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# Cosmological Model with Time Varying Cosmological Constant, Quadratic Equation of State and Special form of Deceleration Parameter in *f (R, T)* Gravity

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ABSTRACT

In this paper, Bianchi-V space-time is considered with time varying cosmological constant and a quadratic equation of state $p = \beta\rho^2 - \rho$, (Singh, G. P et al.: Astrophys. Space Sci. **360**, 34, 2015) where $\beta \neq 0$ is a constant in the frame work of $f(R,T)$ gravity (Harko et al. in Phys.Rev. **D 84**:024020, 2011) where $f(R,T)$ is an arbitrary function of Ricci scalar R and trace of the energy momentum tensor T. The Einstein's field equations have been solved by taking into account the special form of deceleration parameter (Singha, A., Debnath, U.:Int.J. Theor. Phys. **48,** 2009). We observe that in $f(R, T)$ gravity, an extra acceleration is always present due to coupling between matter and geometry. The geometrical and physical aspect of the model is also studied. We find that the model has initial singularity and the physical parameters diverge at the initial epoch. The model resemble ΛCDM model for large time $t$. The energy conditions of the model are also examined and found to be consistent with recent cosmological observations.

**Keywords:** Bianchi type-V space-time, Quadratic equation of state, Special form of deceleration parameter, $f(R,T)$ gravity.

## I. INTRODUCTION

The observational data of high redshift type SN Ia supernovae [1-2] shows that our Universe for later stages of evolution indicates accelerated expansion and confirmed later by cross checks from the cosmic microwave background radiation and large scale structure [3-6] strongly suggest that the Universe is spatially flat and dominated by an exotic component with large negative pressure, referred to as dark energy [7-10].

In order to explain the nature of dark energy and the accelerated expansion, various theoretical models have been proposed such as quintessence, phantom energy, k-essence, tachyon, f-essence, chaplygin gas, etc. Among these different models of DE, the modified gravity theories are $f(R)$ gravity [11-15], Gauss-Bonnet gravity or $f(G)$ gravity [16-20] and

$f(T)$ gravity [21-23], where $T$ is scalar torsion. These modified gravities have recently been verified to explain the late-time accelerated expansion of the Universe.

Recently, Harko et al. [24] proposed $f(R,T)$ modified theories of gravity, where the gravitational Lagrangian is the function of the Ricci scalar $R$ and the trace of the stress energy tensor $T$. The $f(R,T)$ gravity model depends on a source term, representing the variation of the matter stress energy tensor with respect to the metric. A general expression for this source term is obtained as a function of the matter Lagrangian $L_m$ so that each choice of $L_m$ would generate a specific set of field equations. The $f(R,T)$ gravity models can explain the late time cosmic accelerated expansion of the Universe.

By choosing a particular form of the deceleration parameter, which gives an early deceleration and late time acceleration for dust dominated model, [26-27, 30] shows that this sign flip in can be obtained by a simple trigonometric potential. The quintessence model with a minimally coupled scalar field by taking a special form of decelerating parameter $q$ in such a way that which provides an early deceleration and late time acceleration for borotropic fluid and Chaplygin gas dominated models discussed by [31]. Motivated from the studies outlined above we choose a form of $q$ as a function of the scale factor $a$ so that it has the desired property of a signature flip.

In literature, various homogeneous and anisotropic cosmological models such as the Bianchi type models are studied in the context of dark energy as well as in alternative or modified theories of gravity. Homogeneous and anisotropic models of the universe are becoming more and more popular because of the anomalies found in the observations like Cosmic Microwave Background (CMB) and Large-Scale Structure [23, 24]. Also, models that are spatially homogeneous and anisotropic are helpful in describing the evolution of the early stages of the universe. Bianchi type V models are significant because they include the space of constant negative curvature as a special case. Therefore, we confine ourselves to Bianchi type-V model in the context of $f(R,T)$ gravity.

