Shedding new light on black hole magnetospheres

B. Cerutti[1]

[1] *Institut de Planétologie et d'Astrophysique de Grenoble, CNRS/Université Grenoble Alpes*

Spinning black holes have long been suspected to be involved in some of the most extreme astrophysical phenomena such as, e.g., active galactic nuclei, tidal disruption events, gamma-ray bursts, and microquasars. The activity of black holes is often associated with the creation and the launching of a relativistic magnetized plasma jet accompanied by efficient particle acceleration and non-thermal radiation. Horizon-scale observations of supermassive black holes reveal that these processes occur in the closest vicinity to the black-hole event horizon: the magnetosphere, the inner parts of the accretion flow and the jet. Yet, the underlying physical mechanisms are still poorly understood because they result from a complex interplay between general relativity, electrodynamics and plasma physics. I will review our current efforts to model black hole magnetospheres from first principles with the help of general relativistic radiative particle-in-cell simulations. These numerical methods can capture plasma processes at a microscopic kinetic level where particle acceleration takes place, and therefore, they may hold the key to bridge the gap between theoretical models and horizon-scale observations of black holes.