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ORIGINAL ARTICLE

Hawking non-thermal and thermal radiations of Reissner Nordström anti-de Sitter black hole by Hamilton-Jacobi method

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Abstract We have investigated Hawking non-thermal and purely thermal Radiations of Reissner Nordström anti-de Sitter (RNAdS) black hole by massive particles tunneling method. The spacetime background has taken as dynamical, incorporate the self-gravitation effect of the emitted particles the imaginary part of the action has derived from Hamilton-Jacobi equation. We have supposed that energy and angular momentum are conserved and have shown that the non-thermal and thermal tunneling rates are related to the change of Bekenstein-Hawking entropy and the derived emission spectrum deviates from the pure thermal spectrum. The results for RNAdS black hole is also in the same manner with Parikh and Wilczek's opinion and explored the new result for Hawking radiation of RNAdS black hole.

Keywords Massive particle tunneling · RNAdS black hole

1 Introduction

By the information loss paradox (Hawking 1974, 1975), the information carried out by a physical system falling toward black hole singularity has no way to recover after a black hole has completely disappeared. The loss of information was considered as preserved inside the black hole and so was not a serious problem in the classical theory. In 1976 a semi-classical calculation of black hole radiance was proposed by Hawking and showed that the emitted radiation is exactly thermal. In particular, the detailed form of the radiation does not depend on the detailed structure of the body that collapsed to form the black hole. With the emission of thermal radiation (Hawking 1974, 1975), black holes could lose energy, shrink, and eventually evaporate and becomes smaller and smaller until disappears completely. In this basis, many research works on the thermal radiation of black holes have been made (Kraus and Wilezek 1995a, 1995b; Parikh and Wilezek 2000; Hemming and Keski-Vakkuri 2001). It seems that an initially pure quantum state, by collapsing to a black hole and then evaporating completely, has evolved to a mixed state and in this situation it is impossible for one to predict about certainty what the final quantum state will be even if the initial quantum state were precisely known and therefore violates the fundamental principles of quantum theory due to prescribe a unitary time evolution of basis states. When the black hole has evaporated down to the Planck size, quantum fluctuations dominate and the semi classical calculations would no longer be valid, as spacetime is subject to violent quantum fluctuations on this scale. There are various ideas about how the paradox is solved.

Since the 1997 proposal of the AdS/CFT correspondence, the predominant belief among physicists is that information is preserved and that Hawking radiation is not precisely thermal but receives quantum corrections. Other possibilities include the information being contained in a Planckian remnant left over at the end of Hawking radiation or a modification of the laws of quantum mechanics to allow for non-unitary time evolution.

Hawking radiation from massive uncharged particle tunneling (Zhang and Zhao 2005c, 2005d) and charged particle tunneling (Zhang and Zhao 2005c, 2005d, 2006) from black hole was first proposed by Zhang and Zhao. Accom-

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