Interacting holographic dark energy with logarithmic correction

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Abstract. The holographic dark energy (HDE) is considered to be the most promising candidate of dark energy. Its definition is motivated from the entropy-area relation which depends on the theory of gravity under consideration. Recently a new definition of HDE is proposed with the help of quantum corrections to the entropy-area relation in the setup of loop quantum cosmology. Employing this new definition, we investigate the model of interacting dark energy and derive its effective equation of state. Finally we establish a correspondence between generalized Chaplygin gas and entropy-corrected holographic dark energy.

Keywords: gravity, dark energy theory
1 Introduction

Nowadays it is generally accepted in the astrophysics community that the observable universe is expanding in an accelerated manner due to the presence of dark energy. The notion of dark energy is strongly favored by the observations of type Ia supernova, large scale structure and cosmic microwave background anisotropies [1]. From the quantum field theoretic point of view, the dark energy is nothing but vacuum energy possessing negative pressure [2]. While from the Einstein’s general relativity, the dark energy candidate most probably be the cosmological constant. However, as is well known, there are two difficulties arise from the cosmological constant scenario, namely the two famous cosmological constant problems the fine-tuning problem and the cosmic coincidence problem [3]. Other alternative candidates for dark energy [2] include the Chaplygin gas, quintessence and phantom energy to name a few.

To alleviate the cosmic coincidence and cosmic fine-tuning problems, the model of dark energy interacting with dark matter has been proposed [4]. Observations suggest that the ratio of energy densities of matter and dark energy $r_m$ is closer to unity at present time, however in pure dark energy models (without interaction), this ratio must decrease. It leads to another problem why $r_m \sim 1$ happens at present time? A possible resolution is to assume that dark energy could decay into matter (or vice versa) in order to keep a roughly constant ratio in the history of the universe. With the use of this interaction, the problem of phantom crossing is also resolved as the Friedmann equations give stable attractor solution at the present time [5]. This model is also favored by observations of supernova of type Ia where tight constraints are determined on the coupling parameter of the dark energy-dark matter interaction [6]. Besides Einstein’s gravity, the interaction is also modeled in other gravity theories like the f(R) [7], Brans-Dicke [8], braneworld [9], Horava-Lifshitz [10] and Gauss-Bonnet [11] gravity.

In recent years, the holographic dark energy has been studied as a possible candidate for dark energy. It is motivated from the holographic principle which might lead to the quantum gravity to explain the events involving high energy scale. In the thermodynamics of black hole, there is a maximum entropy in a box of length $L$, commonly termed, the Bekenstein-Hawking entropy bound $S \sim M_p^2 L^2$, which scales as the area of the box $A \sim L^2$ [12]. To avoid the breakdown of the local quantum field theory, Cohen et al [13] suggested that the entropy for an effective field theory should satisfy $L^3 \Lambda^3 \leq S^{3/4} \sim (M_p L)^{3/2}$. Here $L$ is the size of the region which serves as the infra-red cut-off while $\Lambda$ is the ultra-violet cut-off. Incidentally this last equation can be re-written in the form $L^3 \rho_\Lambda \leq L M_p^2$, where $\rho_\Lambda \sim \Lambda^4$ is the energy density corresponding to the zero-point energy and cut-off $\Lambda$. Thus the total energy in a region of size $L$ cannot exceed the mass of a black hole of the same size. From this discussion we can deduce that $\rho_\Lambda \leq M_p^2 L^{-2}$. This inequality can be saturated and it
becomes $\rho_\Lambda = 3n^2 M_p^2 L^{-2}$, where $3n^2$ is introduced for convenience. The holographic dark energy interacting with matter has been widely discussed in the literature, for instance [14]. The resulting interaction also modifies the equations of state of both dark matter and dark energy. In this paper we determine the expression for the later quantity and discuss its implications. Throughout the paper we use units $c = \hbar = 1$.

