Astrophys Space Sci (2012) 337:415–423
DOI 10.1007/s10509-011-0837-0

Chameleonic Generalized Brans–Dicke model and late-time acceleration

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Received: 4 July 2011 / Accepted: 12 August 2011 / Published online: 10 September 2011

Abstract In this paper we consider Chameleonic Generalized Brans–Dicke Cosmology in the framework of FRW universes. The bouncing solution and phantom crossing is investigated for the model. Two independent cosmological tests: Cosmological Redshift Drift (CRD) and distance modulus are applied to test the model with the observation.

Keywords Chameleon cosmology · Brans–Dicke theory · Phantom crossing · Bouncing universe · Cosmological Redshift Drift · Distance modulus · Chi-squared

1 Introduction

Various cosmological observations, mainly Cosmic Microwave Background (CMB) Dunkley et al. (2009), Komatsu et al. (2009), Supernova type Ia (SNIa) Knop et al. (2003), Riess et al. (2004), Weak Lensing Leauthand et al. (2010), Baryon Acoustic Oscillations (BAO) Parkinson et al. (2010), and redshift surveys such as 2dF Galaxy Redshift Survey (2dFGRS) Cole et al. (2005) at low redshift and DEEP2 redshift survey Yan et al. (2009) at high redshift, have provided cross-checked data to determine cosmological parameters with high precision. These parameters imply that our approximately 13.72 Gyear-old universe is nearly spatially flat, homogeneous and isotropic at large scale, i.e. a Friedmann-Lemaître-Robertson-Walker (FLRW) universe with zero curvature, and has entered an accelerating phase since $z \approx 0.46$ (Riess et al. 2004). Moreover, according to this so-called *Concordance Model* (or ΛCDM model), the universe consists of 4.6% baryonic matter, 22.8% non-relativistic unknown matter, namely dark matter (DM), and a remarkable amount of 72.6% smoothly distributed dominant component, dubbed dark energy (DE) (Komatsu et al. 2009).

The equation of state (EoS), $w = p/\rho$, of DE, is the main parameter which determines the gravitational effect of DE on the evolution of the universe, and can be measured from observations without need to have a definite model of DE. Strong evidences imply that the EoS of DE lies in a narrow range around $w \approx -1$ and has a smooth evolution (Riess et al. 2004; Amanullah et al. 2010). However, slow variation of w in cosmic time is not excluded. Theoretically, one can classify the EoS of DE with respect to the barrier $w = -1$ (Cai et al. 2010), namely the phantom divide line (PDL). That is, DE with the EoS of $w = -1$ employs the cosmological constant, Λ, with a constant energy density. The case with dynamical EoS where $w \geq -1$, is referred to as quintessence (Gonzalez et al. 2006) and $w \leq -1$ corresponds to an odd theoretical matter case, known as phantom energy (Nojiri et al. 2003; Caldwell et al. 2003), Capozziello et al. (2006) which potentially has elusive properties. For instance, phantom energy density increases with time as the universe expands, which consequently leads to divergence of the scale factor in finite time (Caldwell et al. 2003). Moreover, sound speed in this kind of matter *may* be superluminal. In addition to these three subclasses, there is another suggestion for the EoS of DE, the so-called quintom (Cai and Wang 2008), in which w crosses the phantom divide line as time evolves. It behaves like quintessence in some periods of history of the universe, and like phantom in the rest. It is worth noting that a single

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