Seminar

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Institute for Plasma Research

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Title: Magnetohydrodynamic study of Magnetic Island Coalescence – Role of Shear Flows

Speaker: Mr. Jagannath Mahapatra

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Date: 16th October 2023 (Monday)

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Google meet link: https://meet.google.com/vra-ncjc-qpv

Abstract

Magnetic reconnection (MR) is one of the fundamental plasma processes in which the magnetic field topology changes and a substantial fraction of the global magnetic energy is converted to plasma kinetic energy, heat energy and particle acceleration. Hence, MR is believed to be one of the reasons behind many observed eruptive/energetic events, for ex., solar flare, coronal mass ejection, planetary aurora formation, plasma disruptions in tokamak, to mention a few. Typically, MRs occur at a local magnetic null point in the plasma where thin current sheets (CS) form. Any change in plasma parameters around these local CS (for ex., presence of a guide field, anisotropy in density, temperature across the CS, presence of sheared flows) can affect the overall MR mechanism by altering the plasma flow pattern and (or) magnetic field strength. Further, plasma collisionality plays a major role in controlling the size of the CS. In collisionless plasmas (for ex, earth magnetosphere, solar corona, etc.), the CS becomes comparable to or less than the ion skin-depth such that the overall mechanism is predominantly kinetic. However, for collisional plasmas (for ex., in many laboratory experiments, solar photosphere, etc.) the CS thickness is much larger than the kinetic scales and one can use a simple single-fluid resistive MHD model to study MR.

Resistive MR mechanisms in naturally reconnecting systems can be categorized in two different classes: first, MR in thin, long CS when they become unstable to tearing or plasmoid instability and second, MR during the interaction of multiple flux tubes/current filaments. The present work is focused on understanding the dynamics and parametric dependencies in the latter class of reconnecting systems, using a special MHD equilibrium, namely, Fadeev's magnetic island equilibrium.

In this Thesis, by using a relatively simple 2D/2.5D ViscoResistive-MagnetoHydroDynamic (VR-MHD) model, the effect of shear flows during the coalescence of two magnetic islands is investigated. The role of island width, effect of scale of in-plane and out-of-plane sheared flow, role of compressibility on the MR dynamics in CS and the overall reconnection mechanism during the island coalescence instability has been studied. Further, two different class of Fadeev equilibrium have been addressed namely, non-force-free and force-free equilibrium. In this presentation, several of the above said results will be discussed along with major current challenges and possible future directions.