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ORIGINAL ARTICLE

Cosmology of some holographic dark energy models in chameleonic Brans-Dicke gravity

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Abstract We study some holographic dark energy models in chameleonic Brans-Dicke field gravity by taking interaction between the dark energy components in FRW universe. Firstly, we take the holographic dark energy model with Granda-Oliveros cut-off and discuss interacting as well as non-interacting cases. Secondly, we consider the holographic dark energy with both power-law as well as logarithmic corrections using Hubble scale as infrared cut-off in interacting case only. We describe the evolution of some cosmological parameters for these holographic dark energy models. It is concluded that the phantom crossing can be achieved more easily in the presence of chameleonic Brans-Dicke field as compared to simple Brans-Dicke as well as Einstein's gravity. Also, the deceleration parameter strongly confirms the accelerated expanding behavior of the universe.

Keywords Brans-Dicke theory · Scalar field · Holographic dark energy

1 Introduction

Present observational data (Riess et al. 1998; Perlmutter et al. 1999) substantiates the dominance of dark energy (DE) in the composition of our universe that causes the cosmic expansion speedy day by day. There have been many proposals to resolve the mysterious picture of DE, however, none of them is regarded to be much successful (Caldwell et al. 1998; Caldwell 2002; Bertolami and Sen 2002). Among DE candidates, modified gravity theories are the most prominent one and comparatively less ambiguous (Flanagan 2004; Lobo 2008). Brans-Dicke (BD) theory as an alternative gravitational framework obtained by the inclusion of scalar field into the tensor field geometry, tackles enormous cosmological issues successfully (Bertolami and Martins 2000; Banerjee and Pavon 2001). This framework with dynamical gravitational constant ($G = \frac{1}{\phi}$) incorporates Mach's principle (Brans and Dicke 1961), Dirac's large number hypothesis (Weinberg 1972) and weak equivalence principle. The compatibility with local gravity tests restricts the BD parameter ω to very large values, i.e., $\omega \geq 40{,}000$ (Bertotti et al. 2003; Felice et al. 2006).

The holographic DE (HDE) is an interesting dynamical candidate of DE that originates from the holographic principle of quantum gravity which is defined as *in a physical system, there should be finite number of degrees of freedom which scale within the bounding area of that system instead of its volume* (Horava and Minic 2000). In cosmology, the application of this principle yields the well-known HDE model that connects DE density to cosmic horizon, a global facet of the universe and the spacetime foam Fischler and Susskind (1998). By taking the assumption that HDE and matter cannot be conserved separately, it can yield a possible solution to the cosmic coincidence problem. Li (2004) argued that the energy density should be constrained by the inequality in terms of infrared (IR) cut-off radius L and reduced Planck mass M_p given by $\rho_D \leq 3c^2 M_p^2/L^2$, where c^2 is a dimensionless constant. Since the entropy-area relationship implies the Friedmann equation as well as the well-known expression of HDE, therefore it would be interesting to study this relation. In modern physics, HDE attracted many researchers in recent past due to its success in solving numerous cosmological issues (Susskind 1995;

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