

A dark energy model alternative to generalized Chaplygin gas

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Abstract

We propose a new fluid model of dark energy for $-1 \leq \omega_{\text{eff}} \leq 0$ as an alternative to the generalized Chaplygin gas models. The energy density of dark energy fluid is severely suppressed during barotropic matter dominant epochs, and it dominates the universe evolution only for eras of small redshift. From the perspective of fundamental physics, the fluid is a tachyon field with a scalar potential flatter than that of power-law decelerated expansion. Different from the standard Λ CDM model, the suggested dark energy model claims that the cosmic acceleration at present epoch can not continue forever but will cease in the near future and a decelerated cosmic expansion will recover afterwards.

1 Introduction

Recent cosmic observations, including Type Ia Supernovae[1, 2], Large Scale Structure (LSS)[3, 4, 5, 6, 7, 8] and Cosmic Microwave Background (CMB)[9,

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10, 11, 12] have independently indicated that the universe is currently undergoing an accelerated expansion phase. The source for this late time cosmic acceleration has been dubbed “dark energy”, which is distinguished from ordinary matter species such as baryons and radiation in the sense that it has a negative pressure. The cosmic accelerated expansion of the Universe occurs when the gravitational force produced by the barotropic ordinary matter is counteracted by the negative pressure of dark energy. Despite many years of research and much progress, the nature and the origin of dark energy have not been confirmed yet.

Phenomenologically, the best candidate of dark energy that is perfectly consistent with the current observation data is the so-called cosmological constant (CC) Λ which was introduced by Einstein in his gravitational field equations[13]. However, CC explanation for dark energy encounters some fundamental obstacles in physics, *e.g.*, the fine-tuning problem and the coincidence problem[14]. From the particle physics perspective, the CC should be interpreted as the energy density ρ_{vac} of the quantum vacuum, which is close to Planck density M_P^4 ($M_P = 1/\sqrt{8\pi G}$ is the reduced Planck mass) in magnitude. The observed value of the dark energy density is much less than that, $\rho_{obs} \approx 10^{-123} \rho_{vac}$. Eliminating this great difference of about 123 orders of magnitude between the observed value of dark energy and that estimated from quantum field theory requires some severe fine-tuning mechanisms to work[15, 16, 17, 18, 19, 20, 21]. On the other hand, even if this fine-tuning problem could be evaded, the coincidence problem remains due to the fact that the vacuum energy is time independent and non-dynamical.

The resolution of CC problems has probably to wait for the advent of a satisfied quantum theory of gravity in 4-dimensional spacetime. As a temporary expedient in cosmology community, the fine-tuning problem is assumed to have been solved for some underlying reasons: CC is zero for some reason and dark energy that drives the late time cosmic accelerated expansion has nothing to do with it. Notice that the observations actually say little about the time evolution of the equation of state (EoS) of dark energy, researchers have proposed many alternative models (see Review article [22] and references listed therein) to explain the late time cosmic acceleration and alleviate the corresponding coincidence problem, among which the Chaplygin gas model [23] appears very interesting. In such a simple model, the acceleration of the universe at late times is due to an alien fluid that has the specific EoS $p = -A/\rho$, with A a positive constant. The intriguing characteristic of Chaplygin gas is that in the flat Robertson-Walker background,

$ds^2 = -dt^2 + a^2(t)d\mathbf{x}^2$ (a is the scale factor of an expanding universe),

$$\rho = \sqrt{A + \frac{B}{a^6}} \quad (1)$$

where B is an integration constant. At early times when $a \ll (B/A)^{1/6}$, the gas behaves as a pressureless dust, $\rho \sim \sqrt{B}/a^3$. Meanwhile it approaches asymptotically a cosmological constant ($\rho \sim -p \sim \sqrt{A}$) at late times when $a \gg (B/A)^{1/6}$. The Chaplygin gas model of dark energy suffers from strong observational pressure from explaining CMB anisotropies [24]. This shortcoming is alleviated in a generalized Chaplygin gas model introduced in [25] with $p = -A/\rho^\alpha$. However, it follows from the observational data that the parameter α is severely constrained within the range $0 \leq \alpha \leq 0.2$ at the 95% confidence level, implying the little difference between the time dependent generalized Chaplygin gas and the time independent cosmological constant.

