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ORIGINAL ARTICLE

Corrected horizon of Kerr-Sen black hole as a series with terms involve powers of the inverse of the area

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Abstract By means of the semiclassical approximations for the action, the horizon of Kerr-Sen black hole is studied. The corrected entropy of the Kerr-Sen black hole in a low-energy string theory is calculated. By assumption of a flat Friedman-Robertson-Walker (F.R.W.) geometries, we study horizon and present the semi-classic approximation affects of the thermodynamics properties. We discuss some physical consequences of this result and the properties of the Kerr-Sen black hole.

Keywords Hawking temperature · Plank constant · Corrected horizon · Action · Kerr-Sen black hole

1 Introduction

One of the substantially properties of a black hole is that it carries entropy (Akbar and Saifullah 2002). It has been claimed that the entropy of a black hole is proportional to the surface area at the event horizon and then the Kerr-Sen black hole has been studied through the quantum field theoretic calculation (Banerjee and Modak 2009). Understanding this entropy is an enormous challenge in modern physics. The quantum gravity effects are also felt by observers outside the event horizon; as clearly indicated by Hawking's semi-classical calculations which show that a generic black hole radiates as a perfect black body at Hawking temperature T_H (Khani et al. 2013).

When studying black hole evaporation by Hawking radiation using the quantum tunneling approach, a semiclassical treatment is used to study changes in thermodynamical quantities (Adler 1999; Adler et al. 2001). The quantum corrections to the Hawking temperature and the Bekenstein-Hawking area law have been studied for the Schwarzschild, Kerr and Kerr-Newman black holes (Darvishi et al. 2013). In this paper, we scrutiny the semi-classic state of thermodynamically properties for a low energy Kerr black hole. Our main purpose is to interrogate how the semi-classic approximation affect the thermodynamics of the Kerr-Sen black hole and corrected entropy and horizon (Khani et al. 2013; Sen 1992).

Quantum field theory has too many degrees of freedom to consistently describe a gravitational theory. The main indication that we have seen of this overabundance of degrees of freedom is the fact that the horizon entropy-density is infinite in quantum field theory. The divergence arises from modes very close to the horizon, but the divergent horizon entropy is not an ordinary ultraviolet phenomenon. The modes which account for the divergence are very close to the horizon and would appear to be ultra short distance modes. But they also carry very small energy and therefore correspond to very long times to the external observer.

The entropy bound can be generalized to flat F.R.W. (Friedman-Robertson-Walker) geometries. First, consider the general case of $d+1$ dimensions. The metric has the following form (Nikjou et al. 2013)

$$d\tau^2 = -dt^2 + a(t)^2 \sum_{j=1}^{d} dx_j^2, \qquad (1)$$

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