# Theoretical Astrophysics

The Niels Bohr International Academy
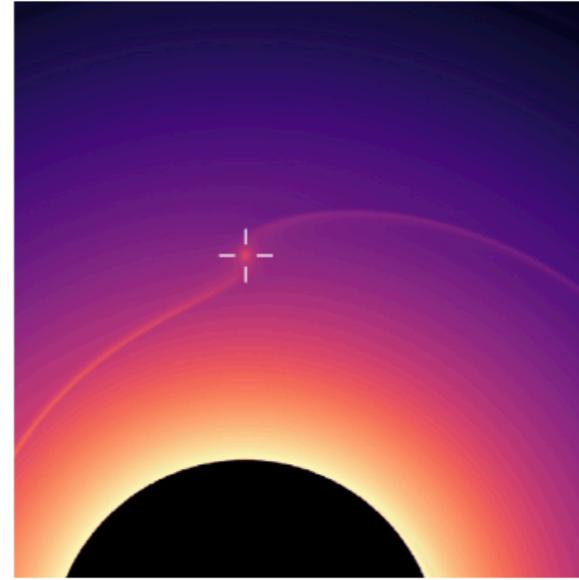
Martin Pessah

mpessah@nbi.dk

Astrophysical Dynamics
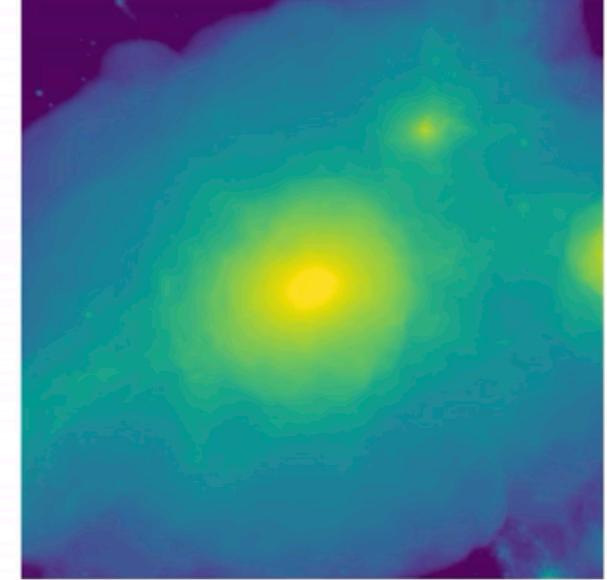
Accretion Disks & Black Hole Binaries

Protoplanetary Disks & Planet Formation
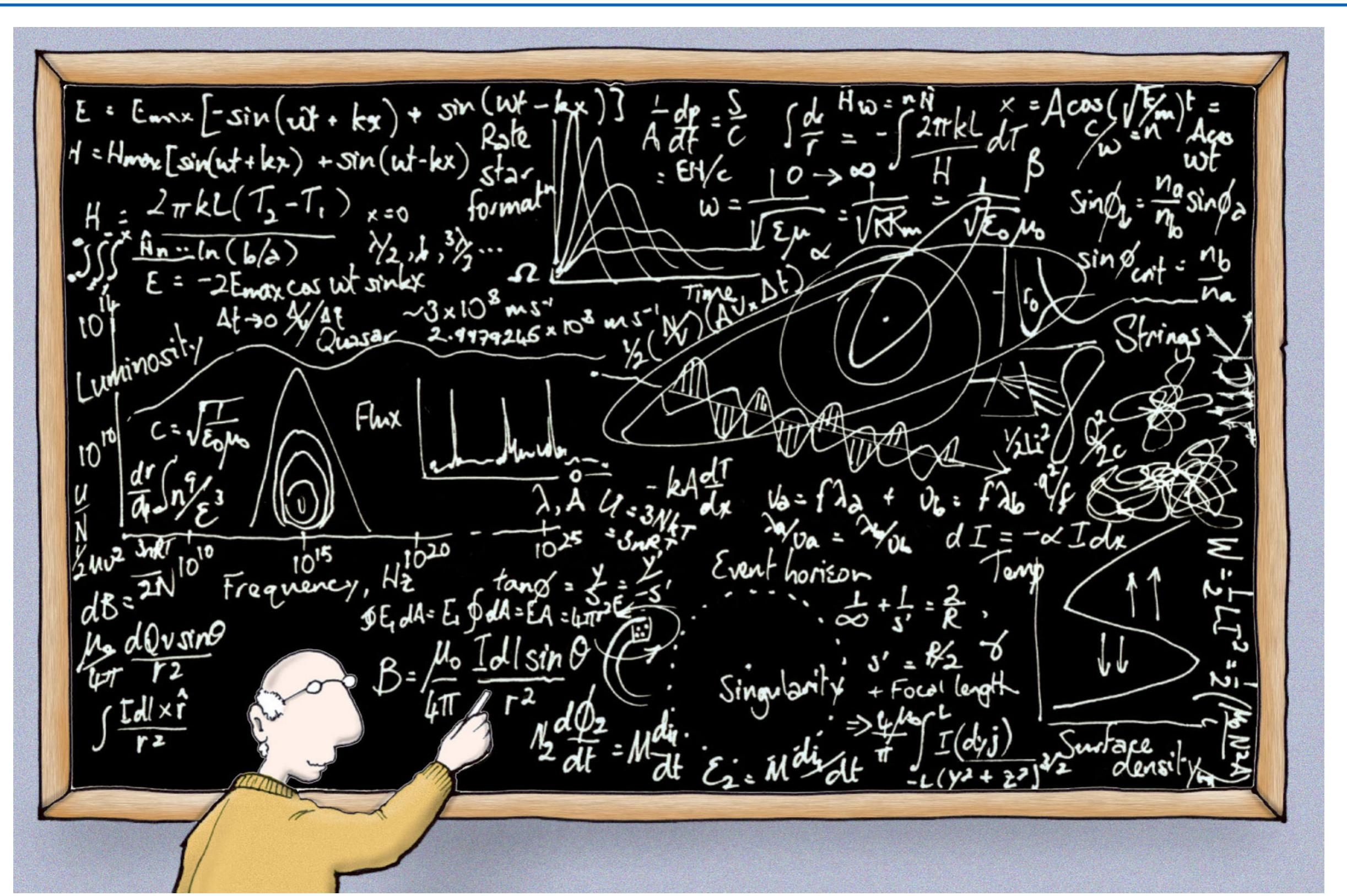
Tidal Disruptions & Massive Black Holes

