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T. Fernandes: The canonical ensemble of a d-dimensional Reissner-Nordström black hole in a cavity

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We construct the canonical ensemble of a Reissner-Nordström black hole in a cavity for an arbitrary number of dimensions. The system of a charged black hole in a cavity can be described by a partition function given by the Euclidean path integral approach, where we consider the usual Einstein-Maxwell action with the Gibbons-Hawking-York boundary term and an additional boundary term depending on the Maxwell tensor. The spacetime is then Euclideanized and time becomes periodic. The inverse temperature at the boundary is fixed, which corresponds to the total time length at the cavity, and the charge is also fixed, which corresponds to the flux of the Maxwell tensor at the cavity. The zero loop approximation is performed, and the path integral is simplified, which allows us to find the black hole solutions for the fixed temperature and electric charge. We find that, below a critical electric charge, there are three solutions, from which two are stable. Above the critical charge, there is only one solution, which is stable. We find analytical expressions for the points where these solutions meet and for the critical charge. Regarding thermodynamics, the energy, the pressure, the entropy and the electric potential are obtained. The stability of the solutions corresponds to the solutions with positive heat capacity at constant electric charge. The limit of very large cavity is performed, and it is found that, contrarily to the uncharged Hawking black hole, a black hole with sufficient electric charge is stable, connecting thus to previous calculations in the literature, notably by Davies in 1978.

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