Astrophys Space Sci (2012) 337:773–778
DOI 10.1007/s10509-011-0889-1

ORIGINAL ARTICLE

Cosmological observations in non-local $F(R)$ cosmology

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Received: 16 June 2011 / Accepted: 8 October 2011 / Published online: 26 October 2011

Abstract In this article in a generalization of our previous work (Farajollahi and Milani in Mod. Phys. Lett. A 25:2349–2362, 2010), we investigate the dynamics of the non-local $F(R)$ gravity after casting it into local form. The non-singular bouncing behavior and quintom model of dark energy are achieved without involving negative kinetic energy fields. Two cosmological tests are performed to constrain the model parameters. In case of phantom crossing the distance modulus predicted by the model best-fits the observational data. In comparison with the CPL parametrization for drift velocity, the model in some redshift intervals is in good agreement with the data.

Keywords $F(R)$ · Non local · Bouncing solution · Phantom-crossing · Velocity drift · Distance modulus

1 Introduction

The cosmological observations have provided increasing evidence that our universe is undergoing a late-time acceleration expansion (Tzirakis and Kinney 2007). To explain this observation, a variety of theories are put forward to introduce a new fluid called dark energy, which possesses a negative enough pressure (e.g. Totani et al. 1997; Perlmutter et al. 1998; Riess et al. 1998; Bahcall et al. 1999). According to the observational data from the Type Ia Supernovae (Riess et al. 2004) and WMAP satellite (Jassal et al. 2005a, 2005b), our universe is spatially flat and consist approximately of %25 dark matter and %75 dark energy. From the simplest models for dark energy as cosmological constant to the recent proposed models such as quintessence (Bennett et al. 2003), phantom (Caldwell 2002; Nojiri and Odintsov 2003, 2005; Caldwell et al. 2003; Wang et al. 2000), or combination of these two in a unified model named quintom (Sadeghi et al. 2008, 2009; Guo et al. 2005; Xia et al. 2005; Setare 2006; Zhao and Zhang 2006; Zhao et al. 2007; Setare et al. 2008; Setare and Saridakis 2008a, 2008b, 2009) all try to explain the accelerating expansion universe.

An alternative approach to explain dark energy is the modification of general relativity (GR) (Deffayet et al. 2002; Carroll et al. 2004, 2005a; Capozziello et al. 1969, 2006; Freese and Lewis 2002). Here, as a generalization of the work in Farajollahi and Milani (2010), we consider a non-local modified gravity, where in addition an arbitrary function of Ricci scalar, $F(R)$, is added in the action, with the aim to explain the dark energy responsible for current universe acceleration. For cosmic acceleration, the equation of state (EoS) parameter is less that $-1/3$, while for quintessence, Chaplygin gas (Kamenshchik et al. 2001) and holographic dark energy models (Li 2004; Huang and Li 2004), ω always stays bigger than -1 and for the phantom models is smaller than -1 (Cai et al. 2007). For a dynamical dark energy, the EoS parameter evolves from $\omega > -1$ to $\omega < -1$ (or vice versa) and is called "the phantom divide crossing".

In particular, the quintom model of Feng et al. (2005) were initially proposed to obtain a model of dark energy with the $\omega > -1$ in the past and $\omega < -1$ at present. The model can be viewed as dynamical model for dark energy with the feature that its EoS parameter can smoothly cross over the cosmological constant barrier $\omega = -1$. To construct

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