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ORIGINAL ARTICLE

Cosmological dynamics of a bulk scalar field in the DGP setup

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Abstract We reconsider the issue of cosmological dynamics in a DGP setup with a bulk scalar field. The ghost-free, normal branch of this DGP-inspired braneworld scenario has the potential to realize a self-consistent phantom-like behavior. The roles played by the bulk canonical scalar field on this phantom-like dynamics are explored. Within a dynamical system approach, the effective phantom nature of the scenario is investigated with details. This analysis shows that there is a stable, late-time de Sitter phase.

Keywords Braneworld cosmology · Induced gravity · Bulk scalar field · Phantom-like behavior

1 Introduction

According to the recent cosmological observations, our universe is undergoing an accelerating phase of expansion and transition to the accelerated phase has been occurred in the recent cosmological past (Riess 2004; Astier et al. 2006; Wood-Vasey et al. 2007; Spergel 2007; Hinshaw 2007; Colless et al. 2001; Tegmark et al. 2004; Cole et al. 2005; Springel et al. 2006; Boughn and Crittenden 2004, 2005; Fosalba et al. 2003; Fosalba and Gaztanaga 2004; McEwen et al. 2007; Nolta 2004; Vielva et al. 2006; Contaldi et al. 2003; Komatsu et al. 2009; Lampeitl et al. 2009). The simplest way to describe the accelerated expansion of the universe is to adopt a cosmological constant. However, huge amount of fine-tuning required for its magnitude and other theoretical problems such as unknown origin and lake of dynamics make it unfavorable for cosmologists (Padmanabhan 2003; Carroll 2001). So, to explain this remarkable behavior of the universe, many theoretical approaches have been proposed in recent years (Copeland et al. 2006; Nojiri and Odintsov 2003, 2004a, 2004b, 2006a, 2006b, 2007, 2008, 2009, 2011; Caldwell 2002; Arkani-Hamed et al. 2004; Piazza and Tsujikawa 2002; Wei and Cai 2006; Vikman 2005; Anisimov et al. 2005; Wang et al. 2005; Elizalde et al. 2005; Zhao and Zhang 2006; Zhou et al. 2009; Apostolopoulos and Tetradis 2006; Alam et al. 2004; Nesseris and Perivolaropoulos 2005; Libanov et al. 2007; Setare and Saridakis 2008; Scherrer and Sen 2008; Briscese et al. 2007; Nozari et al. 2009b; Sami 2009a, 2009b; Caldera-Cabral et al. 2009; Sahni and Starobinsky 2006; Sahni 2004a; Cai et al. 2010; Zhang 2009; Capozziello et al. 2003; Sotiriou and Faraoni 2010; Abdalla et al. 2005; Bamba et al. 2008, 2009; Carroll et al. 2004; Amendola et al. 2007; Sawicki and Hu 2007a, 2007b).

In 2000, Dvali, Gabadadze and Porrati (DGP) introduced a braneworld model of gravity that has the capability to explain the late-time acceleration of the universe. In this model our universe is a 3-brane embedded in a Minkowski bulk (Dvali et al. 2000, 2002; Dvali and Gabadadze 2001). The standard model particles and gauge fields are confined on the brane but graviton and possibly some sort of non-standard matter are free to probe the entire bulk spacetime. This setup is based on a modification of gravitational theory in an induced gravity (*IG*) perspective (Dvali et al. 2000, 2002; Dvali and Gabadadze 2001; Lue 2006). The DGP braneworld scenario as an infra-red (IR) modification of the general relativity, explains the late-time accelerated expansion of the universe in its self-accelerating branch via leakage of gravity to extra dimension. The late-time acceleration of the universe is driven by the manifes-

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