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Advances in Fusion-Relevant Physics on the Large Plasma Device

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Studies of turbulence and transport in the Large Plasma Device (LAPD) have: documented the role of drift-Alfvén waves and flows in avalanche events; revealed a new instability in the edge of increased β plasmas; and demonstrated an interaction between ICRF waves and edge turbulence, leading to strong modulation of the former and enhancement of the latter. Intermittent collapses of the plasma pressure profile (avalanches) are observed with off-axis heating in LAPD and are associated with unstable drift-Alfvén waves. Flows play a critical role in the dynamics, in particular in the onset of the drift-Alfvén waves and avalanches through the interplay of the stabilizing flow shear and the destabilizing pressure gradient. Active control of the flows is obtained using biasing; this leads to control over the size and frequency of avalanches. With controlled flows, a regime is found in which avalanches are absent. Strongly electromagnetic turbulence, identified as being due to a new instability, the Gradient-Driven Drift Coupling Instability (GDC), is observed in the edge of increased β plasmas in LAPD. As the plasma beta is increased (up to 15%), magnetic fluctuations are observed to increase substantially, with $\delta B/B \sim 1\%$ at the highest β, while density fluctuations decrease slightly. Parallel magnetic fluctuations are observed to be dominant at the highest β, with $\delta B_\parallel/\delta B_\perp \sim 2$. Comparisons of the experimental data with linear and nonlinear GENE simulations of the GDC yield good qualitative and quantitative agreement. An experimental campaign on the physics of ICRF waves on LAPD has established a correlation between strong modulation of core coupled fast waves and edge density fluctuations, both of which increase with antenna power. Strong low-frequency modulation of coupled fast wave power is observed via direct measurement of the core RF waves with magnetic probes. This modulation is well correlated with low-frequency edge density fluctuations associated with drift waves (measured with Langmuir probes). The amplitude of the RF modulation and the amplitude of edge density fluctuations in the drift wave frequency range both grow with increasing RF power, suggesting some nonlinear coupling between the edge drift waves and large amplitude fast waves in the core region.

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