

Short Gamma-Ray Bursts in the Dawn of Gravitational Wave Astronomy

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PROBLEM STATEMENT

As two neutron stars merge they produce gravitational waves and powerful jets (Figure 1). The properties of these jets are poorly understood.

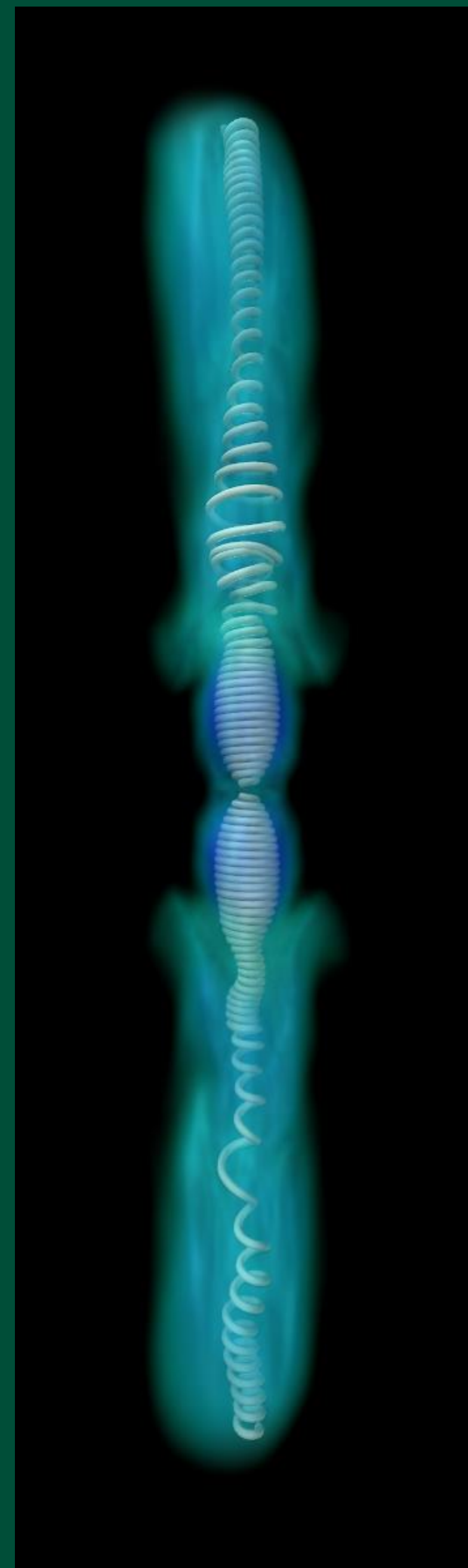
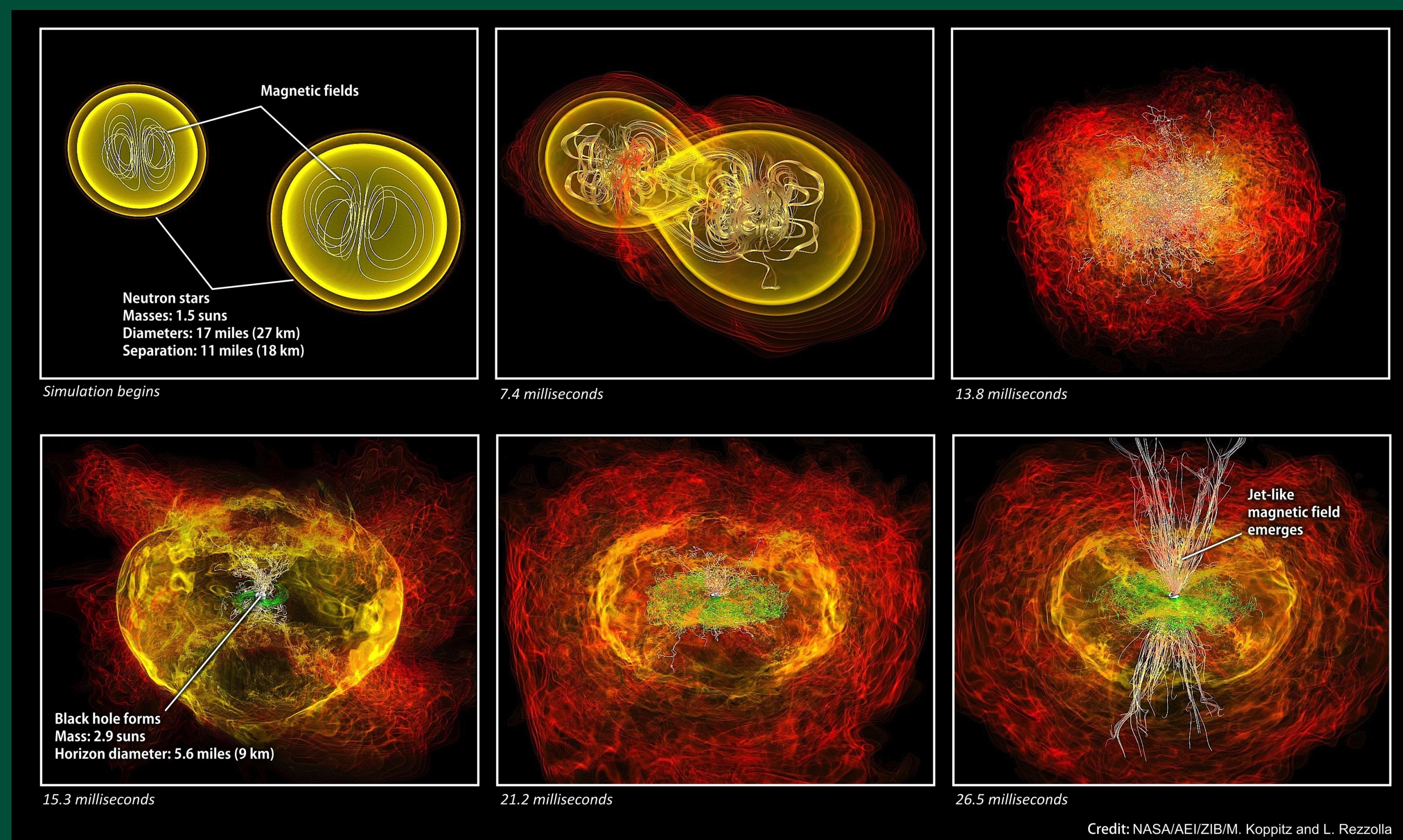


