Semi-Classical Charged Black Holes

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Based on work with Lárus Thorlacius,
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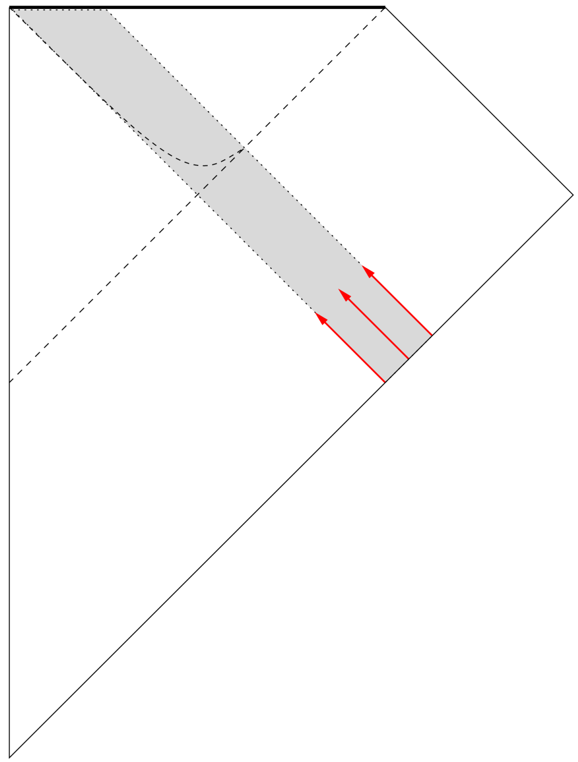
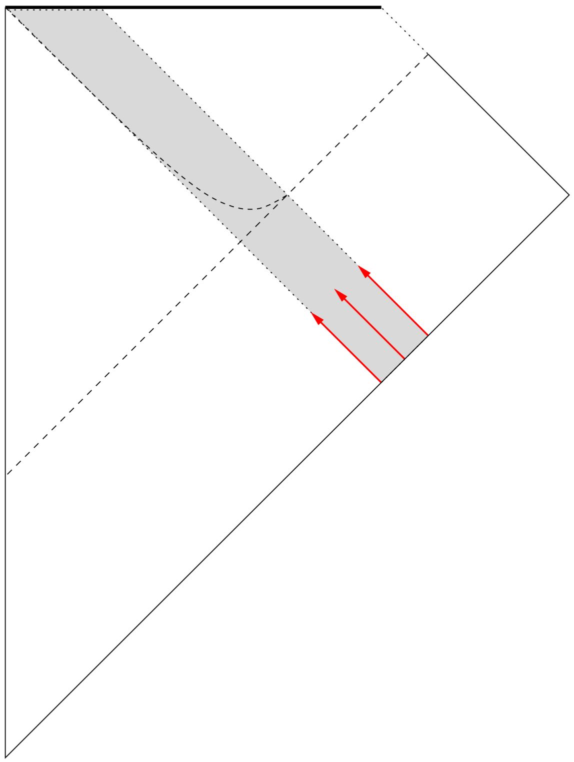
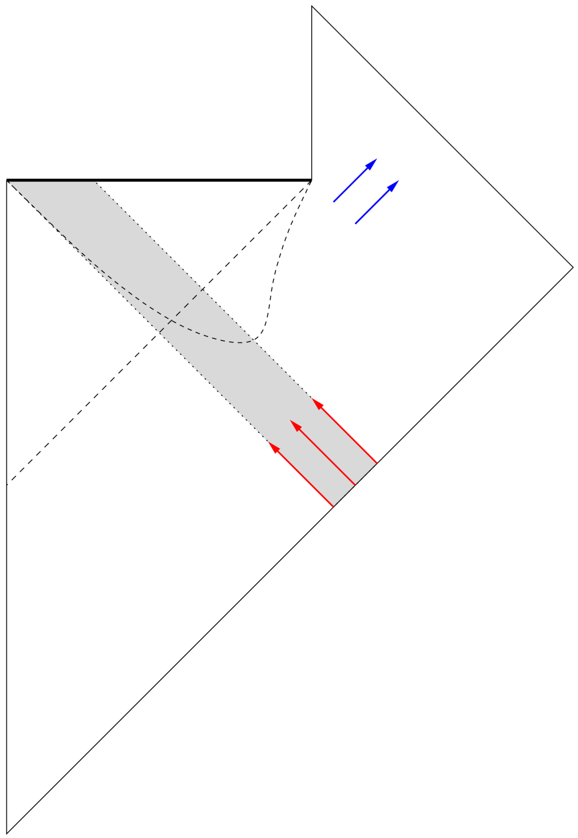
Introduction

