Kinetic simulations of plasma thrusters

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The modelling of Hall thruster (SPT-100) is a very important issue in view of the increasing importance of such propulsion in space applications as satellite guidance, orbit transfer and deep space exploration projects. Models of Hall thrusters have been developed using hybrid fluid-particle approaches. A question which cannot be resolved by these models, and which in fact strongly limits the reliability of their results, is the electron transport in SPTs, and in particular the important role of the electron interactions with the channel walls (strong secondary electron emission) and of the azimuthal oscillations (anomalous transport). In order to provide a better understanding of the physics inside the Hall thruster SPT-100, different fully kinetic PIC-MCC models (1D(r), 2D(r,z) and 2D(r,θ)) of the acceleration channel have been developed. An other important issue is the modelling of electric thruster plumes. Indeed, a major concern in the use of these devices is the possible damage their plumes may cause to the host spacecraft and to communication interference of satellites. In particular, low energy charge-exchange (CEX) ions (created by collisions between ions and un-ionized propellent in which electrons are transferred) are strongly influenced by the self-consistent electric fields. These fields cause CEX ions to propagate radially and to flow upstream possibly causing contamination and degradation by sputtering on components even when located beyond the line of sight of the exhaust beam. A 2D axisymmetric numerical code is developed for the simulation of the very-near-field and far-field plume regions operating in various ambient plasmas. The code is based on a combination of particle simulation for the ionic components and fluid computational techniques for electrons.

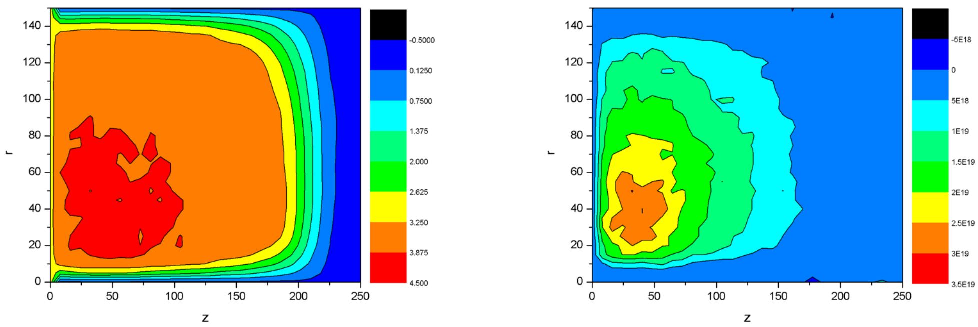

Fig. 1 - Plasma potential (V) and electron density (m^{-3}) inside the acceleration channel.

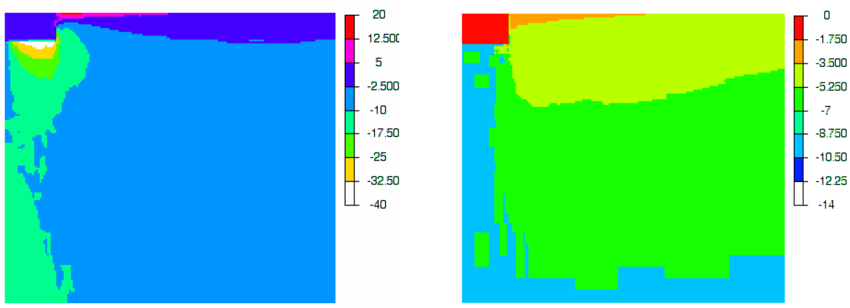

Fig. 2 - Plasma potential (V) and ion density (m^{-3}, log scale) in the plume region.