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ORIGINAL ARTICLE

Observational constraints on G-corrected holographic dark energy using a Markov chain Monte Carlo method

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Abstract We constrain holographic dark energy (HDE) with time varying gravitational coupling constant in the framework of the modified Friedmann equations using cosmological data from type Ia supernovae, baryon acoustic oscillations, cosmic microwave background radiation and X-ray gas mass fraction. Applying a Markov Chain Monte Carlo (MCMC) simulation, we obtain the best fit values of the model and cosmological parameters within 1σ confidence level (CL) in a flat universe as: $\Omega_b h^2 = 0.0222^{+0.0018}_{-0.0013}$, $\Omega_c h^2 = 0.1121^{+0.0110}_{-0.0079}$, $\alpha_G \equiv \dot{G}/(HG) = 0.1647^{+0.3547}_{-0.2971}$ and the HDE constant $c = 0.9322^{+0.4569}_{-0.5447}$. Using the best fit values, the equation of state of the dark component at the present time w_{d0} at 1σ CL can cross the phantom boundary $w = -1$.

Keywords Cosmology · Dark energy · Holographic model · Gravitational constant · Data fitting

1 Introduction

The astronomical data from "Type Ia supernova" (Riess et al. 1998; Perlmutter et al. 1999) indicate that the current universe is in an accelerating phase. These observational results have greatly inspirited theorists to understand the mechanism of this accelerating expansion. In the framework of standard cosmology, an exotic energy with negative pressure, the so-called dark energy, is attributed to this cosmic acceleration. Up to now, some theoretical models have been presented to explain the dynamics of dark energy and cosmic acceleration of the universe. The simplest but most natural candidate is the cosmological constant Λ, with a constant equation of state (EoS) $w = -1$ (Sahni and Starobinsky 2000; Peebles and Ratra 2003). As we know, the cosmological constant confronts us with two difficulties: the fine-tuning and cosmic coincidence problems. In order to solve or alleviate these problems many dynamical dark energy models with time-varying EoS have been proposed. The quintessence (Wetterich 1988; Ratra and Peebles 1988), phantom (Caldwell 2002; Nojiri and Odintsov 2003b,a), quintom (Elizalde et al. 2004; Nojiri et al. 2005; Anisimov et al. 2005; Cai et al. 2010), K-essence (Armendariz-Picon et al. 2000, 2001), tachyon (Padmanabhan 2002; Sen 2002), ghost condensate (Arkani-Hamed et al. 2004; Piazza and Tsujikawa 2004), agegraphic (Cai 2007; Wei and Cai 2008) and holographic (Witten 2000) are examples of dynamical models. Although many dynamical dark energy models have been suggested, the nature of dark energy is still unknown.

Models which are constructed based on fundamental principles are more preferred as they may exhibit some underlying features of dark energy. Two examples of such kind of dark energy models are the agegraphic (Cai 2007; Wei and Cai 2008) and the holographic (Hsu 2004; Li 2004) models. In this work we focus on the holographic dark energy model. The holographic model is built on the basis of the holographic principle and some features of quantum gravity theory (Witten 2000). According to the holographic principle, the number of degrees of freedom in a bound system should be finite and is related to the area of its boundary. In holographic principle, a short distance ultra-violet (UV)

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