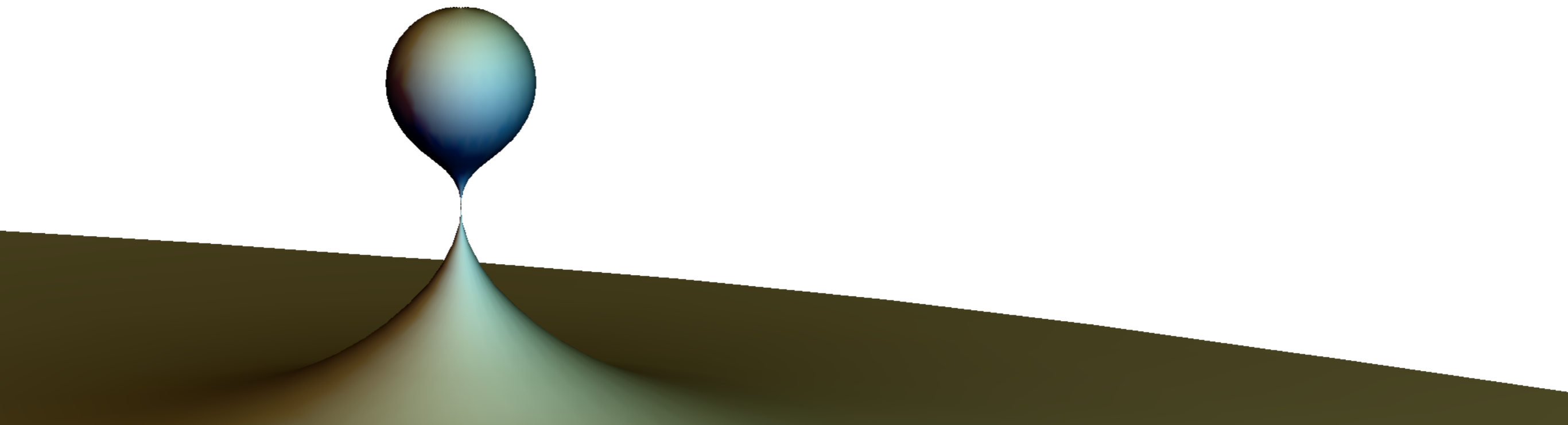


# Black Hole Mergers

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Marina Martínez Montero  
KU Leuven



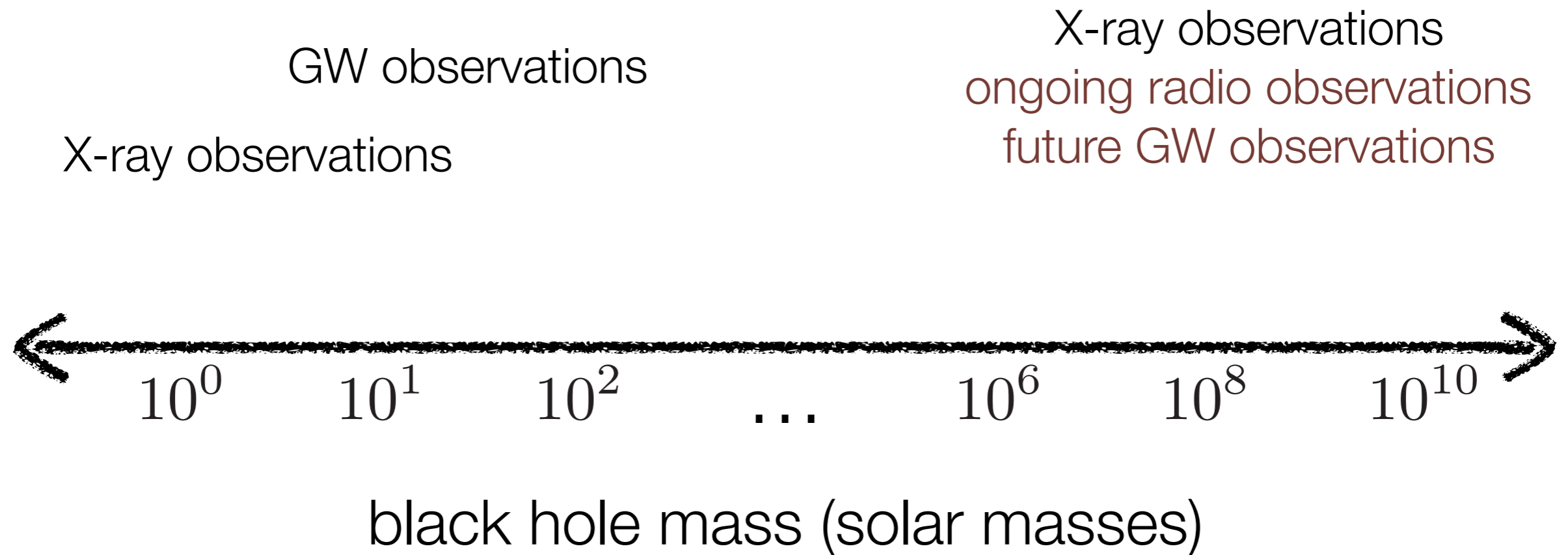


# Black holes

Black hole shadow in front of the milky way.  
Image credit: ESA.

