

Strong Cosmic Censorship: the nonlinear story

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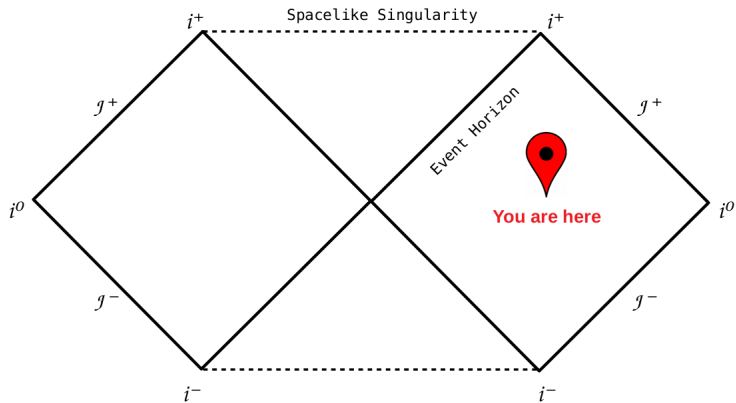
¹CENTRA, Instituto Superior Técnico

January 24 2019. Gravitational Waves, Black Holes and
Fundamental Physics. Athens

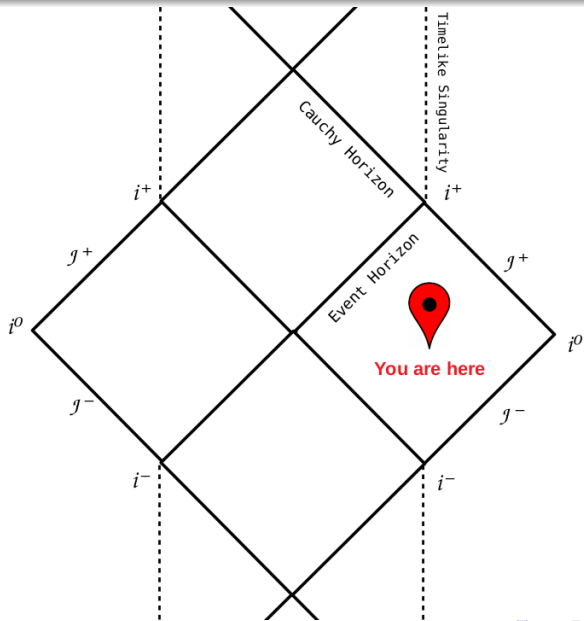
SCC: General Relativity is a deterministic theory

Boundaries of the maximal evolution of initial data are unstable, giving rise upon perturbation to singular boundaries beyond which the field equations cease to make sense.

