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ORIGINAL ARTICLE

Interaction between viscous varying modified cosmic Chaplygin gas and Tachyonic fluid

J. Sadeghi · H. Farahani

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Abstract In this paper we study the interaction between the general form of viscous varying modified cosmic Chaplygin gas and the Tachyon fluid in the framework of Einstein gravity. We want to reconstruct the Tachyon potential and total equation of state parameter graphically by using numerical methods. In the presence of deceleration parameter, the interaction between components becomes sign changeable to explain different evolutionary eras in the universe. We review the potential and total equation of state parameter in Emergent, Intermediate and Logamediate scenarios of scale factor numerically. Analysis of total equation of state parameter show that, $\omega_{tot} < -1$ and $\omega_{tot} > -1$ imply the phantom-like and quintessence-like behaviors respectively. we have checked the effects of cosmic and viscosity elements on the interaction process. Stability is checked in all the models by the squared velocity of sound.

Keywords Dark energy · Chaplygin gas · Tachyon field · Interaction · Stability

1 Introduction

The most attractive subject in cosmology is the accelerating expansion of the universe which is based on the recent astrophysical data explaining the universe is spatially flat and an invisible cosmic fluid called dark energy with a hugely negative pressure which is responsible for this expansion. This type of matter violates the strong energy condition, i.e., $\rho + 3p < 0$. There are various phenomenological models describing dark energy. Cosmological constant is the simplest one which gave rise to the Λ-CDM model, but it suffers from two critical problems; fine tuning and coincidence. The first one relates the small value of cosmological constant and the second problem caused because we live in an epoch that the magnitude of dark energy and dark matter are comparable. Other candidates of dark energy are for examples quintessence (Wetterich 1988), phantom (Caldwell 2002), quintom (Feng et al. 2005; Cai et al. 2007a, 2007b, 2010; Cai and Wang 2008), tachyon (Setare et al. 2009), holographic dark energy (Setare 2007a, 2007b, 2009), K-essence (Afshordi et al. 2007) and various models of Chaplygin gas. The simplest case of this model based on Chaplygin equation of state (Chaplygin 1904) to describe the lifting force on a wing of an air plane in aerodynamics. The Chaplygin gas (CG) was not consistent with observational data (Makler et al. 2003; Sandvik et al. 2004; Zhu 2004; Sen 2003). Therefore, an extension of CG model proposed (Bilic et al. 2002; Bazeia 1999), which is called generalized Chaplygin gas (GCG) (Setare 2007c, 2007d). However, observational data ruled out such a proposal. Then, GCG extends to the modified Chaplygin gas (MCG) (Debnath et al. 2004). There is still more extensions such as generalized cosmic Chaplygin gas (GCCG) (Gonzalez-Diaz 2003), and modified cosmic Chaplygin gas (Pourhassan 2013; Saadat and Pourhassan 2013).

On the other hand bulk viscosity plays an important role in the evolution of the universe. The idea that Chaplygin gas may has viscosity first proposed by the Zhai et al. (2006) and then developed by Saadat and Pourhassan (2013), Xu et al. (2012), Saadat and Farahani (2013), Amani and Pourhassan (2013).

J. Sadeghi · H. Farahani (✉)
Department of Physics, Mazandaran University,
P.O. Box 47416-95447, Babolsar, Iran
e-mail: h.farahani@umz.ac.ir

J. Sadeghi
e-mail: pouriya@ipm.ir