Galaxy Clusters & Cosmology
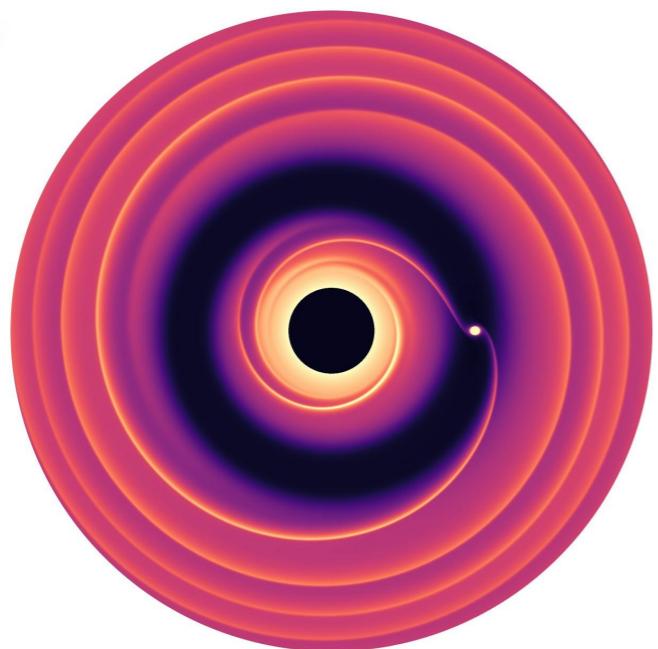
Understand the dynamics of astrophysical systems to learn about the physical properties of planets, stars, black holes, and galaxies.

How?
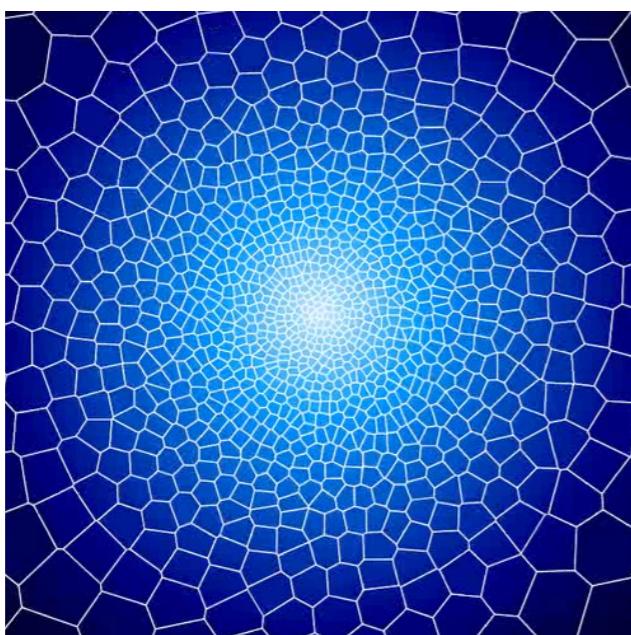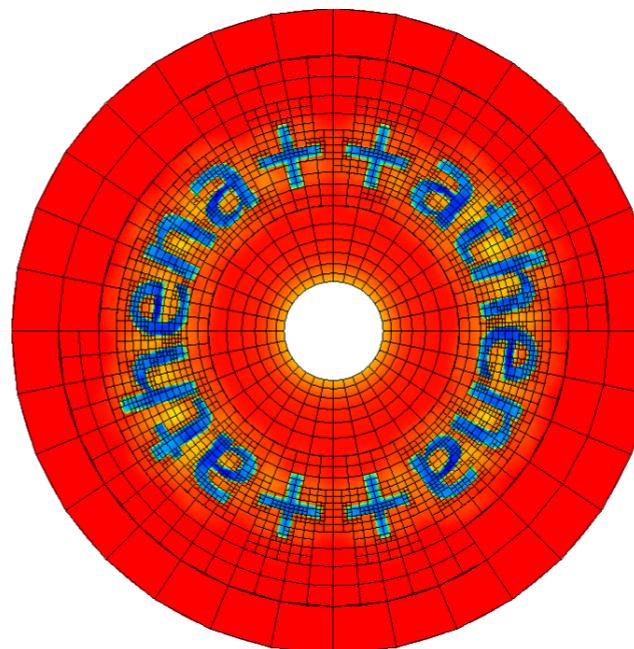
# State-of-the-art Numerical Codes
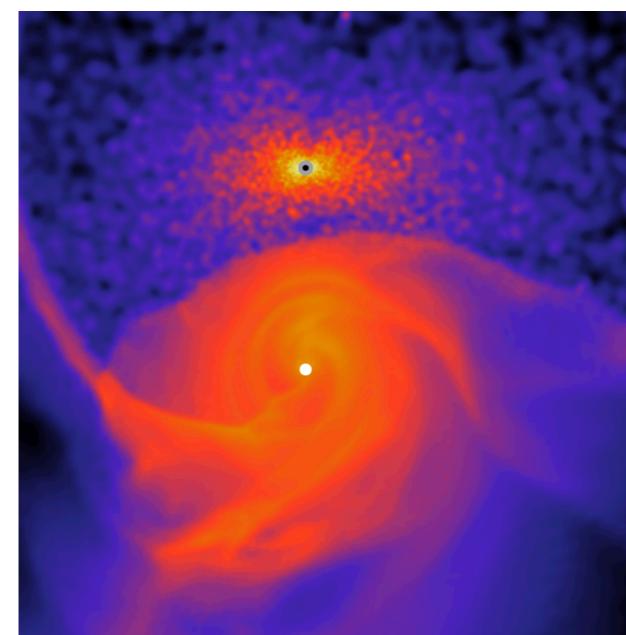
FARGO3D

