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Global Hall-MHD simulations of magnetorotational instability
FATIMA EBRAHIMI, B. LEFEBVRE, C.B. FOREST, A. BHATTACHARJEE, Center for Integrated Computation and Analysis of Reconnection and Turbulence and Center for Magnetic Self-Organization, University of New Hampshire — Hall-MHD numerical simulations of the Madison Plasma Couette Flow Experiment (MPCX) have been performed using the extended MHD code NIMROD. The MPCX has been constructed to study the Magnetorotational Instability (MRI) in an unmagnetized and fast flowing plasma. The two-fluid Hall effect, which is relevant to some astrophysical situations such as protostellar disks, is also expected to be important in the MPCX. We first derive the local Hall dispersion relation including resistivity and viscosity, extending earlier work by S. Balbus and C. Terquem. The predictions of the local analysis are compared with global linear stability analysis of the MRI for a range of magnetic Prandtl and magnetic Reynolds numbers. It is found that in all cases the MHD stability limit and mode structure are altered by the Hall term. Two-fluid physics also affects significantly the nonlinear evolution and the saturation of the axisymmetric MRI. To further study momentum transport and self-generation of magnetic field in an MRI-driven turbulent state, we have carried out fully nonlinear MHD computations. Non-axisymmetric modes play an increasingly important role as the magnetic Reynolds number increases, and grow to large amplitudes. Supported by NSF grant 0962244.

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