

Black hole jet reactivation through magnetic polarity reversal in GRMHD simulations

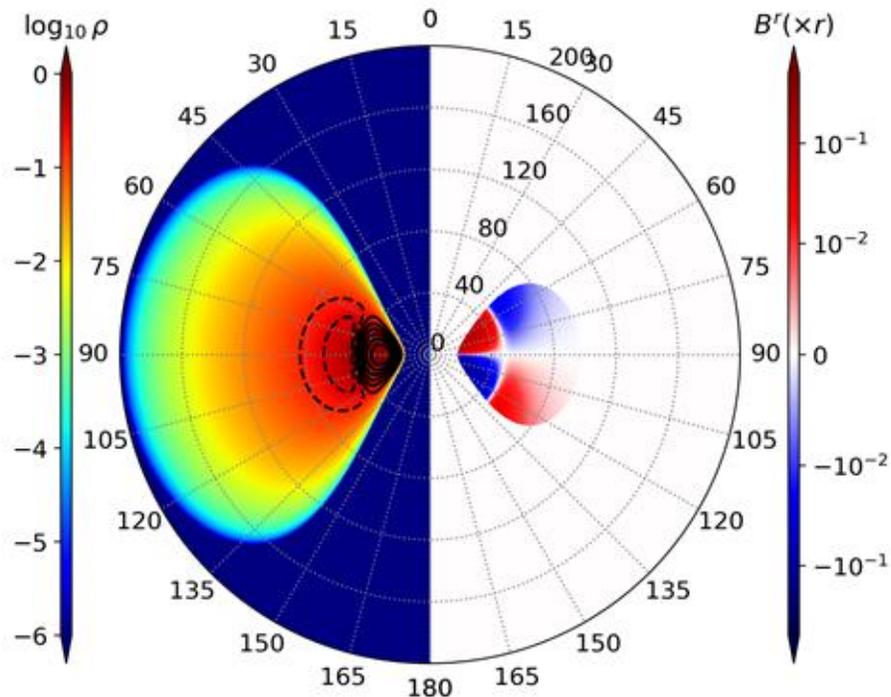
CAMK Annual Meeting
4 FEB 2026

Wen Xuan Sia

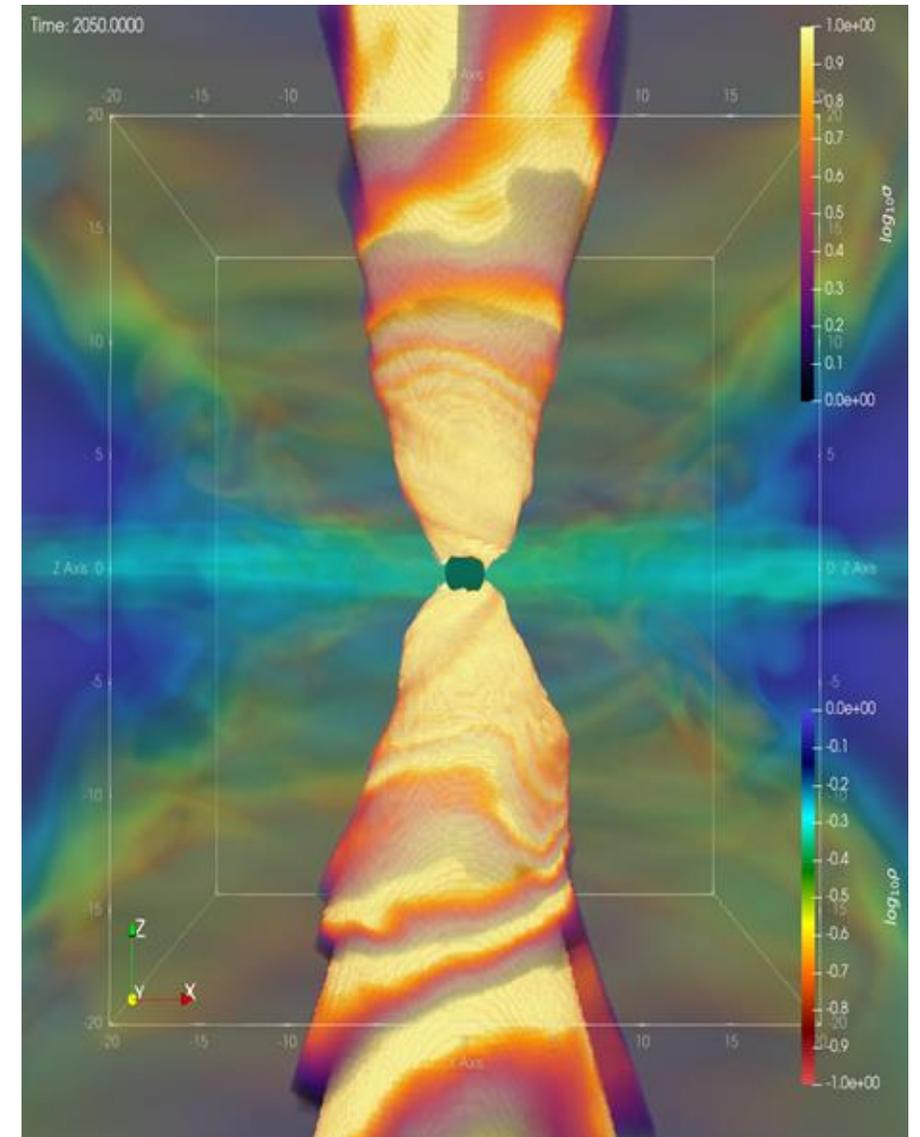
Supervisor: Dr. Krzysztof Nalewajko
Collaborator: Dr. Oliver Porth

