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And then there was light: what black hole imaging with the Event Horizon Telescope can teach us about particle acceleration

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The physicist John Wheeler famously said “black holes have no hair”, however black holes end up having pretty complex “hair" when they gravitationally capture material in a process called accretion. By the time the infalling material approaches the event horizon via an accretion disk, it is comprised of turbulent plasma with temperatures much hotter than the solar corona, and magneto-rotationally driven turbulence generates and/or amplifies strong, and strongly ordered, magnetic fields. The most dramatic outcome of this process is the launching of enormous magnetised plasma structures called 'jets', that can extend to millions to billions of times larger than their launch scale, and may be tapping the rotational energy of the black hole. These jets are also of great interest for astroparticle physics as the suspected source of ultra-high energy cosmic rays, neutrinos, gamma-rays, attaining in situ particle energies far beyond the LHC at CERN. However, there is a decades long debate about the location and dominant processes responsible for particle acceleration in general. In particular the separation between the macroscopic, fluid scales and the plasma scales creates many challenges.

After a brief introduction to the Event Horizon Telescope (EHT), I will highlight how the methods we use to interpret our results (e.g., [1-2]) strongly depend on prescriptions for kinetic processes we cannot self-consistently describe in our primary tool: ideal general relativistic magnetohydrodynamics (GRMHD) simulations. There are several analogs to solar physics, but in a very different physical regime and without the ability to directly observe the emitting structures, we instead use information from radio through gamma-rays and variability signatures to try to constrain our models. I will discuss several areas under development for improving the consistency of the models, including very large-scale GRMHD simulations that capture the physical properties of the jets to observable scales [3] and very high resolution, 3D GRMHD simulations that start to resolve current sheets [4].

References

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