

# Tachyonic teleparallel dark energy

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**Abstract** Teleparallel gravity is an equivalent formulation of general relativity in which instead of the Ricci scalar  $R$ , one uses the torsion scalar  $T$  for the Lagrangian density. Recently teleparallel dark energy has been proposed by Geng et al. (in Phys. Lett. B 704, 384, 2011). They have added quintessence scalar field, allowing also a non-minimal coupling with gravity in the Lagrangian of teleparallel gravity and found that such a non-minimally coupled quintessence theory has a richer structure than the same one in the frame work of general relativity. In the present work we are interested in tachyonic teleparallel dark energy in which scalar field is responsible for dark energy in the frame work of torsion gravity. We find that such a non-minimally coupled tachyon gravity can realize the crossing of the phantom divide line for the effective equation of state. Using the numerical calculations we display such a behavior of the model explicitly.

**Keywords** Teleparallel gravity · Tachyon field · Crossing of phantom divide

## 1 Introduction

Recent cosmological observations from supernovae Ia (Perlmutter et al. 1999; Riess et al. 1998), cosmic microwave background radiation (Spergel et al. 2003; Komatsu et al. 2009, 2010), large scale structure (Tegmark et al. 2004;

Seljak et al. 2005), baryon acoustic oscillations (Eisenstein et al. 2005) and weak lensing (Jain and Taylor 2003) have revealed that our universe is in accelerated expansion phase and it began this acceleration at the near past. In order to explain the late time cosmic acceleration one can use dark energy or dark gravity approaches. In the dark gravity approach, one modifies the left-hand side of the Einstein equation to obtain a modified gravity theory. The simplest model of this category is the well-known  $f(R)$  gravity in which the Ricci scalar in the Einstein-Hilbert action replaces by a general function of the Ricci scalar (Nojiri and Odintsov 2006; De Felice and Tsujikawa 2010; Sotiriou and Faraoni 2010). In the second approach we introduce an exotic energy component with negative pressure called dark energy in the right-hand side of the Einstein equation in the frame work of general relativity (for a review see Copeland et al. 2006).

The simplest candidate of dark energy is a tiny positive time-independent cosmological constant  $\Lambda$  with the equation of state  $\omega = -1$  (Weinberg 1989; Sahni and Starobinsky 2000; Peebles and Ratra 2003; Padmanabhan 2003). However, it suffers from two serious theoretical problems, i.e., the cosmological constant problem (why  $\Lambda$  is about 120 orders of magnitude smaller than its natural expectation value?) and the coincidence problem (why are we living in an epoch in which the dark energy density and the dust matter energy are comparable?). As a solution of these problems various dynamical dark energy models have been proposed. The dynamical nature of dark energy can originate from various scalar fields such as quintessence (Wetterich 1988; Ratra and Peebles 1988; Caldwell et al. 1998), phantom (a scalar field with negative kinetic energy) and also tachyon scalar field (Alexander 2002; Mazumdar et al. 2001; Gibbons 2002; Garousi et al. 2005; Copeland et al. 2005; Sen 1999; Bergshoeff et al. 2000; Kluson 2000). Holo-

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