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ORIGINAL ARTICLE

Cosmological dynamics of a quintom field on the warped DGP brane

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Abstract As a generalization of the Brans-Dicke type scalar-tensor gravity in a braneworld context, we study cosmological phase space of a braneworld model with induced gravity in the presence of a scalar field on the brane. We consider a quintom field minimally or non-minimally coupled to induced gravity on the warped DGP brane and we present a detailed analysis of the critical points, their stability and late-time cosmological viability of the solutions within a phase space approach. In particular, de Sitter solutions, different from the famous self-accelerated branch of the DGP model are found and the phase-space analysis for checking their attractor properties is performed. We analyze also the possibility of crossing of the phantom divide by the effective equation of state parameter of the model. We also focus on the classical stability of the solutions in w–w' phase plane.

Keywords Braneworld models · Induced gravity · Scalar field · Phase space

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1 Introduction

Recent observational data have indicated that current universe is almost flat and undergoing a positively accelerated phase of expansion. To explain this cosmic positive acceleration, mysterious dark energy has been proposed. There are several dark energy models which can be distinguished by, for instance, their equation of state (EoS) parameter ($w_{de} = \frac{P_{de}}{\rho_{de}}$) during the evolution of the universe. An accelerated expansion can be realized by using a scalar field whose origin may be found in superstring or supergravity theories; some of these models are quintessence, k-essence, tachyonic models, dilatonic models and phantom fields (Elizalde et al. 2004; Nozari et al. 2009; Bamba et al. 2012; Copeland et al. 2006). Astrophysical data also indicate that w lies in a very narrow strip close to -1. The case $w = -1$ corresponds to the cosmological constant. For w less than -1 the phantom dark energy is observed, and for w more than -1 (but less than $-\frac{1}{3}$) the dark energy is described by quintessence field. Moreover, the analysis of the properties of dark energy from recent observational data mildly favor models of dark energy with w crossing -1 line in the near past. So, the phantom phase equation of state with $w < -1$ is still mildly allowed by observations. In this case, the universe lives in its phantom phase which ends eventually at a future singularity (the Big Rip singularity). There are also a lot of evidence all around of a dynamical equation of state parameter, which has crossed the so called phantom divide line $w = -1$ in recent past, at the value of red shift parameter $z \approx 0.25$ (Nesseris and Perivolaropoulos 2007; Wu et al. 2008; Cai et al. 2005). Most of dark energy models treat scalar field(s) as dark component(s) with a dynamical equation of state. Currently scalar fields play crucial roles in modern cosmology. In the inflationary scenario they generate an exponential rate of evolution of the universe as well as density fluctuations due to vacuum energy.