In the present paper, spatially homogeneous and anisotropic Bianchi type-V cosmological model with time dependent cosmological constant $\Lambda$ and a quadratic equation of state $p=\beta\rho^2-\rho$ (where $\beta \neq 0$ is a constant) in the context of $f(R,T)$ gravity theory have been studied. We provide basic field equations of the $f(R, T)$ theory of gravity for the functional form$f(R,T)=R+ 2f(T)$.We obtain explicit field equations corresponding to Bianchi type V metric for $f(R,T)=R+2f(T)=R+2\lambda T$,where$\lambda$is a constant. The solutions of the Einstein's field equations have been obtained by applying special form of deceleration parameter. Some features of the evolution of the metric have been examined. The geometrical and physical aspect of the model is also studied. The energy conditions of the model are also examined.

## II. GRAVITATIONAL FIELD EQUATIONS OF $f(R,T)$ GRAVITY

The action for the modified $f(R,T)$ gravity is

$$S=\frac{1}{16\pi}\int f(R,T)\sqrt{-g}d^4x+\int L_m\sqrt{-g}d^4x \quad , \tag{1}$$

where $R$, $T$ and $L_m$ are the Ricci scalar, the trace of stress-energy tensor of matter and the matter Lagrangian density respectively.

We define the stress-energy tensor of matter as

$$T_{ij} = -\frac{2}{\sqrt{-g}} \frac{\delta\sqrt{-g}L_m}{\delta g^{ij}} \quad . \tag{2}$$

The gravitational field equation of $f(R,T)$ gravity is given by

$$f_R(R,T)R_{ij} - \frac{1}{2}f(R,T)g_{ij} + (g_{ij}\nabla^k\nabla_k - \nabla_i\nabla_j)f_R(R,T) = 8\pi T_{ij} - f_T(R,T)T_{ij} - f_T(R,T)\Theta_{ij} \quad , \tag{3}$$

where $f_R(R,T) = \frac{\partial f(R,T)}{\partial R}$ , $f_T(R,T) = \frac{\partial f(R,T)}{\partial T}$ , $\Theta_{ij} = -2T_{ij} - pg_{ij}$ and $\nabla_i$ denote the covariant derivative.

The stress-energy tensor is given by

$$T_{ij} = (\rho + p)u_i u_j - p\, g_{ij} \quad , \tag{4}$$

Where the four velocity $u_i$ satisfies the condition $u^i\nabla_j u_i = 0$ and $u^i u_i = 1$.

For the functional form

$$f(R,T) = R + 2f(T) \, , \tag{5}$$

where $f(T)$ is an arbitrary function of the trace $T$ of the stress energy tensor of matter.

In order to describe the early universe, here we assumed the string fluid as source of matter.

The field equations in $f(R,T)$ gravity also depend on the physical nature of the matter field through the tensor $\Theta_{ij}$. Hence several theoretical models can be obtained for different choice of $f(R,T)$. The cosmological consequences for the class $f(R,T) = R + 2f(T)$ have been recently discussed in details by many authors [25-29].

Spatially homogeneous and anisotropic Bianchi type–I model in $f(R,T)$ gravity has presented by [25] while [26-27] have studied Bianchi type-III and Kaluza-Klein cosmological models in this theory. [28-29], have studied cosmological models in $f(R,T)$ gravity in different Bianchi type space-times.

Many authors like [33, 35-36] have discussed LRS Bianchi type-I and Bianchi type-V and a general class of Bianchi models in $f(R,T)$ gravity by considering $f(R,T) = R + 2f(T)$ respectively.

