Astrophys Space Sci (2013) 345:381–386
DOI 10.1007/s10509-013-1393-6

ORIGINAL ARTICLE

Cosmological evolution of agegraphic dark energy with the sign-changeable interaction

Y.D. Xu · X.H. Zhai

Received: 16 January 2013 / Accepted: 14 February 2013 / Published online: 20 February 2013

Abstract In this paper, we study a cosmological model with the sign-changeable interaction between agegraphic dark energy (ADE) and dark matter. For the accelerated expansion of the universe, the model parameters n and β should satisfy the condition $n > 1$ and $-\frac{2}{3} < \beta < 0$. We also investigate the effect of the parameters n and β on the evolutive behavior of our universe. Furthermore, by analysis it is shown that the equation of state of ADE with the sign-changeable interaction can cross the phantom divide from $w_d > -1$ to $w_d < -1$ for the appropriate n and β. This is different from that of ADE with usual interaction, whose equation of state changes from $w_d < -1$ to $w_d > -1$.

Keywords Interaction · Agegraphic dark energy · Cosmological evolution

1 Introduction

Astronomical observations such as SNe Ia (Riess et al. 1998; Perlmutter et al. 1999), WMAP (Bennett et al. 2003) and SDSS (Tegmark et al. 2004) suggest that about seventy percent of the total energy in the universe is an exotic energy component called dark energy, a substance with negative pressure and can drive the speed-up expansion of the universe. The simplest candidate for dark energy is cosmological constant in which the equation of state (EoS) is independent of the cosmic time. This model is the so-called ΛCDM model, consisting of a mixture of the cosmological constant Λ and the cold dark matter (CDM). However, the cosmological constant is always entangled with the coincidence problem, namely why the densities of the dark energy and the dark matter are comparable today.

In order to alleviate the coincidence problem, possible interactions between dark energy and dark matter have been intensively studied in recent years (Zimdahl and Pavon 2001; Guo and Zhang 2005; Wei and Cai 2006; Cai and Wang 2005; Chen et al. 2009; He et al. 2009; Chimento 2010; Setare 2006, 2007; Jamil et al. 2010a, 2010b). Since the format of interaction term Q can not be determined from fundamental physics, one can only discuss it to a phenomenological level. The most familiar interaction is $Q = 3cH\rho$, where c is a coupling constant denoting the transfer strength, and ρ is taken to be the density of dark energy, dark matter, or the sum of them. Obviously, these interactions are always positive or negative and hence can not change their signs. Recently, from the latest observational data Cai and Su (2010) found that $\delta(z) = Q/(3H)$ is likely to cross the non-interacting line ($\delta = 0$), namely, interaction Q could change its sign in the approximate redshift range of $0.45 \lesssim z \lesssim 0.9$. Noting that this redshift range is coincident with the one of our universe changing from deceleration to acceleration (Copeland et al. 2006; Frieman et al. 2008), Wei (2011a) has proposed a new type of interaction $Q = q(\alpha\dot{\rho} + 3\beta H\rho)$, where α and β are both dimensionless constants. Since the new interaction is proportional to the deceleration parameter $q \equiv -\ddot{a}a/\dot{a}^2$, it is possible that the interaction Q can change its sign when our universe changes from deceleration ($q > 0$) to acceleration ($q < 0$). Noting that the term $\alpha\dot{\rho}$ in Q is introduced from the dimensional point of view (Wei 2011a), one can remove this term by setting $\alpha = 0$, and then Q becomes simply $Q = 3\beta q H\rho$ (Wei 2011b). For this new type of interaction,

Y.D. Xu (✉)
School of Science, Huaihai Institute of Technology, Lianyungang 222005, China
e-mail: ydxu@hhit.edu.cn

X.H. Zhai
Shanghai United Center for Astrophysics (SUCA), Shanghai Normal University, Shanghai 200234, China