# Black holes in nature

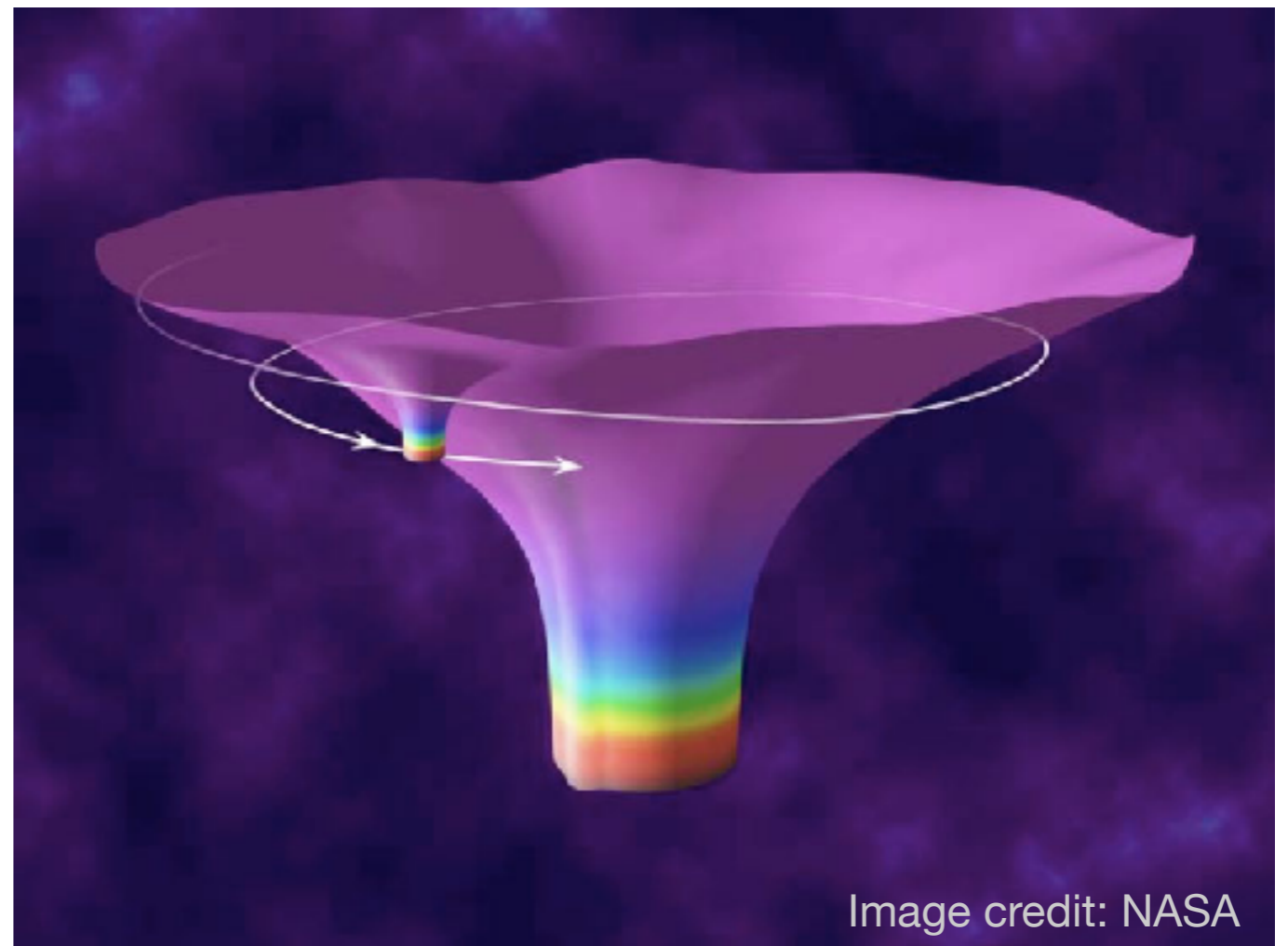
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# Black holes and black hole mergers

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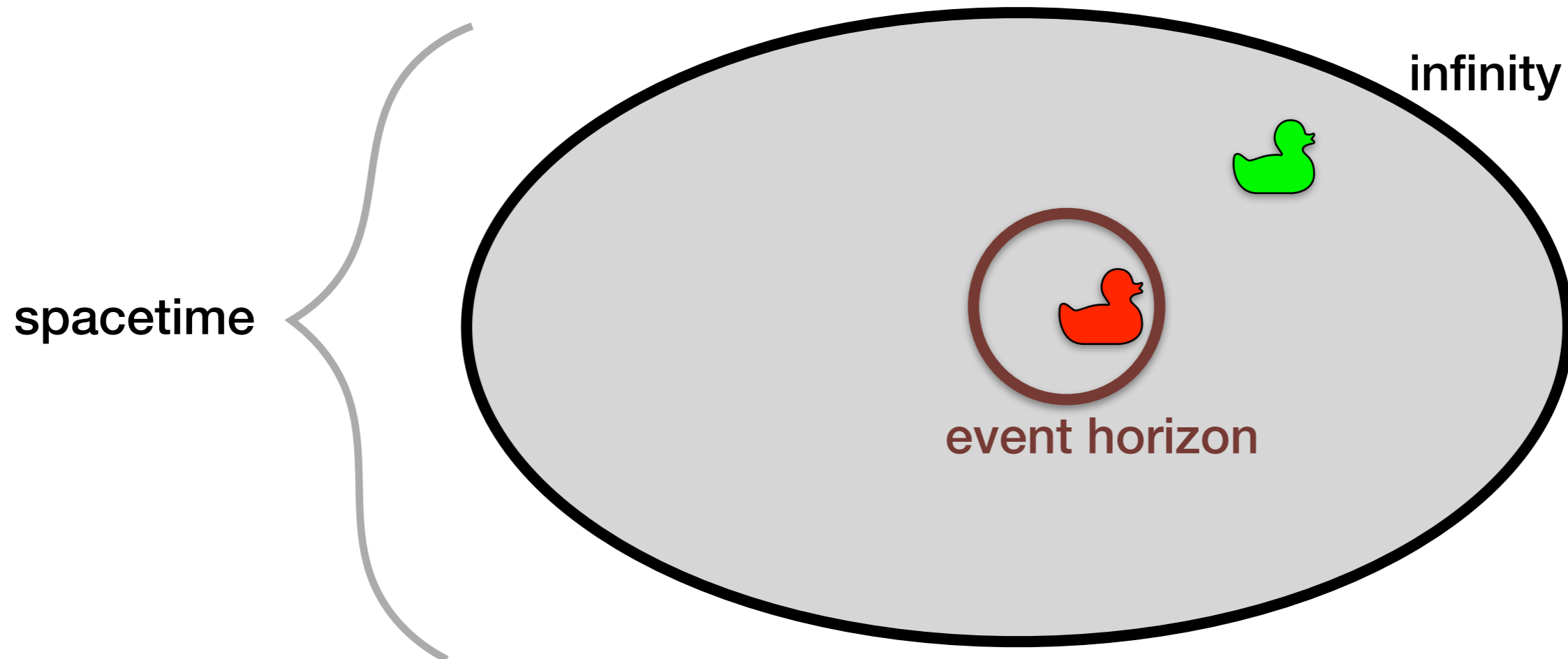
- GWs
- Shadows
- Event horizons



