GENERAL-RELATIVISTIC KINETIC PLASMA SIMULATIONS OF BLACK-HOLE MAGNETOSPHERES AND JETS

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Black holes drive powerful relativistic jets, using magnetic fields dragged in by their accretion flows. The jets' plasma should be so diffuse as to be effectively collisionless, and self-consistently supplied by pair creation near the horizon. I will present the first general-relativistic kinetic plasma simulations of the collisionless magnetospheres of rotating black holes, showing the launching of electromagnetic jets by the Blandford-Znajek mechanism. The simulations reveal a population of particles with negative energy at infinity, which can contribute significantly to black-hole rotational-energy extraction in a variant of the Penrose process. The kinetic approach will be useful for studying the accretion flows of the Event Horizon Telescope targets, Sgr A* and M87, where the plasma is likewise of low density and collisionless, and for probing black holes nonthermal X-ray and γ-ray emission from first principles.