The gravitational field equations are obtained as

$$R_{ij} - \frac{1}{2}Rg_{ij} = 8\pi T_{ij} - 2f'(T)T_{ij} - 2f'(T)\Theta_{ij} + f(T)g_{ij} \, , \tag{6}$$

Now using equation (4), equation (6) reduces to

$$R_{ij} - \frac{1}{2}Rg_{ij} = 8\pi T_{ij} - 2f'(T)T_{ij} + [2pf'(T) + f(T)]g_{ij} \, . \tag{7}$$

## 1. METRIC AND FIELD EQUATIONS

The Bianchi-Type-V line element can be written as

$$ds^2 = dt^2 - A(t)^2 dx^2 - e^{2x}[B(t)^2 dy^2 + C(t)^2 dz^2] \quad , \tag{8}$$

where $A(t)$, $B(t)$ and $C(t)$ are the scale factors (metric potential) and functions of the cosmic time $t$ only (non-static case).

The Einstein's field equations (7) for metric (8) can be written as

$$\frac{\ddot{B}}{B}+\frac{\ddot{C}}{C}+\frac{\dot{B}\dot{C}}{BC}-\frac{1}{A^2}=-(8\pi+3\lambda)p+\lambda\rho-\Lambda \tag{9}$$

$$\frac{\ddot{A}}{A}+\frac{\ddot{C}}{c}+\frac{\dot{A}\dot{C}}{AC}-\frac{1}{A^2}=-(8\pi+3\lambda)p+\lambda\rho-\Lambda \tag{10}$$

$$\frac{\ddot{A}}{A}+\frac{\ddot{B}}{B}+\frac{\dot{A}\dot{B}}{AB}-\frac{1}{A^2}=-(8\pi+3\lambda)p+\lambda\rho-\Lambda \tag{11}$$

$$\frac{\dot{A}\dot{B}}{AB}+\frac{\dot{B}\dot{C}}{BC}+\frac{\dot{A}\dot{C}}{AC}-\frac{3}{A^2}=(8\pi+3\lambda)\rho+\lambda p-\Lambda \quad . \tag{12}$$

$$-2\frac{\dot{A}}{A}+\frac{\dot{B}}{B}+\frac{\dot{C}}{C}=0 \quad . \tag{13}$$

where dot $(\cdot)$ indicates the derivative with respect to $t$.

The mean Hubble parameter $H$ for LRS Bianchi type-I metric may given by

$$H=\frac{\dot{a}}{a}=\frac{1}{3}\left(\frac{\dot{A}}{A}+\frac{\dot{B}}{B}+\frac{\dot{C}}{C}\right) \quad . \tag{14}$$

The directional Hubble parameters in the direction $x$, $y$ and $z$ respectively can be define as

$$H_x=\frac{\dot{A}}{A}\ ,\ H_y=\frac{\dot{B}}{B}\ \text{and}\ H_z=\frac{\dot{C}}{C} \quad . \tag{15}$$

The anisotropy parameter of the expansion is define as

$$\Delta=\frac{1}{3}\sum_{i=1}^{3}\left(\frac{H_i-H}{H}\right)^2 \quad , \tag{16}$$

where $H_i\,(i=1,2,3)$ represent the directional Hubble parameters in the directions of $x$, $y$ and $z$ axis respectively.

The shear scalar $\sigma^2$, defined by $\sigma^2=\frac{1}{2}(\sum_{i=1}^{3}H_i^2-3H^2)$ . (17)

The spatial volume is given by $V=ABC$

The average scale factor is $a=V^{\frac{1}{3}}=(ABC)^{\frac{1}{3}}$. (18)

From equation (13) we get

$$A^2=BC. \tag{19}$$

Solving equation (9), (10) and (11), we get

$$A=l_1 a\exp\left(m_1\int\frac{dt}{a^3}\right). \tag{20}$$

$$B=l_2 a\exp\left(m_2\int\frac{dt}{a^3}\right). \tag{21}$$

$$C=l_3 a\exp\left(m_3\int\frac{dt}{a^3}\right). \tag{22}$$

Where the constants satisfy the relations $m_1+m_2+m_3=0$ and $l_1l_2l_3=1$

Using equations (20), (21), (22) in equation (19), we obtain $l_1 = \exp\left(-m_1 \int \frac{dt}{a^3}\right)$.