# Event horizon

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Null surface in spacetime that separates the points that are causally connected to asymptotic infinity from those that are not



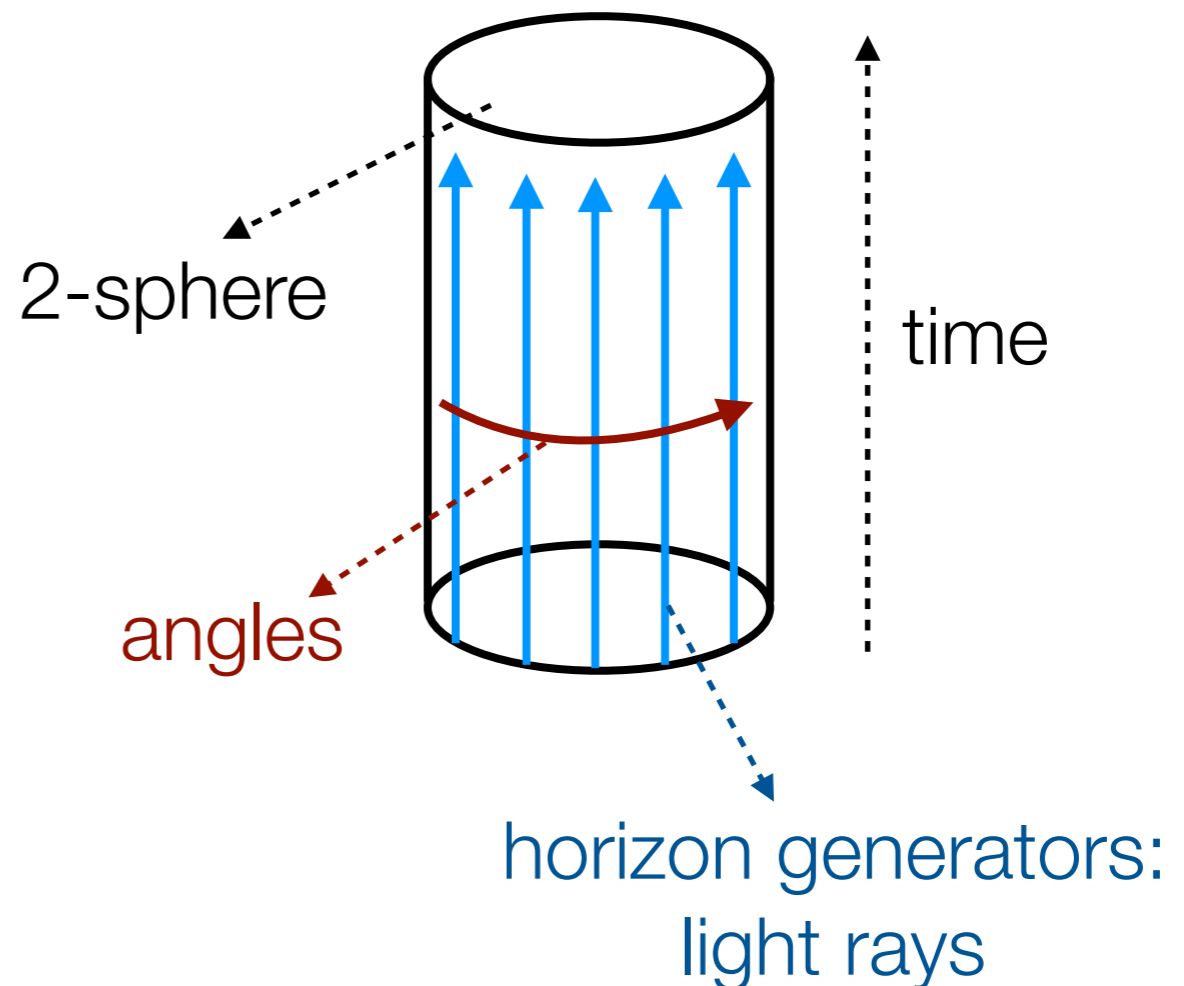
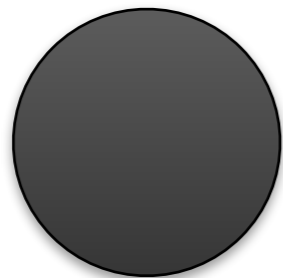
# Event horizon