In this paper we study a new kind of fluid models of dark energy, whose EoS is phenomenologically suggested to be

$$p = -\rho + \rho \text{sinc}(\mu\pi\rho^{(0)}/\rho) \quad (2)$$

where $\text{sinc}(\xi) := \sin(\xi)/\xi$, μ is a dimensionless fine-tuning parameter, and $\rho^{(0)}$ is assumed to be the present energy density of the dark energy fluid. Our aim is to examine to what extent this fluid model can deviate from the time independent CC. The investigation is restricted at the background level. We find that during the matter era the energy density of suggested dark energy fluid is suppressed compared to that of dark matter, satisfying the requirement for the sufficient growth of large-scale structure and the constraint of the universe age problem. The onset of late time cosmic acceleration occurs around the redshift $z \sim 0.6$. The coincidence problem why the accelerated expansion of the universe is rephrased as why the EoS of dark energy fluid takes the suggested form, for which we have proposed a tachyon interpretation originated from superstring theory. Throughout the paper we adopt the Planck units $c = \hbar = M_P = 1$, and assume that there is no direct interactions between different fluids.

2 Model

EoS of the pure CC is $p = -\rho$, where both p and ρ are constant as we can see from the energy conservation equation when dark energy does not

couple with barotropic fluids. In obtaining a dynamical dark energy fluid that deviates from pure CC, we can simply amend the EoS of such a fluid to $p = -\rho + F(\rho)$ with an energy density dependent function $F(\rho)$. Since lots of astrophysical data support the pure CC behaviour of dark energy fluid in the present time, we choose

$$F(\rho) = \rho \text{sinc}(\mu\pi\rho^{(0)}/\rho) \quad (3)$$

EoS of the supposed dark energy fluid can alternatively be described by the ratio $\omega = p/\rho$, which turns out to be

$$\omega = -1 + \text{sinc}(\mu\pi\rho^{(0)}/\rho) \quad (4)$$

In view of the astrophysical constraint on the universe age[26], we simply take the value of fine-tuning parameter μ to be $\mu \approx 0.931$ in this work (See explanation below Eq.(22)). Thus, at large redshift, $\rho \gg \rho^{(0)}$, $\omega \rightarrow 0$. While at present, $\rho \approx \rho^{(0)}$, $\omega \approx -1$.

To obtain a viable dark energy model we have to require that the energy density of dark energy fluid remains negligible during the barotropic matter dominating eras, emerging only at late times to give rise to the current observed accelerated expansion of the universe. Therefore, we assume the coexistence of some independent barotropic fluids with suggested dark energy fluid in the model. EoS of these barotropic fluids is assumed to be $\omega_b = p_b/\rho_b$, where for simplicity $\omega_b = \text{Const}^1$. The Friedmann equations in the flat Robertson-Walker background read

$$3H^2 = \rho + \sum_b \rho_b \quad (5)$$

$$2\dot{H} = -\rho - p - \sum_b (1 + \omega_b)\rho_b \quad (6)$$

where $H := \dot{a}/a$ is the Hubble parameter, and a dot denotes the derivative with respect to the cosmic time t . The dark energy fluid is supposed not to interact with the barotropic fluid. Therefore,

$$\dot{\rho} + 3H(\rho + p) = 0, \quad \dot{\rho}_b + 3H(1 + \omega_b)\rho_b = 0. \quad (7)$$

The solutions to these two equations are

$$\rho = \frac{\mu\pi\rho^{(0)}}{2 \arctan[a^3 \tan(\mu\pi/2)]} \quad (8)$$

¹If the barotropic fluid consists only of the cold dark matter, we have $\omega_b = \omega_m = 0$.

