Study of abnormal transport in a magnetized plasma column

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In the presence of a magnetic field B perpendicular to an electric field E, charged particles drift in the EXB direction. Combined with plasma inhomogeneities, this drift is favorable to the apparition of instabilities that considerably increase the transport across the magnetic field B (« anomalous transport »). Cross-field configurations are exploited in numerous applications : ions sources, hall thrusters for satellites, magnetron discharges, Penning gauges, fusion plasmas... A better understanding and ultimately the control of anomalous transport is a major issue in all of them.

MISTRAL is an experimental device (linear magnetized plasma column) based at PIIM laboratory used to study EXB plasmas with magnetized electrons and weakly or not magnetized ions with some typical plasma parameters given by : plasma length = 1.2 m, plasma diameter = 20 cm, T_e = 1-6 eV, n_e = 10^{14}-10^{16} m^{-3}….. The MISTRAL plasma has been characterized experimentally [1] with several diagnostics (Langmuir probe, fast camera, emission spectroscopy) but very small amount of theoretical work has been achieved so far. Coherent structures rotating in the azimuthal direction have been observed in MISTRAL rotating at a frequency comparable to the EXB rotation frequency [2]. The Simon-Hoh instability [3,4] is one of the candidates to explain the coherent rotating structures observed in MISTRAL.

Our aim is to complete the characterization of the observed instabilities along with theoretical modelling to explain the origin of coherent structures in MISTRAL. The spatio-temporal acquisitions of plasma parameters (n_e, T_e, V_{plasma}, V_{float}) have been performed with the help of Langmuir probes for Ar and Xe plasma along with fast camera acquisitions. The graphical analysis for the dispersion relation obtained from the preliminary analytical work [5] has been done using the parameters obtained with the Langmuir probe. A theoretical model is in development for describing the instabilities in MISTRAL plasma conditions.

References

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