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Null surface in spacetime that separates the points that are causally connected to asymptotic infinity from those that are not

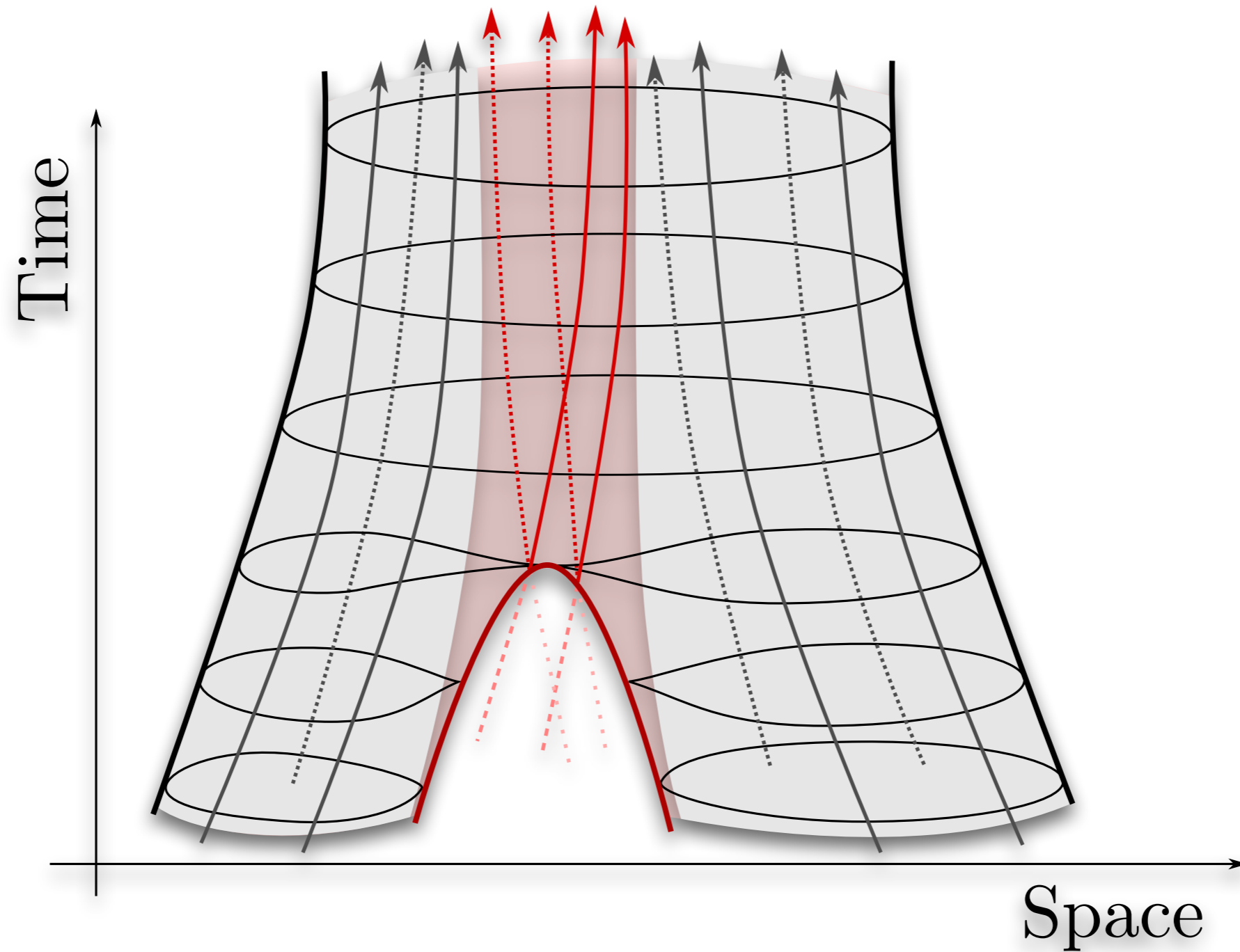
Schwarzschild example:

2-sphere



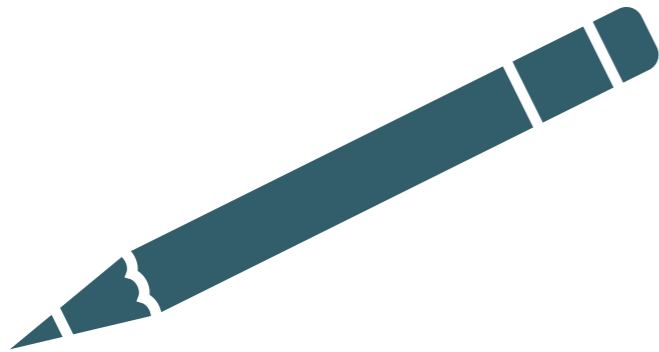
# Event horizon of a black hole merger

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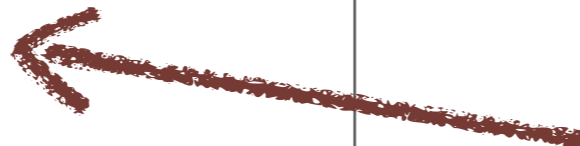


