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ORIGINAL ARTICLE

Dynamics of the self-interacting chameleon cosmology

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Abstract In this article we study the properties of the flat FRW chameleon cosmology in which the cosmic expansion of the Universe is affected by the chameleon field and dark energy. In particular, we perform a detailed examination of the model in the light of numerical analysis. The results illustrate that the interacting chameleon filed plays an important role in late time universe acceleration and phantom crossing.

Keywords Chameleon · Interaction · Phantom crossing · Dark energy

1 Introduction

Recently, the observations of high redshift type Ia supernovae and the surveys of clusters of galaxies (Riess et al. 1998; Bennet et al. 2003; Pope et al. 2004) reveal the universe accelerating expansion and that the density of matter is very much less than the critical density. Also the observations of Cosmic Microwave Background (CMB) anisotropies indicate that the universe is flat and the total energy density is very close to the critical one (Spergel et al. 2003).

The above observational data properly complete each other and point out that the dark energy (DE) is the dominant component of the present universe which occupies about %73 of the energy of our universe, while dark matter (DM) occupies %23, and the usual baryonic matter about %4. There are prominent candidates for DE such as the cosmological constant (Sahni and Starobinsky 2000; Weinberg 1989), a dynamically evolving scalar field (like quintessence) (Caldwell et al. 1998; Zlatev et al. 1999) or phantom (field with negative energy) (Caldwell et al. 2003) that explain the cosmic accelerating expansion. Meanwhile, the accelerating expansion of universe can also be obtained through modified gravity (Zhu et al. 2004), brane cosmology and so on (Zhu and Alcaniz 2005; Sadeghi et al. 2008, 2009; Guo et al. 2005; Xia et al. 2005; Setare 2006, 2007; Zhao and Zhang 2006; Zhao et al. 2007; Setare et al. 2008; Setare and Saridakis 2008, 2009a, 2009b; Cai et al. 2007; Capozziello et al. 2003, 2006; Farajollahi et al. 2011; Setare and Jamil 2010; Davis et al. 2009; Ito and Nojiri 2009; Tamaki and Tsujikawa 2008; Farajollahi and Salehi 2010; Mota and Shaw 2007; Dimopoulos and Axenides 2005).

Two of the most serious issues with regards to the DE models, in particular with cosmological constant as a candidate, are the fine tuning problem and cosmic coincidence problem. The absence of a fundamental mechanism which sets the cosmological constant to zero or very small value is the cosmological constant "fine-tuning" problem and a good model should limit the fine tuning as much as possible. The problem of comparability of the DE density and the DM energy density at the recent epoch known as the coincidence problem and one of the most frequently used approach to moderate the cosmological coincidence problem is the tracker field DE scenario (Zlatev et al. 1999). The DE can track the evolution of the background matter in the early stage, and only recently, it has negative pressure, and becomes dominant . Thus, its current condition is nearly independent of the initial conditions (Lyth and Riotto 1999; Easson 2007; Peebles and Ratra 1988).

On the other hand, to explain the early and late time acceleration of the universe. It is most often the case that

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