Seminar

Institute for Plasma Research

Title : Studies in Non-Neutral Plasmas using Particle-in-Cell Simulations

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Time : 02.00 PM

Venue : Committee Room 4, (New Building), IPR

Abstract:

Confinement of Non-neutral plasmas in laboratory is invariably accompanied by continuous generation of charged particles due to collisions with very low density background neutrals. This leads to processes which are driven by resonant particle effects leading to instabilities, nonlinear saturation and transport in magnetized Non-neutral plasmas. Hence a particle level simulation valid for a variety of trap geometry and useful at arbitrary densities is an important tool to understand some of these effects.

As a part of this thesis, an Electrostatic, OPEN-MP parallelized, 2D3v Particle-in-Cell (PIC) code with facility for Monte-Carlo-Collisions (MCC) has been developed to simulate 2D dynamics of plasmas of arbitrary neutrality in cross-sections of magnetic traps, along with 3D collisional interaction of the plasma with a background of neutrals at any given temperature and pressure. The code is written in Cartesian co-ordinates, which makes it flexible to simulate plasma dynamics in trap cross-sections of arbitrary size and shape, as well as large toroidal aspect ratios. To understand the axial dynamics, a downscaled 1D version of the PIC code has also been developed for simulation 1D dynamics of plasmas confined within various types of numerical 1D walls to mimic experimental conditions.
This suite of PIC codes has been successfully utilized to investigate linear and nonlinear dynamics of radial breathing modes, and ion-resonance instabilities in cylindrically confined non-neutral plasmas. These simulations have revealed and explained new and interesting nonlinear dynamics of non-neutral plasmas such as formation of density voids and spontaneous triggering of poloidal modes from the radial breathing modes, and symmetric tearing of electron clouds and reorganization of the torn sections into a single cloud configuration in the course of ion-resonance instabilities. The MCC part of the code has been used to investigate the process of destabilization of electron plasmas by impact ionization of background neutrals, and the influence of elastic collisions between electrons and background neutrals on the ensuing ion resonance instability. Using the 1D PIC code it has successfully demonstrated, with a suitable numerical experiment, that plasmas can be significantly heated, if the plasma is taken through an adiabatic thermodynamic cycle of quasistatic compression and non-quasi-static expansion back to its initial dimensions.

In this thesis talk, crucial aspects of the code development and details of the physics problems addressed will be presented along with future scope of this work.