# How do people study event horizons?

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very symmetric  
static or stationary  
black holes



black hole mergers

or

less symmetric  
stationary black holes



# Extreme mass ratio black hole mergers

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$$\frac{m}{M} \ll 1$$

$m$   
●

$m$  fixed

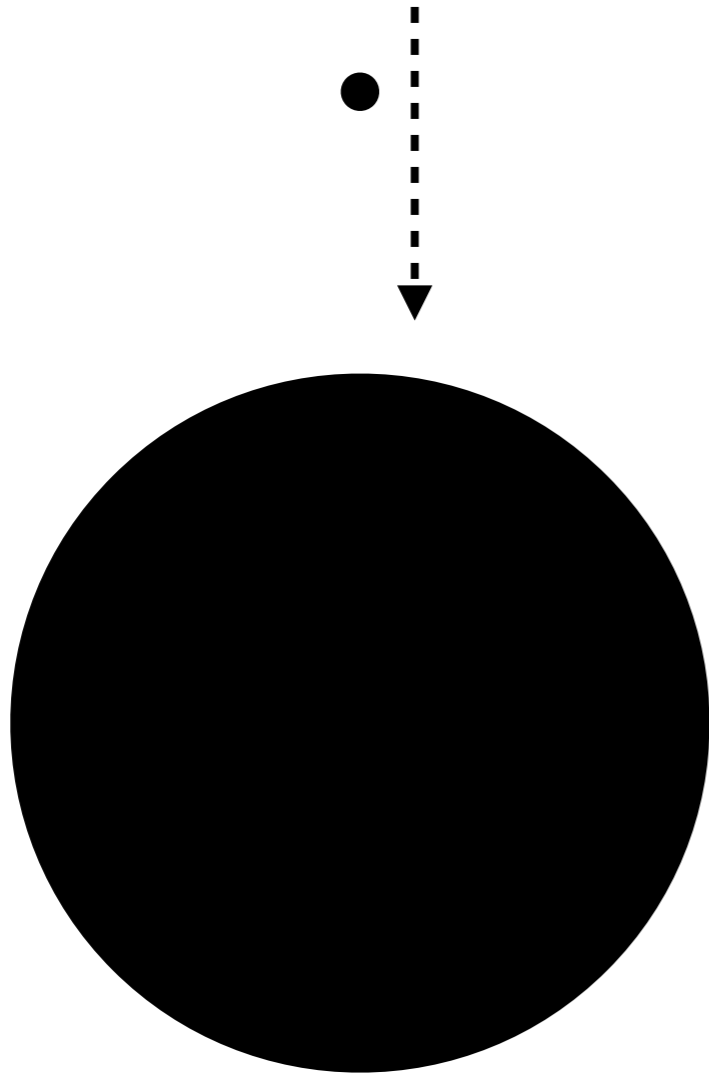
$$M \rightarrow \infty$$

