Interacting entropy-corrected agegraphic Chaplygin gas model of dark energy

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Abstract

In this work, we consider the interacting agegraphic dark energy models with entropy correction terms due to loop quantum gravity. We study the correspondence between the Chaplygin gas energy density with the interacting entropy-corrected agegraphic dark energy models in non-flat FRW universe. We reconstruct the potentials and the dynamics of the interacting entropy-corrected agegraphic scalar field models. This model is also extended to the interacting entropy-corrected agegraphic generalized Chaplygin gas dark energy.

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I. INTRODUCTION

The dark energy (DE) problem is one of the most famous problems in modern cosmology since the discovery of accelerated expansion of the universe by supernova cosmology project and high redshift supernova experiments [1]. The WMAP (Wilkinson Microwave Anisotropy Probe) experiment [2], indicates that the dark energy occupies about 70% of the total energy of the universe. The simplest candidate for dark energy is the cosmological constant in which the equation of state is independent of the cosmic time. However, two problems arise from the cosmological constant, namely the fine-tuning and the cosmic coincidence problems [3]. In order to alleviate or even solve these problems, many dynamical dark energy models have been suggested, whose equation of state evolves with cosmic time. i) The dynamical dark energy can be realized by scalar fields. Scalar field models arise in string theory and are studied as a candidates for dark energy. It includes quintessence [4], K-essence [5], phantoms [6], tachyon [7], dilaton [8], quintom [9] and so forth. ii) The interacting dark energy models, by considering the interaction between dark matter and dark energy, including Chaplygin gas [10], braneworld models [11], holographic DE and agegraphic DE models , etc.

The holographic dark energy model (HDE) is one of interesting candidates for dark energy, which have been suggested based on the holographic principle. This model has been extensively investigated in the literature [12–14]. In the principle of holographic, the energy density depends on the entropy-area relationship of black holes in Einstein gravity [12, 15]. This entropy is given as $S_{BH} = A/(4G)$, where $A \sim L^2$ is the area of horizon. The energy density of HDE is given by

$$\rho_D = 3n^2 M_p^2 L^{-2},$$

where $n$ is a numerical factor, $M_p$ is the reduced plank mass and $L$ is a length scale. If we take the length scale $L$ as a size of current universe or particle horizon, the accelerated expansion of the universe can not be derived by HDE model [16]. However, in the case of event horizon as a length scale, HDE model can derive the universe with accelerated expansion [14]. The problem arises from the event horizon length scale is that the it is a global concept of spacetime and existence of it depends on the future evolution of the universe only for universe with forever accelerated universe. Furthermore, the holographic with event horizon as a length scale is not compatible with the age of some old high redshift objects [18]. To avoid the problem of causality, appearing with event horizon area as a
IR cut-off, Garanda and Oliviers proposed a new IR cut-off for the HDE containing the Hubble and time derivative Hubble scales [19]. This new model of HDE depends on local quantities.

In the context of loop quantum gravity (LQG), the entropy-area relationship, \( S_{\text{BH}} = \frac{A}{4G} \), can be modified from the inclusion of quantum effects. The quantum corrections provided to the entropy-area relationship leads to the curvature correction in the Einstein-Hilbert action and vice versa [20]. The corrected entropy is given by [21]

\[
S_{\text{BH}} = \frac{A}{4G} + \tilde{\alpha} \ln \left( \frac{A}{4G} \right) + \tilde{\beta},
\]

where \( \tilde{\alpha} \) and \( \tilde{\beta} \) are dimensionless constants of order unity. Considering the entropy correction, the energy density of entropy-corrected holographic dark energy (ECHDE) can be given as [17]

\[
\rho_D = 3n^2 M_p^2 L^{-2} + \alpha L^{-4} \ln(M_p^2 L^2) + \beta L^{-4},
\]

where \( \alpha \) and \( \beta \) are the dimensionless constant. The second and third terms are due to entropy correction. Putting \( \alpha = \beta = 0 \), the energy density of ECHDE reduces to the energy density of ordinary HDE.

