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Viscosity and Creation Particle with Entropy-Corrected of Dark Energy Model

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Abstract In this paper, we compare cosmology with fluid dynamics and study the effect of creation particle and viscosity. The modified entropy -corrected holographic help us to discuss the dark energy in early universe. We obtain the several parameters in cosmology in case of creation particle and viscosity. We consider some physical action and apply the modified entropy -corrected holographic and obtain the special condition for the dark energy. In that case, we show that the universe with viscosity and creation particle can guarantee the dark energy model and some inflation cosmology. We can compare the corresponding equation state and some thermodynamical quantity with QCD universe and lattice model by some special in cosmology.

Keywords Entropy Corrected, Holographic, Dark Energy, QCD Universe

1. Introduction

As we know the bulk viscosity and creation particle play important role in fluid dynamics and QCD for describing early universe[1]. In that case for explaining the dynamics of the early universe, we face with causal bulk viscous thermodynamics. On the other hand the energy density in isotropic homogenous world will be important to describing universe in several points of view. In that case the bulk viscosity and energy density have relation as $\eta = \rho^s$, where η is the bulk viscosity coefficient and ρ is the energy density. Also this relation and causal bulk viscosity thermodynamics are able to give a model for the phenomenological matter construction in the early universe[2-6]. In QCD and lattice simulation also RHIC results show that in heavy-ion collision hot and dense matter be formed[7-9]. On the other hand the creation particle also explain the early universe, in that case the creation pressure is $P_C = -\beta'(P+\rho)$ where P and ρ are pressure and energy density for the fluid dynamics. We take advantage from above information and use the entropy - corrected of dark energy model and explain the early universe[10]. In this paper we account the creation particle and use the modified entropy -corrected holographic and obtain the equation state and corresponding potential for the Quintessence and Tachyon model.

$$S = \frac{A}{4G} + \alpha \ln\frac{A}{4G} + \beta \qquad (1)$$

where α and β are dimensionless constants of order unity. The exact values of these constants are not yet determined and still an open issue in quantum gravity. These corrections arise in the black hole entropy in LQG due to thermal equilibrium fluctuations and quantum fluctuations[11-15]. Taking the corrected entropy-area relation (1) into account, the energy density of the HDE will be modified as well. On this basis, Wei[16] proposed the energy density of the so-called "entropy-corrected HDE" (ECHDE) in the form

$$\rho_D = 3c^2 M_p^2 L^{-2} + \alpha L^{-4} \ln(M_p^2 L^2) + \beta L^{-4} \qquad (2)$$

In the special case $\alpha = \beta = 0$, the above equation yields the well-known HDE density. Since the last two terms in Eq. (2) can be comparable to the first term only when L is very small, the corrections make sense only at the early stage of the universe. When the universe becomes large, ECHDE reduces to the ordinary HDE.

2. Creation Particle and Dark Energy

As we know the energy conservation equations for viscous and creation particles ECHDE and DM are,

$$\dot{\rho} = 3H(\rho_\Lambda + P) = 9H^2 - Q + 3HP_c \qquad (3)$$

where $P_C = -\beta' P$ is creation pressure. So, the conservation equation will be as,

$$\dot{\rho} = 3H\rho[(1+\beta')(1+\omega)] = 9H^2\xi - Q \qquad (4)$$

where ξ is the bulk viscosity, and also for matter section we have following equation,

$$\dot{\rho}_m + 3H_{\rho m} = Q \qquad (5)$$

where $\omega_\Lambda = -\frac{P}{\rho}$ is the equation of state (EoS) parameter of the interacting viscous and creation particles ECHDE and Q stand for the interaction term. In here first we take a derivative to equation (3) and obtain $\dot{\rho}$ as follow,

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$$\rho_{\Lambda}=-2H\rho[2y+\frac{1}{\gamma c}(\frac{G'}{2G}-Y)(1+\frac{8\pi G\alpha H^2\Omega}{3c^4\gamma^c})] \quad (6)$$

where

$$y=1-(\frac{\Omega}{c^2\omega_c})^{\frac{1}{2}}\cos n(\sqrt{|k|}\,y) \quad (7)$$