$M$

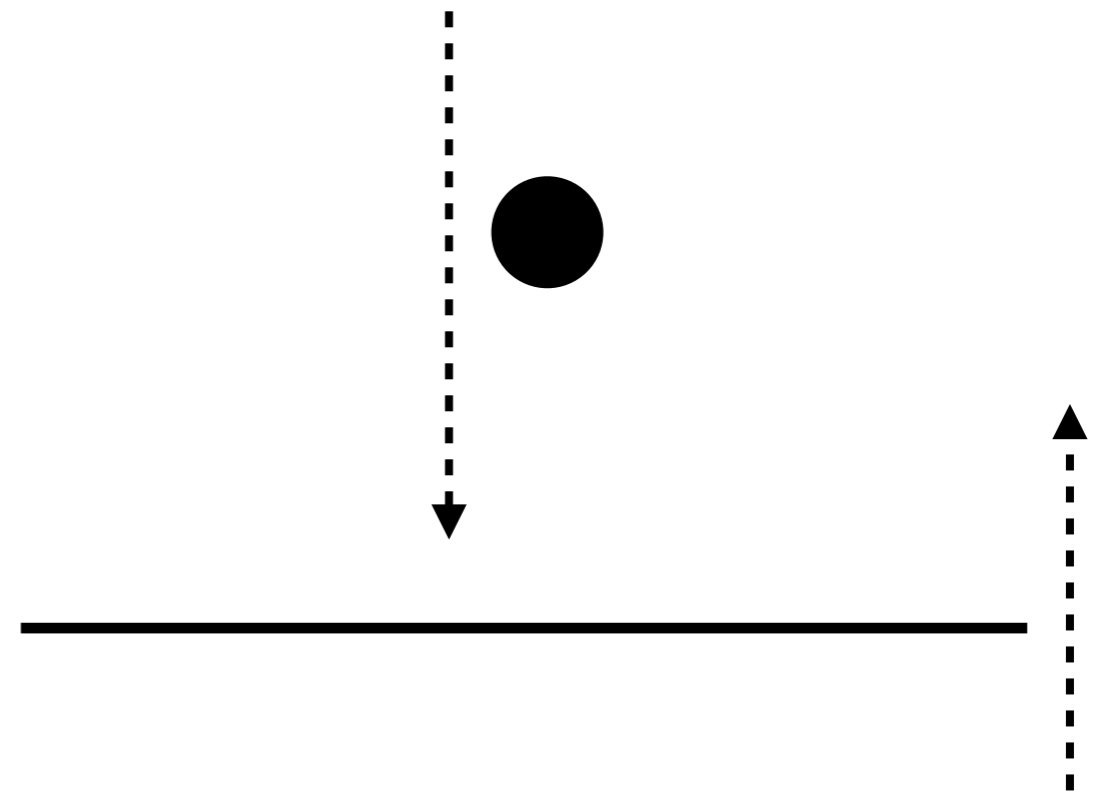


# Our construction

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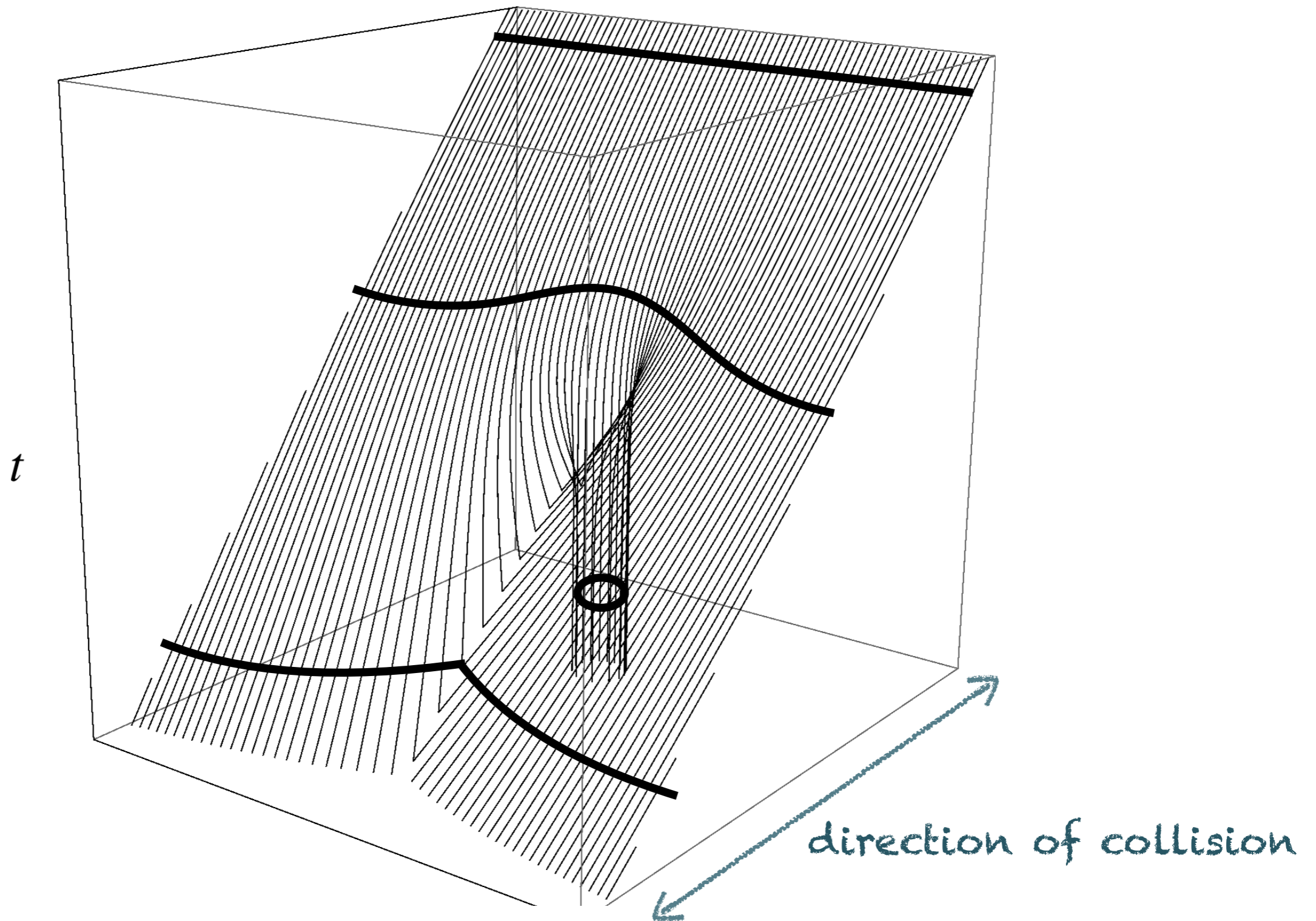
Curvature dominated  
by small black hole



We integrate geodesics in the spacetime of the small black hole

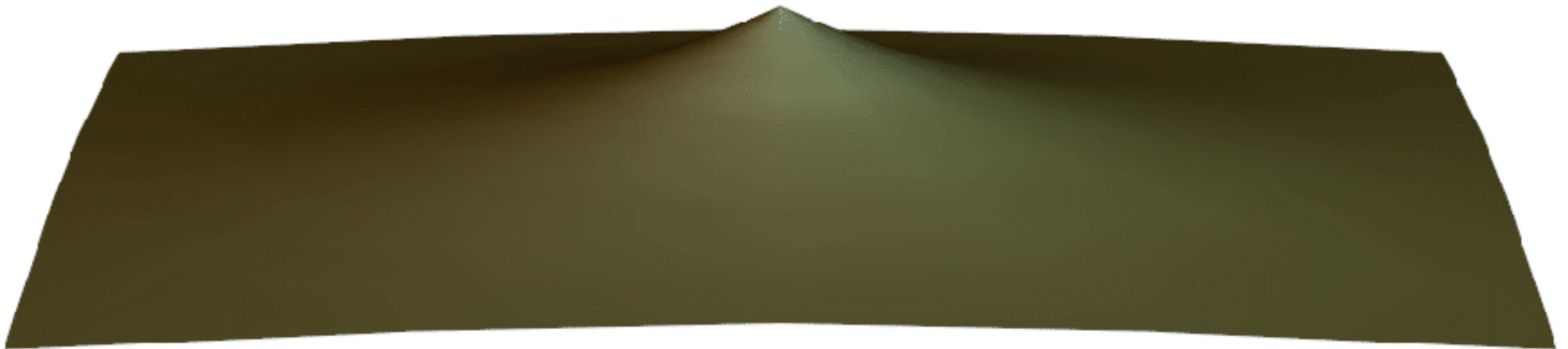
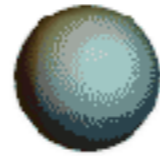
# Event horizon and constant time slices

