Seminar

Institute for Plasma Research

Title : Development of High Speed 1D-2V PIC-MCC Numerical Engine for Plasma Thruster

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Date : 14th June 2018 (Thursday)

Time : 11.00 AM

Venue : Committee Room 3, (New Building), IPR

Abstract :

Electric propulsion is one of the commonly used methods for satellite station orbit keeping and deep space mission. One such method is a Steady-state Plasma Thruster (SPT). Though in use over 50 years, physics understanding of SPT is a rapidly evolving field. One of the core issues is the accurate estimation of transport coefficient of particles, momentum and energy in the cross field region in an SPT. It has been found experimentally that the effect of wall dynamics and magnetic field geometry as well as the location of formation of virtual cathode are also fundamental to the understanding of SPTs. Thus realistic geometry, boundary conditions and particle level transport studies as well as theoretical understanding are essential to gain complete control over several important optimization factors of thrust generation using SPT.

Particle in cell simulation (PIC) methods have proven to be of great use in cross-field device simulations. For SPTs, while intuitive understanding is obtained using fluid models, as thrust generation crucially depends strongly on cross-field instabilities and transport mechanisms, for good quantitative understanding and optimization, development of an efficient and fast PIC based numerical engine is essential.

In this work, to begin with, a 1D1V (along the axial length of SPT) PIC solver is developed and bench-marked quantitatively for linear Landau damping, nonlinear Landau damping and particle trapping or phase space structure formation as well as for two stream instability and its saturation. As a next step towards thruster geometry, a radial magnetic field is applied near the exit of the thruster. The resulting 1D-2V equations are solved using PIC technique. As neutral collisions are fundamental to sustain plasma production in an SPT, the 1D-2V code is augmented with Monte-Carlo Collisions (MCC) leading to a 1D2V-PIC-MCC solver. This is further bench-marked for upper hybrid oscillation frequency. In this M.Tech defense talk, the details of the formulation, the code development, bench mark studies as well as future direction of the project will be presented.