Since $l_1$ is a constant, so we may assume that $m_1 = 0$ so that $l_1 = 1$ and consequently $l_2 l_3 = 1$ and $m_2 + m_3 = 0$. Without loss of generality, we take $l_2 = l_3^{-1} = c_1$ and $m_2 = -m_3 = c_2$, where $c_1$ and $c_2$ are non-zero constants. Thus equations (20) to (22) yields

$$A = a \tag{23}$$

$$B = c_1 a \exp\left(c_2 \int \frac{dt}{a^3}\right) \tag{24}$$

$$C = \frac{1}{c_1} a \exp\left(-c_2 \int \frac{dt}{a^3}\right). \tag{25}$$

In order to solve the system completely we impose a special form of deceleration parameter as

$$q = -\frac{\ddot{a}a}{\dot{a}^2} = -1 + \frac{\alpha}{1 + a^\alpha}. \tag{26}$$

where $a$ is mean scale factor of the universe , $\alpha$ ( > 0) is constant. This low has been recently proposed by[32] for FRW metric. From figure (*i*) we have seen that $q$ decreases from $+1$ to $-1$ for evolution of the universe.

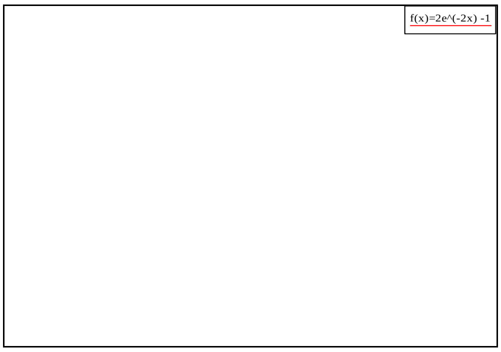


*Figure* (i): The variation of $q$ vs. $t$ for $\alpha = 2$

From (26) after integrating, we obtain the Hubble parameter as

$$H = \frac{\dot{a}}{a} = n\left(1 + a^{-\alpha}\right) \quad , \tag{27}$$

where $n$ is an arbitrary constant of integration.

Here we assume the deceleration parameter as given in (26), which can be integrated twice to give $H = \frac{\dot{a}}{a}$ as in equation (27) and the average scale factor as

$$a = (e^{n\alpha t} - 1)^{\frac{1}{\alpha}} \tag{28}$$

The spatial volume is given by

$$V = a^3 = ABC. \tag{29}$$

i.e. $$V = (e^{\alpha t} - 1)^{\frac{3}{\alpha}} \text{, here we consider } n = 1. \tag{30}$$

Considering $n = 1$, the metric potential can be obtained as

$$A = (e^{\alpha t} - 1)^{\frac{1}{\alpha}}. \tag{31}$$

$$B = c_1 (e^{\alpha t} - 1)^{\frac{1}{\alpha}} \exp\left\{ c_2 \frac{(e^{\alpha t} - 1)^{\frac{(\alpha-3)}{\alpha}} {}_2F_1\left(1, \frac{\alpha-3}{\alpha}; 2 - \frac{3}{\alpha}; 1 - e^{\alpha t}\right)}{(\alpha - 3)} \right\}, \tag{32}$$

$$C = \frac{1}{c_1} (e^{\alpha t} - 1)^{\frac{1}{\alpha}} \exp\left\{ - c_2 \frac{(e^{\alpha t} - 1)^{\frac{(\alpha-3)}{\alpha}} {}_2F_1\left(1, \frac{\alpha-3}{\alpha}; 2 - \frac{3}{\alpha}; 1 - e^{\alpha t}\right)}{(\alpha - 3)} \right\}. \tag{33}$$

Where ${}_2F_1$ is hyper geometric function.