ATHENA++

AREPO
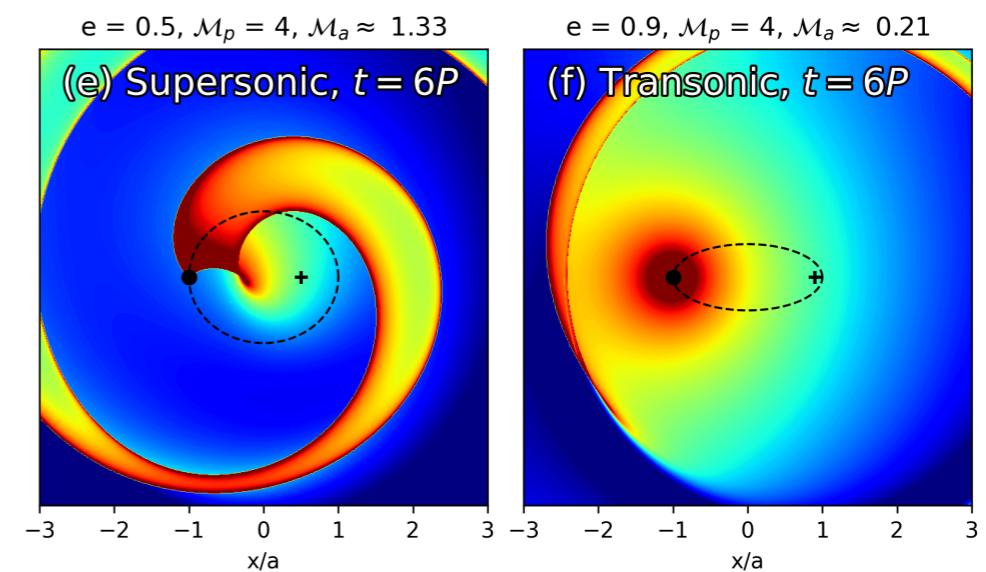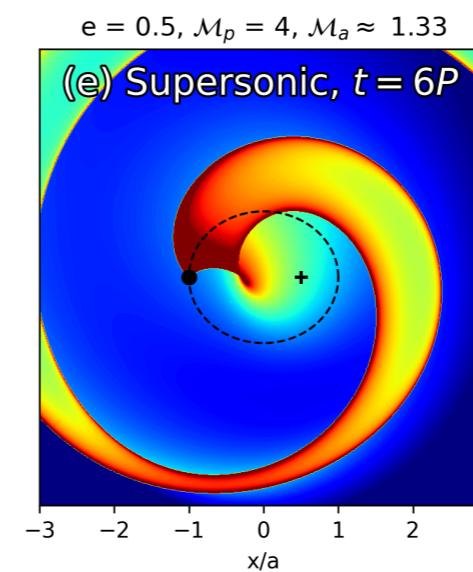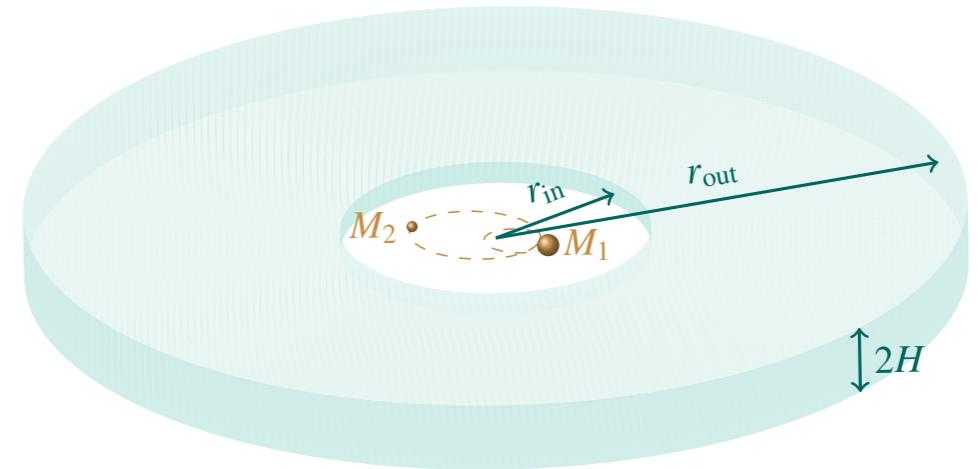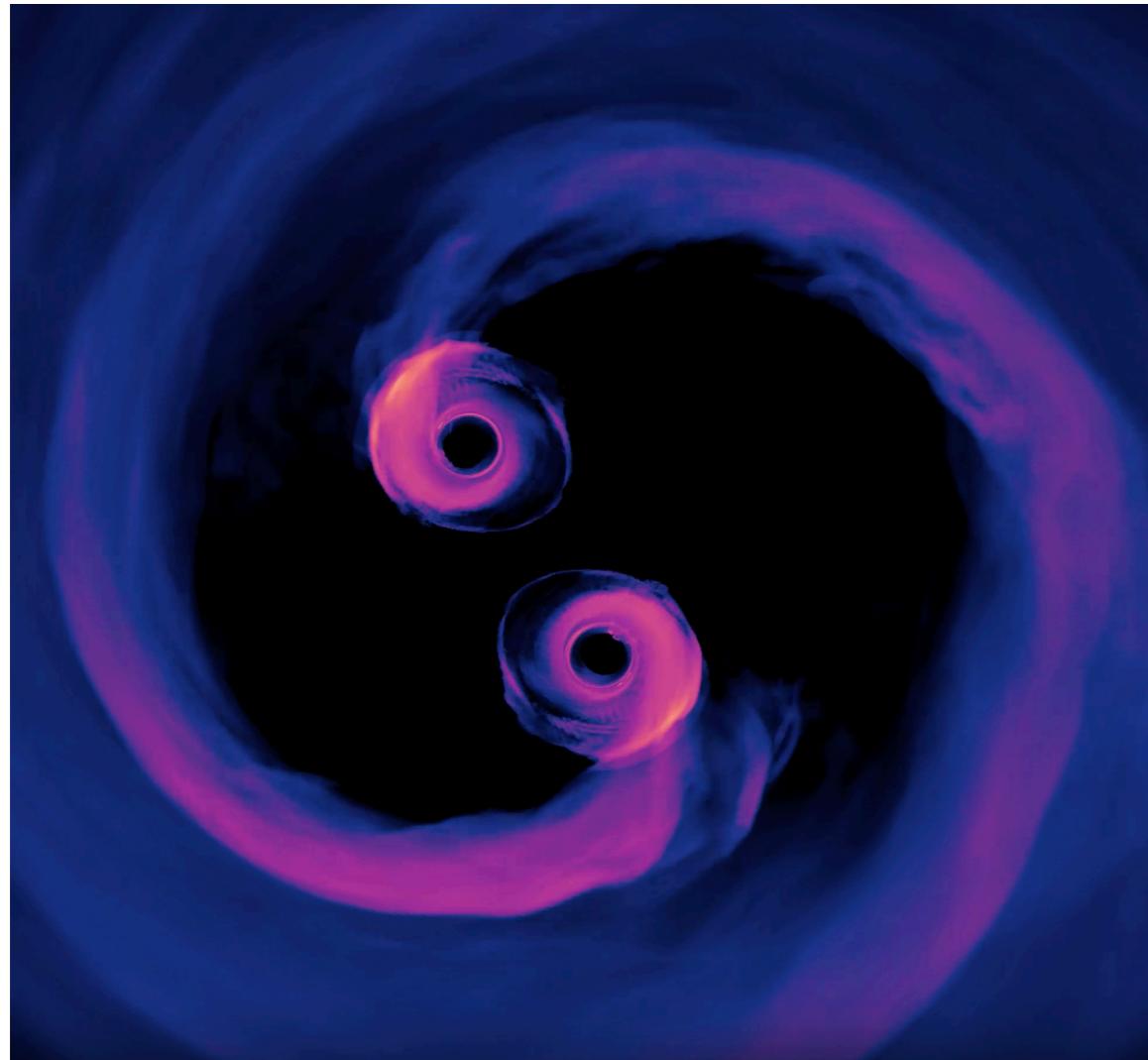
GIZMO

