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Magnetorotational Turbulence and Dynamo in a Collisionless Plasma

MATTHEW KUNZ, Princeton University

Low-luminosity black-hole accretion flows are collisionless. A kinetic approach is thus necessary to understand the transport of heat and angular momentum, the acceleration of particles, and the growth and structure of the magnetic field in these systems. I present results from the first 6D kinetic simulation of magnetorotational turbulence and dynamo, which was performed using the hybrid-kinetic particle-in-cell code Pegasus. Special attention will be paid to the transport of angular momentum by the anisotropic-pressure stress, as well as to the ion-Larmor-scale kinetic instabilities (firehose, mirror, ion-cyclotron) that regulate it. The latter endow the plasma with an effective viscosity that is biased with respect to the magnetic-field direction and spatiotemporally variable. Energy spectra suggest an Alfvén-wave cascade at large scales and a kinetic-Alfvén-wave cascade at small scales, with strong small-scale density fluctuations and weak nonaxisymmetric density waves. Ions undergo nonthermal particle acceleration, their distribution accurately described by a κ distribution. Dedicated nonlinear studies of firehose and mirror instabilities in a shearing plasma will also be presented as a complement to the study of the magnetorotational instability. The profits, perils, and price of using a kinetic approach are discussed.