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Plasma physics with compact objects

Oliver Porth[1], Matthew Liska[2], Gibwa Musoke[1] and Bart Ripperda[3]
[1]Anton Pannekoek Institute for Astronomy, University of Amsterdam; [2]Institute for Theory and Computation, Harvard University; [3]CCA, Flatiron Institute, NY
e-mail (speaker): o.porth@uva.nl

By resolving the emission from plasma around accreting black holes, the Event Horizon Telescope (EHT) has ushered in an age of precision astrophysical source modeling in which the abundance and quality of data now strongly constrains and challenges the physics underlying the models[1,2].

At the same time, global relativistic source models have taken an important step and now resolve turbulence down to the plasmoid scale[3,4], enabling us to directly model transient energetic events.

In this talk I will review recent developments in the modeling of accretion phenomena around compact objects. Next to discussing the sub-luminous EHT targets, I will highlight key results from our current suite of luminous black hole accretion simulations. This includes the identification of both low- and high-frequency quasi-periodic oscillations as a consequence of disk tearing[5] and the magnetic truncation as an explanation to the two-phase nature of disks during state transitions[6].

Making extensive use of GPUs (with the H-AMR code) the simulations now incorporate dynamical radiation fields and two-temperature thermodynamics which allows us to take a significant step towards answering long standing question posed by X-ray binaries and active galactic nuclei: what is the origin of the coronal emission? What processes govern state transitions? Which processes are responsible for quasi-periodic oscillations? State of the art simulations now attack these questions head on.

References
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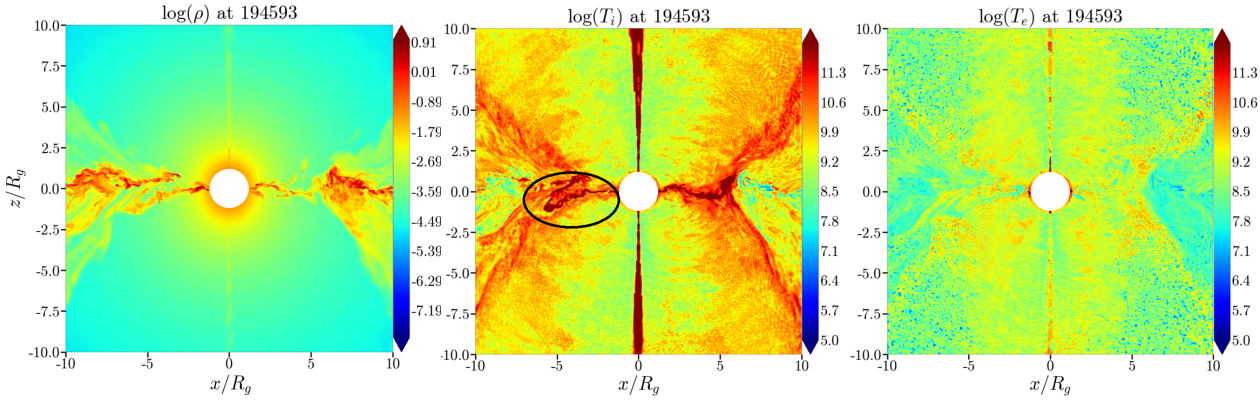

Figure 1. Density, ion- and electron- temperatures in 3D two-temperature radiative GRMHD simulation for an accretion rate ~0.35 of the Eddington limited rate. The inner disk is truncated by strong magnetic fields and accretion proceeds via cold dense clumps. At the same time, a plasmoid unstable equatorial current sheet (highlighted by black ellipse) heats both species. Electrons obtain temperatures of $\sim 10^9$K consistent with coronal temperatures inferred from the hard X-ray component in X-ray binaries and AGN.