Recently, based on principle of quantum gravity, the agegraphic dark energy (ADE) and the new agegraphic dark energy (NADE) models were proposed by Cai [22] and Wei & Cai [23], respectively. The ADE model is based on the line of quantum fluctuations of spacetime, the so-called Károlyházy relation \( \delta t = \lambda t_p^{2/3} t^{1/3} \), and the energy-time Heisenberg uncertainty relation \( E_{\delta t^3} \sim t^{-1} \). These relations enable one to obtain an energy density of the metric quantum fluctuations of Minkowski spacetime as follows [24]

\[
\rho_q \sim \frac{E_{\delta t^3}}{\delta t^3} \sim \frac{1}{t_p^2 t} \sim \frac{M_p^2}{t^2}.
\]

where \( t_p \) and \( M_p \) are the reduced plank time and plank mass, respectively. Choosing the age of universe, as a length measure, the causality problem in HDE is avoided [22]. In ADE model the energy density of dark energy is given by Eq.(4). However, in Friedmann-Robertson-Walker (FRW) universe, due to effect of curvature, one should assume a numerical factor \( 3n^2 \) in Eq.(4) [22]. The new model of agegraphic dark energy (NADE) has been proposed by Wei and Cai [23], in which the cosmic time is replaced by the conformal time. The ADE and NADE models have been constrained by various astronomical observations [25–29].
Regarding the entropy correction due to loop quantum gravity, the agegraphic dark energy models have been investigated. Taking the entropy correction into account, Jamil & Sheykhi generalized the agegraphic tachyon models of dark energy \[30\]. Karami & Sorouri extended the agegraphic dark energy into the entropy-corrected agegraphic dark energy in non-flat universe \[31\]. Faroog, et al.\[32\] studied the correspondence between the tachyon, K-essence and dilaton scalar field models with the interacting entropy-corrected new agegraphic dark energy model in the non-flat FRW universe.

Here, in this work we consider the entropy corrected agegraphic dark energy model. The energy density of entropy-corrected agegraphic dark energy (ECADE) can be easily obtained by replacing \(L\) in Eq.(3) with a time scale \(T\) of the universe. Hence, the energy density of ECADE is given as

\[
\rho_D = 3n^2M_p^2T^{-2} + \alpha T^{-4}\ln(M_p^2T^2) + \beta T^{-4}. \tag{5}
\]

The last terms in Eq.(5) can be comparable to the first term at the early epoch of the universe and negligible when the time scale \(T\) becomes large. Therefore, the entropy correction can be important at the early time and the ECADE model reduces to the ordinary ADE model, when \(T\) becomes large.

On the other hand, the Chaplygin gas model is one of the candidate of dark energy models to explain the accelerated expansion of the universe. The Chaplygin gas dark energy model can be assumed as a possible unification of dark matter and dark energy. The equation of state of a prefect fluid, Chaplygin gas, is given by

\[
P_{ch}^D = -\frac{A}{\rho_{ch}^D}, \tag{6}
\]

where \(A\) is a positive constant, \(P_{ch}^D\) and \(\rho_{ch}^D\) are the pressure and the energy density of the Chaplygin gas dark energy, respectively. Chaplygin gas plays a dual role at different epoch of the history of the universe: it can be as a dustlike matter in the early time (i.e. for small scale factor \(a\)), and as a cosmological constant at late times (i.e. for large values of \(a\)).

This model from the field theory points of view are investigated in \[33\]. The Chaplygin gas emerges as an effective fluid associated with D-branes \[34\] and can also be obtained from the Born-Infeld action \[35\].