2 The model

We assume the background spacetime to be spatially homogeneous and isotropic given by Friedmann-Robertson-Walker (FRW) metric

$$ds^2 = -dt^2 + a^2(t) \left( \frac{dr^2}{1 - kr^2} + r^2(d\theta^2 + \sin^2 \theta d\varphi^2) \right).$$

(2.1)

Here $a(t)$ is the dimensionless scale factor which is an arbitrary function of time and $k$ is the curvature parameter, have dimensions of $length^{-2}$ and it describes the spatial geometry of spacetime. For $k = +1, 0, -1$, we obtain spatially closed, flat and open FRW spacetimes respectively. The Einstein field equation representing the dynamics of FRW spacetime is

$$H^2 + \frac{k}{a^2} = \frac{1}{3M_p^2} [\rho_\Lambda + \rho_m],$$

(2.2)

Here $H \equiv \dot{a}/a$, is the Hubble constant while $\rho_\Lambda$ and $\rho_m$ are the energy densities of dark energy and matter respectively. Also $M_p^2 = (8\pi G)^{-1}$, is the modified Planck mass. One can rewrite eq. 2.2 in the dimensionless form as

$$1 + \Omega_k = \Omega_\Lambda + \Omega_m,$$

(2.3)

where the above density parameters are defined by

$$\Omega_m = \frac{\rho_m}{\rho_{cr}}, \quad \Omega_\Lambda = \frac{\rho_\Lambda}{\rho_{cr}}, \quad \Omega_k = \frac{k}{(aH)^2}.$$  

(2.4)

Here $\rho_{cr}$ is the critical energy density. The energy conservation equations for dark energy and matter are

$$\dot{\rho}_\Lambda + 3H(\rho_\Lambda + p_\Lambda) = -Q,$$

$$\dot{\rho}_m + 3H\rho_m = Q,$$

(2.5)

(2.6)

where $Q$ is an interaction term which can be an arbitrary function of cosmological parameters like the Hubble parameter and energy densities $Q(H \rho_\Lambda, H \rho_m)$. The simplest choice is $Q \simeq H(\rho_\Lambda + \rho_m)$ up to the linear order in energy densities. The relation for the interaction term can be saturated by introducing a coupling parameter $b^2$ by $Q = 3b^2 H(\rho_\Lambda + \rho_m)$ [5]. Observations of cosmic microwave background and galactic clusters show that the coupling parameter $b^2 < 0.025$, i.e. a small but positive constant of order unity [6], a negative coupling parameter is avoided due to violation of thermodynamical laws. It should be noted that the ideal interaction term must be motivated from the theory of quantum gravity. In the absence of such a theory, we rely on pure dimensional basis for choosing an interaction $Q$. In literature,
various forms of $Q$ are proposed \cite{15}. The effective equations of state for dark energy and matter are defined by \cite{16}

$$\omega^\text{eff}_\Lambda = \omega_\Lambda + \frac{\Gamma}{3H}, \quad \omega^\text{eff}_m = -\frac{1}{r_m} \frac{\Gamma}{3H}. \quad (2.7)$$

Here $r_m = \rho_m/\rho_\Lambda$, and $\Gamma = Q/\rho_\Lambda = 3H(1 + r_m)$, is the decay rate of dark energy into matter. Making use of (2.7) in (2.5) and (2.6), we have

$$\dot{\rho}_\Lambda + 3H(1 + \omega^\text{eff}_\Lambda)\rho_\Lambda = 0, \quad (2.8)$$

$$\dot{\rho}_m + 3H(1 + \omega^\text{eff}_m)\rho_m = 0. \quad (2.9)$$

Notice that the definition and derivation of holographic dark energy ($\rho_\Lambda = 3n^2M_p^2L^{-2}$) depends on the entropy-area relationship $S \sim A \sim L^2$ in Einstein’s gravity. Here $A$ represents the area of the horizon. However, this definition can be ‘corrected’ from the inclusion of quantum effects, motivated from the loop quantum gravity (LQG). The quantum corrections provided to the entropy-area relationship leads to the curvature correction in the Einstein-Hilbert action and vice versa \cite{17}. The corrected entropy is $S = (A/4G) + \tilde{\gamma}\ln(A/4G) + \tilde{\beta}$, where $\tilde{\gamma}$ and $\tilde{\beta}$ are constants of order unity. The exact values of these constants are not yet determined and still an open issue in loop quantum cosmology. These corrections arise in the black hole entropy in LQG due to thermal equilibrium fluctuations and quantum fluctuations \cite{18}. The entropy corrected holographic dark energy (ECHDE) is given by \cite{19}

$$\rho_\Lambda = 3n^2M_p^2L^{-2} + \gamma L^{-4}\ln(M_p^2L^2) + \beta L^{-4}. \quad (2.10)$$

