Ion and atom flow in a Hall discharge: Impact of operating parameters
STÉPHANE MAZOUFFRE, ICARE - CNRS

A Hall effect thruster is a versatile electric propulsion device that is based on a low-pressure magnetized crossed-field discharge. In this contribution, ion and atom transport phenomena within this type of discharge are examined for a broad range of operating conditions and thruster sizes. The local Velocity Distribution Function of metastable Xe I atoms and metastable Xe II ions (xenon being the usual propellant) is captured by means of continuous-wave Laser Induced Fluorescence spectroscopy at 823.16 nm and 834.72 nm, respectively. The on-axis profile of Xe atom velocity indicates the neutral fluid accelerates in the interior of the thruster and it slows down beyond the exhaust whatever the operating conditions. This unexpected behavior can be explained in terms of ionization probability, energy transfer to walls and ion beam invasion by the background gas. The Xe II ion mean velocity and dispersion profiles along the thruster discharge chamber axis were obtained as a function of applied voltage, gas mass flow rate and magnetic field strength for several thruster geometries. Experimental outcomes provide numerous insights into the physics at work as it will be shown. Besides, the electric field distribution can be accurately inferred from the high order moments of the ion VDF. Recent experiments show ions rotate at relatively low speed in the plume near field of a Hall thruster although they are weakly magnetized. Surprisingly, the way ions rotate seems a priori unaffected by the sign of the magnetic field. To conclude, it will be pointed out that VDF measurements are of great relevance for the development of numerical simulations of a Hall discharge.