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ORIGINAL ARTICLE

Reconstruction and stability of $f(R,T)$ gravity with Ricci and modified Ricci dark energy

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Abstract We take the Ricci and modified Ricci dark energy models to establish a connection with $f(R,T)$ gravity, where R is the scalar curvature and T is the trace of the energy-momentum tensor. The function $f(R,T)$ is reconstructed by considering this theory as an effective description of these models. We consider a specific model which permits the standard continuity equation in this modified theory. It is found that $f(R,T)$ functions can reproduce expansion history of the considered models which is in accordance with the present observational data. We also explore the Dolgov-Kawasaki stability condition for the reconstructed $f(R,T)$ functions.

Keywords Modified gravity · Dark energy

1 Introduction

Contemporary observational data on the cosmic expansion history (Fedeli et al. 2009; Perlmutter et al. 1999; Riess et al. 2007; Spergel et al. 2003; Tegmark et al. 2004) affirm the expanding paradigm of the universe. These developments may be considered as indication either for the existence of strange energy component dubbed as *dark energy* (DE) or for the modification of Einstein-Hilbert action. In the first stance, various representations (Bamba et al. 2012; Sharif and Zubair 2010a, 2010b, 2012a) have been suggested in general relativity to understand the characteristics of DE. In particular, the holographic DE (HDE) appeared as one of the most prominent candidates which has extensively been studied in literature (Huang and Gong 2004; Zhang and Wu 2005). This model has been constructed by incorporating the holographic principle in quantum gravity and its energy density is given by Cohen et al. (1999), Li (2004)

$$\rho_\vartheta = 3c^2 M_p^2 L^{-2},$$

where L is the infrared (IR) cutoff, c is a constant and $M_p^{-2} = 8\pi G$ is the reduced Planck mass. The future event horizon is suggested as the most appropriate choice for the IR cutoff to make it consistent with the observational data (Li 2004). Cai (2007) found this proposal as a challenging issue of causality which motivated the modification of IR cutoff. In Gao et al. (2009), the Ricci scalar is intimated as another proposal resulting in new form of HDE termed as Ricci DE (RDE). Granda and Oliveros (2008, 2009) also suggested a new IR cutoff for HDE in terms of H and $\dot{H}$ which generalizes the RDE known as new HDE (NHDE).

In the second path, the issue of cosmic acceleration can be counted on the basis of modified theories of gravity. In this respect, there are various candidates such as $f(R)$ (Sotiriou and Faraoni 2010), $f(\mathcal{T})$ (Ferraro and Fiorini 2007), where $\mathcal{T}$ is the torsion and $f(R,T)$ (Harko et al. 2011) etc. The $f(R,T)$ gravity is a more general modified theory involving coupling between matter and geometry which is described by the action (Harko et al. 2011)

$$\mathcal{I} = \frac{1}{2\kappa^2}\int f(R,T)\sqrt{-g}dx^4 + \int \mathcal{L}_m\sqrt{-g}dx^4, \qquad (1)$$

where $\kappa^2 = 8\pi G$, and $\mathcal{L}_m$ denotes matter Lagrangian. If we vary the action (1) with respect to the metric tensor then the

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