Here $n^2$, $\gamma$, and $\beta$ are dimensionless constants of order unity. Note that choosing $\gamma = \beta = 0$, yields the well-known holographic dark energy. There is a possibility that the constants involved in (2.10) could be time dependent. In a recent study, Xu \cite{20} has considered $n^2 = n^2(t)$ and hence deduced that the resulting equation of state of holographic dark energy is consistent with the observations of SN Ia and BAO. Hence one can infer the same time dependence for $\gamma$ and $\beta$ as well, however, we shall treat all the parameters $n^2$, $\gamma$ and $\beta$ to be constants. If we choose $L$ as the size of the universe, for instance the Hubble horizon $H^{-1}$, the resulting $\rho_\Lambda$ is comparable to the observational density of dark energy. However, Hsu \cite{21} pointed out that in this case the resulting equation-of-state parameter (EoS) is equal to zero, which cannot accelerate the expansion of our universe. One could also employ the particle horizon as a desirable cut-off but it turned out that it yielded $\omega_\Lambda > -1/3$, a form of exotic matter that could not derive accelerated expansion. To get an accelerating universe, Li \cite{22} proposed that $L$ should be the future event horizon $R_h$. Li defined it as

$$L = a(t)\frac{\sin(y\sqrt{|k|})}{\sqrt{|k|}}, \quad y = \frac{R_h}{a(t)}, \quad (2.11)$$

where $R_h$ is the size of the future event horizon defined as

$$R_h = a(t)\int_0^{\infty} \frac{dt'}{a(t')} = a(t)\int_0^{r_1} \frac{dr}{\sqrt{1 - kr^2}}. \quad (2.12)$$

The last integral has the explicit form as

$$\int_0^{r_1} \frac{dr}{\sqrt{1 - kr^2}} = \frac{1}{\sqrt{|k|}}\sin^{-1}(\sqrt{|k|}r_1) = \begin{cases} \sin^{-1}(r_1), & k = +1, \
 r_1, & k = 0, \
 \sinh^{-1}(r_1), & k = -1. \end{cases} \quad (2.13)$$
In recent years, some new infrared cut-offs have been proposed in the literature. In [23], the authors have added the square of the Hubble parameter and its time derivative within the definition of holographic dark energy. While in [24], the authors propose a linear combination of particle horizon and the future event horizon. However, in this paper we stick to Li's proposal.

Using the definitions of $\Omega_\Lambda$ and $\rho_{cr}$, we obtain a useful relation

$$ HL = \sqrt{\frac{3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2}}{3M_p^2\Omega_\Lambda}}. \quad (2.14) $$

Differentiating $L$ with respect to time $t$ and using (2.14) yields

$$ \dot{L} = \sqrt{\frac{3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2}}{3M_p^2\Omega_\Lambda}} - \cosn(|k|y), \quad (2.15) $$

where

$$ \cosn(|k|y) = \begin{cases} 
\cos y & k = +1, \\
1 & k = 0, \\
\cosh y & k = -1.
\end{cases} \quad (2.16) $$

Differentiating (2.10) with respect to $t$ gives

$$ \dot{\rho}_\Lambda = \left[2\gamma L^{-5} - 4\gamma L^{-2} \ln(M_p^2L^2) - 4\beta L^{-5} - 6n^2M_p^2L^{-3}\right] $$

$$ \times \left[\sqrt{\frac{3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2}}{3M_p^2\Omega_\Lambda}} - \cosn(|k|y)\right]. \quad (2.17) $$

Making use of (2.17) in (2.5) gives

$$ w_\Lambda = -1 - \frac{2\gamma L^{-2} - 4\gamma L^{-2} \ln(M_p^2L^2) - 4\beta L^{-2} - 6n^2M_p^2L^{-3}}{3(3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2})} $$

$$ \times \left[1 - \sqrt{\frac{3M_p^2\Omega_\Lambda}{3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2}\cosn(|k|y)}}\right] \frac{b^2(1 + \Omega_k)}{\Omega_\Lambda}. \quad (2.18) $$