The aim of this paper is to establish a correspondence between the interacting ECADE and ECNADE (entropy-corrected new agegraphic dark energy) scenarios with the Chaplygin
gas model in a non-flat universe. The non-flatness of the universe is favored by astronomical observations [2, 36]. We propose the entropy-corrected agegraphic descriptions of the Chaplygin gas dark energy and reconstruct the potential and the dynamics of the scalar field which describe the Chaplygin cosmology. This work is also extended to the generalized Chaplygin gas model.

II. THE INTERACTING ECADe AS A CHAPLYGIN GAS

The Friedman-Robertson-Walker (FRW) metric for a universe with curvature $k$ is given by

$$ds^2 = dt^2 - a^2(t) \left( \frac{dr^2}{1 - kr^2} + r^2d\Omega^2 \right),$$

(7)

where $a(t)$ is the scale factor, and $k = -1, 0, 1$ represents the open, flat, and closed universes, respectively. The Friedmann equation for a non-flat universe containing dark energy (DE) and cold dark matter (CDM) is written as

$$H^2 + \frac{k}{a^2} = \frac{1}{3M_p^2} (\rho_m + \rho_D).$$

(8)

Let us define the dimensionless energy densities as

$$\Omega_m = \frac{\rho_m}{\rho_c}, \quad \Omega_D = \frac{\rho_D}{\rho_c}, \quad \Omega_k = \frac{k}{H^2a^2},$$

(9)

where $\rho_c = 3M_p^2H^2$ is a critical energy density. Thus, the Friedmann equation with respect to the fractional energy densities can be written as

$$\Omega_m + \Omega_D = 1 + \Omega_k.$$

(10)

substituting the equation of state of Chaplygin gas (i.e., Eq. [6]) into the relativistic energy conservation equation, leads to a evolving density as

$$\rho_{\phi}^{ch} = \sqrt{A + \frac{B}{a^6}},$$

(11)

where $B$ is an integration constant. The energy density and pressure of the scalar field, regarding the Chaplygin gas dark energy is written as

$$\rho_\phi = \frac{1}{2} \dot{\phi}^2 + V(\phi) = \sqrt{A + \frac{B}{a^6}},$$

(12)

$$p_\phi = \frac{1}{2} \dot{\phi}^2 - V(\phi) = \frac{-A}{\sqrt{A + \frac{B}{a^6}}},$$

(13)
Hence, it is easy to obtained the scalar potential and the kinetic energy terms for the Chaplygin gas as

\[ V(\phi) = \frac{2Aa^6 + B}{2a^6 \sqrt{A + \frac{B}{a^6}}}, \]
\[ \dot{\phi}^2 = \frac{B}{a^6 \sqrt{A + \frac{B}{a^6}}}. \]

(14) \hspace{1cm} (15)

Now we reconstruct the ECADE Chaplygin gas dark energy model. In order to do this, first we describe the ECADE model and then reconstruct the ECADE Chaplygin gas model. The energy density of the ECADE is given by Eq. (5) where the time scale \( t \) is chosen as the age of the universe, \( T \). Therefore, the energy density of ECADE is written as

\[ \rho_D = 3n^2 M_p^2 T^{-2} + \alpha T^{-4} \ln(M_p^2 T^2) + \beta T^{-4}, \]

(16)

where \( T \) is defined by

\[ T = \int_0^a \frac{da}{aH}. \]

(17)

Using the Eqs. (9, 16), it is easy to find that

\[ \Omega_D = \frac{n^2}{H^2 T^2} + \frac{\alpha}{3M_p^2 H^2 T^2} \ln(M_p^2 T^2) + \frac{\beta}{3M_p^2 H^2 T^4}. \]

(18)

Differentiating Eq. (16) with respect to cosmic time \( t \), obtains

\[ \dot{\rho}_D = -2H \left( \frac{3n^2 M_p^2 T^{-2} + 2\alpha T^{-4} \ln(M_p^2 T^2) + (2\beta - \alpha) T^{-4}}{\sqrt{3n^2 M_p^2 + \alpha T^{-2} \ln(M_p^2 T^2) + \beta T^{-2}}} \right) \sqrt{3M_p^2 \Omega_D}. \]