GRMHD simulation on black hole jet reactivation

- Athena ++ (2D simulations)
- KHARMA → GPU accelerated GRMHD solver (3D simulations)
- To sustain jet reactivation, we initialized the accretion torus with magnetic fields of opposite polarity.



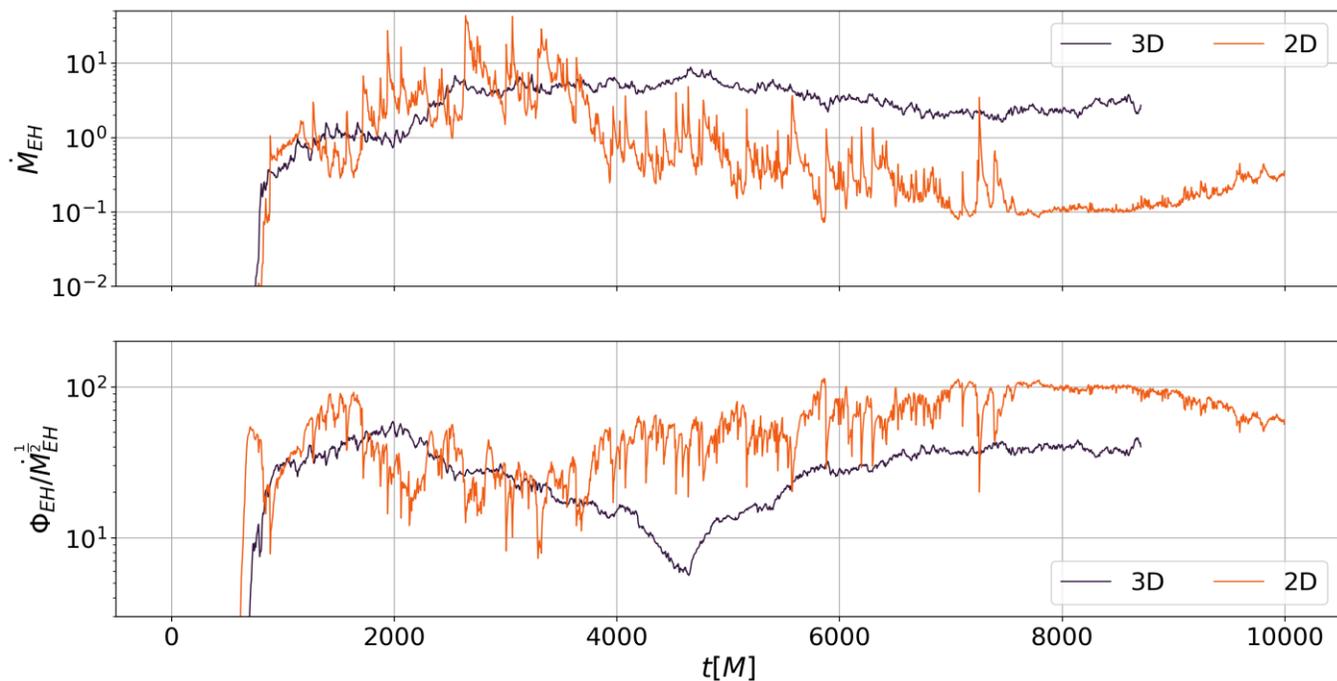
Initial condition of a simulation with a FM torus (left) threaded by magnetic field of opposite polarity