The directional Hubble parameters in the direction $x$, $y$ and $z$ respectively can be obtained as

$$H_x = (1 - e^{-\alpha t})^{-1}. \tag{34}$$

$$H_y = c_2 (e^{\alpha t} - 1)^{-3/\alpha} + (1 - e^{-\alpha t})^{-1}. \tag{35}$$

$$H_z = -c_2 (e^{\alpha t} - 1)^{-3/\alpha} + (1 - e^{-\alpha t})^{-1}. \tag{36}$$

The mean Hubble parameter $H$ for Bianchi type-V metric may given by

$$H = \frac{1}{(1 - e^{-\alpha t})} \tag{37}$$

The anisotropy parameter of the expansion $(\Delta)$ is obtained as

$$\Delta = \frac{2{c_2}^2}{3} e^{-6t} (1 - e^{-\alpha t})^{2 - \frac{6}{\alpha}}. \tag{38}$$

The shear scalar $\sigma^2$ is found as

$$\sigma^2 = {c_2}^2 e^{-6t} \left(1 - e^{-\alpha t}\right)^{\frac{-6}{\alpha}}. \tag{39}$$

The expansion scalar $\theta$ is found to be

$$\theta = 3H = 3\left(1 - e^{-\alpha t}\right)^{-1}. \tag{40}$$

From equation (11) and (12) and using quadratic equation of state $p = \beta\rho^2 - \rho$, where $\beta \neq 0$ is the constant, the energy density $\rho$ and pressure $p$ of perfect fluid are obtained as

$$\rho^2 = \frac{1}{(4\pi + \lambda)\beta} \left[ \alpha (1 - e^{-\alpha t})^{-2} - (1 - e^{-\alpha t})^{-1} - c_2^2 (e^{\alpha t} - 1)^{\frac{-6}{\alpha}} - (e^{\alpha t} - 1)^{\frac{-2}{\alpha}} \right], \tag{41}$$

$$p = \left\{ \begin{array}{l} \frac{1}{(4\pi + \lambda)} \left[ \alpha (1 - e^{-\alpha t})^{-2} - (1 - e^{-\alpha t})^{-1} - c_2^2 (e^{\alpha t} - 1)^{\frac{-6}{\alpha}} - (e^{\alpha t} - 1)^{\frac{-2}{\alpha}} \right] \\ - \sqrt{\frac{1}{(4\pi + \lambda)\beta} \left[ \alpha (1 - e^{-\alpha t})^{-2} - (1 - e^{-\alpha t})^{-1} - c_2^2 (e^{\alpha t} - 1)^{\frac{-6}{\alpha}} - (e^{\alpha t} - 1)^{\frac{-2}{\alpha}} \right]} \end{array} \right\}, \tag{42}$$

The deceleration parameter $q$ is the measure of the cosmic accelerated expansion of the universe. The behaviour of the universe models is determined by the sign of $q$. The positive value of deceleration parameter suggests a decelerating model while the negative value indicates inflation. The deceleration parameter is given by and found to be

$$q=\frac{d}{dt}\left(\frac{1}{H}\right)-1=\frac{\alpha}{e^{\alpha t}}-1\ . \tag{43}$$

Using $\rho$ and $p$ in equation (9) we get

$$\Lambda=\left\{\begin{array}{l}-\frac{(8\pi+3\lambda)}{(4\pi+\lambda)}\left[\alpha(1-e^{-\alpha t})^{-2}-(1-e^{-\alpha t})^{-1}-c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}}-(e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]\\ +(8\pi+4\lambda)\sqrt{\frac{1}{(4\pi+\lambda)\beta}\left[\alpha(1-e^{-\alpha t})^{-2}-(1-e^{-\alpha t})^{-1}-c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}}-(e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]}\\ -c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}}-(3-2\alpha)(1-e^{-\alpha t})^{-2}-2(1-e^{-\alpha t})^{-1}+(e^{\alpha t}-1)^{\frac{-2}{\alpha}}\end{array}\right\}. \tag{44}$$

