Seminar

Institute for Plasma Research

Title : Cross-field chaotic transport of electrons by E × B electron drift instability in Hall thruster

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Date : 9th August 2019 (Friday)

Time : 3.30 PM

Venue : Seminar Hall, IPR

Abstract:

In Hall thruster geometry, the electric and magnetic field configuration creates a huge difference in drift velocity between electrons and ions, which generates electron cyclotron drift instability or E×B electron drift instability [1]. Unstable modes generated from this instability have an important role in cross-field anomalous transport of electrons. One special interest for the industrial development of Hall thruster is characterizing the anomalous cross-field electron transport observed after the channel exit. Since the ionization efficiency is more than 90%, the neutral atom density in that domain is so low that the electron collisions cannot explain the high electron flux observed experimentally. Indeed, the electron transport coefficients are 100 times higher than those given by the collision transport model. Here we are focusing on collision-less chaotic transport of electrons by the E×B drift instability generated unstable modes. The dynamics of electrons are studied numerically in a slowly time varying ($\omega \ll \omega_c$) potential profile in presence of a constant axial electrostatic field E and a radial magnetic field B. The time varying potential is associated with the unstable modes generated by E×B drift instability which follow a dispersion relation [1] and their frequencies ω are very small compared to the gyration frequency ω_c . In presence of those unstable electrostatic modes, the electron trajectories become chaotic, and without the waves they are regular with a constant drift motion. We considered a Cartesian coordinate system where the radial magnetic field B is along the x-direction, the constant axial electric field is along the z-direction and the azimuthal E×B drift direction is along the y-direction. Due to these chaotic wave particle interactions the electrons gain energy from the background waves which increases electron temperature along perpendicular direction by a significant amount, $\frac{T_\perp}{T_\parallel} \sim 4$ and a significant amount of cross-field electron transport is observed along the axial direction.

[1] T. Lafleur, S. D. Baalrud and P. Chabert, Phys. Plasmas 23, 053503 (2016).