Black Holes and Naked Singularities

BCGS weekend seminar
Physikzentrum Bad Honnef

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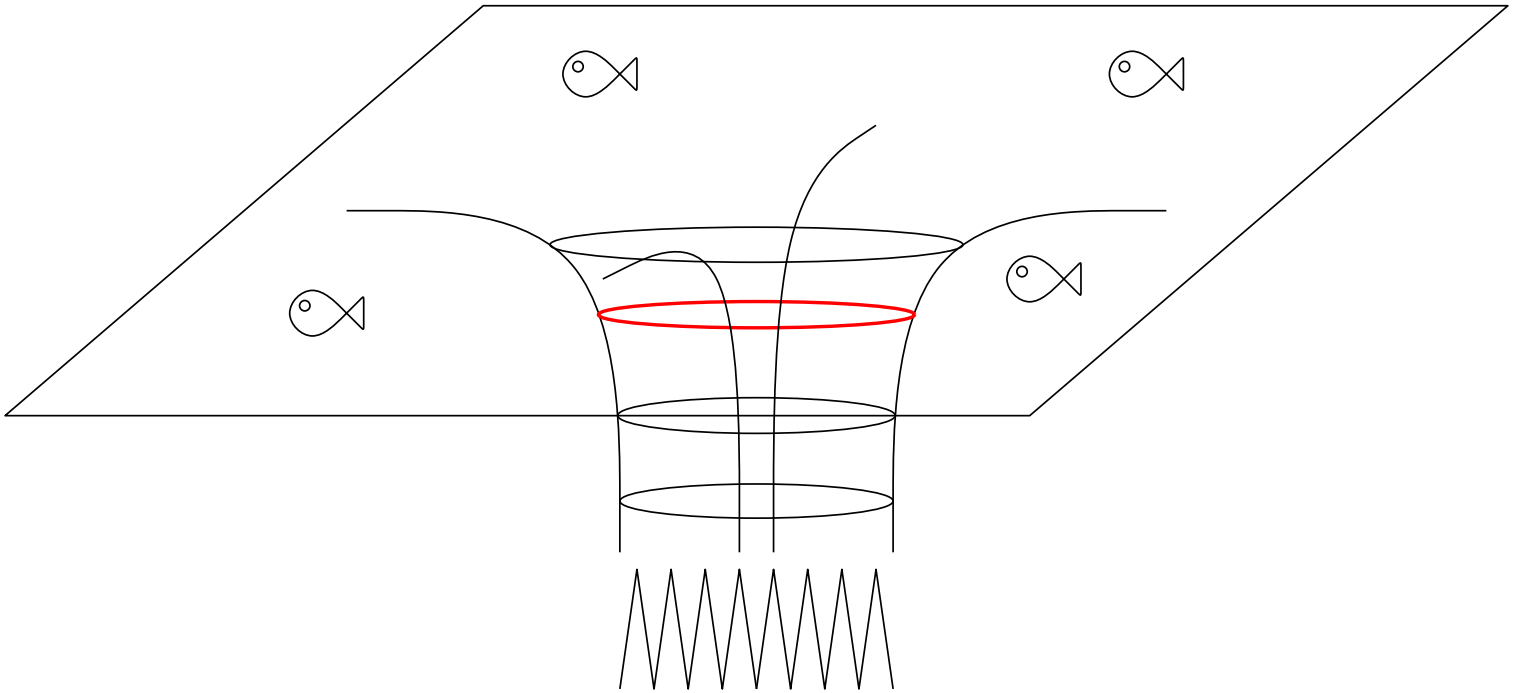
Outline

Black holes

Before we can talk about naked singularities we have to talk about so-called **black holes:**



The Schwarzschild metric

The metric for a static non-charged radial-symmetric black hole is given by the so-called **Schwarzschild metric**:

$$\mathrm{d}s^2 = -\left(1 - \frac{2M}{r}\right)\mathrm{d}t^2 + \left(1 - \frac{2M}{r}\right)^{-1}\mathrm{d}r^2 + r^2\mathrm{d}\Omega^2, \qquad (1)$$

where M is the mass of the object.

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$$\lim_{r\to 2M}\left(1 - \frac{2M}{r}\right) = 0. \tag{2}$$