Figure 1: Left: Numerical simulation of two neutron stars merging to form a black hole (NASA/AEI/ZIB/M. Koppitz and L. Rezzolla). Right: Numerical simulation of jets emerging from a black hole (Barniol Duran, Tchekhovskoy & Giannios 2017).

BACKGROUND

The detection of both gravitational waves from a neutron star merger event and its electromagnetic counterpart marks a new era in multi-messenger astronomy. The detection of the faint short gamma-ray burst (GRB) in August 2017, GRB170817A, the electromagnetic counterpart of a gravitational wave event, provides the most conclusive evidence that neutron star mergers are indeed the progenitors of short GRBs. The need to fully understand the electromagnetic signals from GRBs is even more pressing after this exciting discovery.

SUMMARY OF WORK

My research group investigates short GRBs and how they are produced by jets. When such jets are misaligned with respect to the direction from the GRB to earth, they are observed to be relatively faint, as was seen for GRB170817A. We use relativistic magneto-hydrodynamical simulations (Figures 1 and 2) to fully explain current and future observations of electromagnetic counterparts from gravitational wave signals.

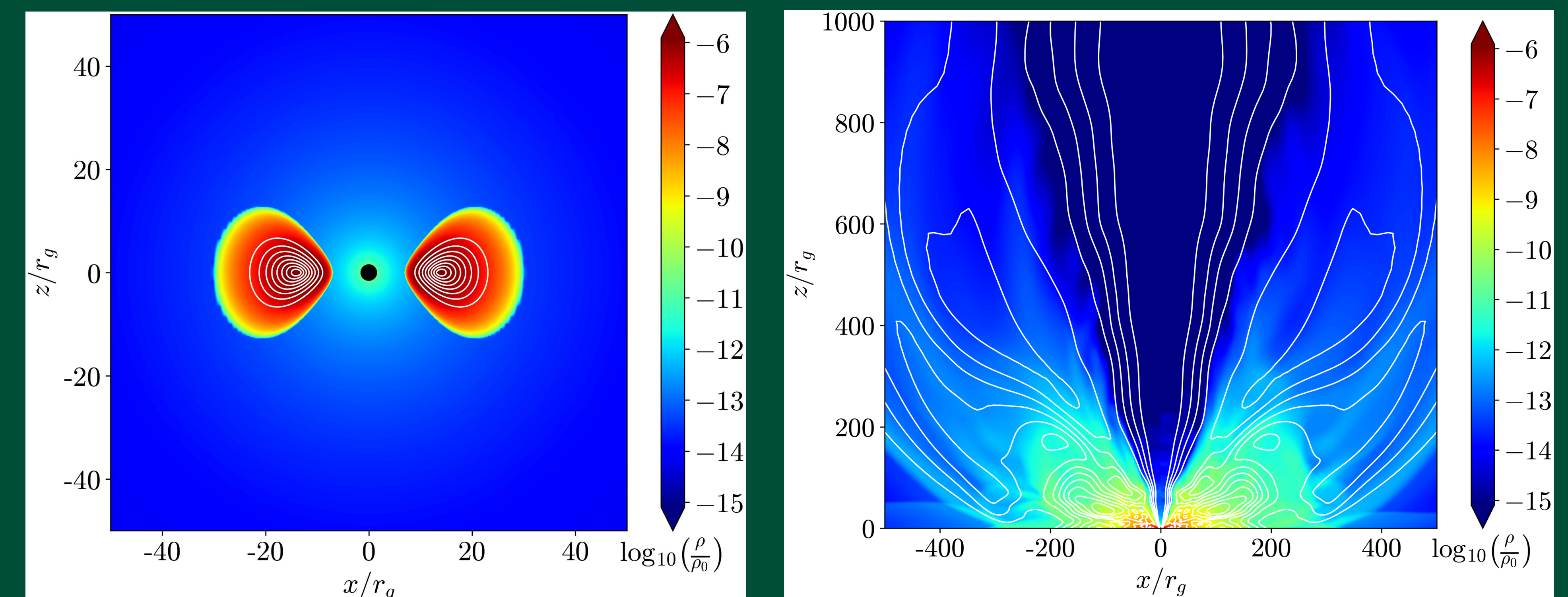


Figure 2: Numerical simulations. Left: Start of the simulation (black hole in the middle with accretion disk). Right: Emergence of jet.

IMPACT ON COMMUNITY

- This research is being supported by the National Science Foundation under Grant 1816694 as a collaborative effort between Purdue University, Northwestern University and Sac State.
- An important component of our research group is training students, who are encouraged to conduct original research projects.
- We aim to broaden participation in science and public literacy with a series of public lectures at the Sacramento State planetarium.