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Investigations on Electron Temperature Gradient (ETG) Turbulence in Large Laboratory Plasma of LVPD

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Understanding electron transport across magnetic field lines in a fusion device is critical. Linear calculations based on numerical and theoretical models reveal that the ETG mode is a fast growing instability driven by electron temperature gradient(ETG). It becomes significantly relevant even in high confinement scenario, despite ion heat transport becoming neoclassical, electron heat transport still remain anamalous [1]. The fluctuations of electron gyroscale have been reported from NSTX [2] and its role have been invoked to explain the plasma transport in Tore Supra [3]. However, all signatures of ETG turbulence could not be obtained due to its small wavelength(~µm) in high magnetic fields (~20kG) and complex geometry of tokamak, which restrict measurements and have limited control over the parameters that govern the turbulence. Basic plasma devices (linear or toroidal), on the other hand, provide a simplified geometry and control of magnetic field, thus brings scale length of turbulence well within the measurable limits. This provide a clear incentive to study ETG in basic plasma devices such as Large Volume Plasma Device(LVPD). However, these devices usually have plasma, which is contaminated by the presence of ionising, hot and non-thermal electrons, a potential source of instability. This renders making a case for ETG difficult.

An unambiguous observation on ETG driven turbulence is reported in LVPD [4]. Removal of unutilized primary ionizing and non-thermal electrons and imposition and control of gradient in electron temperature (∇T_e) are all achieved by placing a large (ϕ=2m) magnetic Electron Energy Filter (EEF) in the middle of the device. In the dressed plasma, the observed ETG turbulence in lower hybrid range of frequencies, f = (1- 80 kH_z) is characterized by a broadband with a power law. The mean wave number, $k_\perp \rho_e$= (0.1-0.2) satisfies the condition $k_\perp \rho_e \leq 1$. Experiments are further carried out on the measurement of turbulent particle and heat flux and results are compared with theoretical predications of ETG driven turbulent transport [5]. It is observed that the non-adiabatic ion response is responsible for plasma particle transport and the phase velocity opposite to electron diamagnetic drift direction is responsible for inward particle flux. In addition to this, electromagnetic radial particle flux is also measured [6]. It is observed that despite having convective flux radially inward, the net energy flux remains directed radially outward [7]. Detailed results on ETG and induced transport will be presented in the conference.

References

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