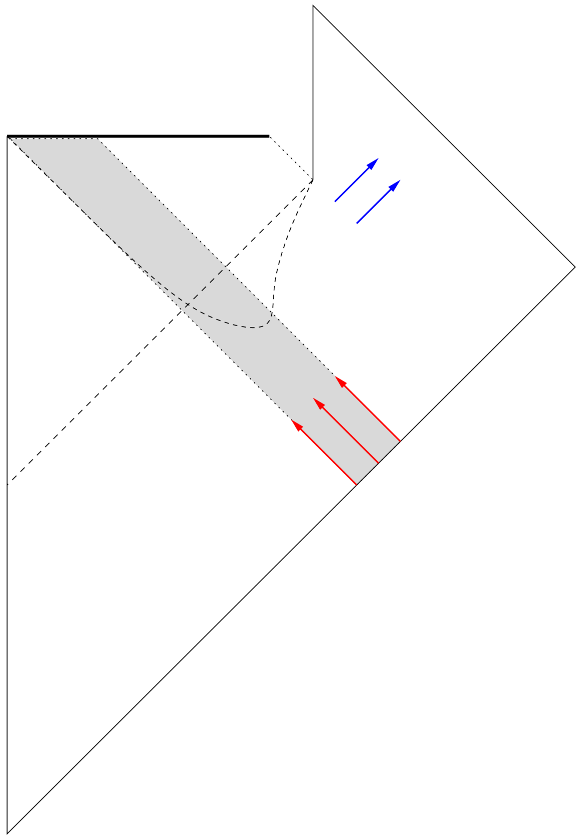




E. Poisson, W. Israel (1990)
A. Ori (1991)
S. Hod, T. Piran (1998)

Introduction





S. W. Hawking (1975)

2D Dilaton Gravity

$$S_G = \int \sqrt{-g}\, e^{-2\phi} \{ R + 4(\nabla\phi)^2 + 4\lambda^2 \} d^2x$$

Area function $\psi = e^{-2\phi}$

We choose coordinates (y^+, y^-) So that the metric is

$$g_{\mu\nu} = \frac{-e^{2\rho}}{2} \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

But we still have gauge freedom

$$x^\pm = x^\pm(y^\pm), \qquad \rho(x^+, x^-) = \rho(y^+, y^-) - \frac{1}{2} \log \frac{dx^+}{dy^+} \frac{dx^-}{dy^-}$$

Callan, Giddings, Harvey, Strominger (1992)

2D Dilaton Gravity

$$S_G = \int \sqrt{-g}\, e^{-2\phi} \{ R + 4(\nabla\phi)^2 + 4\lambda^2 \} d^2 x$$

Kruskal coordinates are chosen such that:

$$\psi = e^{-2\rho} = M - \lambda^2 x^+ x^-$$

This is a static Schwarzschild-like solution that describes a black hole of mass M

2D Dilaton Gravity

For classical charged matter we add:

