Nernst Theorem and Statistical Entropy of 5-Dimensional Rotating Black Hole

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Abstract: In this paper, by using quantum statistical method, we obtain the partition function of Bose field and Fermi field on the background of the 5-dimensional rotating black hole. Then via the improved brick-wall method and membrane model, we calculate the entropy of Bose field and Fermi field of the black hole. And it is obtained that the entropy of the black hole is not only related to the area of the outer horizon but also is the function of inner horizon's area. In our results, there are not the left out term and the divergent logarithmic term in the original brick-wall method. The doubt that why the entropy of the scalar or Dirac field outside the event horizon is the entropy of the black hole in the original brick-wall method does not exist. The influence of spinning degeneracy of particles on entropy of the black hole is also given. It is shown that the entropy determined by the areas of the inner and outer horizons will approach zero, when the radiation temperature of the black hole approaches absolute zero. It satisfies Nernst theorem. The entropy can be taken as the Planck absolute entropy. We provide a way to study higher dimensional black hole.

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