$$\lim_{r\to 0}\left(1 - \frac{2M}{r}\right) = -\infty. \tag{3}$$

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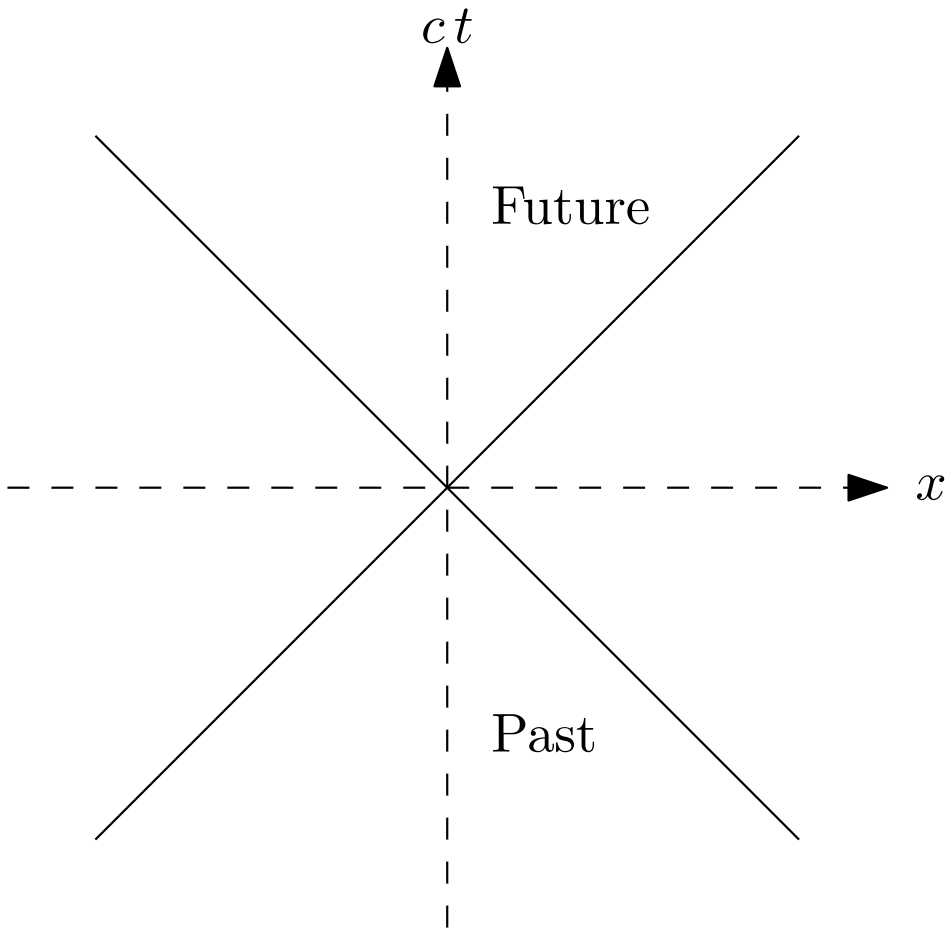
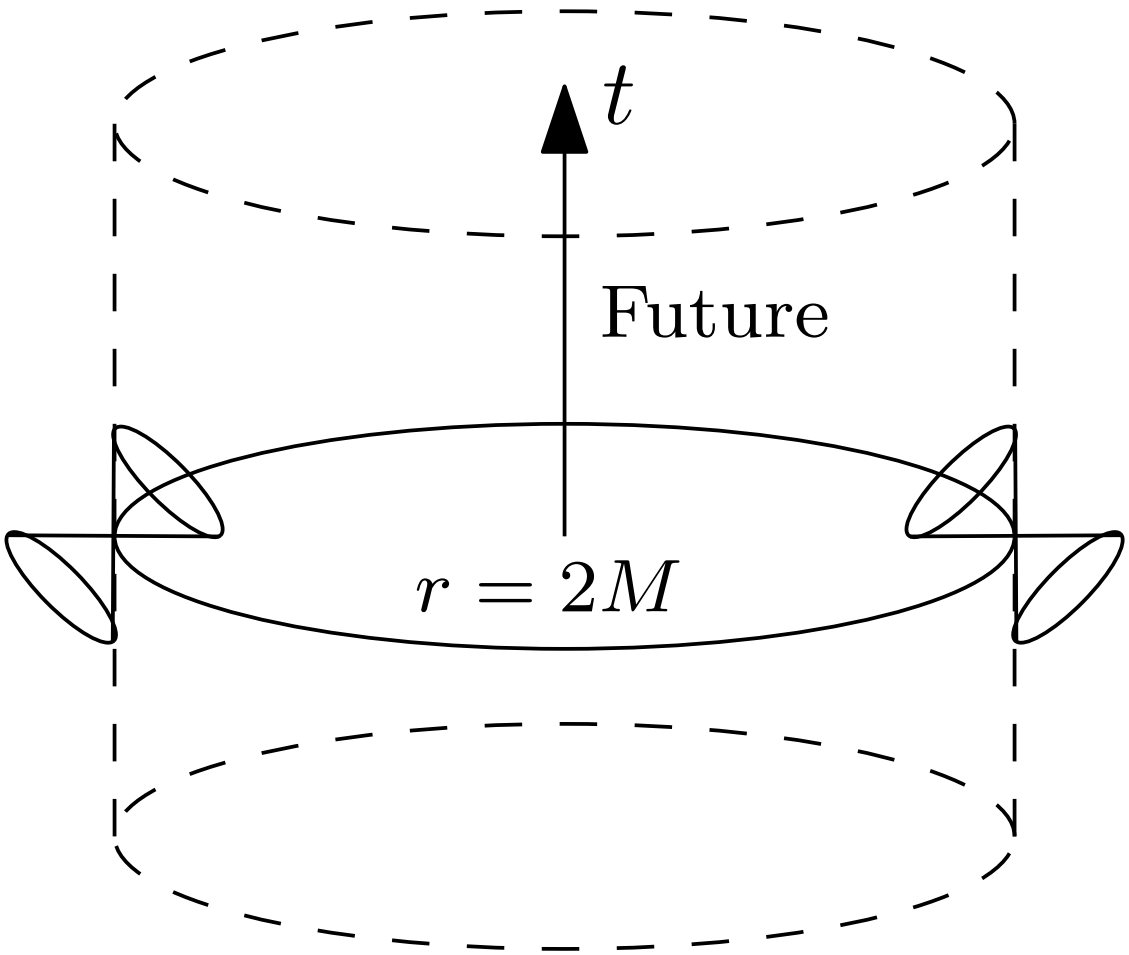