In here we shall assume $Q=3b^2H(\rho_m+\rho)$, so we have,

$$Q=3b^2H\rho_{\Lambda}(\frac{1+\Omega_k+\Omega_{\bar{\alpha}}}{\Omega_{\Lambda}}) \quad (8)$$

$$\omega_{\Lambda}=-1+\frac{3\varepsilon}{1+\beta}+\frac{4y}{3(1+\beta)}-\frac{b^2}{(1+\beta)}(\frac{1+\Omega_{\Lambda}+\Omega_{\bar{\alpha}}}{\Omega_{\Lambda}})+\frac{2}{3\gamma_c(1+\beta)}[\frac{G'}{2G}-Y](1+\frac{8\pi G\alpha H^2\Omega}{3c^4\gamma_C}) \quad (9)$$

Discussion: from now, we change β to β' if $\bar{\alpha}=0$ then according to equation $\Omega_{\bar{\alpha}}=\frac{\bar{\alpha}GH^2}{2\pi}(1+\Omega_k)^2$ and if $\Omega_{\bar{\alpha}}=0$ and if $\varepsilon=G'=0$ then the equation turn to

$$\omega_{\Lambda}=-1+\frac{4y}{3\beta'}+\frac{2}{3\gamma_c(1+\beta')}-\frac{2y}{3\gamma_c(1+\beta')}[1+\frac{8\pi G\alpha H^2\Omega}{3c^4\gamma_c}]-\frac{b^2}{(1+\beta')}[\frac{1+\Omega_k}{\Omega_{\Lambda}}] \quad (10)$$

According to article[16], $\rho_{\Lambda}=\frac{3c^2}{8\pi GL^2}+\frac{\alpha}{L^4}\ln(\frac{L^2}{8\pi G})+\frac{\beta}{L^4}$, so If $\alpha=\beta=0$ then $\rho_{\Lambda}=\frac{3c^2}{8\pi GL^2}$ that is know "HDE" then we have

$$\gamma_c=1+\frac{8\pi G}{3cL^2}[\alpha\ln(\frac{L^2}{8\pi G})+\beta] \quad (11)$$

And $\gamma_c=1$. In case of $\alpha=\beta=0$ and $\gamma_c=1$ and using equation (5) in (8) we have following equation,

$$\omega_{\Lambda}=-\frac{1+3\beta'}{3(1+\beta')}-\frac{2}{3(1+\beta')}(\Omega_{\Lambda})^{\frac{1}{2}}\cos(n\sqrt{|k|}\,y) \quad (12)$$

So we see here for $\beta'=0$ there is not creation particle and achieve the usual Ω_{Λ}.

Now we are going to consider two examples. first we focus the Quintessence model. As we know the density and pressure for this model will be following

$$\rho_Q=\frac{1}{2}\Phi^2+\upsilon(\Phi) \quad (13)$$

$$p_Q=\frac{1}{2}\Phi^2-\upsilon(\Phi) \quad (14)$$

$$\frac{p_Q}{\rho_Q}=\omega_Q=\frac{\Phi^{\cdot 2}-2\upsilon(\Phi)}{\Phi^{\cdot 2}+2\upsilon(\Phi)} \quad (15)$$