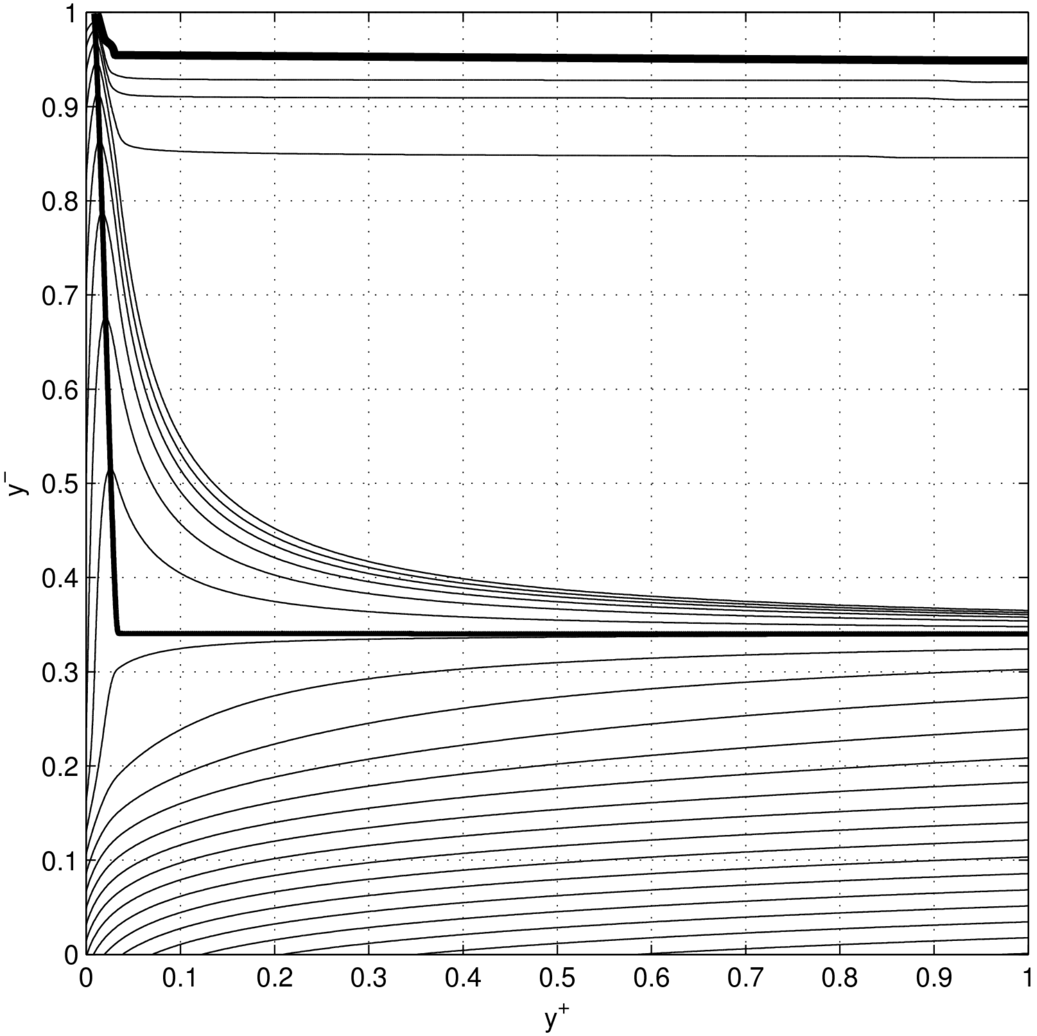
$$S_{CM} = -\int \sqrt{-g}\left\{\frac{1}{4}e^{-2\phi}F^2 + \frac{1}{2}|Df|^2\right\}d^2x$$

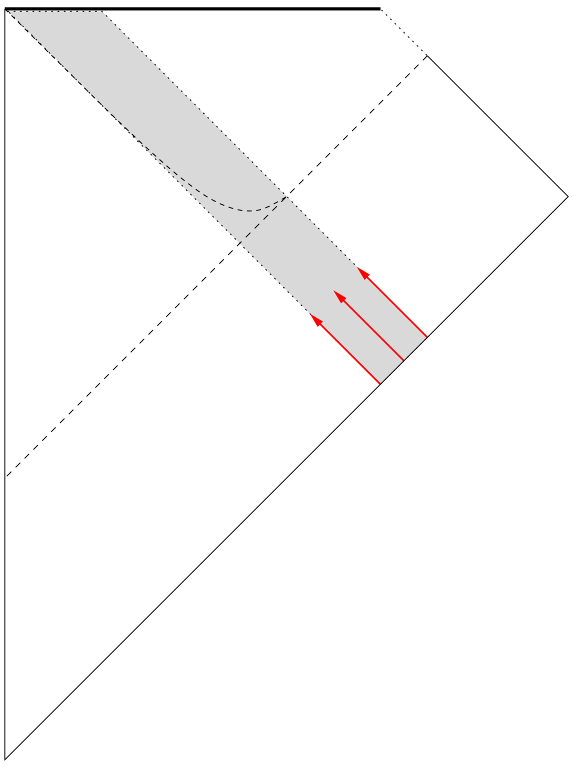
For semi-classical charged matter we use bosonized mass less fermions:

$$S_{QM} = -\int \sqrt{-g}\left\{\frac{\kappa}{4}R\Box^{-1}R + 2\pi(\nabla Q)^2 + \frac{2e^2}{\psi}Q(Q-2Q_0)\right\}d^2x$$

