Astrophys Space Sci (2012) 337:487–491
DOI 10.1007/s10509-011-0849-9

ORIGINAL ARTICLE

Phantom phase power-law solution in $f(G)$ gravity

A.R. Rastkar · M.R. Setare · F. Darabi

Received: 18 June 2011 / Accepted: 11 August 2011 / Published online: 28 September 2011

Abstract Power-law solutions for $f(G)$ gravity coupled with perfect fluid have been studied for spatially flat universe. It is shown that despite the matter dominated and accelerating power-law solutions, the power-law solution exists for an special form of $f(G)$ when this universe enters a Phantom phase.

Keywords Power-law · $f(G)$ gravity · Phantom phase

1 Introduction

Nowadays, it is strongly believed that the universe is experiencing an accelerated expansion. Recent observations from type Ia supernovae (Riess et al. 1998; Perlmutter et al. 1999; Astier et al. 2006) associated with the Large Scale Structure (Abazajian et al. 2004, 2005) and Cosmic Microwave Background anisotropies (Spergel et al. 2003, 2006) have provided main evidence for this cosmic acceleration. These observations also suggest that our universe is spatially flat, and consists of about 70% dark energy (DE) with negative pressure, 30% dust matter (cold dark matter plus baryons), and negligible radiation. On the other hand, the nature of dark energy is ambiguous. The simplest candidate for dark energy is a cosmological constant having the equation of state with the parameter $w = -1$. However, this scenario suffers from serious problems like a huge fine tuning and the coincidence problem (Sahni and Starobinsky 2006a, 2000b; Carroll 2001; Copeland et al. 2006). Alternative models of dark energy suggest a dynamical form of dark energy, which is often realized by one or two scalar fields. In this respect, dark energy has many dynamical components such as quintessence (Ratra and Peebles 1988; Wetterich 1988; Caldwell et al. 1998; Zlatev et al. 1999), K-essence (Armendariz-Picon et al. 2000), tachyon (Sen 2002; Padmanabhan 2002; Setare 2007a), phantom (Caldwell 2002; Wei and Tian 2004; Onemli and Woodard 2004; Setare 2007b; Nojiri and Odintsov 2003a) ghost condensate and quintom (Feng et al. 2005; Guo et al. 2005; Cai et al. 2007, 2010; Setare et al. 2008; Setare and Saridakis 2008a, 2008b) and so forth.

It is known that Einstein's theory of gravity may not describe gravity at very high energies. The simplest alternative to general relativity is Brans-Dicke scalar-tensor theory (Brans and Dicke 1961). Modified gravity also provides the natural gravitational alternative for dark energy (Nojiri and Odintsov 2006a, 2007a, 2007b, 2007c; Setare 2010; Cognola et al. 2007a; Setare and Saridakis 2008b; Setare 2008; Nojiri et al. 2006c). Moreover, thanks to the different roles of gravitational terms relevant at small and at large curvature, the modified gravity presents natural unification of the early-time inflation and late-time acceleration. It may naturally describe the transition from non-phantom phase to phantom one without necessity to introduce the exotic matter. But, among the most popular modified gravities which may successfully describe the recent cosmic speed-up is $f(R)$ gravity. Very simple versions of such theory like $\frac{1}{R}$ (Capozziello 2002; Capozziello et al. 2003; Carroll et al. 2004) and $\frac{1}{R} + R^2$ (Nojiri and Odintsov 2007d) may lead

A.R. Rastkar · F. Darabi (✉)
Department of Physics, Azarbaijan University of Tarbiat Moallem, Tabriz 53714-161, Iran
e-mail: f.darabi@azaruniv.edu

A.R. Rastkar
e-mail: a_rastkar@azaruniv.edu

M.R. Setare
Department of Science, Payame Noor University, Bijar, Iran
e-mail: rezakord@ipm.ir