Abstract

In this thesis, we have experimentally investigated the role of electron temperature gradient in the excitation of electromagnetic turbulence in high beta ($\beta$) plasma of Large Volume Plasma Device (LVPD). The LVPD offers a suitable platform for the study of high beta ($\beta \geq 1$) turbulence in a laboratory plasma. To enable these studies, LVPD has been built along with the supporting subsystems such as large magnet coil system, two geometrically different plasma sources, power supply system, diagnostics, diagnostic platform and data acquisition and control system. The experiments are carried out using different electron emission source function but keeping the plasma beta same.

Initial investigations are concerned with generating suitable plasma conditions for the turbulence studies. Efforts are made to look for different electron emitters for the required control on the electron temperature profile. Two different configurations are used to produce plasma of the same beta but with different temperature profile. A detailed characterization of plasma is undertaken in the laboratory. Results explaining the morphological features of high beta plasma are described.

Spontaneously excited density and magnetic field fluctuations are observed in a high $\beta$ plasma. We have investigated fluctuations in plasma density, magnetic field and plasma potential by multipoint measurements. We notice radially two distinct regions i.e core region ($r < 45cm$) and density gradient region ($r \geq 45cm$), where fluctuations stay correlated. Results of the experimental investigation of fluctuations in the core region are discussed in this thesis.

In the core region of LVPD plasma, the electron temperature gradient is established and the instability is spontaneously excited when a narrow multifilamentary electron source is used. The scale length of instability excited by electron temperature gradient ($\nabla T_e$) in fusion devices like tokamaks is $\leq 25 \mu m$, which makes it extremely difficult to do direct measurements of wavelength and frequency of these modes. Since LVPD plasma can be produced in a very small magnetic field, the scale length of this instability is $\geq 1cm$ which can be conveniently measured experimentally. As a confirmation that the turbulence is produced because of electron temperature gradient, we have repeated the experiment using a broad source where both temperature gradient and the instability is significantly suppressed. The basic experimental characteristics of turbulence in the core of LVPD plasma exhibits that turbulence is caused by electron temperature gradient as plasma density is flat, both $\delta n_e - \delta \phi_p$ and $\delta n_e - \delta B_z$ are strongly anticorrelated. Joint wave number - frequency spectra, $S(k_\perp, \omega)$ spectra of both $\delta n_e$ and $\delta B_z$ are seen to be broad with peak at $\omega \sim 7 \times 10^4$ rad/s and $k_\perp \approx 0.2$ rad/cm. First experimental evidence of W-ETG turbulence and its comparison with the theoretical work on W-ETG modes for long scale fluctuations in high $\beta$ plasma is presented.