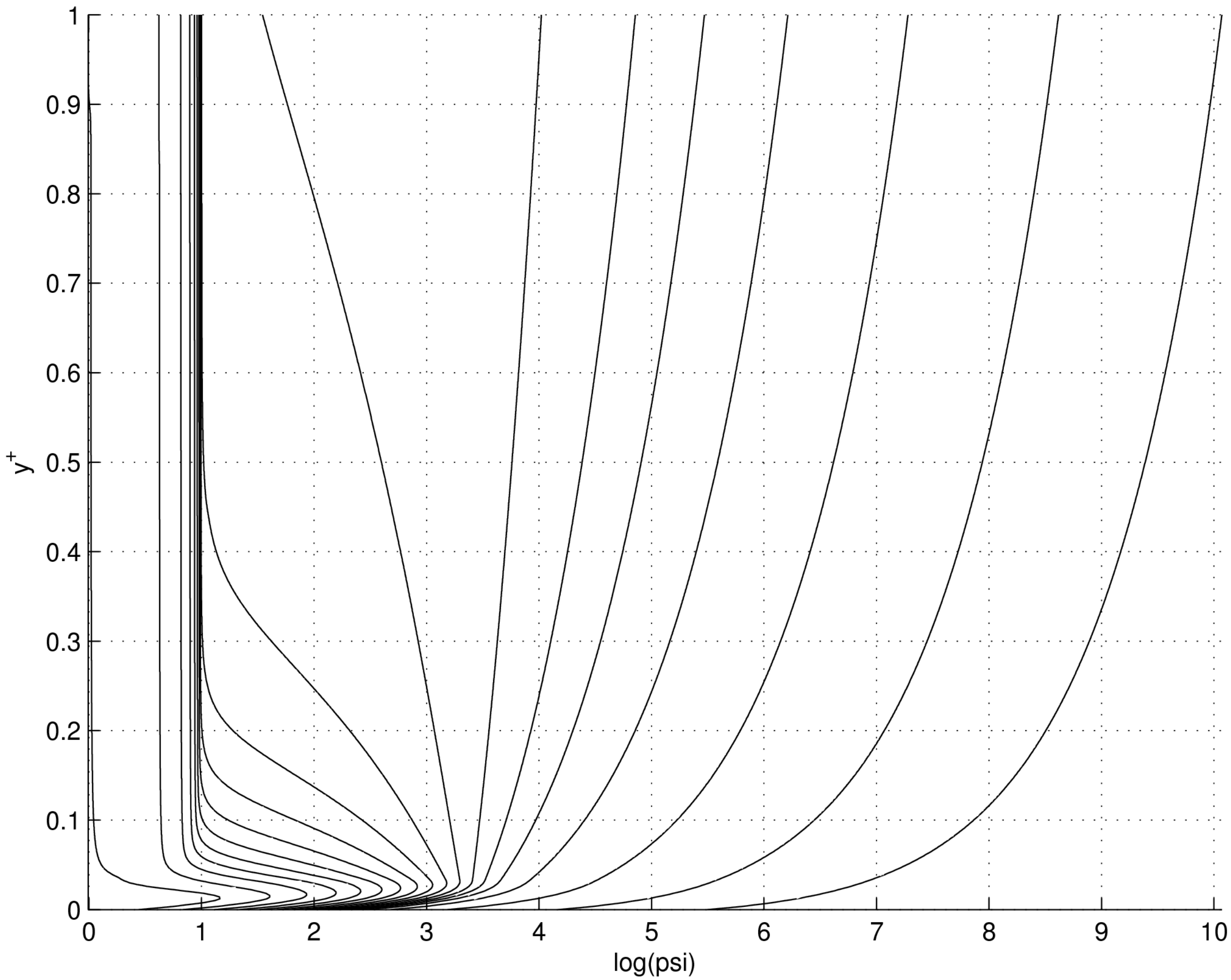
Frolov, Kristjansson, Thorlacius (2005,2006)

