Astrophys Space Sci
DOI 10.1007/s10509-013-1598-8

ORIGINAL ARTICLE

A 5D holographic dark energy in DGP-BRANE cosmology

H. Farajollahi · A. Ravanpak

Received: 23 May 2013 / Accepted: 6 August 2013

Abstract This paper is aimed to investigate 5D holographic dark energy (HDE) in DGP-Brane cosmology by employing a combination of Sne Ia, BAO and CMB observational data and constraining cosmological parameters. The FRW dynamics for the normal branch ($\epsilon = +1$) solution of induced gravity brane-world model is taken with the assumption that matter in 5D bulk is HDE such that its holographic nature is reproduced effectively in 4D universe. In the HDE model, we used Hubble horizon as IR cutoff instead of future event horizon. This way, while the model predicts current universe acceleration, it also removes the problem of circular reasoning and causality observed in using future event horizon as IR cutoff.

Keywords Holographic dark energy · DGP-brane cosmology

1 Introduction

The exciting and ingenious idea of HDE that has recently attracted many researchers is capable to interpret current cosmic acceleration (Li 2004; Myung 2005; Nojiri and Odintsov 2006; Setare 2007; Feng 2008; Setare and Vagenas 2009; Farajollahi et al. 2011). The idea initiated from the cosmological application of the more fundamental holographic principle, and despite some objections, it reveals the dynamical nature of the vacuum energy by relating it to cosmological volumes. The holographic principle states that due to the limit set by the formation of a black hole, in effective field theory, the UV Cut-off, Λ_{uv}, is related to the IR Cut-off L via $L^3\Lambda_{uv}^4 \leq LM_p^2$ where M_p is reduced Planck mass. The effective field theory describes all states of system except those already collapsed to the black. The vacuum energy density via quantum fluctuation is given by $\rho_{vac} \sim \Lambda_{uv}^4 \sim M_p^2 L^{-2}$ where L is characteristic length scale of the universe. From vacuum energy density, the dark energy density caused via quantum fluctuation is given by $\rho_{de} \sim 3d^2 M_p^2 L^{-2}$ where d is a model parameter. By taking different characteristic length scale one can construct various HDE models.

On the other hand, a large amount of current research heads towards higher dimensional gravity, and in particular, brane cosmology (Antoniadis et al. 1988; Randall and Sundrum 1999), in which assumes Universe as a brane embedded in higher dimensional spacetime. A well-known example of brane cosmological model is the Dvali-Gabadadze-Porrati (DGP) braneworld model (Dvali et al. 2000), in which the 4D world is a FRW brane embedded in a 5D Minkowski bulk. On the 4D brane the gravity action is proportional to M_P^2 whereas in the bulk it is proportional to the corresponding quantity in 5D, M_5^3. The total energy-momentum is confined on a 3D brane embedded in a 5D infinite volume Minkowski bulk. There are two different ways to confine the 4D brane into the 5D spacetime in DGP model via two separate branches denoted by $\epsilon = \pm 1$ with distinct features. The $\epsilon = +1$ branch is capable to interpret the current cosmic acceleration without any need to introduce dark energy, whereas for $\epsilon = -1$ branch, dark energy is needed (Deffayet 2001; Chimento et al. 2006).

Holographic dark energy in the context of DGP brane cosmological models has been investigated in Wu et al.

H. Farajollahi (✉)
School of Physics, University of New South Wales, Sydney, NSW 2052, Australia
e-mail: h.farajollahi@unsw.edu.au

A. Ravanpak
Department of Physics, Vali-e-Asr University, Rafsanjan, Iran

Published online: 24 October 2013