Charged particles transport in the Hall effect thruster

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Plasma transport phenomena in the SPT and TAL Hall effect thrusters was a subject of many studies [1-2]. Despite this fact, the origin of a so-called anomalous transport is not understood to this date. As a result, in the theoretical and numerical models [3] researches assume ad-hoc cross-field diffusion coefficients, which may differ by several times from the classical Bohm result.

To study the transport phenomenon we develop several models. The first model is 2-dimensional in space (for axial and azimuthal directions), but 3-dimensional in velocity. A similar geometry was adopted in references [4-5], but we try to push the simulation to the realistic scale (several centimeters), while keeping the minimum spatial resolution on the order of the Debye length.

The next model is 3D in space. Because of numerical limitation the geometry of the thruster is idealized. However, we will account for the radial inhomogeneity, including important wall effects like self-consistent sheath structure, etc. To overcome the limiting restrictions of the particles-in-cell method on spatial/temporal scales [6], we'll try applying the implicit method [7] to the 3D simulations, to make simulations relevant to the Hall thruster plasma conditions.

It is hoped that the numerical results will provide a better understanding of the anomalous transport in Hall thrusters due to the collective modes, shed light on the nature of the observed high-frequency oscillations, and give an incentive on how to suppress them.

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[3] J.Szabo, Fully kinetic numerical modeling of a plasma thruster, PhD thesis, MIT, 2001.

[4] M.Hirakawa and Y.Arakawa, Particle simulation of plasma phenomena in Hall thrusters, IEPC-95-164 technical paper, 1995.

[5] M.Hirakawa and Y.Arakawa, Numerical simulation of plasma particle behavior in a Hall thruster, AIAA-96-3195 technical paper, 1996.

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Hall Effect Thrusters. Gridded Ion Thrusters. Electrostatic Propellants.Â Rather than using a system of grids that are electrically charged to produce the electrostatic potential needed to accelerate the ionized propellant, in a HET the plasma itself creates the electrostatic charge through the Hall effect, discovered in the 1870s by Edwin Hall. In these thrusters, the backplate functions as both a gas injector and an anode.Â The cross-channel thrust increases seen in the X2 thruster werenâ€™t observed, meaning that this effect could have been something particular to that design. Hall thrusters use a magnetic field effect to accelerate ions (charged particles) to high speeds, producing thrust. Here's how it works: a spacecraft's solar panels or other power source charge an anode's walls to a high positive energy level. Electrons injected by a downstream cathode are attracted to the anode and drawn into an insulator channel.Â In those motors, electrons combine with an inert gas to create ionized Xenon in the same way as a Hall thruster, but the resulting plasma is accelerated by a negative grid at the end of the motor, rather than a magnetic field, to create thrust. Once the plasma leaves the engine, a "cathode neutralizer" injects electrons to prevent a static charge buildup on the spacecraft. As for performance? Â§ Realistic (and simpler) models of Hall Thrusters need an estimation of electron mobility Â® Can we define an electron mobility in the conditions of a Hall thruster ? EPS 2008 Hersonissos. GREPHE.Â Â§ Charged particle losses in the B direction included. o Bohm losses for ions frequency: 2UB/L o Electron losses when electron reaches end plates and if. energy in the B direction larger than potential difference between plasma and end wall o Grid: negative bias â€“ Limiter and walls grounded. Hall thrusters, Hall-effect thrusters (HETs), stationary plasma thrusters (SPTs), and magnetic-layer thrusters are all names for essentially the same device that is characterized by the use of a dielectric insulating wall in the plasma channel, as illustrated in Fig. 7-1. The wall is typically manufactured from dielectric materials such as boron nitride (BN) or borosil (BN-SiO2) in flight thrusters, and also sometimes alumina (AL2O3) in laboratory thrusters.Â In the Hall thruster with dielectric walls illustrated in Fig.Â the channel exit, space charge is not an issue and the ion current density and the thrust density can be considerably higher than that achievable in gridded ion thrusters.