

Abstract Submitted  
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**Black hole free energy during charged collapse**<sup>1</sup> ARIEL EDERY, HUGUES BEAUCHESNE, Bishops University — Numerical work on gravitational collapse in isotropic coordinates has recently shown that the negative of the gravitational Lagrangian approaches the (Helmholtz) free energy of a Schwarzschild black hole at late times of the collapse. We investigate numerically this association during the collapse of a charged scalar field to a Reissner-Nordström (RN) black hole in isotropic coordinates. Charged collapse yields a large outgoing matter wave in the exterior region but this has a negligible effect on the interior. The thermodynamics via the free energy can therefore be investigated by focusing on the interior. We find that the percentage discrepancy between the numerical value for the Lagrangian and the analytical expression for the free energy reach values as low as 3% depending on the initial state. As a consistency check, we also implement a procedure for prolonging the evolution of the exterior region. The matter Lagrangian approaches zero everywhere (interior and exterior) showing clearly that the entropy of the charged black hole is gravitational in origin.

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