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ORIGINAL ARTICLE

Interacting holographic generalized cosmic Chaplygin gas model

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Abstract In this paper we consider a correspondence between the holographic dark energy density and interacting generalized cosmic Chaplygin gas energy density in flat FRW universe. Then, we reconstruct the potential of the scalar field which describe the generalized cosmic Chaplygin cosmology. In the special case we obtain time-dependent energy density and study cosmological parameters. We find stability condition of this model which is depend on cosmic parameter.

Keywords FRW cosmology · Dark energy · Holography

1 Introduction

Accelerating expansion of universe described by dark energy with adequate negative pressure (Padmanabhan 2003; Sahni and Starobinsky 2000). There are several theories to describe the dark energy such as quintessence (Peebles and Ratra 1988), cosmological constant (Nobbenhuis 2006), k-essence model (Armendariz-Picon et al. 2000) and tachyonic model (Sen 2005). An interesting model to describe dark energy is Chaplygin gas (Kamenshchik et al. 2001; Bento et al. 2002). This model based on Chaplygin equation (CG) of state $p = -B/\rho$. The CG was not consistent with observational data (Perlmutter et al. 1998; Riess et al. 2004; Miller et al. 1999; Bennet et al. 2000). Therefore, an extension of CG model proposed (Bilic et al. 2002; Xu et al. 2012), which is called generalized Chaplygin gas (GCG), and indeed proposed unification of dark matter and dark energy. However, observational data ruled out such a proposal. Then, by Debnath et al. (2004), GCG extended to the modified Chaplygin gas (MCG). Recently, the generalized cosmic Chaplygin gas (GCCG) model introduced (Gonzalez-Diaz 2003) in such a way that the resulting models can be made stable and free from unphysical behaviors even when the vacuum fluid satisfies the phantom energy condition (Rudra 2013a, 2013b).

Another way to study dark energy arises from holographic principle that states that the number of degrees of freedom related directly to entropy scales with the enclosing area of the system. In that case the total energy of the system with size L should not exceed the mass of the same black hole size. It means that,

$$L^3\rho_\Lambda \le L M_p^2, \tag{1}$$

where ρ_Λ is the quantum zero-point energy density which comes from UV cutoff Λ, also M_p denotes Planck mass. The largest L is required to saturate this inequality. Then, its holographic energy density is given by the following expression,

$$\rho_\Lambda = \frac{3c^2 M_p^2}{L^2}, \tag{2}$$

where c is free dimensionless parameter which commonly considered as a constant, while there is possibility to consider non-constant c (Radicella and Pavon 2010; Saadat 2013). Based on cosmological state of holographic principle, the holographic model of dark energy has been proposed and studied widely in the literature (Li 2004; Guberina et al. 2006; Setare 2007a, 2007b, 2007c; Setare and Vagenas 2009). In that case holographic model of dark en-

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