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A multi-fluid 2-D simulation of a co-axial Hall plasma discharge
AARON KNOLL, MARK CAPPELLI, High Temperature Gasdynamics Laboratory, Stanford University — A multi-fluid 2-D simulation of a co-axial E x B plasma discharge is presented, resolving the azimuthal dynamics leading to the growth and saturation of high-frequency (0.5 – 10 MHz) azimuthally-propagating fluctuations. The simulation accounts for finite-rate ionization kinetics, with associated losses of particles and energy to the bounding ceramic walls. These discharges are typical of Hall thruster plasma accelerators, which are increasingly being used in space propulsion applications. The simulations presented are for full scale thrusters that operate in the 1 kW power levels, capturing the entire azimuthal domain. The simulations focus on the role played by these fluctuations in establishing the cross-field electron current in regions of relatively strong magnetic fields (50-200 Gauss). The time-average predictions for plasma properties are in qualitative and quantitative agreement with experiments, and the findings seem to be supportive of the experimental results that indicate that high frequency fluctuations may be more important at defining electron current at lower discharge voltages, where the azimuthal electron shear is small.

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