**The Cosmic Jerk Parameter**:-

Observations confirm that in the early years of the universe, the dark energy would have been too small to counteract the gravity of the matter in the universe, and the expansion would have initially slowed. After the universe grew big enough, though, the dark energy would dominate, and the universe would start to accelerate from some five to six billion years ago [37]. Cosmologists believe that the universe transitioned from deceleration to acceleration in a cosmic jerk. The knowledge of how and when the jerk occurred was an important step in figuring out just what the dark energy is. The deceleration to acceleration transition of the universe occurs for different models with a positive value of the jerk parameter and negative value of the deceleration parameter [38-42]. For example flat CDMΛ models have a constant jerk j =1. Cosmic jerk parameter is a dimensionless third derivative of the scale factor with respect to the cosmic time, defined as

$$j(t)=\frac{1}{H^3}\frac{\dddot{a}}{a}$$

Above equation can be express in terms of Hubble and deceleration parameter as

$$j(t)=q+2q^2-\frac{\dot{q}}{H}\ .$$

For this model, cosmic jerk parameter is obtain as

$$j(t)=(1-\alpha)(1-2\alpha)+3\alpha(1-\alpha)(1-e^{-\alpha t})+\alpha^2(1-e^{-\alpha t})^2\ .$$

**Energy Conditions**:-

1. Weak Energy Condition (WEC): $\rho\geq 0$

$$\sqrt{\frac{1}{(4\pi+\lambda)\beta}\left[\alpha(1-e^{-\alpha t})^{-2}-(1-e^{-\alpha t})^{-1}-c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}}-(e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]}\geq 0$$

2. Null Energy Condition (NEC):- $\rho+p\geq 0$

$$\rho+p=\frac{1}{(4\pi+\lambda)}\left[\alpha(1-e^{-\alpha t})^{-2}-(1-e^{-\alpha t})^{-1}-c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}}-(e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]$$

3. Dominant Energy Condition (DEC):- $\rho-p\geq 0$

$$\rho - p = 2\sqrt{\frac{1}{(4\pi+\lambda)\beta}\left[\alpha(1-e^{-\alpha t})^{-2} - (1-e^{-\alpha t})^{-1} - c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}} - (e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]}$$
$$-\frac{1}{(4\pi+\lambda)}\left[\alpha(1-e^{-\alpha t})^{-2} - (1-e^{-\alpha t})^{-1} - c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}} - (e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]$$

4. Strong Energy Condition (SEC):- $\rho + 3p \geq 0$

$$\rho + 3p = \frac{3}{(4\pi+\lambda)}\left[\alpha(1-e^{-\alpha t})^{-2} - (1-e^{-\alpha t})^{-1} - c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}} - (e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]$$
$$-2\sqrt{\frac{1}{(4\pi+\lambda)\beta}\left[\alpha(1-e^{-\alpha t})^{-2} - (1-e^{-\alpha t})^{-1} - c_2^2(e^{\alpha t}-1)^{\frac{-6}{\alpha}} - (e^{\alpha t}-1)^{\frac{-2}{\alpha}}\right]}$$