Using (2.18) in (2.7) gives

$$ w_\Lambda^{\text{eff}} = -1 - \frac{2\gamma L^{-2} - 4\gamma L^{-2} \ln(M_p^2L^2) - 4\beta L^{-2} - 6n^2M_p^2L^{-3}}{3(3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2})} $$

$$ \times \left[1 - \sqrt{\frac{3M_p^2\Omega_\Lambda}{3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2}\cosn(|k|y)}}\right]. \quad (2.19) $$

The above expression represents the effective equation of state for the entropy corrected holographic dark energy interacting with matter. An interesting case arises when the FRW universe is spatially flat $k = 0$, then eq. (2.19) gives $w_\Lambda^{\text{eff}} = -1$. However in the non-flat case, the complete expression on right hand side in (2.19) will play crucial role and phantom...
crossing will be possible for selected choices of parameters. Another important implication of ECHDE besides phantom energy is the cosmological inflation in the early universe: in this case the Hubble horizon $H^{-1}$ and the future event horizon $R_h$ will coincide i.e. $L = R_h = H^{-1}$ (collectively implying $H = \text{constant}$ during the inflation era). Therefore the equation of state of ECHDE during the inflation era will be

$$w^{\text{eff}}_\Lambda = -1 - \frac{2\gamma H^2 - 4\gamma H^2 \ln(M_p^2 H^{-2}) - 4\beta H^2 - 6n^2 M_p^2}{3(3n^2 M_p^2 + \gamma H^2 \ln(M_p^2 H^{-2}) + \beta H^2)} \times \left[ 1 - \sqrt{\frac{3M_p^2 \Omega_\Lambda}{3n^2 M_p^2 + \gamma H^2 \ln(M_p^2 H^{-2}) + \beta H^2}} \cos^n(\sqrt{|k|} y) \right].$$

After the end of the inflationary phase, the universe subsequently enters in the radiation and then matter dominated eras. Since during the later two stages, the dark energy is not the dominant component of the total cosmic energy density, one can safely take $\gamma = \beta = 0$, i.e. the correction terms can work only in the inflationary or in the late time acceleration phases. For the later case, the infra-red cut-off will be $L = R_h$ ($R_h \neq H^{-1}$ and $R_h \neq \text{constant}$).

Notice that if the accelerated expansion is due to phantom energy then the future event horizon is a decreasing function of time ($\dot{R}_h \leq 0$) while for all other cases, $\dot{R}_h > 0$ [25].

3 Correspondence between generalized Chaplygin gas and ECHDE

Since there are numerous candidates for dark energy, it is essential to know how these various candidates are related to each other. In this connection, we proceed to obtain a correspondence between generalized Chaplygin gas (GCG) and ECHDE. One of the possible candidates for dark energy is the GCG which is the generalization of the Chaplygin gas [26]. It has an amazing property of interpolating the evolution of the universe from the dust phase to the accelerated phase of the universe and hence best fits the observational data [27]. The model of GCG as well as its further generalization have been extensively studied in the literature [28].

The GCG is defined as [29]

$$p_\Lambda = -\frac{D}{\rho_\Lambda^\alpha},$$

(3.1)

Here $D$ is a positive constant and $\alpha$ is also a constant. Notice that fixing $\alpha = 1$ yields the Chaplygin gas. It is shown in [30] that the matter power spectrum is compatible with the observed one only for $\alpha < 10^{-5}$, which makes the generalized Chaplygin gas practically indistinguishable from the standard cosmological model with cosmological constant ($\Lambda$CDM). In [31], the Chaplygin inflation has been investigated in the context of loop quantum cosmology and it is shown that the parameters of the Chaplygin inflation model are consistent with the WMAP 5-year results.

