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ORIGINAL ARTICLE

Effects of modified dispersion relation on the thermodynamics of Achúcarro-Ortiz horizon and tunneling radiation probability

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Abstract The modified dispersion relation was used to study the quantum gravitational effects on the Achúcarro-Ortiz horizon. In continue, the quantum gravitationally modified entropy of Achúcarro-Ortiz space-time is used to obtain the tunneling radiation probability. The results show that the tunneling radiation probability is modified.

Keywords Modified dispersion relation · Achúcarro-Ortiz · Tunneling radiation probability

Black hole thermodynamics may be studied by analysis of Hawking temperature via usual thermodynamics relations(Hawking 1975). To obtain a microscopic picture of horizon, the Hawking temperature may be viewed from many viewpoints. It is interesting that in some frameworks, the Hawking temperature undergoes corrections in different sources. For example self-gravitational corrections (Parikh and Wilczek 2000; Kraus and Wilczek 1995; Parikh 2002, 2004) as well as quantum gravitational corrections (Setare and Vagenas 2004; Setare 2003, 2004a, 2004b, 2005, 2006). Quantum gravitational one may be obtained by employing the generalized uncertainty principle (Setare and Vagenas 2004; Adler et al. 2001; Han et al. 2008; Farmany et al. 2008; Shu and Shen 2008; Wang et al. 2008; Setare 2004a, 2004b; Zhao and Zhang 2006; Xiang 2006; Farmany 2012; Farmany et al. 2012a, 2012b) as well as modified dispersion relation (Amelino-Camelia et al. 2006, 2004; Ling et al. 2006; Han et al. 2008; Farmany 2013). In this article, employing the modified dispersion relation, the quantum gravitational effects on the Achúcarro-Ortiz horizon was studied. It is shown that quantum gravitational effects may affect on the entropy of horizon and modify the tunneling radiation probability of Achúcarro-Ortiz horizon.

In order of Kerr and Schwarzschild, BTZ solution obtain a black hole which is locally AdS and/or asymptotically anti de Sitter instead of flat space-time. Also, it has no curvature singularity at all. It is interesting that AdS black holes are members of this solution (Maldacena et al. 1999; Spradlin and Strominger 1999; Setare 2004a, 2004b).

According to Achúcarro and Ortiz (1993), the Kaluza-Klein reduction of a simplest version of a $(2+1)$ dimensional Bañados et al. (1992) metric of a 3-dimensional theory of gravity

$$ds^2 = -\xi dt^2 + \xi^{-1} dr^2 + r^2\left(d\theta - \frac{J}{2r^2}dt\right)^2 \tag{1}$$

(where $\xi = (-M + \frac{r^2}{l^2} + \frac{J^2}{4r^2})$, M and J are mass and angular momentum, respectively) read a two-dimensional line element as:

$$ds^2 = -\xi dt^2 + \xi^{-1} dr^2 \tag{2}$$

where $-\infty < t < +\infty$, and $0 \le r < +\infty$. The outer and inner area of such horizon r_+ and r_-, concerning the positive mass of black hole with $J \neq 0$, are

$$r_\pm^2 = \frac{l^2}{2}\left(M \pm \sqrt{M^2 - \frac{J^2}{l^2}}\right) \tag{3}$$

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