Event horizon

Then for the Schwarzschild black hole:



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- Exact calculations are in general very difficult or impossible.
- The so-called **LTB-model** is a completely solvable model with radial symmetry(like the Schwarzschild metric):

$$\mathrm{d}s^2 = -\mathrm{d}t^2 + \frac{R'(t,r)^2}{1+2E(r)}\mathrm{d}r^2 + R^2(t,r)\mathrm{d}\Omega^2, \tag{4}$$

where $R(t,r)$ and $E(r)$ are some unknown functions.

Causality

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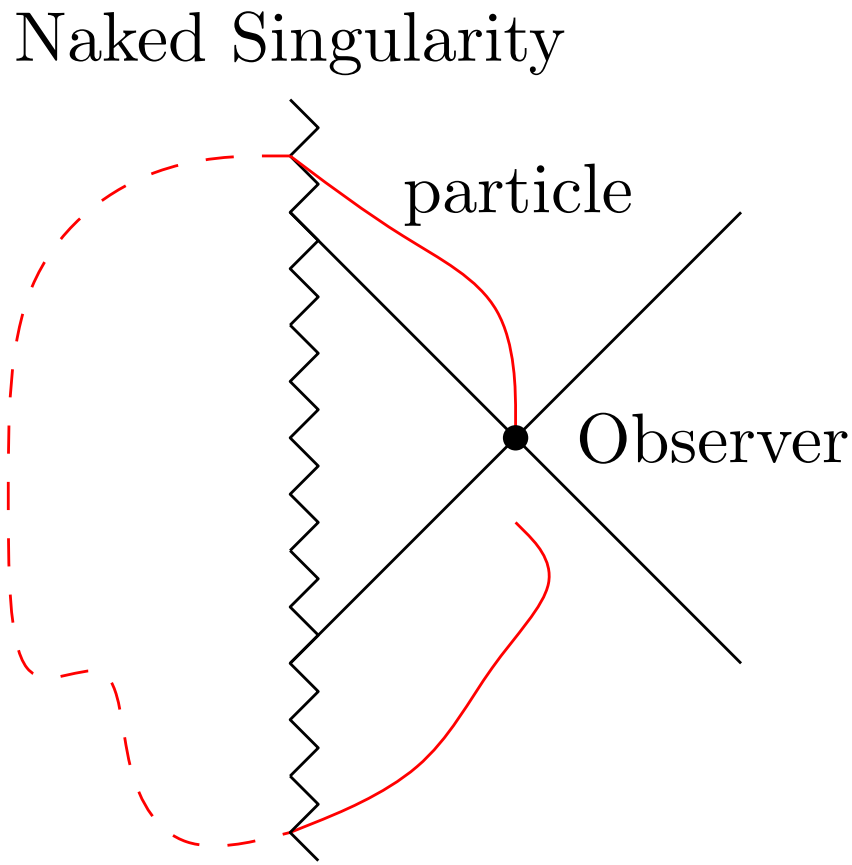

Cosmic censorship

In 1969 Roger Penrose formulated the so-called **cosmic censorship hypotheses:**

Theorem (Cosmic censorship hypotheses)

Weak case: *There is no singularity visible from future null infinity. In other words, singularities need to be hidden from an observer at infinity by the event horizon of a black hole.*

Strong case: *General relativity is a deterministic theory, in the same sense that classical mechanics is a deterministic theory. In other words, the classical fate of all observers should be predictable from the initial data.*

Quantum Gravity

So the main question of my thesis is:

> Are naked singularities absent if one considers quantum mechanics together with general relativity?

I will try to apply the procedure of **canonical quantization** to a solution of the LTB-model which has a naked singularity and I will study the properties of the outcome.

Thanks for your attention!