Sailfish

Supercomputers

Black Hole Binary Systems

e = 0.5, $\mathcal{M}_p = 4$, $\mathcal{M}_a \approx 1.33$

(e) Supersonic, $t = 6P$

e = 0.9, $\mathcal{M}_p = 4$, $\mathcal{M}_a \approx 0.21$

(f) Transonic, $t = 6P$
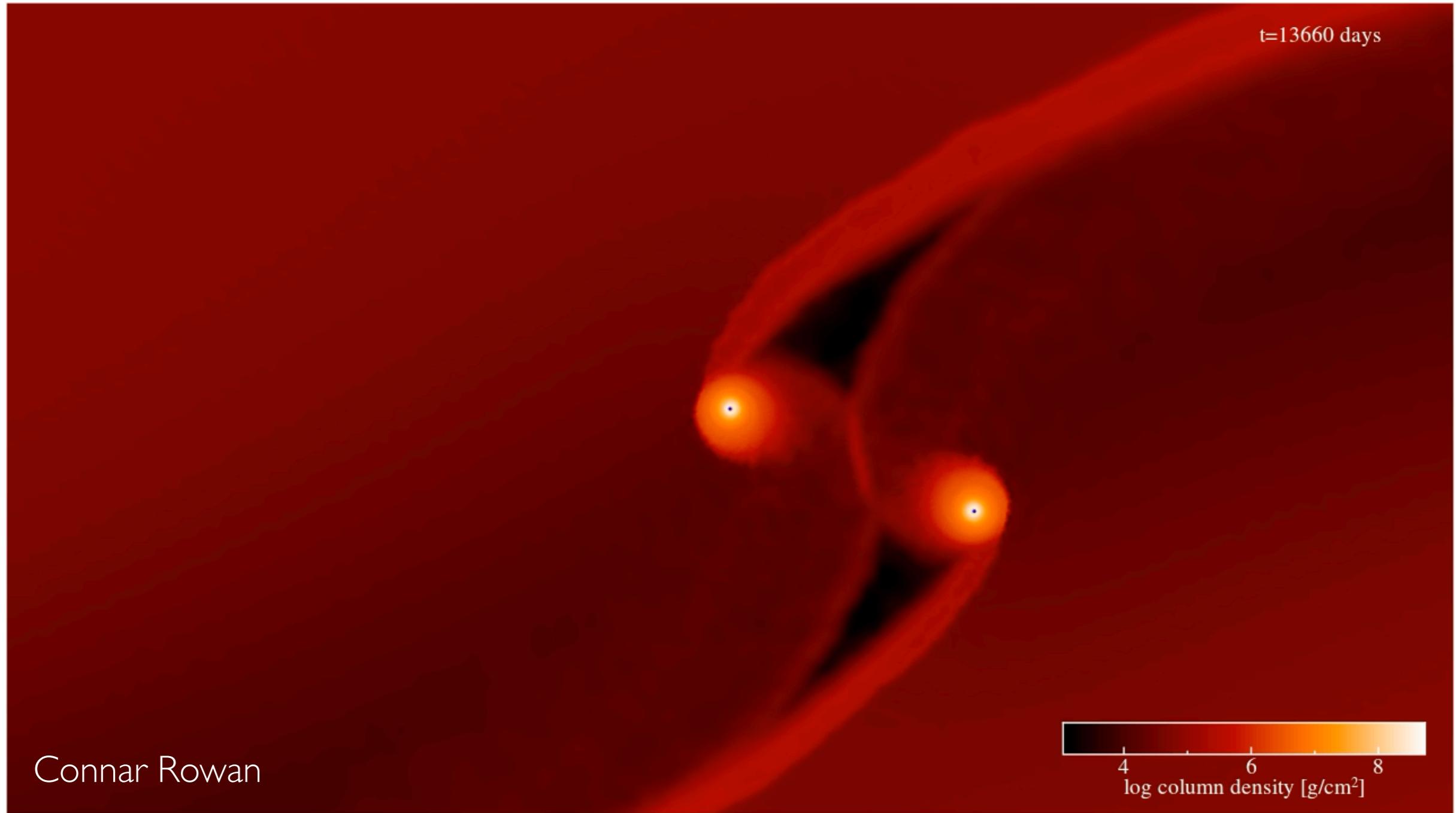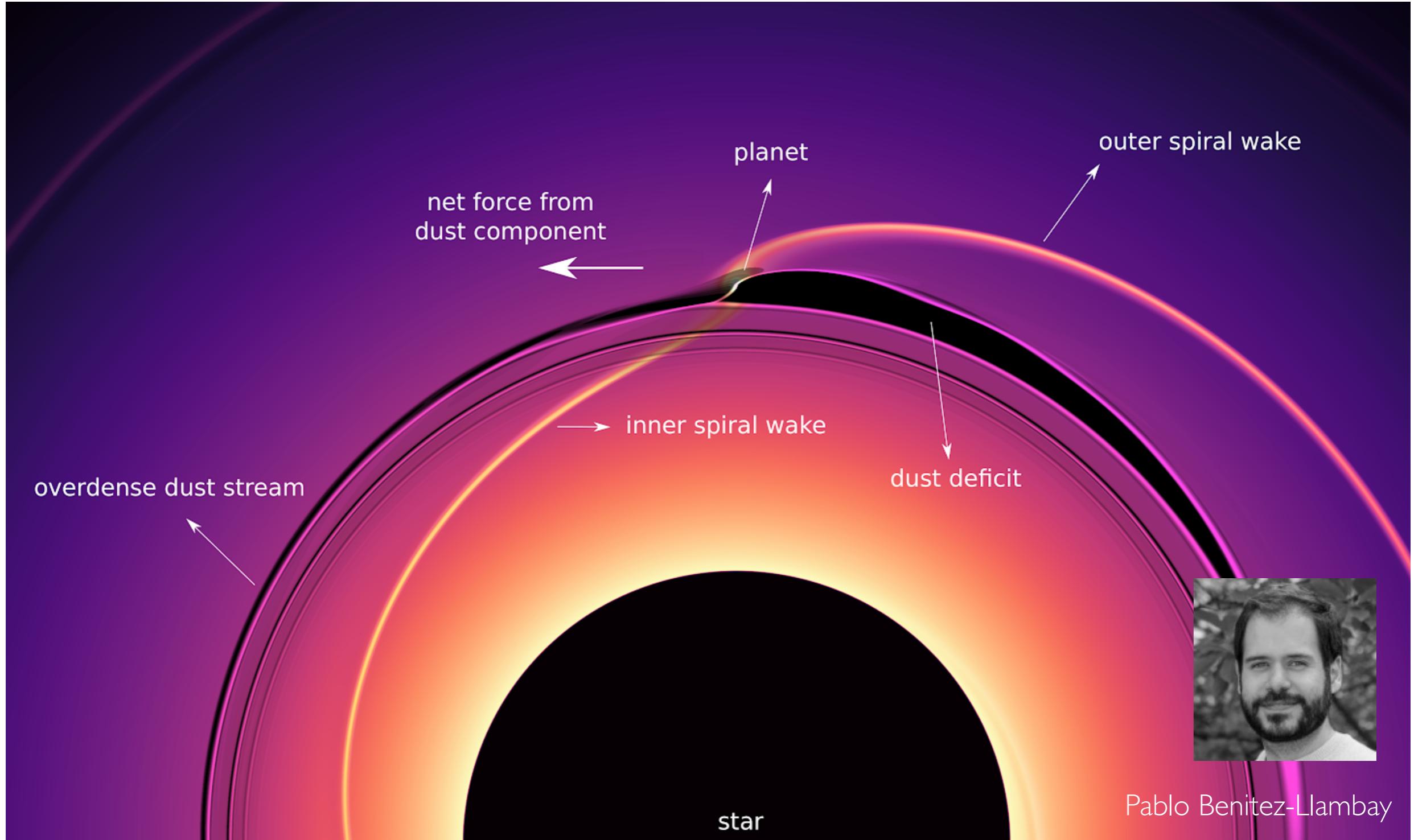
Black hole binaries in all mass rages in gaseous media

