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[colloquium] How do black holes shine? – multiwavelength emission in the high-energy Universe

Thursday, July 7, 2022 2:00 PM (1h 20m)

Astrophysical black holes are surrounded by accretion disks, jets, and coronae consisting of magnetized, (near)-collision-less relativistic plasma. They produce observable high-energy radiation, and it is currently unclear where and how this emission is exactly produced. The radiation typically has a non-thermal component, implying a power-law distribution of emitting relativistic electrons. Magnetic reconnection and plasma turbulence are viable mechanisms to tap the large reservoir of magnetic energy in these systems and accelerate electrons to extreme energies. The accelerated electrons can then emit high-energy photons that themselves may strongly interact with the plasma, rendering a highly nonlinear system. Modeling these systems necessitates a combination of magnetohydrodynamic models to capture the global dynamics of the formation of dissipation regions, and a kinetic treatment of plasma processes that are responsible for particle acceleration, pair creation and annihilation, and radiation. I will present novel studies of accreting black holes and how they radiate in regions close to black hole event horizon, using both first-principles general relativistic kinetic particle-in-cell simulations and global large-scale three-dimensional magnetohydrodynamics models. I will answer the question of how well fluid-type models like magnetohydrodynamics can capture collision-less plasma physics. With a combination of models, I determine where and how dissipation of magnetic energy occurs, and what kind of emission signatures are typically produced. In the end, I will outline how an approach of global magnetohydrodynamics, and kinetic models will enable quantitative comparisons with observations of multiwavelength observations of radio, X-ray, and TeV emission from accreting black holes and potentially study the structure of spacetime.

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