Here also we obtain the derivative of field and corresponding equation as following,

$$p_Q+\rho_Q=\Phi^2 \quad (16)$$

$$\dot{\Phi}^2=\rho_{\Lambda}(1+\omega_{\Lambda}) \quad (17)$$

$$\Phi^2=\rho_Q(1+\frac{p_Q}{\rho_Q}) \quad (18)$$

$$V(\Phi)=\frac{1}{2}\rho_{\Lambda}(1-\omega_{\Lambda}) \quad (19)$$

Then according to equation (9) and (15) we have

$$\omega_Q=-1+\frac{3\varepsilon}{1+\beta'}+\frac{4y}{3(1+\beta')}-\frac{b^2}{(1+\beta')}(\frac{1+\Omega_k+\Omega_{\bar{\alpha}}}{\Omega_{\Lambda}})+\frac{2}{3\gamma_c(1+\beta')}[\frac{G'}{2G}-Y](1+\frac{8\pi G\alpha H^2\Omega}{3c^4\gamma_C}) \quad (20)$$

$$V(\Phi)=\frac{3H^2\Omega_{\Lambda}}{16\Pi G}[2+\frac{1}{1+\beta'}(3\varepsilon-b^2\frac{1+\Omega_{\Lambda}+\Omega_{\bar{\alpha}}}{\Omega_{\Lambda}}+\frac{4y}{3}+\frac{2}{3\gamma_C}(\frac{G'}{2G}-Y)(1+\frac{8\pi G\alpha H^2\Omega}{3c^4\gamma^c}) \quad (21)$$

$$\Phi^{\cdot 2}=\frac{3h^2\Omega_{\Lambda}}{8\Pi G}\frac{1}{1+\beta'}[3\varepsilon-b^2\frac{1+\Omega_{\Lambda}+\Omega_{\bar{\alpha}}}{\Omega_{\Lambda}}+\frac{4y}{3}+\frac{2}{3\gamma_c}\frac{G'}{2G}-Y(1+\frac{8\pi G\alpha H^2\Omega}{3c^4\gamma_c})] \quad (22)$$

We note here for $\beta'=0$, ω_Q, $V(\Phi)$, and Φ^2 will be same as usual Quintessence model.

Now we are going to discuss the second model as Taychon model. In Tachyon model first we obtain the density, pressure, potential and field which are obtain following equations

$$\rho_T=\frac{v(\Phi)}{\sqrt{1-Q^{\cdot 2}}} \text{ or } V(\Phi)=\rho_T\sqrt{1-\Phi^{\cdot 2}} \quad (23)$$

$$P_T=-V(\Phi)\sqrt{1-\Phi^{\cdot 2}} \quad (24)$$

$$\frac{P_T}{\rho_T}=\omega_T=\Phi^{\cdot 2}-1=\omega_T \quad (25)$$

$$\Phi^{\cdot 2}=1+\omega_T \quad (26)$$

And again according to equations (9) and (26) we obtain the equation state as a following

$$\omega_T=-1+\frac{1}{(1+\beta')}[3\varepsilon+\frac{4y}{3}+b^2(\frac{1+\Omega_{\Lambda}+\Omega_{\bar{\alpha}}}{\Omega_{\Lambda}})+\frac{2}{3\gamma_c}(\frac{G'}{2G}-Y)(1+\frac{8\pi G\alpha H^2\Omega}{3c^4\gamma}) \quad (27)$$

Also here we see that the creation particle play important role with β' and for the $\beta' zero$ we will arrive at usual Tachyon model. And then the corresponding Tachyon potential will be as,

$$V(\Phi) = \frac{3h^2\Omega_\Lambda}{8\Pi G}\left[\frac{1}{(1+\beta')}\left(3\varepsilon - b^2\left(\frac{1+\Omega_\Lambda+\Omega_{\bar{\alpha}}}{\Omega_\Lambda}\right) + \frac{4y}{3}\left(\frac{2}{3\gamma_c}\right)\frac{G'}{2G} - Y\right)\left(1 + \frac{8\pi G\alpha H^2 \Omega}{3c^4\gamma}\right)\right] \tag{28}$$

3. Conclusions

In this paper, we compared cosmology with fluid dynamics and studied the effect of creation particle and viscosity. We calculated the several parameters in cosmology in case of creation particle and viscosity. We obtained some physical action and applied the modified entropy-corrected holographic and found the special condition for the dark energy. We found that the universe with viscosity and creation particle can guarantee the dark energy model and some inflation cosmology. In future we can do lots of job in QCD calculation with this model.

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