Black Hole Binary Systems

t=13660 days

Connar Rowan

log column density [g/cm²]
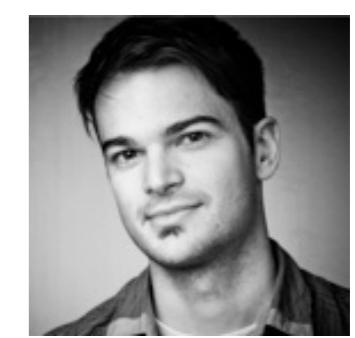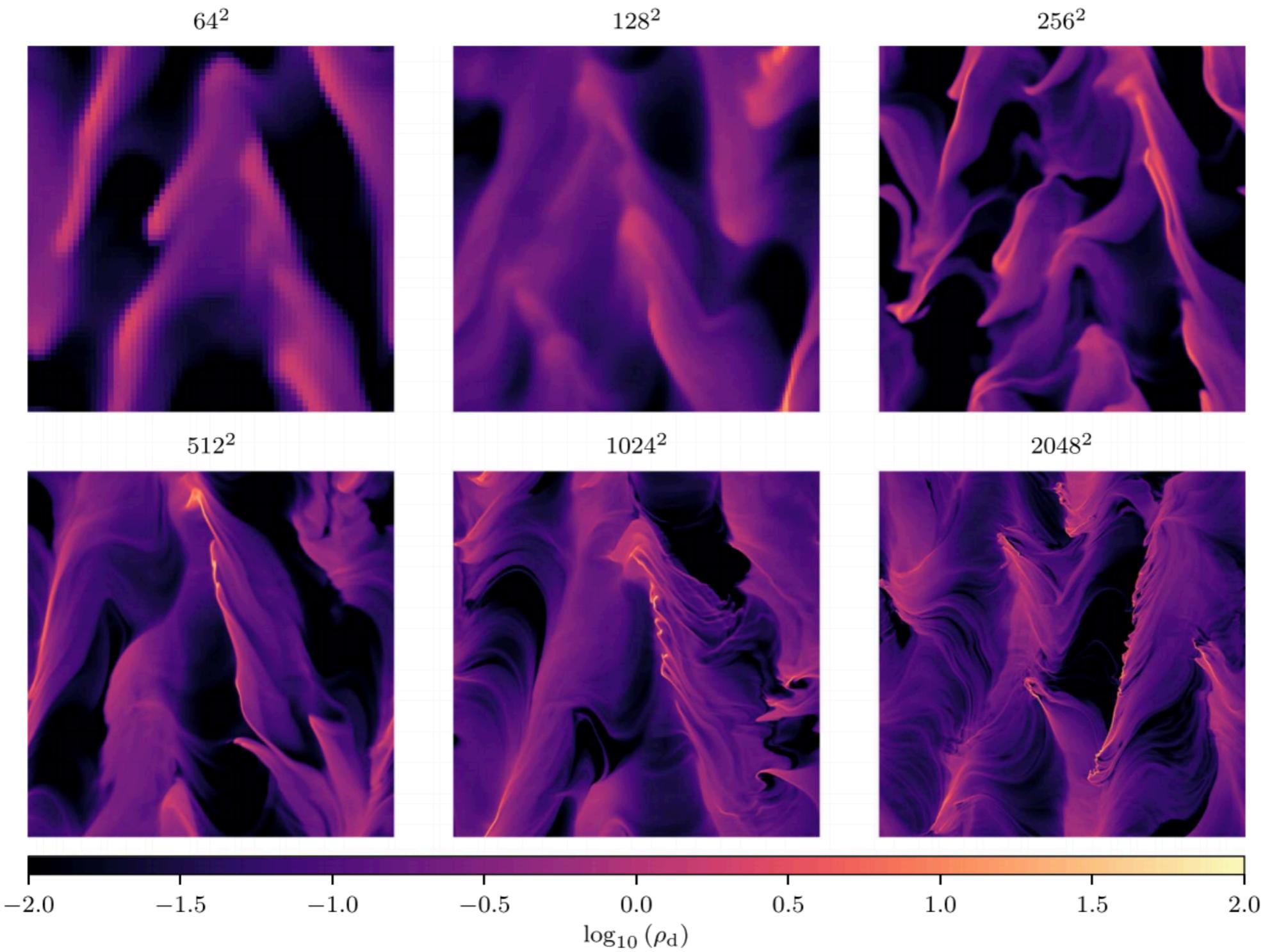
Dust & Planetary Migration
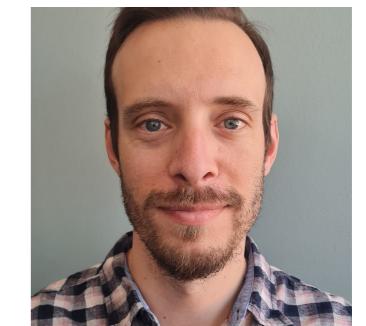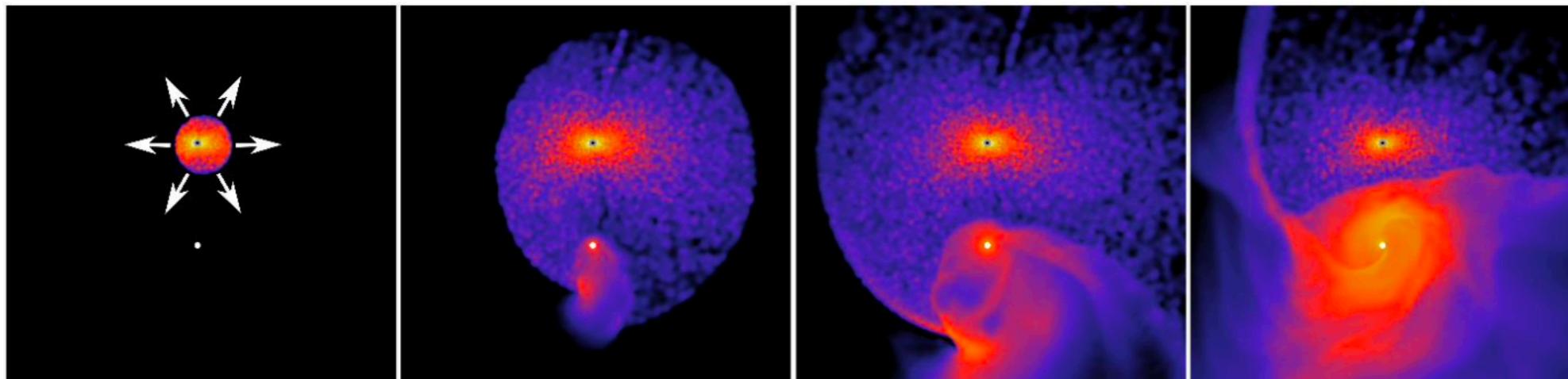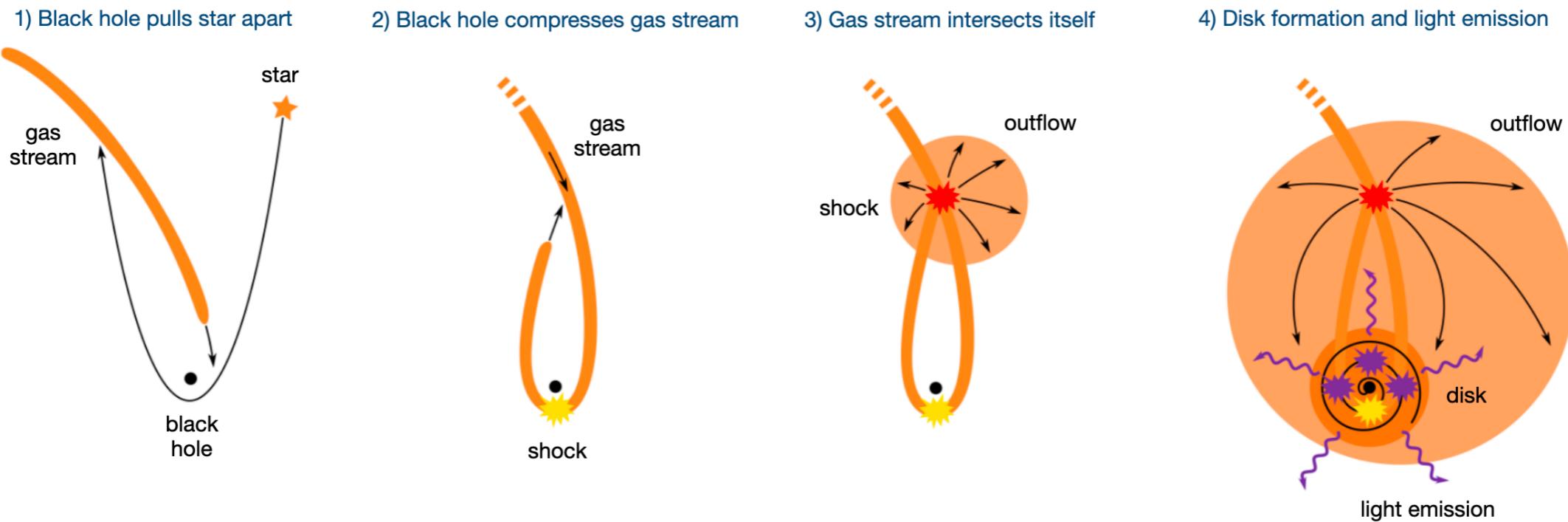