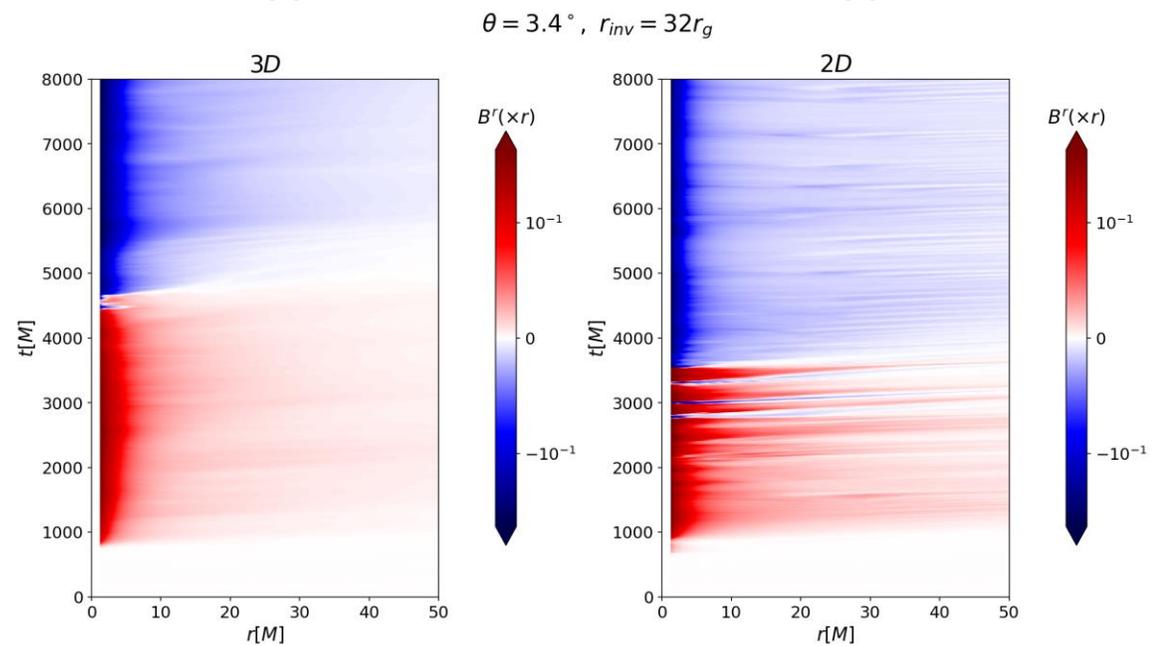
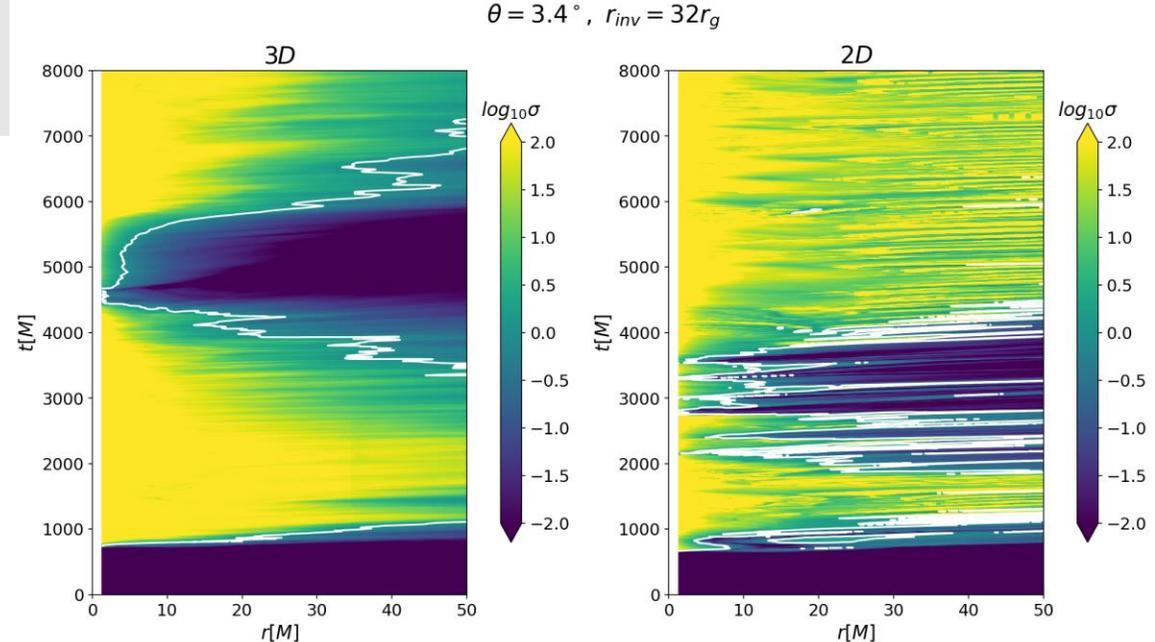
3D volume rendering of a black hole with its accreting torus and its jet

