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# Theory: Grand canonical ensemble of a d-dimensional Reissner-Nordström black hole space in a cavity

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The grand canonical ensemble of a d-dimensional Reissner-Nordström black hole space in a cavity is analyzed through the Euclidean path integral approach. The partition function of the ensemble is given in terms of the fixed temperature and fixed electric potential at the boundary of the cavity. One performs the zero loop approximation, i.e., only the contribution of the solutions which are stationary points of the action are considered. One finds two solutions for the charged black hole, □+1 and □+2, where □+2 is the largest. The stability is analyzed through perturbations of the reduced action, yielding instability of □+1 and stability of □+2. Through the correspondence between the partition function and the thermodynamic grand potential, one obtains the mean energy, mean charge, the entropy and the thermodynamic pressure of the system. Now, a spontaneous process in the grand canonical ensemble can never increase the grand canonical potential □, otherwise the second law of thermodynamics would be violated. Thus, it is of interest to compare, for a cavity with fixed size, temperature, and electric potential, the value of □ for the black hole □+2 solution with the value of □ of a nongravitating charged shell, which serves as a model for charged hot flat space. In this way, one can investigate possible phase transitions between black holes and hot flat space.

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