Pablo Benitez-Llambay

Key Processes in Planet Formation
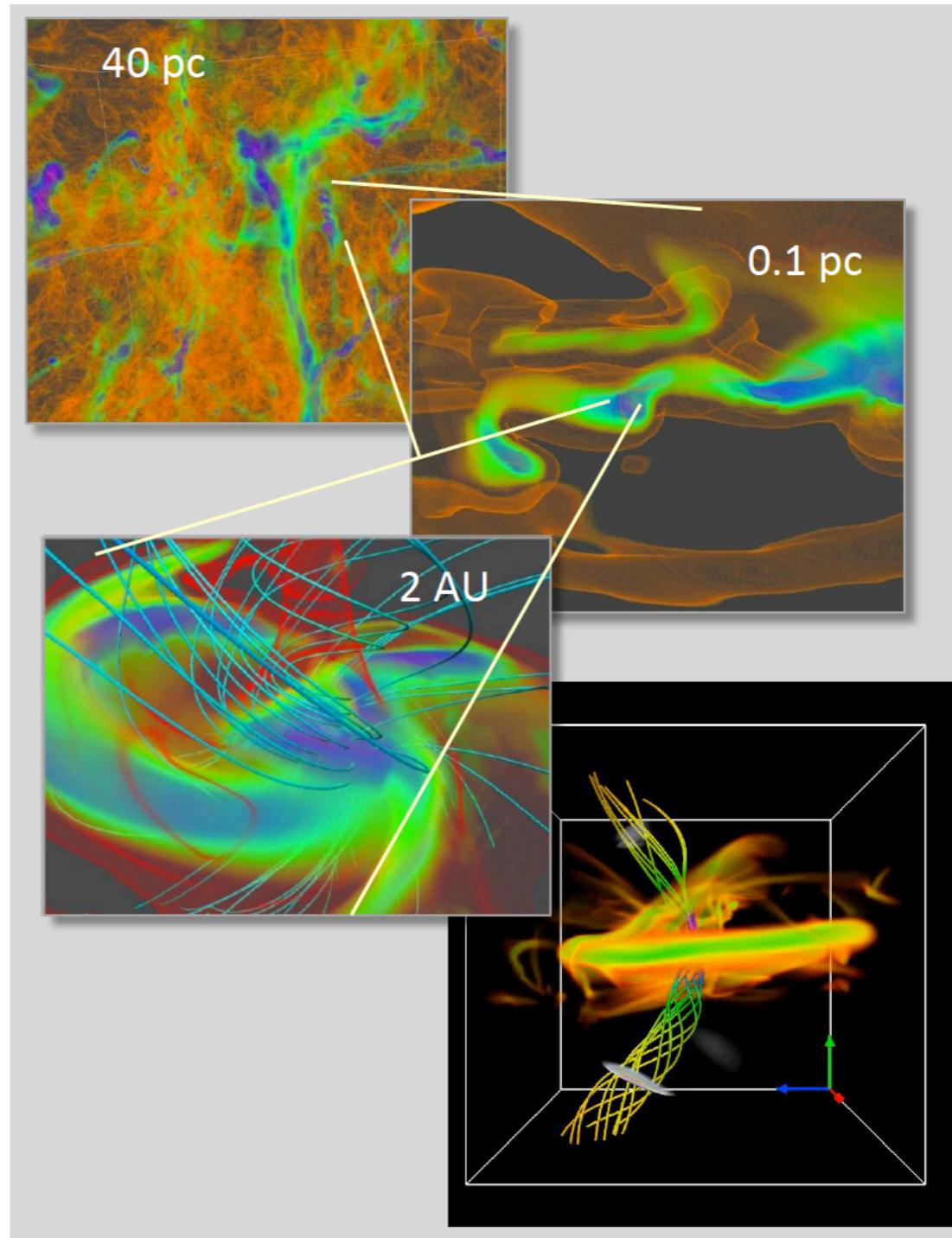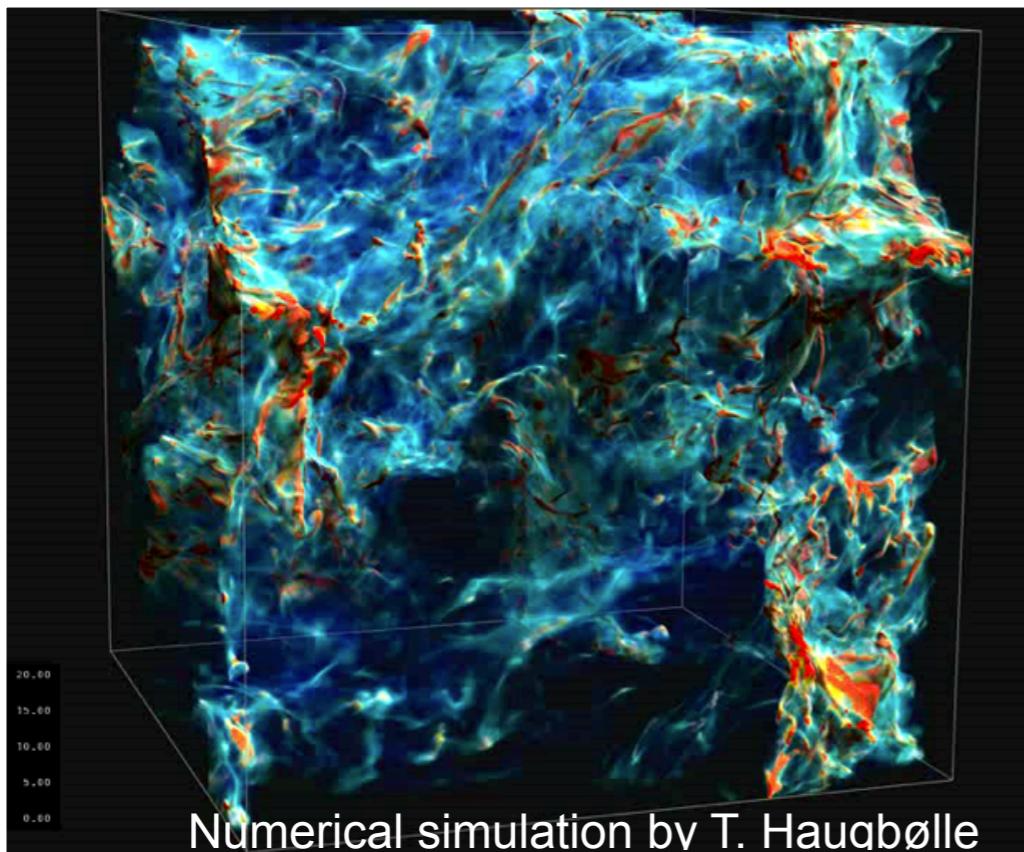
Leonardo Krapp

Tidal Disruption Events

1) Black hole pulls star apart

star

gas stream

black hole

2) Black hole compresses gas stream

gas stream

shock

3) Gas stream intersects itself

