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ORIGINAL ARTICLE

Generalized second law of thermodynamics with corrected entropy in tachyon cosmology

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Abstract This work is to study the generalized second law (GSL) of thermodynamics in tachyon cosmology where the tachyon field is coupled to the matter Lagrangian while the boundary of universe is assumed to be a dynamical apparent horizon. The two logarithmic and power law corrected entropy on the apparent horizon is also discussed and the conditions for validity of GSL in both scenarios are investigated by using observational data of Sne Ia. In comparison to other research works, since the model is constrained by observational data, the conditions obtained for the dimensionless constant parameter, α in both logarithmic and power law entropy correction of GSL are (physically) meaningful and realistic. The model also predicts an accelerating universe with no phantom crossing in the past or future.

Keywords Tachyon cosmology · Thermodynamics · GSL · Entropy corrected · Cosmic acceleration

1 Introduction

Observations confirm that about two third of the universe content is filled with a component dubbed as dark energy (DE) which causes cosmic acceleration (Jarosik et al. 2011). The cosmological constant is the simplest candidate for DE to fit the observational data. However, the measured expansion rate of the universe sets its scale being of order of 10^{-12} GeV; suffers from fine-tuning when compared with the Planck scale (10^{18} GeV) (Shaw and Barrow 2011). Alternatively, there are a number of DE models which exploit scalar fields or some other exotic fields like phantom fields with negative energy (Caldwell 2002; Piao and Zhou 2003). Noting that, such scalar fields are usually so light (order of 10^{-33} eV) that need an extremely fine tuning. It is also claimed in the literature, that cosmic evolution of some kinds of these fields contradicts with the solar system tests (Nojiri and Odintsov 2004). It is most often the case that such fields interact with matter, (i) directly due to a Lagrangian coupling, (ii) indirectly through a coupling to the Ricci scalar or as the result of quantum loop corrections (Damour et al. 1990; Carroll 1998; Carroll et al. 1992; Biswas et al. 2006). Recently, a new model has been proposed in which a tachyon scalar field non-minimally couples to matter Lagrangian. The validity of this model in many cosmological scenarios has also been investigated for example in Farajollahi (2012, 2011a, 2011b, 2011c, 2011d) and Farajollahi and Salehi (2011).

On the other hand, inspired by the black hole physics, there is a deep connection between gravity and thermodynamics. An evidence for this connection in general relativity (GR) can be shown in deriving Einstein field equations in Rindler spacetime by using the relation between entropy and the horizon area as well as first law of thermodynamics. In addition, the validity of the generalized second law of thermodynamics (GSL) has been under extensive consideration by many researchers (Brustein 2000; Izquierdo and Pavon 2006; Gong et al. 2007a; Horvat 2007). According to GSL, the entropy of the fluid inside the hori-

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