(19)

Considering the interaction between dark matter and dark energy, the energy conservation equations for ECADE and CDM are

\[ \dot{\rho}_m + 3H \rho_m = Q, \]
\[ \dot{\rho}_D + 3H \rho_D (1 + w_D) = -Q, \]

(20) \hspace{1cm} (21)

where \( Q = 3b^2 H \rho \) denotes the interaction between dark matter and dark energy and \( b^2 \) is a coupling parameter. Inserting Eq. (19) in (21) yields the EoS parameter of interacting ECADE as

\[ w_D = -1 + \frac{2}{3} \left( 2D_T - 3n^2 M_p^2 T^2 - \alpha \right) \sqrt{3M_p^2 \Omega_D} - \frac{b^2 (1 + \Omega_k)}{\Omega_D}. \]

(22)
where \( D_T = 3n^2M_p^2T^2 + \alpha \ln(M_p^2T^2) + \beta = \rho_D T^4 = \Omega_D \rho_c T^4 \). It should be noted that the parameter \( \beta \) is covered in definition of \( D_T \). In the limiting case of \( \alpha = \beta = 0 \), representing the interacting ADE model without the entropy correction, \( D_T = 3n^2M_p^2T^2 \) and the Eq.(22) reduces into the simple form as

\[
 w_D = -1 + \frac{2}{3} \sqrt{\frac{\Omega_D}{n^2}} - \frac{b^2(1 + \Omega_k)}{\Omega_D}. \tag{23}
\]

Here, Eq.(23) is same as Eq.(14) in Ref.[38], for the EoS parameter of ordinary agegraphic dark energy model. Now, we can construct the interacting ECADE Chaplygin gas model. By equating the Eqs.(11) and (16), we have

\[
 B = \frac{a^6(-AT^8 + D_T^2)}{T^8}. \tag{24}
\]

Using Eqs.(6), (11) and (22) one can obtain

\[
 w_D = \frac{-A}{\rho_D^ck} = \frac{-A}{A + Ba^{-6}} \tag{25}
\]

\[
 = -1 + \frac{2}{3} \frac{T(2D_T - 3n^2M_p^2T^2 - \alpha)\sqrt{3M_p^2\Omega_D}}{D_T^{3/2}} - \frac{b^2(1 + \Omega_k)}{\Omega_D}.
\]

Substituting \( B \) in Eq.(25), we obtain the constant \( A \) as

\[
 A = \frac{1}{3T^8} \left[ 2T \sqrt{3M_p^2\Omega_D D_T(-2D_T + 3n^2M_p^2T^2 + \alpha) + 3D_T^2(1 + b^2\frac{1 + \Omega_k}{\Omega_D})} \right]. \tag{26}
\]

Putting \( \alpha = \beta = 0 \) and \( b = 0 \), the relations (24) and (26) can be easily reduced into Eqs.(22) and (24) in Ref.[37] for ordinary ADE Chaplygin gas without interaction parameter. Substituting \( A \) and \( B \) in Eqs.(12) and (14), we can rewrite the scalar potential and kinetic energy terms as

\[
 V(\phi) = \sqrt{\frac{3M_p^2\Omega_D}{D_T}} - \frac{2}{3T^3}((-2D_T + 3n^2M_p^2T^2 + \alpha) + \frac{D_T^2}{2} \frac{2 + b^2\frac{1 + \Omega_k}{\Omega_D}}{T^4}). \tag{27}
\]

\[
 \dot{\phi} = \sqrt{\frac{2}{3T^3} \sqrt{\frac{3M_p^2\Omega_D}{D_T}} (-2D_T + 3n^2M_p^2T^2 - \alpha) - \frac{b^2}{T^4} D_T \frac{1 + \Omega_k}{\Omega_D}}. \tag{28}
\]