outflow

shock

4) Disk formation and light emission

outflow

disk

light emission

Clement Bonnerot

Interstellar Medium & Star Formation

Numerical simulation by T. Haugbølle

40 pc

0.1 pc

2 AU
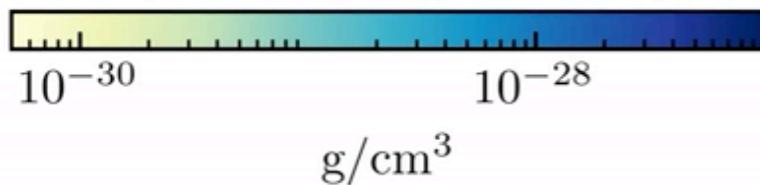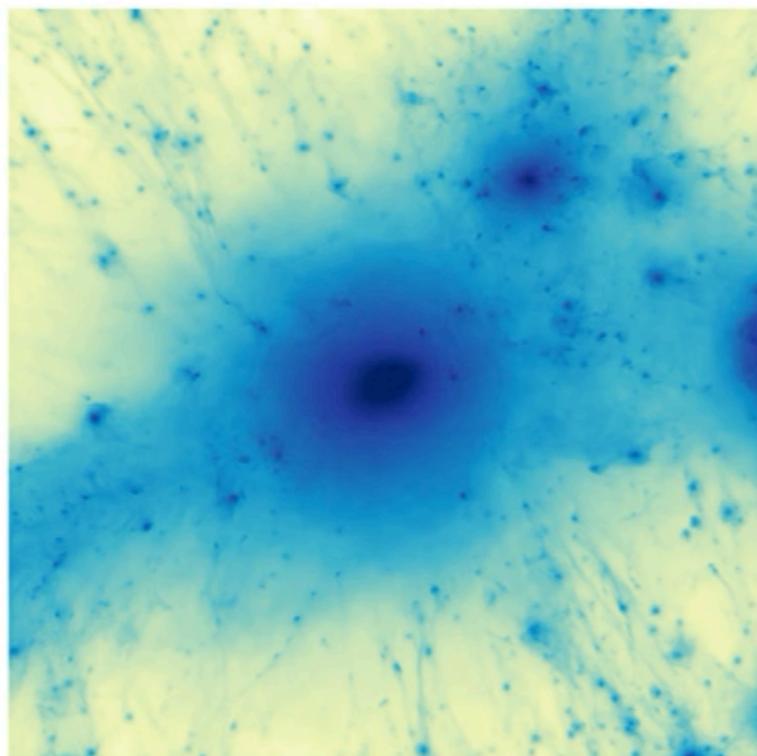
Troels Haugboelle <haugboel@nbi.dk>

