Seminar

Institute for Plasma Research

Title : Effect of controlling toroidal field topology in a simple toroidal plasma: An experimental study

Speaker : Mr. Umesh Kumar
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Date : 17 January, 2019 (Thursday)

Time : 11.00 AM

Venue : Seminar Hall, IPR

Abstract:

In a simple magnetized torus (SMT), plasma is confined using an external, purely toroidal, magnetic field. As there is very little or no toroidal current in an SMT, magnetic rotational transform ceases to exist, leading to open, single particle orbits and consequent absence of single particle confinement. In the presence of a continuous ionizing source such as a hot cathode or an electron cyclotron resonance mechanism, magnetic drifts of particles create vertical charge separation leading to a residual vertical electric field, which in turn, transports the plasma outward along the major radius direction and eventual loss of plasma. A transit time or quasi-static equilibrium is achieved due to a weak balance between plasma source and radial losses, thus making the nature of plasma source to be a crucial component in determining the overall plasma properties. A poloidally continuous metal strip is used to minimize the residual vertical electric field. An SMT provides a relatively simple and well diagnosable test-bed for experimental plasma studies which are at once, of both fundamental importance as well as have strong applications such as edge physics of Tokamaks, RFPs and similar devices.

In this experimental thesis work performed in BETA, a simple magnetized toroidal device at the Institute for Plasma Research, an attempt is made to address some of the following questions : (i) As minimizing the residual vertical field is crucial to the nature of quasi-static equilibrium, its mean density and temperature profiles, consequent low frequency fluctuations, turbulence and transport, can one use a relatively weak external magnetic field to create parallel connection lengths or pathways for electrons long the total field line direction so that the residual vertical field is minimized further [1, 3]? (ii) Is there a novel, yet simple way of experimentally determining the magnetic field line topology [1]? (iii) If so, by varying the vertical magnetic field for a given toroidal field strength, can one experimentally determine the changes in the nature of plasma mean profiles, fluctuations and mean poloidal plasma flows [2]. (iv) Are there special ratios of vertical to toroidal field strengths which significantly improve plasma confinement and why? (v) Does the nature of mean profiles, fluctuations and overall confinement, crucially dependent on the type of plasma source, for example, hot cathode-based source or electron cyclotron resonance-based source [4]? In this Thesis defense talk, details of several new experimental findings obtained by controlling the parallel connection length or parallel transit time of electrons for two different plasma sources will be presented along with plausible arguments. Unsolved issues and several open problems pointing at possible future direction have also been identified in this Thesis work.