2D vs 3D reactivation

- While 2D simulations using this setup exhibit rapid reactivation, their 3D counterparts do not.



History of the accretion rate and magnetic flux at the horizon for a 2D and 3D run

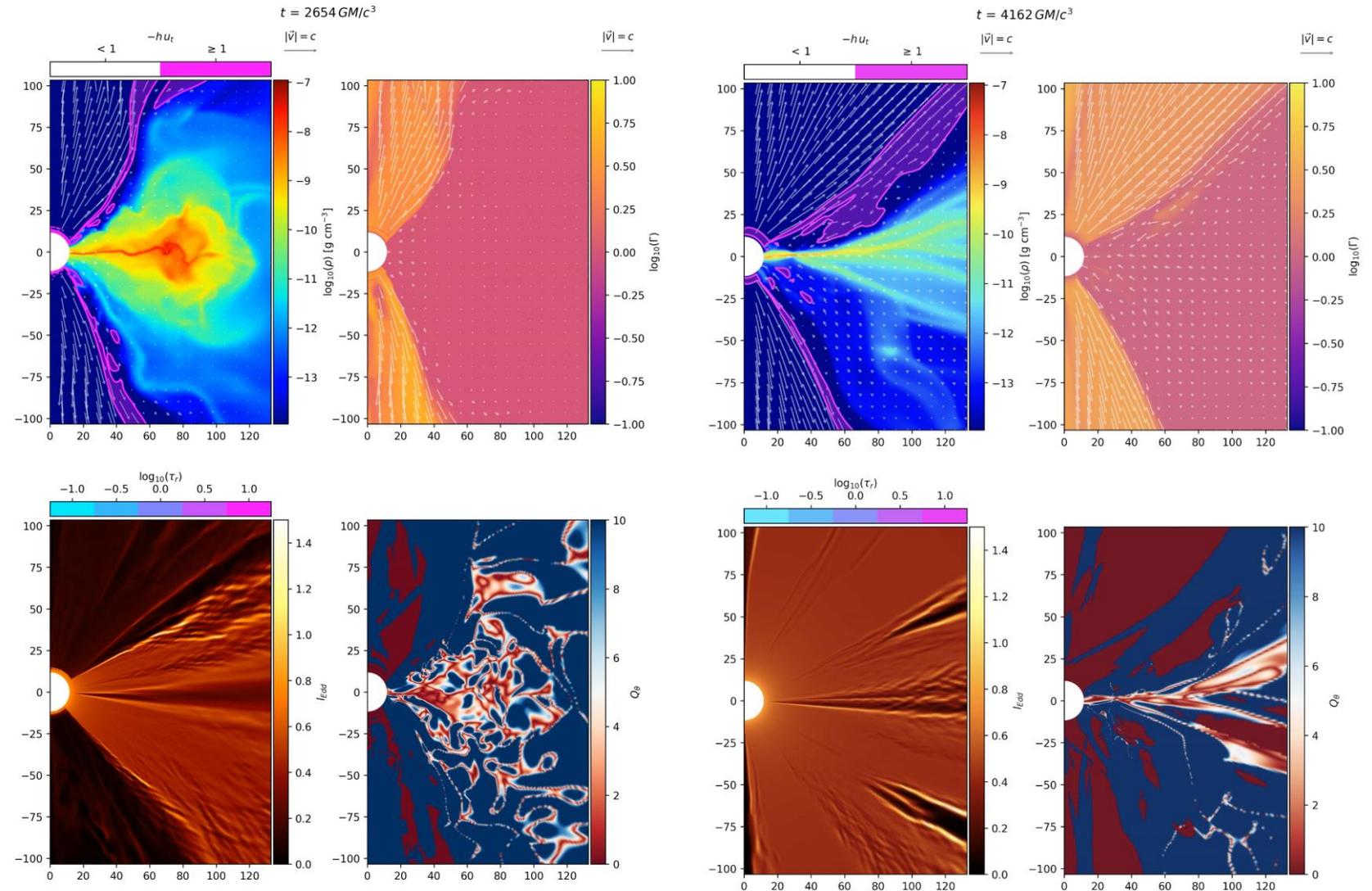


Spacetime diagram of the north jet detailing the reactivation and polarity switching process

M1 Radiation Module for BHAC

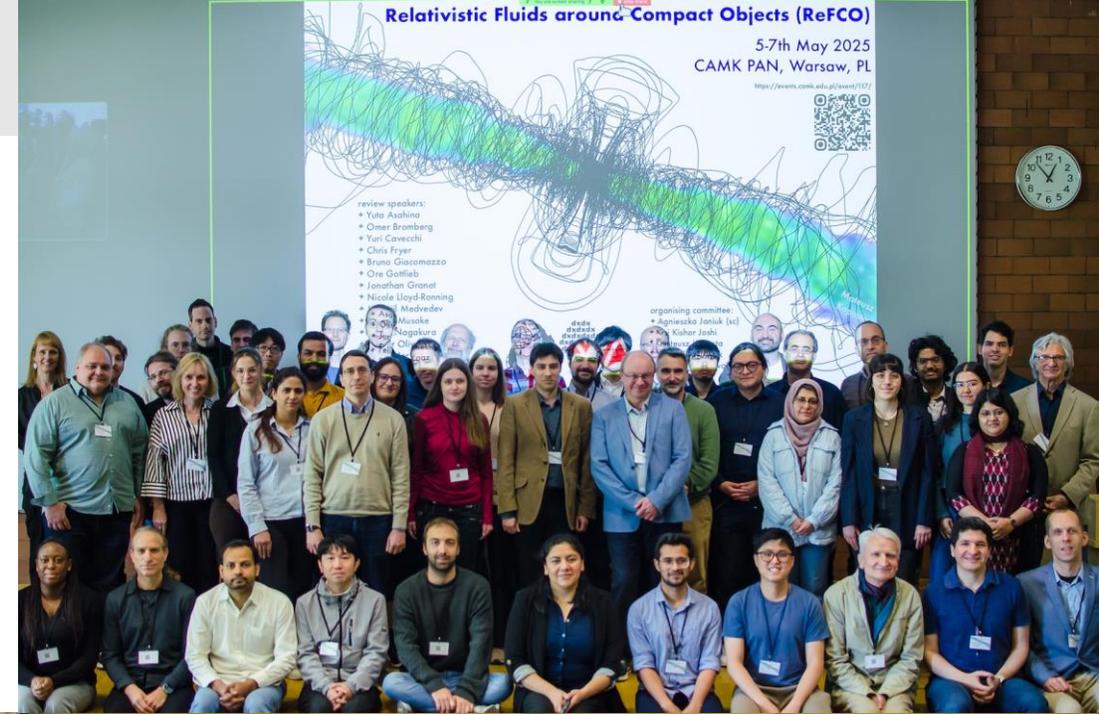
In collaboration with Dr. Oliver Porth

- Stable run at $\dot{M} = 10^{-3} \dot{M}_{Edd}$
- Implemented Comptonization scattering opacity
- Used in a study for Thermonuclear burst of neutron star by a Master student, Simo



Activities Attended

- Attended REFCO (May 2025)
- Attended and presented a talk at RagTime 2025 (November 2025)
- Attended KHARMA GRMHD workshop (November 2025)



2025 Summary

- Performed a suite of GRMHD simulations in both 2D and 3D to explore black hole jet reactivation through magnetic polarity reversal.
- Partial fix of BHAC's radiative GRMHD module and assisted in analysis of simulation of thermonuclear burst on neutron stars.
- Attended conferences, workshop and classes