The density evolution of GCG is given by

$$\rho_\Lambda = \left[ D + \frac{B}{a^3(1+\alpha)} \right]^\frac{1}{1+\alpha},$$

(3.2)

where $B$ is a constant of integration. We proceed with the reconstruction of the potential and the dynamics of the scalar field in the light of the ECHDE. The energy density and the
pressure of the homogeneous and time dependent scalar field $\Phi$ are given by

$$
\rho_\Lambda = \frac{\sigma}{2} \dot{\Phi}^2 + V(\Phi),
$$

$$
p_\Lambda = \frac{\sigma}{2} \dot{\Phi}^2 - V(\Phi).
$$

(3.3)  

(3.4)

Here $\sigma = -1$ corresponds to the phantom while $\sigma = +1$ represents the standard scalar field which represent the quintessence field, also $V(\Phi)$ is the potential. In this case $w_\Lambda$ is given by

$$
w_\Lambda = \frac{p_\Lambda}{\rho_\Lambda} = \frac{\sigma \dot{\Phi}^2 - 2V(\Phi)}{\sigma \dot{\Phi}^2 + 2V(\Phi)}.
$$

(3.5)

We observe that it results in the violation of the null energy condition $\rho_\Lambda + p_\Lambda = \sigma \dot{\Phi}^2 > 0$, if $\sigma = -1$. Since the null energy condition is the basic condition, its violation yields other standard energy conditions to be violated likewise dominant energy condition $(\rho_\Lambda > 0, \rho_\Lambda \geq |p_\Lambda|)$ and the strong energy condition $(\rho_\Lambda + p_\Lambda > 0, \rho_\Lambda + 3p_\Lambda > 0)$. Due to the energy condition violations, it makes the failure of cosmic censorship conjecture and theorems related to black hole thermodynamics. The prime motivation to introduce this weird concept in cosmology does not come from the theory but from the observational data. According to the forms of dark energy density and pressure (3.3) and (3.4), one can easily obtain the kinetic energy and the scalar potential terms as

$$
\dot{\Phi}^2 = \frac{1}{\sigma} (1 + \omega_\Lambda) \rho_\Lambda,
$$

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

(3.6)  

(3.7)

But we know that

$$
w_\Lambda = -\frac{D}{\rho_\Lambda^{\alpha+1}} = -\frac{D}{(3n^2M_p^2L^{-2} + \gamma L^{-4} \ln(M_p^2L^2) + \beta L^{-4})^{\alpha+1}}.
$$

(3.8)

Therefore using (2.18) and (3.8) yields the value of the parameter

$$
D = (3n^2M_p^2L^{-2} + \gamma L^{-4} \ln(M_p^2L^2) + \beta L^{-4})^{\alpha+1} \\
\times \left[ \left( 1 + \frac{2\gamma L^{-2} - 4\gamma L^{-2} \ln(M_p^2L^2) - 4\beta L^{-2} - 6n^2M_p^2}{3(3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2})} \right) \\
\times \left( \frac{3M_p^2\Omega_\Lambda}{3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2}} \right) \cos^n(\sqrt{\kappa y}) \right] + \frac{b^2(1 + \Omega_k)}{\Omega_\Lambda}.
$$

(3.9)

Eq. (3.2) implies $B = a^{3(\alpha+1)}(\rho_\Lambda^{\alpha+1} - D)$, which after using (3.9) takes the form

$$
B = -a^{3(\alpha+1)}(\rho_\Lambda^{\alpha+1} - D) \\
\times \left[ \left( 1 - \frac{3M_p^2\Omega_\Lambda}{3n^2M_p^2 + \gamma L^{-2} \ln(M_p^2L^2) + \beta L^{-2}} \right) \cos^n(\sqrt{\kappa y}) \right] + \frac{b^2(1 + \Omega_k)}{\Omega_\Lambda}.
$$

(3.10)
Using eqs. (3.6), (3.7), (3.9) and (3.10), we obtain the kinetic and potential terms

\[ \sigma \dot{\Phi} = -\left(3n^2 M_p^2 L^{-2} + \gamma L^{-4} \ln(M_p^2 L^2) + \beta L^{-4}\right) \]

\[
\times \left[ \frac{2\gamma L^{-2} - 4\gamma L^{-2} \ln(M_p^2 L^2) - 4\beta L^{-2} - 6n^2 M_p^2}{3(3n^2 M_p^2 + \gamma L^{-2} \ln(M_p^2 L^2) + \beta L^{-2})} \right] \\
\times \left\{ 1 - \sqrt{\frac{3M_p^2 \Omega_\Lambda}{3n^2 M_p^2 + \gamma L^{-2} \ln(M_p^2 L^2) + \beta L^{-2}}} \cos(\sqrt{|k|y}) \right\} - \frac{b^2(1+\Omega_k)}{\Omega_\Lambda}, \tag{3.11} \]

