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ORIGINAL ARTICLE

# Tachyonic (phantom) power-law cosmology

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**Abstract** Tachyonic scalar field-driven late universe with dust matter content is considered. The cosmic expansion is modeled with power-law and phantom power-law expansion at late time, i.e. $z \lesssim 0.45$. WMAP7 and its combined data are used to constraint the model. The forms of potential and the field solution are different for quintessence and tachyonic cases. Power-law cosmology model (driven by either quintessence or tachyonic field) predicts unmatched equation of state parameter to the observational value, hence the power-law model is excluded for both quintessence and tachyonic field. In the opposite, the phantom power-law model predicts agreeing valued of equation of state parameter with the observational data for both quintessence and tachyonic cases, i.e. $w_{\phi,0} = -1.49^{+11.64}_{-4.08}$ (WMAP7+BAO+$H_0$) and $w_{\phi,0} = -1.51^{+3.89}_{-6.72}$ (WMAP7). The phantom-power law exponent $\beta$ must be less than about $-6$, so that the $-2 < w_{\phi,0} < -1$. The phantom power-law tachyonic potential is reconstructed. We found that dimensionless potential slope variable $\Gamma$ at present is about 1.5. The tachyonic potential reduced to $V = V_0\phi^{-2}$ in the limit $\Omega_{\mathrm{m},0} \to 0$.

**Keywords** Power-law cosmology · Tachyonic dark energy

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## 1 Introduction

There have been clear evidences that the present universe is under accelerating expansion as observed in, e.g. the cosmic microwave background (CMB) (Masi et al. 2002; Larson et al. 2011; Komatsu et al. 2011), large-scale structure surveys (Scranton et al. 2003; Tegmark et al. 2004), supernovae type Ia (SNIa) (Perlmutter et al. 1998, 1999; Riess 1999; Riess et al. 1998, 2004, 2007; Goldhaber et al. 2001; Tonry et al. 2003; Astier et al. 2006; Amanullah et al. 2010) and X-ray luminosity from galaxy clusters (Allen et al. 2004; Rapetti et al. 2005). One prime explanation is that the acceleration is an effect of a scalar field evolving under its potential to acquire negative pressure with $p < -\rho c^2/3$ giving repulsive gravity. Form of energy with this negative pressure range is generally called dark energy (Padmanabhan 2005, 2006; Copeland et al. 2006). Scalar field is responsible for symmetry breaking mechanisms and super-fast expansion in inflationary scenario, resolving horizon and flatness problems as well as explaining the origin of structures (Starobinsky 1980; Guth 1981; Sato 1981; Albrecht and Steinhardt 1982; Linde 1982). Introducing a cosmological constant into the field equation is simplest way to have dark energy (Weinberg 1989; Ford 1987; Dolgov 1997), but it creates new problem on fine-tuning of energy density scales (Sahni and Starobinsky 2000; Peebles and Ratra 2003). For the cosmological constant to be viable, idea of varying cosmological constant needs to be installed (Sola and Stefancic 2005; Shapiro and Sola 2009). If dark energy is the scalar field, the field could have non-canonical kinetic part such as tachyon which is classified in a type of k-essence models (Armendariz-Picon et al. 2000, 2001). The tachyon field is a negative mass mode of an unstable non-BPS D3-brane in string theory (Garousi 2000; Sen 2002a, 2002b) or a massive scalar field on anti-D3 brane

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