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Modeling and simulation of Hall thruster plasma discharges at JPL

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Numerical simulations of Hall-effect thrusters (HET) are of paramount importance in their development and flight qualification cycle as they predict operation in space, support to laboratory tests, guide thruster design, and provide insight into the inherently complex plasma physics of these devices. Hall2De, a hydrodynamics code for the simulation of the plasma discharge in Hall thrusters, has been in development for the last ten years and is continuously improved and validated at the Jet Propulsion Laboratory. The code was instrumental in the discovery of magnetic shielding, a design technique that tailors the applied magnetic field in a way that minimizes erosion of the thruster walls by ion sputtering. More recently, Hall2De simulations also explained the physics behind the much reduced but finite erosion of magnetic poles observed in a laboratory Hall thruster and how to minimize it. It has also been employed to predict thruster operation in space for Psyche, the first mission to use Hall thrusters beyond lunar orbit. There are still some physics in these devices however that remain elusive, most notably, the existence of anomalous electron transport across magnetic field lines. In this presentation we will provide an overview of the impact these physics-based simulations have had on our understanding of these low-temperature discharges and some of the challenges we are faced with in the near term.