

DFD08-2008-001307

Abstract for an Invited Paper
for the DFD08 Meeting of
the American Physical Society

The Physics of Spacecraft Hall-Effect Thrusters

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The Hall-effect thruster (HET) is an advanced spacecraft propulsion system that uses electrical power provided by the spacecraft to generate thrust by ionizing and accelerating propellant to high velocities. HETs are now used in earth orbit for satellite propulsion and are being considered for a variety of missions in deep space. While HETs have been tested in laboratories for over forty years and first flew in space some thirty-five years ago, until recently, very little was known about the plasma inside these devices or the processes involved in the ionization and acceleration of propellant. This lack of knowledge led to the expensive trial-and-error approach practiced in HET development over the decades. The difficulty in collecting interior plasma data stems from the intense heat fluxes created by the plasma that makes traditional plasma diagnostics challenging to implement. My talk summarizes results of our research aimed at understanding fundamental plasma processes that occur in HET discharge channels, and shows how we have used this knowledge to gain a better understanding of HET physics and to advance the state-of-the-art in Hall-effect thruster technology.