# Plane Symmetric Cosmological Model with Barotropic Perfect Fluid in C-field Theory with Time-dependent term – Λ

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**Abstract:** We have studied the Hoyle – Narlikar C- field cosmology for plane symmetric space time with varying cosmological constant for barotropic perfect fluid distribution. To get deterministic solution we assume that Λ=1/ as considered by Chen and Wu, where R is a scale factor and A = B where A and B are metric potentials. The conservation equation and ,being energy-momentum tensor for matter and is the energy momentum tensor for C-field.

We find that creation field (C) increase with time and Λ1/which matches with the result obtained by Hoyle- Narlikar theory. Above we have discussed special cases of model (28) like dust filled universe (= 0), stiff fluid universe ( = 1) and radiation dominated universe ( = 1/3). The physical and geometrical aspects for this model are also studied.

**Keywords:** Plane Symmetric, creation field, barotropic perfect fluid, cosmological term.

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**Introduction:-** The plane symmetric space time play an important role in the study of the cosmological models. These models are significant role in established cosmological models applicable for expressing the early development of the universe. Plane symmetric cosmological models are attractive by reason of these models are homogeneous and anisotropic. These models are uniformly of the field equations formed plane symmetric space time useful in constructing cosmological models of spatially homogeneous and anisotropic. Thus, it is useful convenient models of universes and study of these models are very significant.

LRS Bianchi type I in C-field cosmology with Varying Ʌ(t) is investigated by Malekolkalami and Khalafi (1). Sharma et. al. (2) has studied A study of Bianchi type I Cosmological model with cosmological constant. Borkar et. al. (3) has studied LRS Bianchi type I Cosmological model with Prefect fluid and Dark Energy in Bimetric theory of gravitation. Rao and Neelima (4) have investigated LRS Bianchi type I Dark Energy Cosmological model in General Scalar Tensor Theory of Gravitation. Perfect fluid Bianchi type I Cosmological model with time Varying G and Ʌ have been obtained by Singh and Tiwari (5). C- field theory was presented by Hoyle and Narlikar (6-8). Narlikar (9) has studied Singularity and Matter Creation in Cosmological Models. Bianchi type- I massive string cosmological model with magnetic field of barotropic perfect fluid distribution through the techniques used by Latelier and Stachel have studied by Bali et.al. (10).

Chatterjee and Bannerjee (11) is investigated C- field cosmology in higher dimensions. Singh and Chaubey (12) have also investigated Bianchi type I, III, V, VI and Kantowski Sach universes in creation field cosmology. Adhav et al. (13) was presented by Kasner and Axially symmetric universes in C - field theory of gravitation. Adhav et al. (14) have investigated stiff domain walls in creation field cosmology. Recently Ghate et al. (15) have obtained the cosmological models in creation field theory of gravitation with different contexts.Bali and Kumawat (16) was presented by cosmological model with variable G in C-field theory. Saha et. al. (17) also investigated that Bianchi type I Cosmological model with time Dependent Gravitational and Cosmological constants An Alternative Approach. Pradhan and Vishwakarma (18) have obtained A new class of Bianchi type I Cosmological models in Lyra geometry. Bali et. al. (19) have investigated Bianchi type I massive string Cosmological model with Bulk Viscosity and Vacuum Energy Density. Desikan (20) have been obtained by Bianchi type I Cosmological model with Expansion Driven by particle Creation.

Hasmani et. al. (21) has studied Exact Solutions Bianchi type I Cosmological model in f(R) Theory of Gravity. Singh et.al. (22) have been obtained by Einstein field equation with variable gravitational and cosmological constant are considered in the presence of perfect fluid for the Bianchi type-III universe by assuming conservation law for the energy momentum tensor.A cosmological model in creation field cosmology with varying Ʌ in the framework of FRW space time was presented by Bali and Saraf (23). Singh and Ram (24) has obtained Bianchi type – III model of universe filled with a magnetized perfect fluid together with a time – varying constant Ʌ is investigated in general relativity. Kaluza klein cosmological models with varying G in Hoyle Narlikar C-field theory of gravitation for barotropic fluid distribution have been investigated by Ghate and Mhaske (25).Parikh et. al. (26) has investigated cosmological constant Ʌ in Bianchi type III string cosmological model is studied for dust fluid. Time dependent Ʌ in Bianchi type IX cosmological model with barotropic perfect fluid in C-field theory was presented by Parikh et. al. (27).

Deo et. al. (28) has studied Anisotropic Bianchi type I cosmological model with wet dark energy in general theory of relativity. Kotambkar et. al. (29) have been obtained by Anisotropic Bianchi type I cosmological model with Generalized Chaplying Gas and Dynamical Gravitational and Cosmological constant. Sen and Aygun (30) have investigated Bianchi type I universe in Lyra manifold with quadratic equation of state. Pradhan and Vishwakarma (31) has studied A new class of LRS Bianchi type I Cosmological models with perfect fluid. Magnetized Bianchi type I massive string Cosmological model for Perfect Fluid Distribution with cosmological term Ʌ have been investigated by Jain et. al. (32).Bianchi type – VI0 cosmological model for barotropic fluid distribution in C-field cosmology with varying cosmological term Ʌ have been investigated by Tyagi and Parikh (33).

