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Measurement of anomalous resistivity in a magnetic nozzle[1]

SHADRACH HEPNER, BENJAMIN JORNS, University of Michigan, PLASMADYNAMICS AND ELECTRIC PROPULSION LABORATORY TEAM — Magnetic nozzles consist of expanding magnetic fields used to accelerate a plasma for use in in-space propulsion. The question of electron transport in magnetic nozzles is important to understanding how the plasma escapes the field geometry, which is vital for thrust generation. This work investigates the role of instabilities in cross-field electron transport in an expanding magnetic field with applications to propulsion and processing. To investigate the influence of instabilities, we first position a B-dot probe downstream and measure the total induced magnetic field from the plasma during startup. Measuring in the radial and axial directions, integrating over time, and applying Amperes law yields a measurement of azimuthal current density. We then measure plasma potential and pressure with a Langmuir probe, which yields ideal azimuthal current from the gradients and provides the classical resistivity. Comparing the ideal current to that measured with the B-dot probe, we find the total resistivity and subtract the classical value to determine the anomalous effect. We then compare the results to the resistivity predicted with nonlinear wave theory and show that the magnitude of this anomalous effect corresponds to that induced by previously measured instabilities.

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