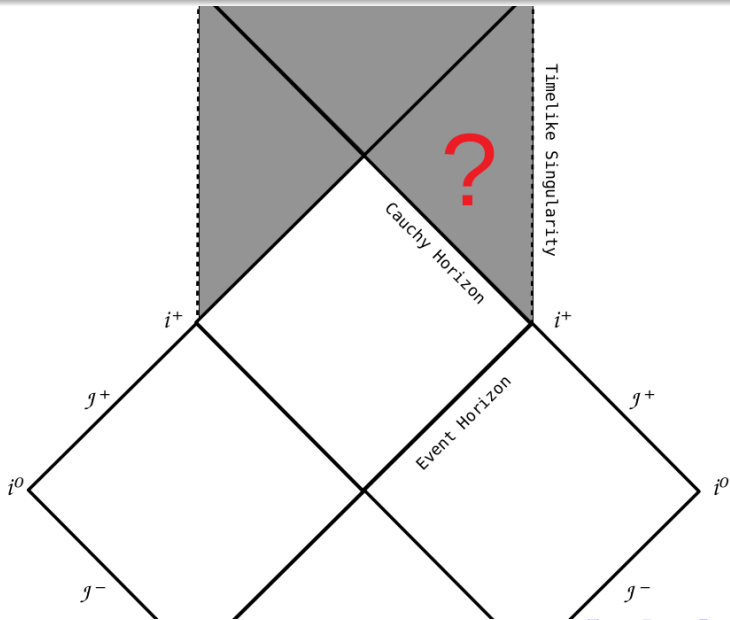
Schwarzschild solution



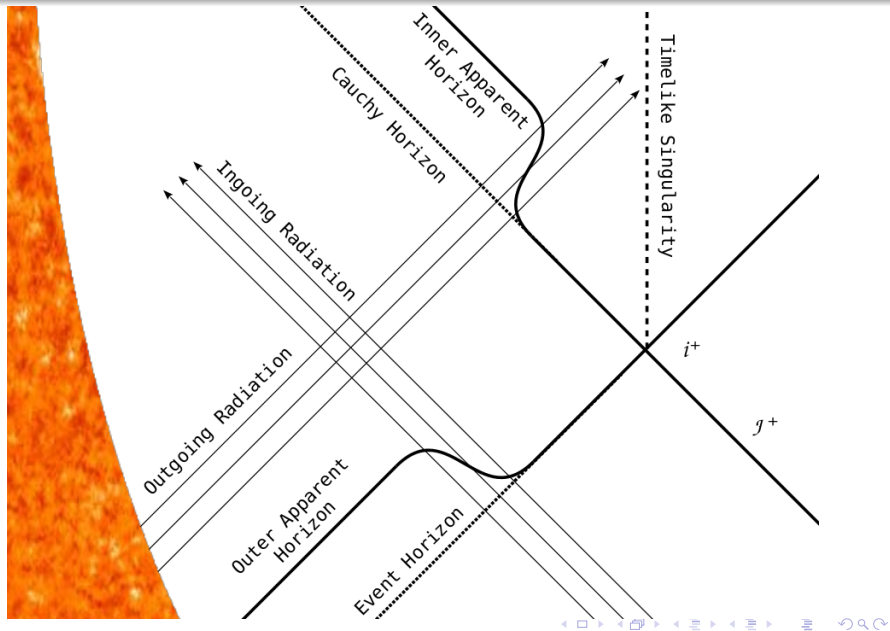
Charged BHs



Charged BHs



Charged BHs: accretion



$$S = \int d^4x \sqrt{-g} \left(R - 2\Lambda - F^2 - 2\Phi_{,\alpha}\Phi^{,\alpha} - 2\mu^2\Phi^2 \right)$$

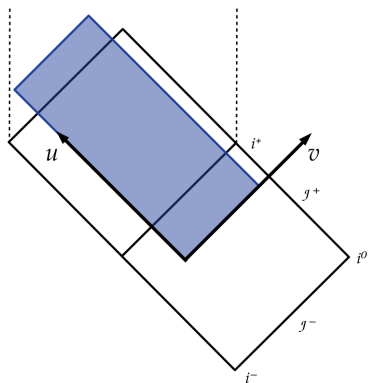
Spherically symmetric spacetimes:

$$ds^2 = -2e^{2\sigma(u,v)} du dv + r^2(u,v) d\Omega^2$$

$$F = F_{uv}(u,v) du \wedge dv, \quad \Phi = \Phi(u,v)$$

u and v are ingoing and outgoing (null) coordinates

Numerical evolutions



purely ingoing pulse:

$$\Phi(u_i, v) = Ae^{-\left(\frac{v-v_c}{w}\right)^2},$$

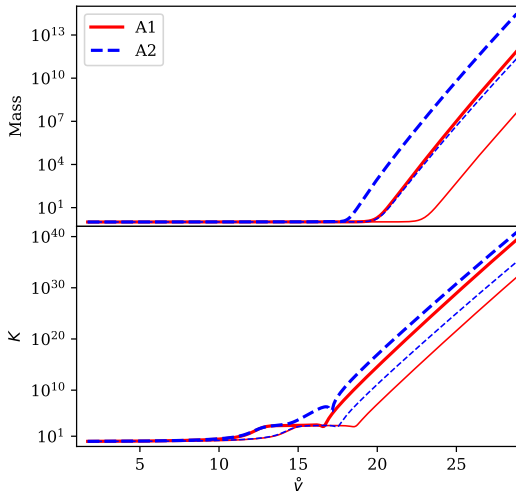
with outgoing flux (initially) set to zero:

$$\Phi_{,u}(u, v_i) = 0$$

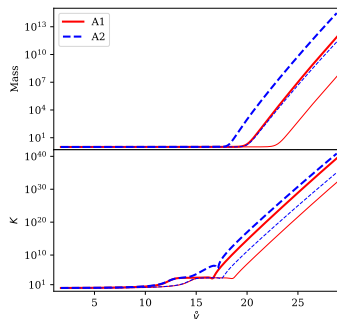
$$M(u, v) = \frac{r}{2} \left(1 + \frac{Q^2}{r^2} - \frac{\Lambda}{3} r^2 + 2e^{-2\sigma} r_{,u} r_{,v} \right)$$

- Scalar invariant measuring the energy content inside a sphere of radius $r(u, v)$
- Blow-up of this scalar signals the breakdown of the field equations

Results: $\Lambda = 0$



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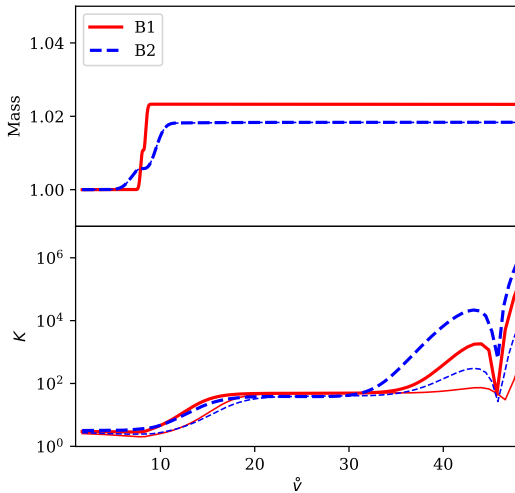
- Following outgoing (constant u) observers
- Thin lines evaluated at $u = u_{EH} + 1$ and thick lines evaluated at $u = u_{EH} + 2$

- Misner-Sharp mass is blowing up
- Geometry cannot be extended past the Cauchy Horizon
- SCC is safe

$$\Lambda \neq 0$$



Results: $\Lambda \neq 0$



- *No mass inflation* configurations in the presence of Λ
- SCC is not enforced by the field equations
- Rotating configurations?
- Other field content?