We can also see that, the Eqs.(26) and (27) of Ref.[37] can be achieved for \( \alpha = \beta = 0 \) and \( b = 0 \). Using \( \dot{\phi} = \phi' H \), we have

\[
 \phi' = \frac{1}{H} \sqrt{\frac{2}{3T^3} \sqrt{\frac{3M_p^2\Omega_D}{D_T}} (-2D_T + 3n^2M_p^2T^2 - \alpha) - \frac{b^2}{T^4} D_T \frac{1 + \Omega_k}{\Omega_D}}. \tag{29}
\]
Integrating Eq. (29), one can obtain the evolutionary form of the phantom scalar field as

\[ \phi(a) - \phi(a_0) = \int_{\ln a_0}^{\ln a} \frac{1}{H} \left[ \frac{2}{3T^3} \sqrt{\frac{3M_p^2 \Omega_D}{D_T}} \left( +2D_T - 3n^2 M_p^2 T^2 - \alpha \right) - \frac{b^2}{T^4} D_T \frac{1 + \Omega_k}{\Omega_D} d \ln a \right] \]

where \( a_0 \) is a present value of scale factor. Here we established the correspondence between the interacting ADE model with Chaplygin gas model and reconstruct the potential and the dynamics of interacting ECADE Chaplygin gas. For convince, putting \( \alpha = \beta = 0 \) and \( b = 0 \) results the relations (28) and (29) of Ref. [37].

### III. THE INTERACTING ECNADE AS A CHAPLYGIN GAS

In this section we construct the interacting entropy-corrected new agegraphic dark energy (ECNADE) model. The energy density of ECNADE is given by

\[ \rho_D = 3n^2 M_p^2 \eta^{-2} + \alpha \eta^{-4} \ln(M_p^2 \eta^2) + \beta \eta^{-4}. \]  \hspace{1cm} (31)

where \( \eta \) is a conformal time given by

\[ \eta = \int \frac{dt}{a} = \int_0^a \frac{da}{Ha^2}. \]

Using the fractional energy density in Eq. (9), the Eq. (32) can be rewritten as

\[ \Omega_D = \frac{n^2}{H^2 \eta^2} + \frac{\alpha}{3M_p^2 H^2 \eta^4} \ln(M_p^2 \eta^2) + \frac{\beta}{3M_p^2 H^2 \eta^4}. \]  \hspace{1cm} (33)

Differentiating Eq. (31) with respect to cosmic time \( t \), one can obtain

\[ \dot{\rho}_D = -\frac{2H}{a} \left( \frac{3n^2 M_p^2 \eta^{-2} + 2\alpha \eta^{-4} \ln(M_p^2 \eta^2) + (2\beta - \alpha) \eta^{-4}}{\sqrt{3n^2 M_p^2 + \alpha \eta^{-2} \ln(M_p^2 \eta^2) + \beta \eta^{-2}}} \right) \sqrt{3M_p^2 \Omega_D}. \]  \hspace{1cm} (34)

Substituting Eq. (34) in Eq. (21), we can obtain the Eos parameter of interacting ECNADE as

\[ w_D = -1 + \frac{2}{3} \frac{\eta(2D_\eta - 3n^2 M_p^2 \eta^2 - \alpha) \sqrt{3M_p^2 \Omega_D}}{D_\eta^{3/2}} - \frac{b^2(1 + \Omega_k)}{\Omega_D}. \]  \hspace{1cm} (35)

where \( D_\eta = 3n^2 M_p^2 \eta^2 + \alpha \ln(M_p^2 \eta^2) + \beta = \rho_D \eta^4 = \Omega_D \rho_D \eta^4 \). Here \( \rho_D \) is the energy density of ECNADE. Now, we can construct the interacting ECNADE model. Equating Eqs. (35) and (11), the constant \( B \) in Chaplygin gas model can be obtained as

\[ B = \frac{a^5(-A \eta^8 + D_\eta^2)}{\eta^8}, \]  \hspace{1cm} (36)
Using Eqs. (6), (11) and (35) we can obtain
\[ w_D = \frac{-A}{\rho_{ch}^D} = \frac{-A}{A + Ba^{-6}} \]
\[ = -1 + \frac{2}{3} \frac{\eta(2D_\eta - 3n^2M_p^2\eta^2 - \alpha)\sqrt{3M_p^2D_\eta}}{D_\eta^{3/2}} - \frac{b^2(1 + \Omega_k)}{\Omega_D}. \]

