Electromagnetic turbulence and transport in high β LAPD plasmas

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The LArge Plasma Device (LAPD) at UCLA is a 17~m long, 60~cm diameter magnetized plasma column with typical plasma parameters $n_e \sim 10^{12}$ cm^{-3}, $T_e \sim 5$ eV, $T_i < 1$ eV, and B ~ 1kG when plasmas are produced using the primary BaO cathode source [1]. A new secondary plasma source has been installed, a 20cm LaB_6 cathode that allows the production of much hotter ($T_e \sim 12$ eV, $T_i \sim 6$ eV) and denser ($n_e \sim 5 \times 10^{13}$ cm^{-3}) plasmas [2]. This hundred-fold increase in plasma pressure combined with lowered magnetic field allows LAPD to be utilized to study the physics of magnetized, high β plasmas. We will report the variation of turbulence and transport driven by edge pressure gradients in LAPD with increasing plasma β (up to ~15%). Density fluctuations are observed to decrease with increasing β while magnetic fluctuations increase. In particular parallel magnetic fluctuations are seen to dominate at the highest β values with $\delta B_{||}/\delta B_{\perp} \sim 2$ and $\delta B/B \sim 1\%$. Perpendicular magnetic fluctuations are observed to saturate while parallel magnetic fluctuations increase continuously with β. The measurements are consistent with the linear excitation of a recently theoretically predicted instability, the Gradient-driven Drift Coupling mode or GDC [3]. This instability is flute-like ($k_{||} = 0$) and grows in finite β plasmas due to density and temperature gradients through the production of parallel magnetic field fluctuations and resulting $\nabla B_{||}$ drifts. Linear and nonlinear calculations using LAPD parameters indicate the instability should grow in these experiments. Comparisons between experimental measurements and theoretical predications for the GDC will be shown. Direct experimental measurements of electrostatic flux have been performed and show a strong reduction with increasing β. At the same time, no evidence is found (e.g. in density profile shape) of enhanced confinement, indicating that other transport mechanisms, perhaps electromagnetic, are active. These observations and future plans for direct evaluation of magnetic transport will be discussed.

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