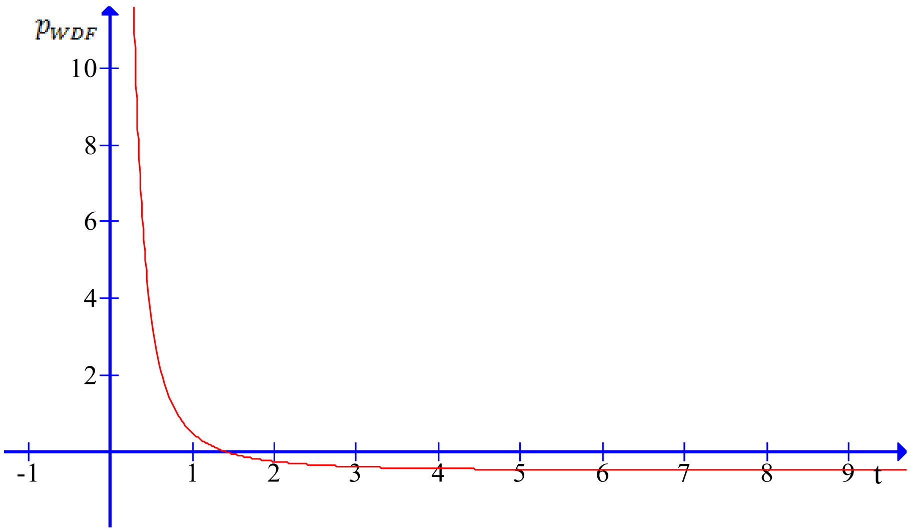

Fig.5

As time increases pressure decreases and it goes to negative.

Case II: Exponential form ($N = 1, \gamma = 1$)

We take exponential form, $V = \alpha e^{\beta t}$

where α and β are constant.

From equations (3.4), (3.5), (3.6), (3.7), (3.8),(3.9),(3.10) and (3.11) are yields,

$a_1 = \alpha^{(1/2)} e^{(\beta t/2)}$

$a_2 = \alpha^{(1/4)} e^{(\beta t/4)} \sqrt{D} \exp \left(\frac{X e^{-\beta t}}{-2\alpha\beta} \right)$

$a_3 = \alpha^{(1/4)} e^{(\beta t/4)} \frac{1}{\sqrt{D}} \exp \left(\frac{X e^{-\beta t}}{2\alpha\beta} \right)$

$\rho_{WDF} = \left(\frac{\rho_*}{2} + \frac{C}{\alpha e^{2\beta t}} \right)$

$p_{WDF} = \frac{C}{\alpha e^{2\beta t}} - \frac{\rho_*}{2}$

$$ds^2 = dt^2 - \alpha e^{\beta t} (dx^1)^2 - \alpha^{(1/2)} e^{(\beta t/2)} D \exp \left(X \int \frac{dt}{V} \right) (dx^2)^2$$
$$- \alpha^{(1/2)} e^{(\beta t/2)} D^{-1} \exp \left(-X \int \frac{dt}{V} \right) (dx^3)^2$$

$\theta = \beta$
$q = -1$
$\sigma^2 = \frac{1}{3}\left\{\beta^2\left(\frac{1}{16}\right) + \frac{3X}{4\alpha e^{\beta t}}\right\}$

Graphical Representation:-Exponential form $\boldsymbol{V = \alpha e^{\beta t}}$

$\rho_{WDF} = \left(\frac{\rho_*}{2} + \frac{C}{\alpha e^{2\beta t}}\right)$, for $\gamma = 1$

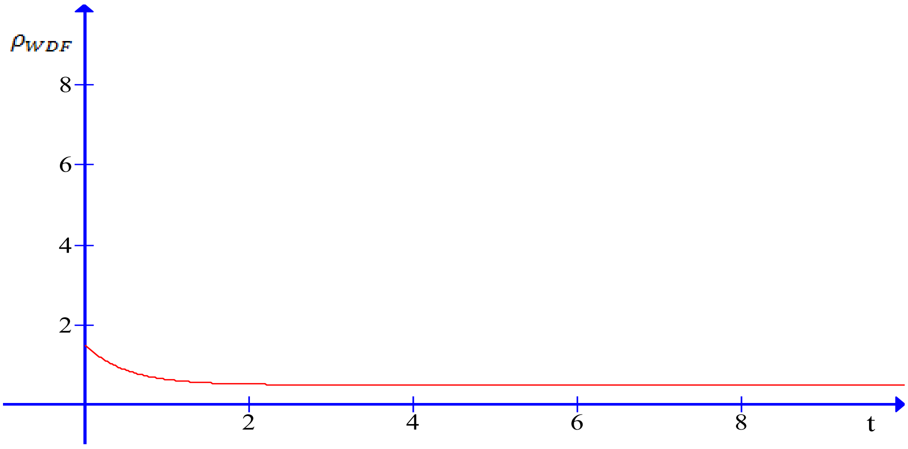

Fig.6

From fig.-6 it is clear that, the density slowly decreases as time increases.

$p_{WDF} = \frac{C}{\alpha e^{2\beta t}} - \frac{\rho_*}{2}$, for $\gamma = 1$

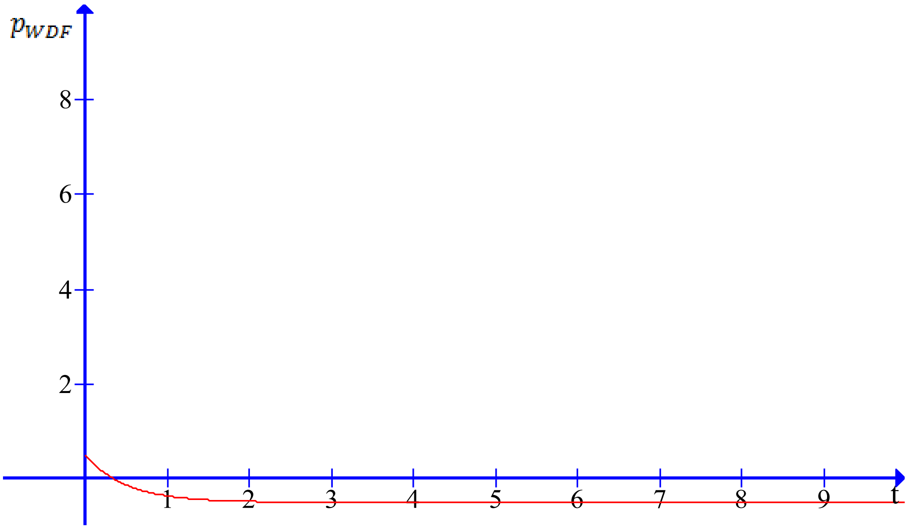

Fig. 7

From fig.-7 it shows that, the pressure decreases and it goes to negative as time increases.

V. CONCLUSION

In this chapter, we have investigated the nature of Bianchi type-V cosmological model for the dark energy component of the universe. The solution has been obtained in quadrature form. The models with constant deceleration parameter have been discussed in details. The model get shrink in presence of magnetic field and expand in its absence respectively. As t tends to zero, it tends to infinity and as t increases or decreases respectively model shrink or expand, correspondingly, as t increases, the scalar of expansion decreases and shear scalar σ decreases.

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