Cosmological Simulations of Galaxy Clusters
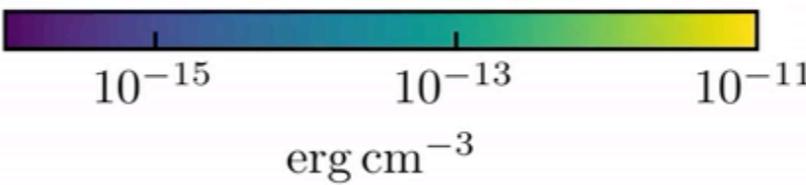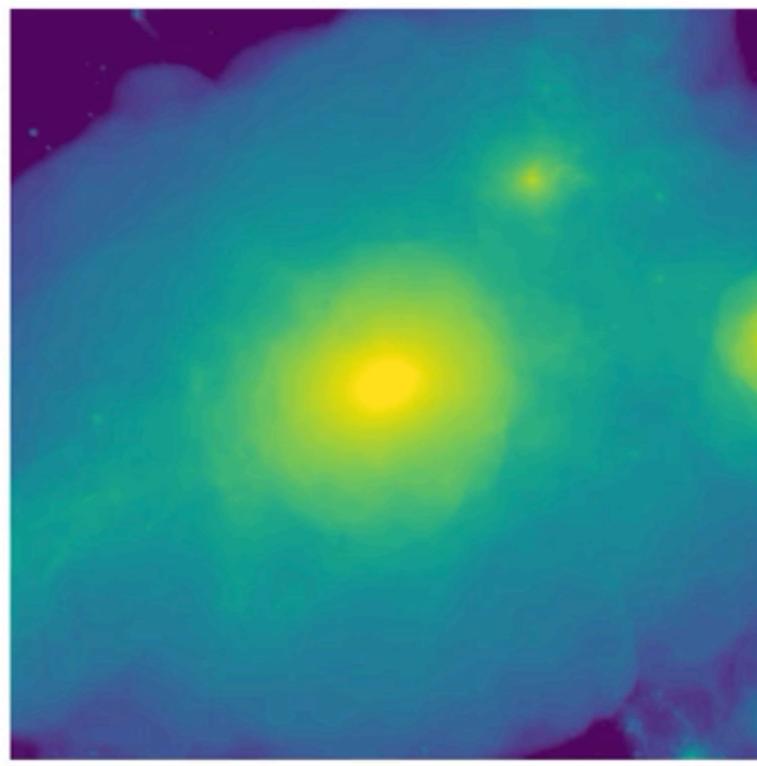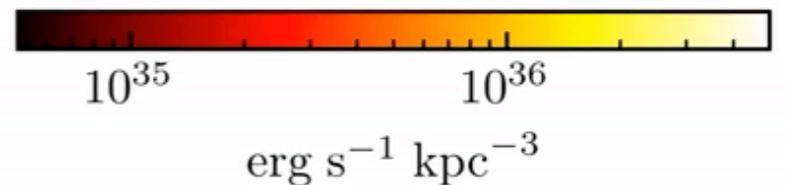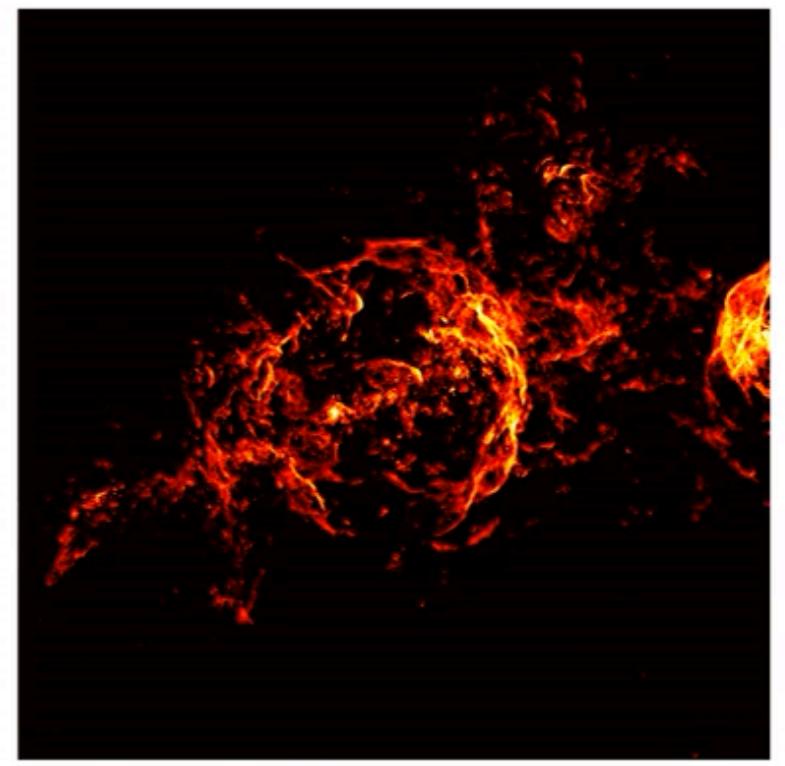
Thomas Berlok <tberlok@nbi.dk>

What You Can Learn

- Fundamental Physics
  Fluid Dynamics + N-body Dynamics
  Magnetohydrodynamics
  Radiative Processes

- Numerical Skills
  From writing your own scripts to running state-of-the-art numerical codes on thousands of processors

- Learn to think
  How to use these building blocks for future projects