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ORIGINAL ARTICLE

Scalar-tensor cosmology and GSLT with entropy corrections

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Abstract This paper investigates the validity of generalized second law of thermodynamics using both the power law and logarithmic entropy corrected formulas in a general scalar-tensor gravity. For this purpose, we take non-flat FRW universe model filled with magnetized perfect fluid matter bounded by four different horizons namely Hubble, apparent, particle and event horizons. We introduce a non-minimal interaction between scalar and matter fields and take Lagrangian density of non-linear electromagnetic effects. Finally, we extend this study to anisotropic case by taking Bianchi I universe model bounded by apparent horizon only and investigate the role of anisotropy parameter on the validity of GSLT. In this case, we also explore the behavior of some cosmological parameters.

Keywords Scalar-tensor theory · Scalar field · Laws of thermodynamics

1 Introduction

"The expanding behavior of cosmos with acceleration" is the most revolutionary finding of the last century which motivated numerous researchers in a new direction. Many observational studies including Supernova (Ia) (Riess et al. 1998; Perlmutter et al. 1998) Wilkinson Microwave Anisotropy Probe (WMAP) (Bennett et al. 2003), Sloan Digital Sky Survey (SDSS) (Tegmark et al. 2004), galactic cluster emission of X-rays (Allen et al. 2004), large scale-structure (Hawkins et al. 2003) and weak lensing (Jain and Taylor 2003) etc substantiate this fact and guarantee the existence of a new type of missing energy with unusual nature in the energy density structure of cosmos. This mysterious component with large negative pressure covers the major portion of density structure of the universe and is termed as dark energy (DE). It is believed that rapid acceleration of the universe is driven by this unknown component of cosmic matter distribution.

In order to accommodate exotic DE reality, enormous strategies have been adopted in literature that utilize either one of the two techniques: modifications in the matter configuration or modifications in the gravitational part of the action functional. The modified matter configuration technique further includes one of the three approaches: introduction of scalar field DE models (Ratra and Peebles 1988; Gorini et al. 2004) like tachyon fields, quintessence etc, the inclusion of viscous effects (shear and bulk) in the energy-momentum part describing the matter contents (Murphy 1973; Calvao et al. 1992) or cosmological constant (Padmanabhan 2008) and the use of different types of equations of state like Chaplygin gas and its modified versions (Chaplygin 1904; Bento et al. 2002). Modified frameworks like scalar-tensor theories, $f(R)$ gravity, $f(T)$ gravity, Gauss-Bonnet gravity, $f(R,T)$ gravity etc are some significant candidates of the second approach (Brans and Dicke 1961; Elizalde et al. 2004; Cognola et al. 2006; Felice and Tsujikawa 2010; Linder 2010; Harko et al. 2011; Daouda et al. 2012). Among these, scalar-tensor generalization of Einstein theory is considered to be the most successful competent due to its increasing number of cosmological applications (Bertolami and Martins 2000; Banerjee and Pavon 2001; Peterson and Tegmark 2011; Sharif and Waheed 2012a, 2012b, 2012c, 2013b). In this regard, scalar-tensor frame-

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