Classical CBHs

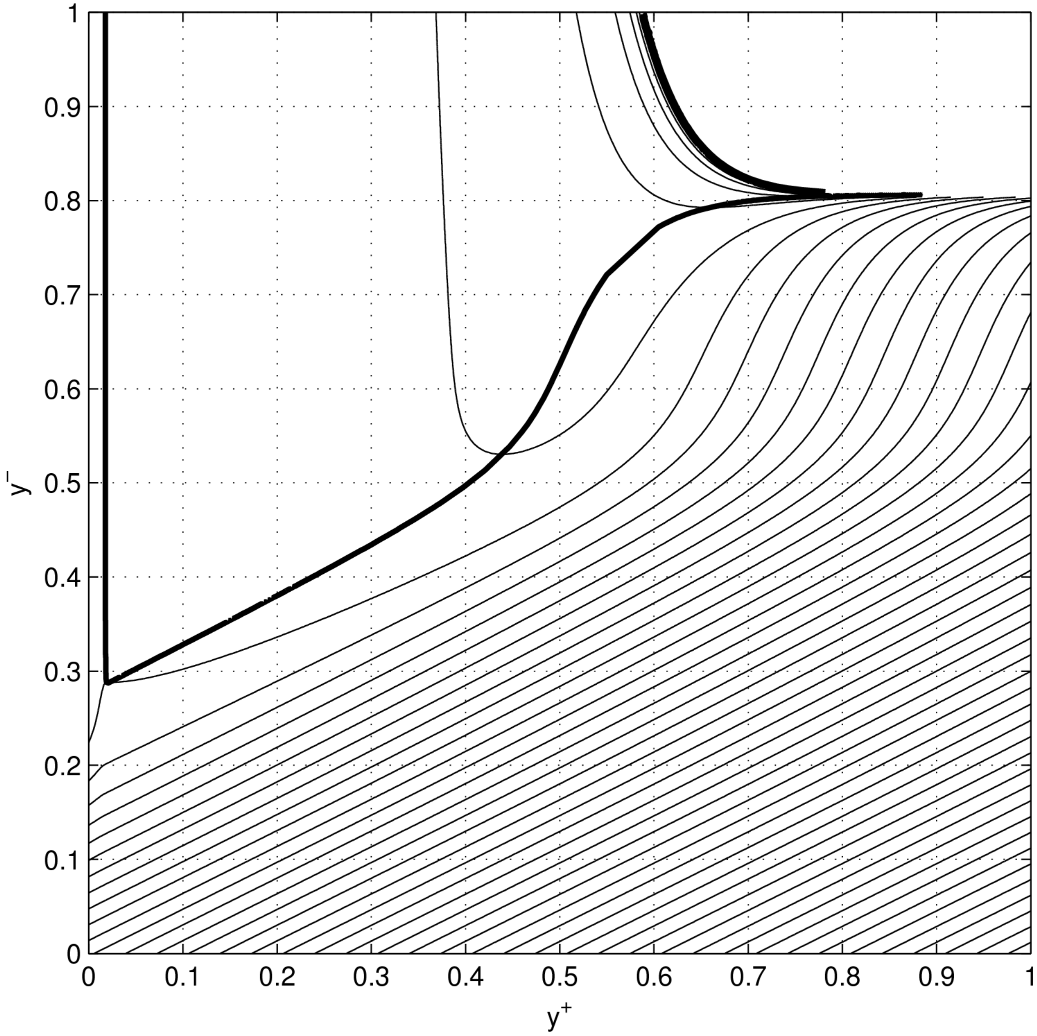


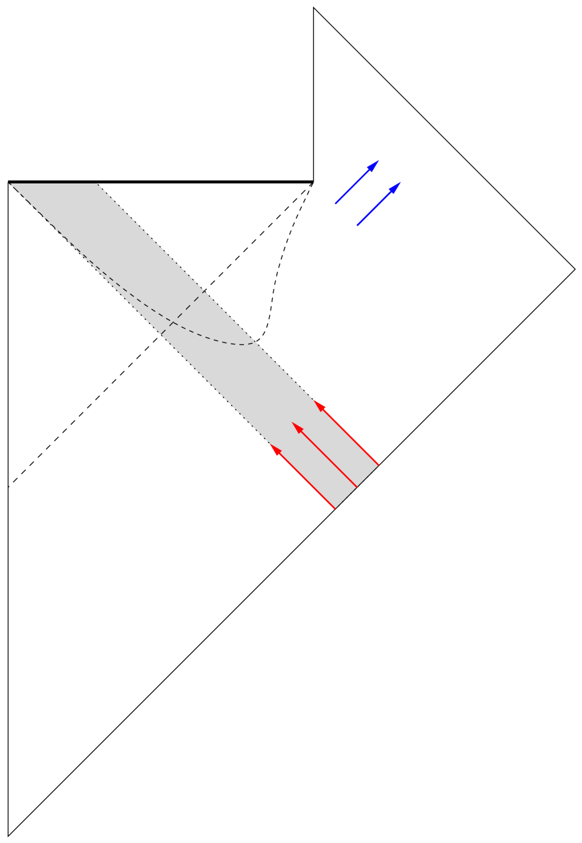


Classical CBHs



Semi-classical CBHs





Semi-classical CBHs