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ORIGINAL ARTICLE

Some aspects of entropic gravity in the presence of a noncommutative Schwarzschild-deSitter black hole

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Abstract We study some features of entropic force approach in the presence of a noncommutative Schwarzschild-deSitter black hole. In this setup, there exists a similarity between the small and large scales. There are two finite cut-off in very short and long distances wherein the force and energy graph stop abruptly at those scales. We find that the existence of a deSitter core around the origin, induced by noncommutativity, in addition to a standard deSitter background at large scale may lead to a violation of the equivalence principle. Finally in order to directly observe the finite cut-off at short-scale gravity, caused by noncommutativity quantum fluctuations, we derive an effective gravitational constant.

Keywords Black hole thermodynamics · Noncommutative geometry · Holographic screens · Entropic force · Cosmological constant · Equivalence principle

1 Introduction

There are many proofs signifying a profound relation between thermodynamics and the general theory of relativity. Discovery of black hole radiation demonstrated that the black hole behaves as a thermal system (Hawking 1975). The thermodynamic laws of black holes suggest a meaningful connection between gravity and thermodynamics (Bardeen et al. 1973). In 1995, Jacobson derived the Einstein field equation from the first law of thermodynamics (Jacobson 1995). Recently, Padmanabhan attained the Einstein field equation by uniting the equipartition law of energy and the holographic principle (Padmanabhan 2010). In addition Verlinde illustrated gravity as an entropic force, as a result of alterations in the information related to the locations of material bodies (Verlinde 2011). He acquired an effective force acting on a test mass coming near to a holographic screen, caused by the alteration of entropy on the screen, which satisfies the Newton's second law for gravitational force. Verlinde's proposal has extensively been debated in the literature (see for instance, Gao 2010; Cai et al. 2010; Konoplya 2010; Nicolini 2010; Banerjee and Majhi 2010; Mureika and Mann 2011; Klinkhamer 2011; Sahlmann 2011; Cai and Saridakis 2011; Nozari and Akhshabi 2011; Visser 2011; Qiu and Saridakis 2012).

Recently, we investigated some aspects of the entropic essence of gravity in the presence of noncommutative Schwarzschild (Mehdipour 2012) and Reissner-Nordström (Mehdipour and Keshavarz 2012) black holes by performing the method of coordinate coherent states representing smeared structures. This method of noncommutativity is the so-called *noncommutative geometry inspired model* (for a review see Nicolini 2009). The eliciting of metrics for noncommutative geometry inspired black holes is established upon the feasible running of the minimal observable length in general relativity. Based on this new model of noncommutativity of coordinates, which performs the Gaussian distribution of coherent states, the Einstein tensor in gravity field equations remains intact but the energy-momentum tensor takes a new form. In fact, due to the emergence of extreme energies at short distances of a noncommutative manifold, the effects of manifold quantum fluctuations become visible and prohibit any measurements to find a particle position with an accuracy more than an inherent length scale, such as the Planck length, and this means that the concept of locality is violated

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