Seminar

Institute for Plasma Research

Title: Studies on external electrode influence on magnetized plasma properties in linear device

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Abstract:

Plasmas created in laboratories are ubiquitously in contact with material bodies such as confining vacuum vessel, discharge electrodes, limiters, electrostatic probes etc. These adjoining surfaces play an important role in the establishment of equilibrium potential and associated charged particle distribution inside the plasma system. The electrodes can be either conducting or insulated, emitting or non-emitting, absorbing or deflecting the charged particles. In each case, the plasma always tends to maintain its quasi-neutrality by suitably establishing a potential relative to its external boundaries. Due to very high mobility, the plasma electrons are in equilibrium with the macroscopic potential distribution; which is usually described by Boltzmann distribution. However, when a magnetic field is externally imposed in the plasma, the electrons are unable to respond quickly to the local potential build-up in the neighbouring magnetic field lines. In this case, the role of conducting external boundaries becomes quite significant; since it tends to equilibrate the potential developed across the magnetic field line by allowing a net flow of current through the conducting boundaries in contact with the plasma system. Similarly, a positive biased electrode inserted inside a magnetized plasma column can influence the plasma potential over a macroscopic level. This in-turn has a global impact on the electron temperature due to loss of faster electrons from the discharge. External plate biasing is a popular technique applied in magnetized plasma to introduce local electric field and density gradient inside plasmas. It is well known that the density and potential gradients in the plasma lead to drifts of charged particles across magnetic field lines and are the source for various instabilities that affects plasma confinement.

This thesis attempts to address a few pertaining issues associated with electrode interactions in magnetized plasma column. In particular, the cross-field transport of charged particles have been investigated for the following cases; (1) the presence of conducting and insulating objects presents along axial boundaries, (2) an obstructed plasma region; and (3) biased electrodes introduced inside the plasma. The experimental results have been emphasized with the help of analytical models; which explains the contrasting behaviour of radial plasma density and potential variations across magnetic field due to short-circuit effect; the role of insulating boundaries on the equilibrium properties of magnetized plasma column; and the plasma diffusion mechanism across magnetic field inside an obstructed region. These experimental results supported by the analytical model can find significance in the basic phenomena observed in linear device, design of plasma sources, and simulating astrophysical plasma object interactions in space.