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LOCAL PARTICLE-IN-CELL SIMULATIONS OF THE MAGNETOROTATIONAL INSTABILITY IN STRATIFIED, SUB-RELATIVISTIC ACCRETION DISKS

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The magnetorotational instability (MRI) is believed to generate the MHD turbulence necessary for efficient outward angular momentum transport in various black hole accretion disks. In low-luminosity accreting black holes, the density in the accreting plasma is so small that particle-particle Coulomb collisions occur very infrequently, making these disks effectively “collisionless”. These collisionless disks around black holes are ubiquitous at the center of nearby galaxies (these include the EHT targets M87 and Sgr A*, at the center of our own Milky Way). Under these conditions, it is believed that particles may develop a non-thermal population and get accelerated to high energies.

We present results of fully kinetic, particle-in-cell plasma simulations of the collisionless MRI, where non-thermal phenomena are included from first principles. Our simulations are local and stratified, which means that we use the local shearing box approximation and include the vertical structure of the disks. This means that our study simultaneously captures the evolutions of the disk midplane as well as the (more magnetized) disk corona. Our study concentrates on the MRI evolution for plasma temperatures relevant at tens of gravitational radii from the central black hole. We find that particle acceleration in our stratified simulations is, on average, significantly more efficient than in the case where disk stratification is not included.

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