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Shearing Box Simulations of the MRI in a Collisionless Plasma

P. SHARMA, G.W. HAMMETT, Princeton Plasma Physics Lab, E. QUATAERT, Berkeley, J.M. STONE, Princeton University — We describe local shearing box simulations of turbulence driven by the magnetorotational instability (MRI) in a collisionless plasma. Collisionless effects may be important in radiatively inefficient accretion flows, such as near the black hole in the Galactic Center. The MHD version of ZEUS is modified to evolve an anisotropic pressure tensor. A fluid closure approximation is used to calculate heat conduction along magnetic field lines. The anisotropic pressure tensor provides a qualitatively new mechanism for transporting angular momentum in accretion flows (in addition to the Maxwell and Reynolds stresses). We estimate limits on the pressure anisotropy due to pitch angle scattering by kinetic instabilities. Such instabilities provide an effective "collision" rate in a collisionless plasma and lead to more MHD-like dynamics. We find that the MRI leads to efficient growth of the magnetic field in a collisionless plasma, with saturation amplitudes comparable to those in MHD. In the saturated state, the anisotropic stress is comparable to the Maxwell stress, implying that the rate of angular momentum transport may be moderately enhanced in a collisionless plasma.

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