and

$$\rho_b = \frac{\rho_b^{(0)}}{a^{3(1+\omega_b)}} \quad (9)$$

respectively. Notice that for radiation $\omega_b = \omega_\gamma = 1/3$ but for a non-relativistic matter $\omega_b = \omega_m = 0$. To examine whether the onset of the late time cosmic acceleration occurs around the redshift $z \sim 1$, we have to study the variation of dimensionless energy density of suggested dark energy fluid

$$\Omega := \frac{\rho}{3H^2} \quad (10)$$

with respect to the redshift variable z , which is related to the scale factor $a(t)$ by relation $a = 1/(1+z)$. Using z , the Friedmann equation (5) becomes

$$3H^2(z) = \rho + \sum_b \rho_b^{(0)} (1+z)^{3(1+\omega_b)}$$

which implies,

$$\frac{H^2(z)}{H_0^2} = \frac{1}{1-\Omega} \sum_b \Omega_b^{(0)} (1+z)^{3(1+\omega_b)} \quad (11)$$

where H_0 is the present value of the Hubble rate, $H_0^{-1} \approx 2998h^{-1}\text{Mpc}$ and $h \approx 0.72$. In Eq.(11) and afterwards we use

$$\Omega^{(0)} = \frac{\rho^{(0)}}{3H_0^2}, \quad \Omega_b^{(0)} = \frac{\rho_b^{(0)}}{3H_0^2} \quad (12)$$

to stand for the dimensionless energy densities of dark energy and barotropic fluids at present epoch respectively. Sometimes $E(z) := H(z)/H_0$ is called the *scaled Hubble expansion rate*. With Ω and $\Omega^{(0)}$, Eq.(8) becomes,

$$\frac{H^2}{H_0^2} = \frac{\mu\pi\Omega^{(0)}}{2\Omega \arctan[(1+z)^{-3} \tan(\mu\pi/2)]}$$

The equivalence of this equation and Eq.(11) indicates

$$\frac{H^2}{H_0^2} = \frac{\mu\pi\Omega^{(0)}}{2 \arctan[(1+z)^{-3} \tan(\mu\pi/2)]} + \sum_b \Omega_b^{(0)} (1+z)^{3(1+\omega_b)} \quad (13)$$

By using the redshift variable z and Eq.(8), we can rewrite the acceleration equation (6) as

$$\frac{d}{dz} \left(\frac{H^2}{H_0^2} \right) = \frac{3}{(1+z)} \left[\frac{\mu\pi\Omega^{(0)}(1+z)^3 \tan(\mu\pi/2)}{2((1+z)^6 + \tan^2(\mu\pi/2)) \arctan^2((1+z)^{-3} \tan(\mu\pi/2))} \right]$$

$$+ \sum_b (1 + \omega_b) \Omega_b^{(0)} (1 + z)^{3(1+\omega_b)} \Big] \quad (14)$$

Obviously, (13) is the solution of Eq.(14) under the initial condition $H(z)|_{z=0} = H_0$. The change of dimensionless energy density of dark energy fluid with respect to redshift z is given by

$$\Omega = \frac{\mu\pi\Omega^{(0)}}{\mu\pi\Omega^{(0)} + 2 \arctan[(1+z)^{-3} \tan(\mu\pi/2)] \sum_b \Omega_b^{(0)} (1+z)^{3(1+\omega_b)}} \quad (15)$$

In FIG.1, we show the $\Omega \sim z$ plot for the suggested model, where we have assumed that the barotropic fluids consist of radiation and non-relativistic cold dark matter, and chosen $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$ and $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$ in consistent with the current observations[26]. Different from CC, the energy density of dark energy fluid in the model under consideration evolves, which remains non-zero for a considerable duration so that the coincidence problem is alleviated. The redshift dependent Ω reaches its maximum $\Omega_{\text{Max}} = 1$ at $z = -1$ while for both $z > -1$ and $z < -1$ cases it decays monotonously. The suggested dark energy dominates the universe energy only for small redshift stages ($-2.6 \lesssim z \lesssim 0.6$). When $z \approx 0.59$ (or $z \approx -2.59$), Ω is caught up with by that of cold dark matter. In the duration for $z \gg 0.59$ (or $z \ll -2.59$) the energy density of dark energy fluid is considerably suppressed so that the sufficient growth of large-scale structures in the universe is allowed.