\[2V(\Phi) = \left(3n^2 M_p^2 L^{-2} + \gamma L^{-4} \ln(M_p^2 L^2) + \beta L^{-4}\right) \]

\[
\times \left[ 2 + \frac{2\gamma L^{-2} - 4\gamma L^{-2} \ln(M_p^2 L^2) - 4\beta L^{-2} - 6n^2 M_p^2}{3(3n^2 M_p^2 + \gamma L^{-2} \ln(M_p^2 L^2) + \beta L^{-2})} \right] \\
\times \left\{ 1 - \sqrt{\frac{3M_p^2 \Omega_\Lambda}{3n^2 M_p^2 + \gamma L^{-2} \ln(M_p^2 L^2) + \beta L^{-2}}} \cos(\sqrt{|k|y}) \right\} + \frac{b^2(1+\Omega_k)}{\Omega_\Lambda}. \tag{3.12} \]

We can write \( \Phi = \Phi' H \), where prime denotes differentiation with respect to \( \ln a \). Hence from (3.11) we can write

\[ \Phi(a) - \Phi(a_0) = \int_0^{\ln a} \frac{1}{H} \left[ -\frac{1}{\sigma} \left(3n^2 M_p^2 L^{-2} + \gamma L^{-4} \ln(M_p^2 L^2) + \beta L^{-4}\right) \right. \]

\[
\times \left( \frac{2\gamma L^{-2} - 4\gamma L^{-2} \ln(M_p^2 L^2) - 4\beta L^{-2} - 6n^2 M_p^2}{3(3n^2 M_p^2 + \gamma L^{-2} \ln(M_p^2 L^2) + \beta L^{-2})} \right) \\
\times \left\{ 1 - \sqrt{\frac{3M_p^2 \Omega_\Lambda}{3n^2 M_p^2 + \gamma L^{-2} \ln(M_p^2 L^2) + \beta L^{-2}}} \cos(\sqrt{|k|y}) \right\} \]

\[
+ \frac{b^2(1+\Omega_k)}{\Omega_\Lambda} \right]^{1/2} \] \[d \ln a. \tag{3.13} \]

Here \( a_0 \) denotes the present value of the scale factor. Also expression (3.12) represents the reconstructed potential. We will also comment that the present analysis can be performed for entropy corrected new agegraphic dark energy (ECNADE) [19] whose definition closely mimics to that of ECHDE (2.10). The former is defined by

\[ \rho_\Lambda = 3n^2 M_p^2 \eta^2 + \beta \eta^{-4}. \tag{3.14} \]

By comparing the above definition (3.14) with (2.10), we note that \( \gamma = 0 \) and \( L \) is replaced with the conformal time \( \eta \equiv \int_0^a \frac{db}{Hb} \). However there are several disadvantages with the ageographic dark energy: it can not generate the inflation era in the early universe unlike the holographic dark energy; it cannot produce a phantom dominated universe since its equation of state parameter is always greater than \(-1\); its energy density decreases with time unlike any other dark energy candidate; quantum corrections are generally ignorable and it worse fits with the observational data [19, 27]. Moreover in this paper we have restricted our analysis for the entropy corrections up to second order although these corrections can be extended to higher orders and the present analysis can be generalized to the desired order of correction.
4 Conclusion

In this paper we have investigated the model of interacting dark energy with the inclusion of entropy corrections to the holographic dark energy. These corrections are motivated from the LQG which is one of the promising theories of quantum gravity. Among various candidates to play the role of the dark energy, the generalized Chaplygin gas has emerged as a possible unification of dark matter and dark energy. This unification arises since its cosmological evolution is similar to an initial dust like matter and a cosmological constant for late times.

In this paper, by considering an interaction between entropy corrected holographic dark energy and matter, we have obtained the equation of state for the interacting entropy corrected holographic dark energy density in the non-flat universe. We have considered a correspondence between the holographic dark energy density and interacting generalized Chaplygin gas energy density in FRW universe. Finally we have reconstructed the potential of the scalar field which describe the generalized Chaplygin cosmology.

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