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ORIGINAL ARTICLE

Thermodynamics of Vaidya-Bonner-de Sitter space time based on the generalized space-time uncertainty

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Abstract In each static or stationary space time k is just surface gravity of the horizon, but in the of Vaidya-Bonner-de Sitter space time, it is no longer the surface gravity of the event horizon. This property makes the Vaidya-Bonner as an important horizon. In this paper, the entropy of Vaidya-Bonner-de Sitter space time is calculated. In continue, employing the generalized uncertainty principle, quantum gravitational corrections to the entropy of Vaidya-Bonner space time is studied.

Keywords Vaidya-Bonner-de Sitter space time · Generalized space-time uncertainty · Black hole thermodynamics

It is interesting that without calculating the energy-momentum tensor of evaporating black hole we calculate the temperature of its event horizon. The of Vaidya-Bonner-de Sitter calculation is the simple method that without calculating the vacuum expectation value of the renormalized energy-momentum tensor, we can determine the horizon's temperature. In this scenario, the Klein-Gordon equation can be reduced to the standard form of wave equation in the tortoise coordinate of the Schwarzschild space time. However in a non-static space time Zheng-Dai approaches give the horizon's temperature. Recently this method have received much attention (Zheng and Xianxin 1992; Zheng et al. 1994; Damour and Ruffini 1976; Balbinot 1986; Hiscock 1981). On the other hand, some property of the Vaidya-Bonner space time differ it with other space times.

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For example, in each static or stationary space time k is just the surface gravity of the horizon, but in the Vaidya-Bonner-de Sitter space time, it is no longer the surface gravity of event horizon and the cosmic horizon. This property makes the Vaidya-Bonner solution as an important horizon (Chen and Yang 2007; Liu et al. 2003; Li and Zhao 2001; Lin and Yang 2009; Zhou and Liu 2009; Li et al. 1999; Niu and Liu 2010). In this letter, we calculate the entropy of the Vaidya-Bonner-de Sitter space time. Let we begin with the Vaidya-Bonner-de Sitter solution,

$$ds^2 = (1-\varsigma)dv^2 - 2vdr - r^2(d\theta^2 + \sin^2\theta d\varphi^2) \tag{1}$$

Where $\varsigma = \frac{2m}{r} + \frac{Q^2}{r^2} + \frac{\lambda r^2}{3}$ and λ is the cosmological constant. Not that mass and charge are Eddington-Finkelstein time v dependent. In 2007, Wanglin et al. (2007) the Hawking temperature of the Vaidya-Bonner-de Sitter event horizon is obtained from a solution to the surface gravity of this space time,

$$T = \frac{r - m - \frac{2}{3}\lambda r^2 - 2r\dot{r}}{2\pi K_B \varsigma r^2} \tag{2}$$

The black hole entropy is usually derived from the Hawking temperature. Setting M to mean energy and T to mean temperature, the entropy may defined from the well-known thermodynamics relation as,

$$dS = \frac{dE}{dT} \approx \frac{dM}{dT} \tag{3}$$

Inserting (2) into (3), one find

$$\frac{dM}{dS} = \frac{r - m - \frac{2}{3}\lambda r^2 - 2r\dot{r}}{2\pi K_B \varsigma r^2} \tag{4}$$