Substituting Eq. (36) in (37), the constant \( A \) can be obtained as
\[ A = \frac{1}{3\alpha^2} \left[ 2\eta\sqrt{3M_p^2D_\eta}(2D_\eta - 3n^2M_p^2\eta^2 + \alpha) + 3aD_\eta^2(1 + b^2) \frac{1 + \Omega_k}{\Omega_D} \right]. \]

Substituting \( A \) and \( B \) in Eqs. (12) and (14), we can rewrite the scalar potential and kinetic energy terms for interacting ECNADE model as follows
\[ V(\phi) = \frac{\sqrt{3M_p^2D_\eta}}{3\alpha\eta^3}(2D_\eta - 3n^2M_p^2\eta^2 + \alpha) + \frac{D_\eta^2(2 + b^2)}{\eta^4 D_\eta^2} \frac{1 + \Omega_k}{\Omega_D}. \]

Using \( \dot{\phi} = \phi' H \), it is clear that
\[ \dot{\phi} = \frac{1}{H} \frac{2}{3\alpha^2} \sqrt{3M_p^2D_\eta}(2D_\eta - 3n^2M_p^2\eta^2 - \alpha) - \frac{b^2}{\eta^4 D_\eta} \frac{1 + \Omega_k}{\Omega_D}. \]

Integrating Eq. (41), we have the evolutionary behavior of the scalar field as
\[ \phi(a) - \phi(a_0) = \int_{\ln a_0}^{\ln a} \frac{1}{H} \frac{2}{3\alpha^2} \sqrt{3M_p^2D_\eta}(2D_\eta - 3n^2M_p^2\eta^2 - \alpha) - \frac{b^2}{\eta^4 D_\eta} \frac{1 + \Omega_k}{\Omega_D} d\ln a. \]

where \( a_0 \) is a present value of scale factor. Here we have established the correspondence between the interacting ECNADE with the Chaplygin gas dark energy and reconstruct the potential and the dynamics of interacting ENCADE Chaplygin gas. It is also emphasized that in the limiting case of \( \alpha = \beta = 0 \) and \( b = 0 \), the relations (35, 36, 38, 40, 41 and 42) reduce to Eqs. (34, 36, 38, 40, 41, 42 and 43), respectively, in Ref. [37].

IV. INTERACTING ECNADE GENERALIZED CHAPLYGIN GAS

In this section we extend this work to the interacting ECNADE generalized Chaplygin gas. The equation of state of generalized Chaplygin gas [33], is given by
\[ p_{ch}^D = \frac{-A}{\rho_{ch}^D} \]
Substituting the above equation into the relativistic energy conservation equation leads to a density evolving as

$$\rho_D^{\text{gch}} = (A + Ba^{-3\gamma})^{1/\gamma},$$  

(44)

where $\gamma = \delta + 1$. Hence, it is easy to find the EoS parameter of generalized Chaplygin gas as

$$w_D^{\text{gch}} = \frac{p_D^{\text{gch}}}{\rho_D^{\text{gch}}} = \frac{-A}{A + Ba^{-3\gamma}}.$$  

(45)