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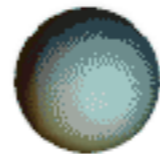
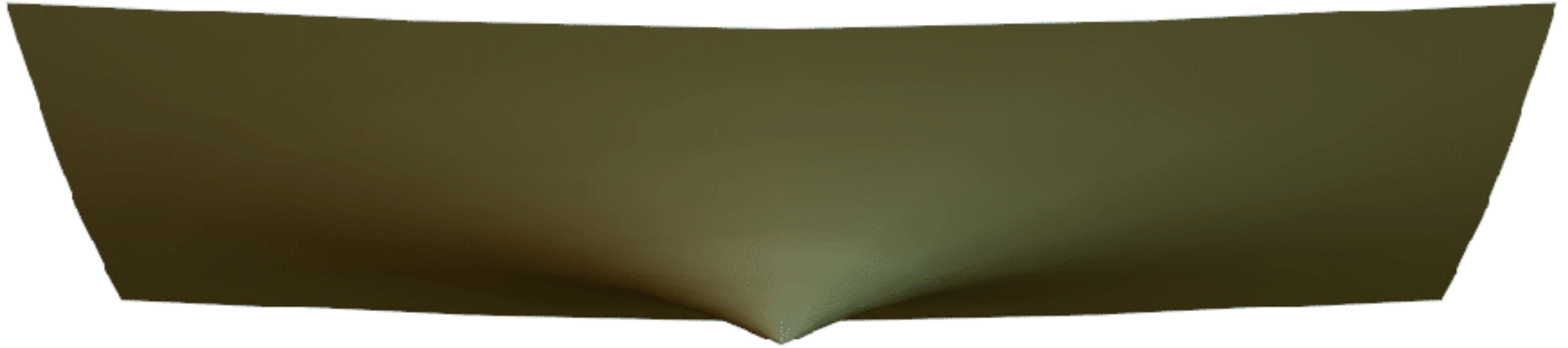
# Extreme mass ratio merger

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# Extreme mass ratio merger

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# merger instant

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same behaviour in  
3+1 and 4+1 dimensions

$$\Delta \propto |t|^{1/2}$$

throat growth  $\propto t$

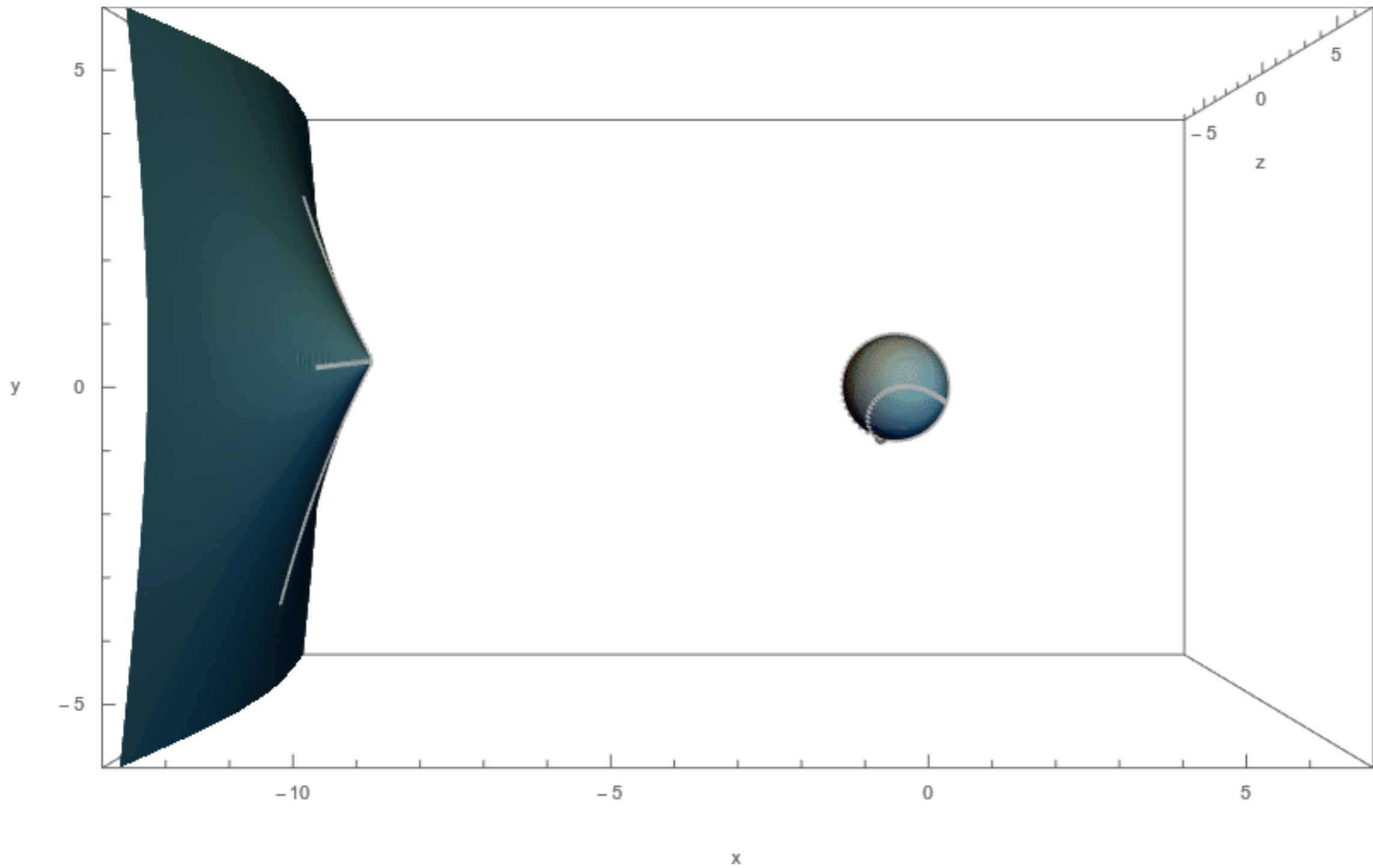
same behaviour in  
equal mass merger  
[arXiv:gr-qc/0303109]

