Fluid modelling of the weakly magnetized plasma column MISTRAL

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Cross-field configurations are used in a variety of applications, including ions sources and Hall thrusters for satellites, magnetron discharges, Penning gauges and fusion plasmas. Understanding and ultimately controlling anomalous transport is a crucial issue for these applications.

MISTRAL is a linear magnetized plasma column based at the PIIM laboratory used to study ExB plasmas with magnetized electrons and weakly or not magnetized ions. MISTRAL is a versatile device in which the following typical plasma parameters can be achieved: plasma length (L) = 1m, plasma diameter = 8 cm, column radius (a) = 10 cm, T_e = 1-6 eV, $n_e = 10^{14}$ - 10^{16} m^{-3}, B = 10-30 mT, P = 10^{-4}-10^{-2} Pa, Gas: H, He, Ar, Kr, Xe. The MISTRAL plasma has been characterized experimentally [1] with several diagnostics (Langmuir probe, fast camera, emission spectroscopy). Coherent structures rotating in the azimuthal direction have been observed in MISTRAL rotating at a frequency comparable to the ExB rotation frequency with azimuthal wave number m = 1, 2. Simon-Hoh type of instabilities [3,4] are one of the candidates to explain the coherent rotating structures observed in MISTRAL, with a complete theoretical picture remaining to be developed.

Our goal is to complete the characterisation of the observed instabilities along with the theoretical modeling in order to understand 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 linear stability of MISTRAL plasma has been explored with the two-species fluid model developed in [5] showing that these plasmas are prone to the centrifugal instability. Extensions of the fluid model to include ion-neutral friction and relax the small Larmor radius ordering are presently in progress.

References

[1] M. Matsukuma, Th. Pierre, A. Escarguel, D. Guyomarc'h, G. Leclert, F. Brochard, E. Gravier, Y. Kawai, Phys. Lett. A 314, 163 (2003)

[2] S. Jaeger, Phd thesis, Université de Provence, Marseille

[3] A Simon, Phys. Fluids 6, 382 (1963)

[4] F. C. Hoh, Phys. Fluids 6, 1184 (1963)

[5] F. F. Chen, Phys. Fluids 9, 965 (1966)