In terms of redshift z , EoS of the dark energy fluid defined in Eq.(4) becomes,

$$\omega = -1 + \frac{(1+z)^3 \tan(\mu\pi/2)}{[(1+z)^6 + \tan^2(\mu\pi/2)] \arctan [(1+z)^{-3} \tan(\mu\pi/2)]} \quad (16)$$

From (16), one has a non-phantom dark energy in the considered model, $-1 \leq \omega \leq 0$. This conclusion remains even if the independent barotropic fluids in the background are taken into account. In that case, ω is replaced by the so-called effective EoS ω_{eff} , defined as

$$\omega_{\text{eff}} := \frac{p + \sum_b \omega_b \rho_b}{\rho + \sum_b \rho_b} = \frac{\omega + \sum_b \omega_b \frac{\rho_b^{(0)}}{\rho} (1+z)^{3(1+\omega_b)}}{1 + \sum_b \frac{\rho_b^{(0)}}{\rho} (1+z)^{3(1+\omega_b)}} \quad (17)$$

It follows from Eq.(8) that,

$$\frac{\rho_b^{(0)}}{\rho} = \frac{2\Omega_b^{(0)}}{\mu\pi\Omega^{(0)}} \arctan \left[(1+z)^{-3} \tan(\mu\pi/2) \right] \quad (18)$$

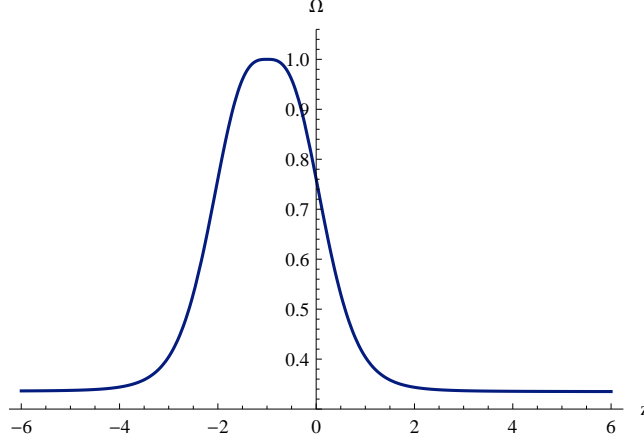


Figure 1: The change of Ω with respect to z in the model under consideration. We assume that the barotropic fluids consist of radiation and non-relativistic cold dark matter, and choose $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$ and $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$. When $z \approx 10$, $\Omega \approx 0.33$ while when $z \approx 10^6$, $\Omega \approx 0.0015$. The energy density of the suggested dark energy fluid decays monotonously for both $z > -1$ and $z < -1$ cases, which dominates only for the small redshift stage ($-2.6 \lesssim z \lesssim 0.6$).

Hence,

$$\omega_{\text{eff}} = \frac{\mu\pi\Omega^{(0)}\omega + 2 \arctan[(1+z)^{-3} \tan(\mu\pi/2)] \sum_b \omega_b \Omega_b^{(0)} (1+z)^{3(1+\omega_b)}}{\mu\pi\Omega^{(0)} + 2 \arctan[(1+z)^{-3} \tan(\mu\pi/2)] \sum_b \Omega_b^{(0)} (1+z)^{3(1+\omega_b)}} \quad (19)$$

Cosmological acceleration occurs when $\omega_{\text{eff}} < -1/3$. By assuming $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$, $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$ and $\mu \approx 0.931$, we plot Eqs.(19) and (16) in FIG.2, from which we see that $-1 \leq \omega_{\text{eff}} \leq 0$. In this model, $\omega_{\text{eff}} < -1/3$ is possible only for $-2.6 \lesssim z \lesssim 0.6$. There are two critical redshift points in the model under consideration, $z_c \approx 0.6$ and $z_c \approx -2.6$. The former that corresponds to the instant when the cosmological deceleration dominated by barotropic matter ceases but the late time acceleration dominated by dark energy fluid starts is the past critical redshift. The latter is the future critical redshift, which predicts an incoming instant when the present cosmological acceleration dominated by dark energy fluid ceases but the decelerated expansion dominated by barotropic matter recovers. When the universe enters into the acceleration phase can alternatively be estimated by the deceleration