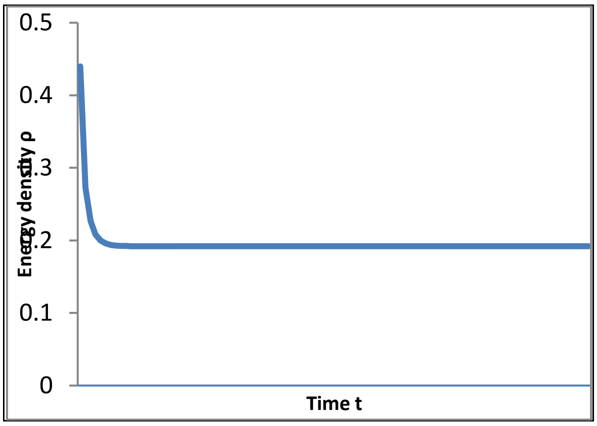


Fig.(ii) Energy density Vs. time t

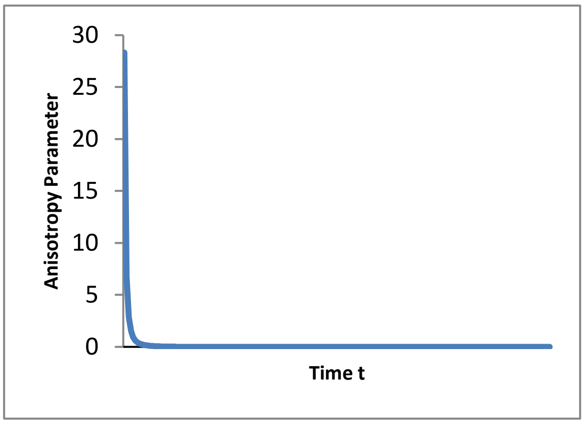


Fig.(iii) Anisotropy Parameter Vs. time t

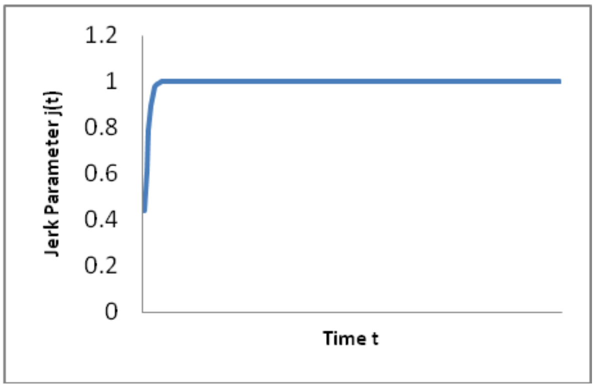


Fig. (iv) Jerk Parameter Vs. time t

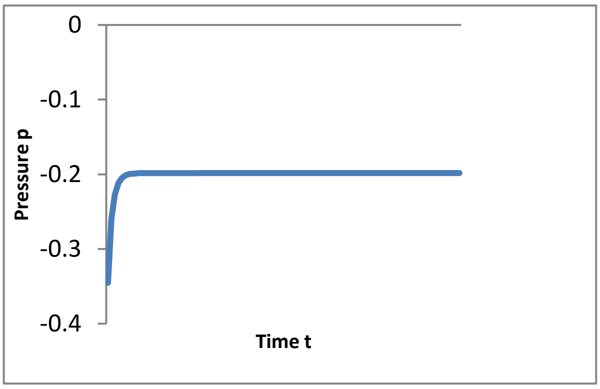


Fig. (v) Pressure Vs. time t

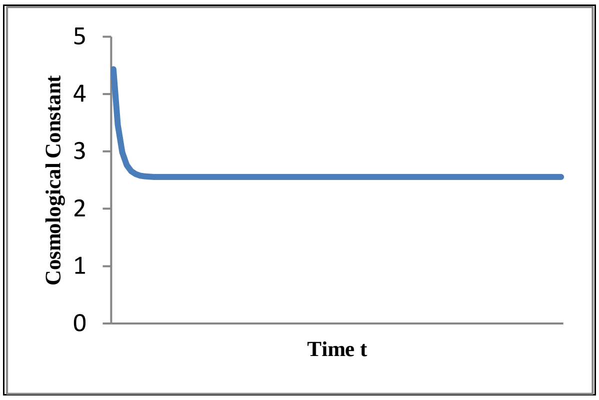


Fig. (vi) Cosmological constant Vs. time t

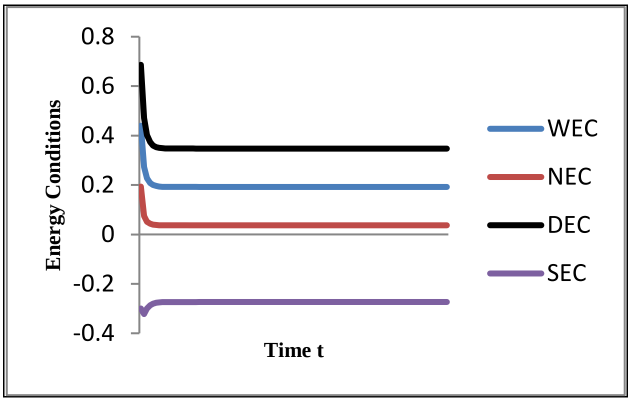


Fig. (vii) Energy conditions Vs. time t

Above are the plot of physical and geometrical parameters of the discussed model vs. cosmic time t for $\alpha = 1.5, \beta = \lambda = 1 \, and \, c_2 = 0.1$

## III. DISCUSSION

The asymptotic behavior of the parameters of presented model is as fallows.

| Parameters | $t \to 0$ | $t \to \infty$ |
|---|---|---|
| $A, B, C, a$ | 0 | $\infty$ |
| $V$ | 0 | $\infty$ |
| $H, H_x, H_y, H_z$ | $\infty$ | 1 |
| $\theta$ | $\infty$ | 3 |
| $\sigma^2$ | $\infty$ | 0 |
| $\Delta$ | $\infty$ | 0 |
| $q$ | $\alpha - 1$ | $-1$ |
| $j(t)$ | $(1-\alpha)(1-2\alpha)$ | 1 |

i. Here, we have observed that the spatial volume $V$ vanishes as $t \to 0$ and then increases exponentially with time $t$.

ii. The model has initial singularity at $t = 0$ as the directional scale factors $A, B$ and $C$ vanishes as $t \to 0$. However, the volume scale factor increases with time showing the late time acceleration of the universe.

iii. The other parameters such as $H, H_x, H_y, H_z$, $\theta$ and $\sigma^2$ diverge at the initial epoch.

iv. In this model, we observed that the universe starts evolving with different expansion rates $H_x, H_y, H_z$ along the three directions respectively. But with sufficient growth of the scale factor with time, we have $H_x = H_y = H_z = 1$. For $t \to \infty$, we obtain $\theta \to 3$ and $\frac{dH}{dt} = 0$ which implies the greatest value of the Hubble's parameter.