Bali and Tikekar (34) was also investigated C -field cosmological model for dust distribution with variable gravitational constant in framework of flat FRW space time. Solutions of Einstein field equation admitting radiation with a negative energy massless scalar field C have been studied by Narlikar and Padmnabhan (35). Tyagi and Singh (36) have been investigated time-dependent in C-field theory with LRS Bianchi type III universe and barotropic perfect fluid. LRS Bianchi type V perfect fluid cosmological model in C-field theory with variable was presented by Tyagi and Singh (37). Patil et al. (38) have obtained Bianchi type IX dust filled universe with ideal fluid distribution in creation field. Bali and Saraf (39) have also investigated C-field cosmological model for dust distribution with varying ***Ʌ*** in FRW space-time. Bianchi type-***IX*** string cosmological model in general relativity is investigated by Bali and Dave (40). Yadav et. al. (41) have investigated Some LRS Bianchi type I Cosmological models with Zero- mass Scalar Field. Spinor field with polynomial nonlinearity in LRS Bianchi type I space-time is also investigated by Saha (42). Ram (43) has obtained Spatially Homogeneous Bianchi type I Perfect Fluid Cosmological Models in f(R) Gravity Theory.

In this paper, we have observed and investigated the Plane symmetric cosmological model for barotropic perfect fluid distribution in C-field cosmology with time dependent term . For deterministic model, we assumed Λ=1/, where R is scale factor. We find that creation field (C) increase with time and Λ 1/.we have also studied and discussed the physical and geometrical parameters of the model.

**2. The Metric and Field Equation**

We have considered Plane Symmetric of the form

.…(1)

in which, A and B are functions of t alone. Hoyle and Narlikar modify the Einstein's field equation by introducing C-field with time dependent cosmological term as:

….(2)

The energy-momentum tensor for perfect fluid and creation field are given by

…..(3)

….(4)

where f > 0 is coupling constant between the matter and creation field and .

The co-moving coordinates are chosen such that = (0, 0, 0, 1).

The non-vanishing components of energy-momentum tensor for matter are given by

….(5)

The non-vanishing components of energy-momentum tensor for creation field are given by

….(6)

Hence, the Einstein's field equation (2) for the metric (1) and energy-momentum tensor (5) and (6) takes the form

….(7)

….(8)

….(9)

The suffix 4 by the symbols A and B denotes differentiation w.r.t. t.

**3. Solution of Field Equations**

The conservation equation of energy momentum tensor is

…..(10)

which leads to

…..(11)

Following Hoyle and Narlikar theory, the source equation of C-field i.e. leads to c = t thus 𝑐̇= 1.

To get determinate solution of equations (7) - (9), we assume condition between the metric potential i.e.

A = B ... (12)

Using (12), equations (7) to (9) becomes

….(13)

….(14)

….(15)

The barotropic perfect fluid condition leads to

; where 0 ... (16)

Using (16) in equation (14) we have

….(17)

Now equations (13) and (17) together with leads to

To get solution of equation (18) we also assume that

….(19)

Using equation (19) in equation (18) we have

Now put = f (B) which leads to = ff'. ... (21)

Now equation (20) with the help of (21) becomes

….(22)

Equation (22) leads to

….(23)

which gives

….(24)

Where =, ….(25)

Equation (24) leads to

….(26)

Hence, equation (26) gives

….(27)

Also the metric (1) reduces to

….(28)

From equation (19) and (15) we have

….(29)

and ….(30)

Now using p = and equation (12) in equation (11) we have

….(31)

Equation (31) leads to

…(32)

To obtain the solution of equation (32) we assume that and , so equation (32) leads to

= …..(33)

Equation (33) gives …..(34)

So, we have …..(35)

which agrees with the value used in source equation. Thus, creation field is proportional to time t.

**4. Physical and Geometrical Properties**

For the model (28), the mass density is given by

…..(36)

The scale factor R is

….(37)

The cosmological constant () is

....(38)

and the deceleration parameter (q) is

….(39)

**5. Special Cases**

**Case I: Dust Filled Universe ( = 0)**

From equation (26), we have

= ….(40)

The metric (28) for the dust filled universe is given by

….(41)

So, the mass density (), scale factor (R), cosmological constant (Ʌ) and the decelerating parameter (q) for the model (41) are given by

….(42)

) ….(43)

….(44)

and ….(45)

**Case II: Stiff Fluid University ( = 1)**

From equation (26), we have

….(46)

The metric (28) for stiff fluid universe is given by

….(47)

Also the mass density (), scale factor (R), cosmological constant () and declaration parameter (q) for the model (47) are given by

….(48)

….(49)

….(50)

and ….(51)

**Case III: Radiation Dominated Universe ( = 1/3)**

From equation (26), we have

….(53)

The metric (28) for radiation dominated universe becomes

….(54)

Also, the mass density (), scale factor (R), cosmological constant () and deceleration parameter (q) for the model (52) are given by

…(55)

…(56)

…(57)

and ….(58)

**6. Conclusion**

The scale factor R for the model (28) increases with time and the cosmological term decreases as time increases i.e . The decelerating parameter from equation (39) i.e. q < 0 whichever show that universe is accelerating. The creation field C increases with time i.e. and 𝑐̇=1 which agrees with the value taken in source equation.

Therefore, all special cases i.e. dust filled universe ( = 0), stiff fluid universe ( = 1)and radiation dominated universe *( = 1/3),* scale factor R increases and cosmological term decreases with time. In case of stiff fluid, model has uniform motion and the universe is accelerating for dust filled and radiation in dominated cases.

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