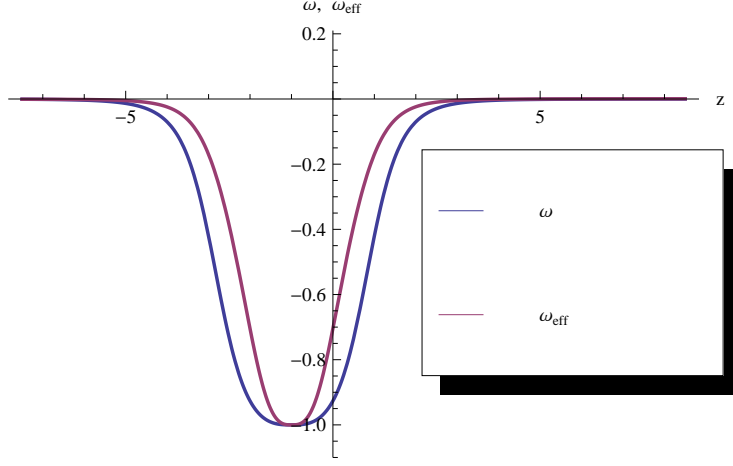


Figure 2: EoS of the suggested dark energy and effective EoS. We have assumed that $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$, $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$ and $\mu \approx 0.931$. Both ω and ω_{eff} are bounded between -1 and 0 . $\omega_{\text{eff}} < -1/3$ occurs when $-2.6 \lesssim z \lesssim 0.6$.

parameter q , defined by

$$q := -\frac{\ddot{a}}{aH^2} = -1 + \frac{(1+z)}{H} \frac{dH}{dz} \quad (20)$$

Substitution of Eqs.(11) and (14) into (20) gives,

$$q = -1 + \frac{3 \arctan[(1+z)^{-3} \tan(\mu\pi/2)]}{\mu\pi\Omega^{(0)} + 2 \arctan[(1+z)^{-3} \tan(\mu\pi/2)] \sum_b \Omega_b^{(0)} (1+z)^{3(1+\omega_b)}} \cdot \left\{ \frac{\mu\pi\Omega^{(0)}(1+z)^3 \tan(\mu\pi/2)}{2 \arctan^2[(1+z)^{-3} \tan(\mu\pi/2)][(1+z)^6 + \tan^2(\mu\pi/2)]} + \sum_b (1+\omega_b)\Omega_b^{(0)}(1+z)^{3(1+\omega_b)} \right\} \quad (21)$$

The universe enters an acceleration phase when $q \leq 0$, which corresponds to $-2.6 \lesssim z \lesssim 0.6$ when we assume $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$, $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$ and $\mu \approx 0.931$. See FIG.3 for detail. When z approaches zero, $q \approx -0.56$, which is in perfect agreement with the prediction ($q \approx -0.55$) of Λ CDM model of cosmology.

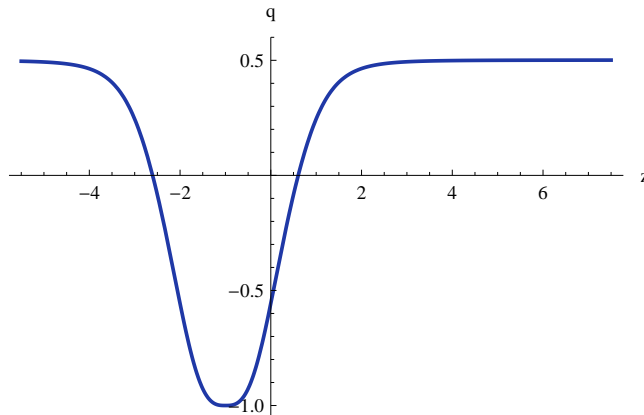


Figure 3: The deceleration parameter q in the considered model, where we assume $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$, $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$ and $\mu \approx 0.931$. $q < 0$ occurs for $-2.6 \lesssim z \lesssim 0.6$.

Let us now estimate the age of the universe in the present model. The cosmological time t at any redshift z is determined by formula

$$t := \int_z^\infty \frac{dz'}{(1+z')H(z')}$$

The age t_0 of the universe is then obtained by setting $z = 0$ in the above equation. For the model under consideration,

$$t_0 = \frac{1}{H_0} \int_0^\infty \frac{dz'}{(1+z') \sqrt{\frac{\mu\pi\Omega^{(0)}}{2 \arctan[(1+z')^{-3} \tan(\mu\pi/2)]} + \sum_b \Omega_b^{(0)} (1+z')^{3(1+\omega_b)}}} \quad (22)$$

We can integrate the integral in Eq.(22) numerically with the initial conditions $\Omega|_{z=0} = \Omega^{(0)}$. The value of t_0 depends strongly upon what the fine-tuning parameter μ is assigned. We show this dependence in TABLE I by listing the possible values of t_0 for several values of parameter μ , where we have taken $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$, $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$ as before. To be consistent with the stellar age bound: $t_0 > 11 - 12$ Gyr, the value of μ can not be too small ($\mu \gtrsim 0.738$). In this paper we choose $\mu \approx 0.931$, which leads to $t_0 \approx 13$ Gyr. Hence the suggested dark energy model is free of the problem of universe age.

