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Instability of free shear layers in the Princeton MRI experiment
A.H. ROACH, E.J. SPENCE, C. GISSINGER, E.M. EDLUND, P. SLOBODA, H. JI, Princeton Plasma Physics Laboratory — The Princeton MRI experiment is a Taylor-Couette device with a liquid metal working fluid. The endcaps of the experiment are split into two differentially rotatable rings. There is a discontinuity in the azimuthal velocity boundary condition at the location of the split between the rings which can be the source of free shear layers that extend into the fluid. When the inner ring rotates faster than the outer ring, these shear layers are unstable to both centrifugal instabilities and shear (Kelvin-Helmholtz) instabilities. The centrifugal instability can be stabilized by sufficient background rotation or a sufficient applied axial magnetic field, allowing the Kelvin-Helmholtz instability to grow. While the centrifugal instability remains relatively localized in the shear layer, the Kelvin-Helmholtz instability has been observed to generate large-scale velocity fluctuations throughout the fluid volume. We examine the competition of these instabilities using experimental measurements of the velocity with ultrasound Doppler velocimetry, linear calculations, and results from nonlinear 3-D MHD simulations. Supported by DOE contract DE-AC02-09CH11466.

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