Keep-in-Touch meeting
(May 29, 2025)

Investigation of the optical emission of Hall Effect thrusters using collisional radiative models, PIC simulations, and machine learning.

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This seminar will provide an overview of what optical emission can offer to the study of Hall Effect thrusters. It is built in the context of the growing New Space industry, marked with the increasing use of micro reusable launchers and ride-share satellite programs, hence the pressing need to reducing space operation costs. This shift has led to growing demand for standardized and miniaturized satellite equipment, with a particular focus on Hall thrusters due to their high thrust-to-power ratio, flexible specific impulse, and high efficiency. This work builds upon the previous development of the LPPic Particle-In-Cell code at the Laboratoire de Physique des Plasmas to explore plasma dynamics and interactions within the thruster by coupling the simulations with virtual diagnostics. First is collective Thomson scattering to explore the electron density fluctuations in the thruster. Second is optical emission spectroscopy coupled with a collisional radiative model to characterize the electron energy distribution function.

The main outcome of this work is to highlight the importance of considering spatial gradients in the plume of the thruster when extracting plasma parameters from optical emission, the validity of the transport and Maxwellian assumptions in the collisional radiative models of neutral species, the proof of line-specific bandwidth limitations for the implementation of optical emission spectroscopy to study high-frequency instabilities (≥ 1MHz). Finally, an innovative enhancement to the optical emission and collisional radiative model was the integration of artificial neural networks, which significantly improved the efficiency and scope of the diagnostic, by speeding up the processing, reducing the needed hardware in orbit, and allowing the optical control of the operating parameters of the thruster.