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ORIGINAL ARTICLE

Semiclassical tunneling radiation of Kehagias-Sfetsos black hole and holographic principle

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Abstract The thermodynamics of Kehagias-Sfetsos black hole is studied. Applying the generalized second law of thermodynamics, a bound on the semiclassical tunneling radiation of black hole is obtained.

Keywords Kehagias-Sfetsos black hole · Tunneling radiation · Holographic bound

It is interesting that a renormalizable theory of gravity may be addressed as a UV-candidate for general relativity at a Lifshitz point (Hořava 2009a). Also the short distance of theory governs the nonrelativistic interactions of gravitons. Recently this power-counting theory received much attention (Hořava 2009b, 2009c; Visser 2009; Volovich and Wen 2009; Nikolic 2009; Sotiriou et al. 2009a, 2009b; Cai et al. 2009a; Orlando and Reffert 2009; Germani et al. 2009; Bogdanos and Saridakis 2009; Lu et al. 2009). The black hole solution of Hořava-Lifshitz theory was developed in Cai et al. (2009a), Ranjan Majhi (2010), Kehagias and Sfetsos (2009), Myung (2009a), Park (2009), Castillo and Larranaga (2009), Henneaux et al. (2010). At this time, there are two approaches of Hořava-Lifshitz gravity as the projectable and nonprojectable. Both of this approaches implies interesting results. For example it is shown that in the nonprojectable theory, there is no evolution at all for any observable. Of course the short distance version of the theory is incompletely equivalent to the general relativity for any λ when employing a consistent Hamiltonian formalism based on the Dirac algorithm (Bellorin and Restuccia 2010; Balasubramanian and McGreevy 2008). The black hole solution, in the nonprojectable approache of Hořava-Lifshitz theory (Kachru et al. 2008; Danielsson and Thorlacius 2009; Mann 2009; Balasubramanian and McGreevy 2009; Bertoldi et al. 2009; Bergshoeff et al. 2009; Greenwald et al. 2009) received much attention in order of projectable ones (Kraus and Wilczek 1995; Kraus and Keski-Vakkuri 1997). In this letter taking Hořava-Lifshitz gravity theory as a new gravitational theory, we study a nonprojectable black hole solution. In continue applying the Parikh-Wilczek method, we obtain the semiclassical black hole tunneling radiation.

The general metric in the $(3+1)$ dimensional ADM formalism is

$$ds^2 = -N^2(r)dt^2 + g_{ij}(dx^i + N^i dt)(dx^j + N^j dt) \tag{1}$$

where g_{ij}, N and N^i are the dynamical fields of scaling mass dimensions $0, 0, 2$, respectively. N and N^i are called lapse and shift variables, respectively. Note that in the Hořava-Lifshitz theory of gravity, the time and space are different scaling behavior as

$$\begin{aligned} &t \to b^z t \\ &x \to bx \end{aligned} \tag{2}$$

the static spherically symmetric solution of the Hořava-Lifshitz theory gives

$$ds^2 = -N^2(r)dt^2 + \frac{dr^2}{f(r)} + r^2(d\theta^2 + \sin^2\theta d\varphi^2) \tag{3}$$

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