Hunting instabilities in the Hall thruster plasma using collective Thomson scattering

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The Hall thruster is an electric propulsion device which uses crossed magnetic and electric fields to confine electrons in an azimuthal drift, while accelerating ions to produce thrust. It has been used to great success for primary propulsion (ESA's SMART-1 mission, 2003) as well as for telecommunications satellite positioning and attitude control. The mass savings it offers in comparison to conventional chemical propulsion technologies are considerable, and in the near future, demanding applications such as space exploration, satellite deorbit and cargo transfer are expected to require higher-powered thrusters of this type. Today, the key obstacle to the development and application of such thrusters is a poor comprehension of phenomena such as anomalous electron transport.

At the thruster exit, anomalous electron transport is ascribed mainly to plasma turbulence. In 2004, the first simulations demonstrating a clear link between such axial transport and a particular thruster instability were performed[1]. To verify these predictions, a specially-adapted collective Thomson scattering diagnostic (PRAXIS) was designed and first tested in 2008. Experiments not only confirmed the presence of the instability[2], but also revealed interesting properties of the mode which have subsequently guided its theoretical treatment.

This talk focuses on the issue of anomalous transport in the thruster, theoretical and numerical results, the scattering diagnostic features, and the detailed characterizations of instabilities which have so far been obtained.

[1]J-C. Adam, A. Héron, and G. Laval. Study of stationary plasma thrusters using two-dimensional fully kinetic simulations, Phys. Plasmas, **11**, No. 1 (2004)

[2]S. Tsikata, N. Lemoine, V. Pisarev, and D. Grésillon. Dispersion relations of electron density fluctuations in a Hall thruster plasma, observed by collective light scattering, Phys. Plasmas, **16**, 033506 (2009)