v. The deceleration to acceleration transition of the universe occurs for the different models with a positive value of the jerk parameter and negative value of the deceleration parameter. It is observed that the presented model resemble with $\Lambda CDM$ model.

vi. From fig. (ii), it is observed that initially the energy density of the model vanishes but for sufficiently large time it is positive throughout the expansion of the universe.

vii. The model has high anisotropy and shear in the beginning. It is observed that the anisotropy decreases to zero very quickly. Hence, the model reaches to isotropy after some finite time which matches with the recent observations as the universe is isotropic at large scale.

viii. For this model, the cosmological constant is a decreasing function of the cosmic time and for sufficiently large time it remains constant throughout the expansion of the universe.

## IV. CONCLUSION

In this paper, LRS Bianchi type-I cosmological model in the context of gravity theory have been studied. Here we discussed the model in which the solutions of the field equations are obtained for special form of deceleration parameter. It is observed that the model exhibits a singularity at . The parameters such as and diverge at the initial epoch. In this model the anisotropy of expansion dies out in the beginning and attains isotropy after some finite time. The energy conditions WEC, NEC and DEC are satisfied whereas SEC is violated. The violation of SEC shows that the universe has anti-gravitating effect which results accelerating expansion of the universe. It is also observed that the model asymptotically achieves a de Sitter phase and expands with the dominance of dark energy.

## V. CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this paper.

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