μ	0.70	0.73	0.738	0.75	0.80	0.85	0.90	0.931	0.95	0.98
t_0 (Gyr)	10.76	10.95	11	11.08	11.48	11.95	12.55	13	13.31	13.85

Table 1: The dependence of universe age upon the choice of the fine-tuning parameter μ in the suggested model, where we have taken $\Omega^{(0)} \approx 0.73$, $\Omega_m^{(0)} \approx 0.27$, $\Omega_r^{(0)} \approx 8.1 \times 10^{-5}$. To satisfy the stellar bound on the age estimation, the magnitude of μ has not to be less than 0.738.

3 Dynamical mechanism

The suggested fluid model of dark energy is consistent with the cosmological observation data (at least at the background level). It provides a phenomenological explanation to the late time cosmic accelerated expansion and alleviates the coincidence problem to some extent. What is the dynamics behind such a phenomenological approach? From the perspective of particle physics, the existence of a time dependent dark energy fluid implies that there is massive scalar field ϕ such as quintessence, phantom or tachyon coupled to gravity with a very flat scalar potential $V(\phi)$ [14]. Because $-1 \leq \omega \leq 0$, the suggested model might be associated with a tachyon field emerging from the scenario of superstring theory. The effective Lagrangian of a non-BPS D3-brane tachyon field ϕ reads,

$$S = - \int d^4x V(\phi) \sqrt{-\det(g_{\mu\nu} + \partial_\mu \phi \partial_\nu \phi)} \quad (23)$$

where $V(\phi)$ is the tachyon potential. The energy momentum tensor determined by the action (23) has the form

$$T_{\mu\nu} = \frac{V(\phi) \partial_\mu \phi \partial_\nu \phi}{\sqrt{1 + g^{\alpha\beta} \partial_\alpha \phi \partial_\beta \phi}} - g_{\mu\nu} V(\phi) \sqrt{1 + g^{\alpha\beta} \partial_\alpha \phi \partial_\beta \phi} \quad (24)$$

The energy density and the pressure density of this tachyon field are $\rho_\phi = -T_0^0$ and $p_\phi = \frac{1}{3} T_i^i$. In a flat FRW background it leads to

$$\rho = \frac{V(\phi)}{\sqrt{1 - \dot{\phi}^2}}, \quad p = -V(\phi) \sqrt{1 - \dot{\phi}^2}. \quad (25)$$

It follows from Eq.(25) that EoS of the tachyon field has the form $p = -V^2(\phi)/\rho$. Hence the Chaplygin gas with EoS $p = -A/\rho$ (where A is a

positive constant) can be mimicked by a tachyon field with a constant potential. We now try to find the tachyon potential behind the suggested fluid model of dark energy with EoS given in Eq.(4). The Friedmann equation and the equation of state of the tachyon field are

$$H^2 = \frac{\rho}{3} = \frac{V(\phi)}{3\sqrt{1-\dot{\phi}^2}}, \quad \omega_\phi = \frac{p}{\rho} = \dot{\phi}^2 - 1. \quad (26)$$

Manifestly, $-1 \leq \omega_\phi \leq 0$. By identifying ω_ϕ and ρ_ϕ with ω and ρ given in Eqs.(16) and (8) respectively, we get

$$\frac{d\phi}{da} = \beta \sqrt{\frac{a}{1 + \alpha^2 a^6}} \quad (27)$$

where $\alpha = \tan(\mu\pi/2)$ and

$$\beta = \frac{1}{H_0} \sqrt{\frac{2\alpha}{\mu\pi\Omega^{(0)}}} \quad (28)$$

The solution of Eq.(27) which satisfies the initial condition $\phi|_{a=0} \rightarrow 0$ reads,

$$\phi(a) = \frac{2}{3}\beta a^{3/2} {}_2F_1\left(\frac{1}{4}, \frac{1}{2}; \frac{5}{4}; -\alpha^2 a^6\right) \quad (29)$$

where ${}_2F_1(a, b; c; \zeta)$ is a hypergeometric function. The dependence of scalar potential for the suggested dark energy tachyon field upon the scale factor a is found to be

$$V(a) = \frac{3\mu\pi H_0^2 \Omega^{(0)}}{2 \arctan(\alpha a^3)} \sqrt{1 - \frac{\alpha a^3}{(1 + \alpha^2 a^6) \arctan(\alpha a^3)}} \quad (30)$$