Now we establish the connection between the interacting ECNADE model and generalized Chaplygin gas dark energy. Equating Eq.(33) with Eq.(44) and also Eq.(45) with Eq.(35), the constant parameters $A$ and $B$ can be obtained as

$$B = [\gamma \left( D_\eta \eta^4 \right) - A] a^3\gamma.$$  

(46)

$$A = \frac{1}{3a} \left( \sqrt{D_\eta} \right)^\gamma \left( 2\eta \sqrt{\frac{3M_D^2\Omega_D}{D_\eta}} (-2D_\eta + 3n^2M_p^2\eta^2 + \alpha) + 3aD_\eta (1 + b^2 + \frac{1}{\Omega_D}) \right)$$  

(47)

Substituting $A$ and $B$ in Eqs.(12) and (14), we re-write the scalar potential and kinetic energy terms for interacting ECNADE generalized Chaplygin gas as follows

$$V(\phi) = \sqrt{\frac{3M_D^2\Omega_D}{D_\eta}} \left( \frac{D_\eta}{\eta^4} \right)^{\gamma\delta} \eta (-2D_\eta + 3n^2M_p^2\eta^2 + \alpha) + \frac{1}{2} \left( \frac{D_\eta}{\eta^4} \right)^{\gamma\delta} (1 + b^2 + \frac{1}{\Omega_D})$$  

(48)

$$\dot{\phi} = \sqrt{\frac{2}{3a} \left( \frac{D_\eta}{\eta^4} \right)^{\gamma\delta} \sqrt{\frac{3M_D^2\Omega_D}{D_\eta}} \eta (2D_\eta - 3n^2M_p^2\eta^2 - \alpha) + \frac{D_\eta}{3\eta^4} - \frac{1}{3} \left( \frac{D_\eta}{\eta^4} \right)^{\gamma\delta} (1 + b^2 + \frac{1}{\Omega_D})}$$  

(49)

Using $\dot{\phi} = \phi' H$, we can find

$$\phi' = \frac{1}{H} \sqrt{\frac{2}{3a} \left( \frac{D_\eta}{\eta^4} \right)^{\gamma\delta} \sqrt{\frac{3M_D^2\Omega_D}{D_\eta}} \eta (2D_\eta - 3n^2M_p^2\eta^2 - \alpha) + \frac{D_\eta}{3\eta^4} - \frac{1}{3} \left( \frac{D_\eta}{\eta^4} \right)^{\gamma\delta} (1 + b^2 + \frac{1}{\Omega_D})}$$  

(50)
Integrating Eq. (50), we obtain the evolutionary behavior of the scalar field as

\[
\phi(a) - \phi(a_0) = \int_{\ln a_0}^{\ln a} \frac{1}{H} \left[ \frac{2}{3a} \frac{D_\eta}{\eta^4} \gamma^{-\delta} \sqrt{\frac{3M_p^2 \Omega_D}{D_\eta}} \eta (2D_\eta - 3n^2 M_p^2 \eta^2 - \alpha) + \frac{D_\eta}{3\eta^4} - \frac{1}{3} \left( \frac{D_\eta}{\eta^4} \right)^{\gamma-\delta} (1 + b^2 \frac{1 + \Omega_k}{\Omega_D} \right) d\ln a
\]

where \(a_0\) is a present value of scale factor. Here we have established the correspondence between the interacting ECNADE with generalized Chaplygin gas model and reconstruct the potential and the dynamics of generalized Chaplygin cosmology. It is worth noting that, by putting \(\gamma = 2, \delta = 1\), all the above equations for interacting ECNADE generalized Chaplygin gas reduce into those for interacting ECADE Chaplygin gas.

V. CONCLUSIONS

Here we considered the interacting entropy-corrected agegraphic dark energy models with CDM in a non-flat universe. We established a correspondence between the interacting ECADE density with the Chaplygin gas energy in a non-flat universe. We reconstructed the potential and the dynamics of the interacting entropy corrected agegraphic scalar field which describe the Chaplygin cosmology. We also derived the potential and dynamics of the interacting entropy-corrected new agegraphic model which describe the Chaplygin cosmology. Finally, we have extended this work into the interacting entropy-corrected new agegraphic scalar field which can describe the generalized Chaplygin cosmology.

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