non axisymmetric mergers are different!

# final comments

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- Extreme mass ratio inspirals (EMRIs) will be observed by LISA and they are far from being well modelled.
- We are working now on including finite size corrections to the extreme mass ratio merger (hopefully bring back GWs).
- There are people in Leuven (Kwinten Fransen, Thomas Hertog) and Brussels (Geoffrey Compère, Jiang Long) who have done a very nice work on EMRIs. Check out their paper: “Gravitational waves from plunges into Gargantua”.

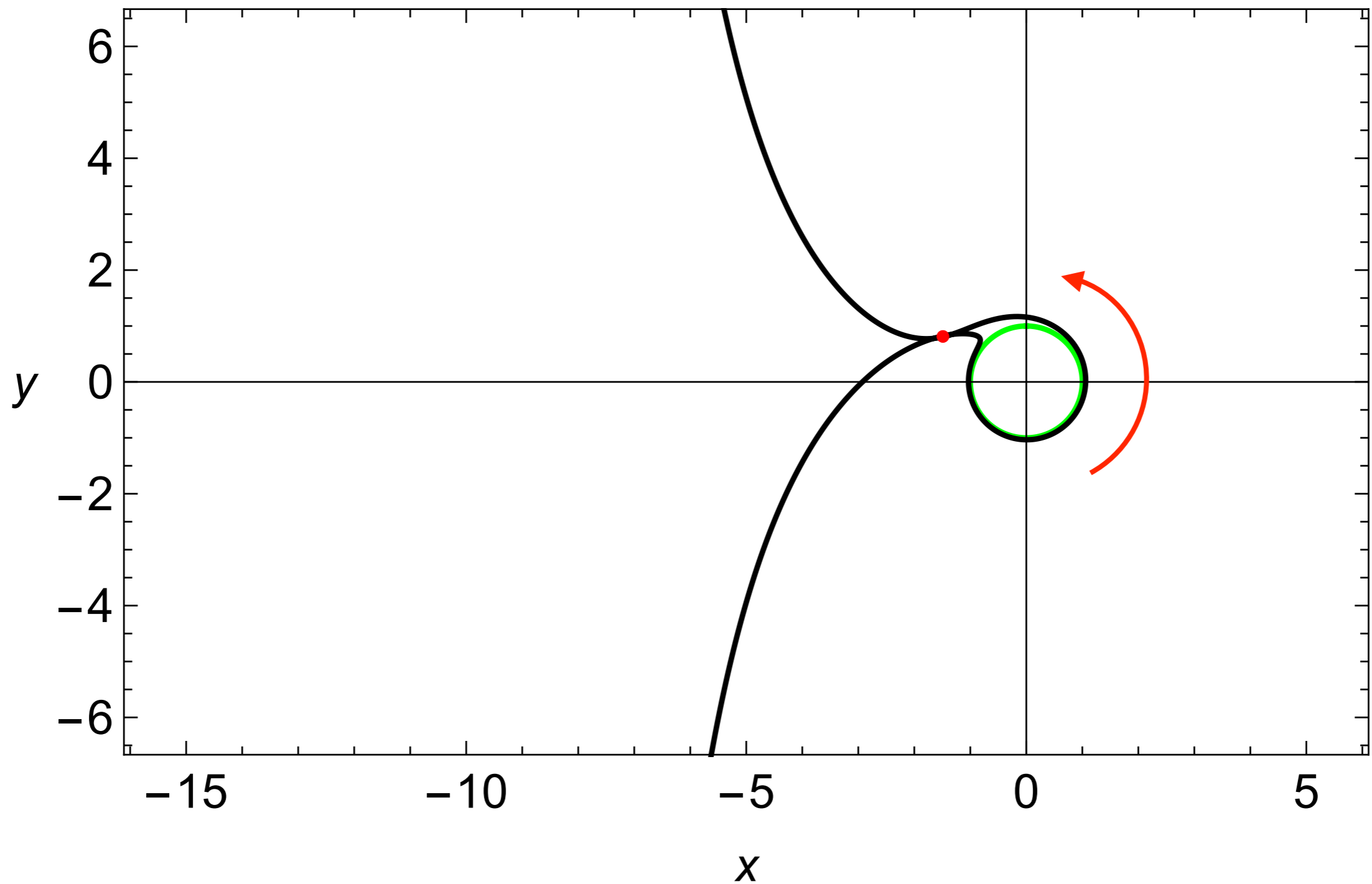


Thank you for your attention!



# Non-axisymmetric black hole mergers

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# Toroidal topology in non-axisymmetric mergers

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