Combination of Eqs.(29) and (30) enables us to further obtain $V(\phi)$. It is difficult to have an analytical expression for $V(\phi)$ in the present case, we choose to plot the potential curve in FIG.4 instead. As expected, such a tachyon potential is not as steep as a reference potential $V(\phi) \propto \phi^{-2}$ of inverse square power-law of the power-law decelerated expansion [27]. It is a competent tachyon potential responsible to an accelerated cosmological expansion.

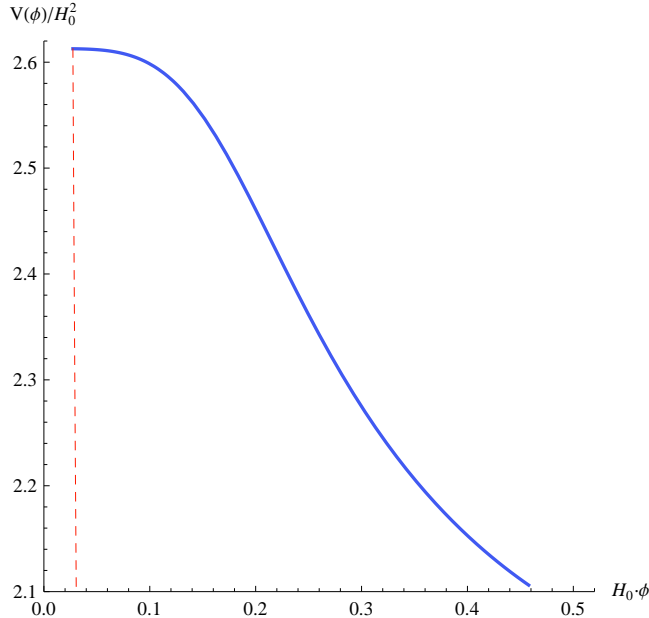


Figure 4: The solid curve stands for the scalar potential of the tachyon field that mimics the suggested dark energy fluid, where $\Omega^{(0)} \approx 0.73$, $\mu \approx 0.931$, $\alpha \approx 9.19$ and $\beta \approx 0.093/H_0$. The dashed curve is a reference potential $V(\phi) \propto \phi^{-2}$ of power-law decelerated expansion. The two potentials take the same initial value at $\phi \approx 0.03/H_0$. Obviously, the former is much flatter than the latter so that it can result in a late time accelerated cosmological expansion.

4 Discussion

In this paper we propose a new fluid model of dark energy as an alternative to the Chaplygin gas model. The energy density of dark energy fluid in the suggested model is considerably suppressed in the barotropic matter dominant eras, and it dominates the universe energy only for cosmic times of small redshift. The model is in perfect agreement with the standard Λ CDM model of cosmology on the present values of effective EoS of dark energy and deceleration parameter, and is free of the age problem of Big Bang model. To understand the model in a dynamical manner, we interpret the fluid as a tachyon field with a special potential, which is flatter than the inverse square power-law potential of the decelerated power-law expansion. Phenomenologically, there are two differences between our model and Λ CDM model in

which the dark energy is viewed as a pure CC. The cosmic accelerated expansion will continue forever in Λ CDM model. In our model the universe is predicted to end up its present accelerated expansion in the near future (at $z \approx -2.6$) and reenter a decelerated expansion phase afterwards. Moreover, the severe coincidence problem of Λ CDM model has been remarkably alleviated in our model. The investigation to this model in the present work is at the background level, it is unknown if there exists in the suggested model a strong integrated Sachs-Wolfe (ISW) effect prohibiting the creation of CMB anisotropy. The study on curvature perturbations in the model is in progress, from which we will know whether the model would be free of the pressure from CMB anisotropies.

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