Predator-prey Oscillations and Reynolds Stress in L-H Transition*

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Using a probe, we measure a clear correlation between $E \times B$ poloidal flows [red in Fig. 1(a)] and the electrostatic Reynolds stress (RS), $\langle \tilde{v}_r \tilde{v}_\theta \rangle$ [green Fig. 1(a) during Limit Cycle Oscillations (LCO) starting at the L-LCO transition, indicated with a vertical bar. The RS and the E_r oscillations during the LCO are slightly off-phase, indicating causality, and they occur ∼1 cm inside the LCFS, as shown in Fig. 1(b). The plasma was sampled at various times during the L-LCO-H evolution.

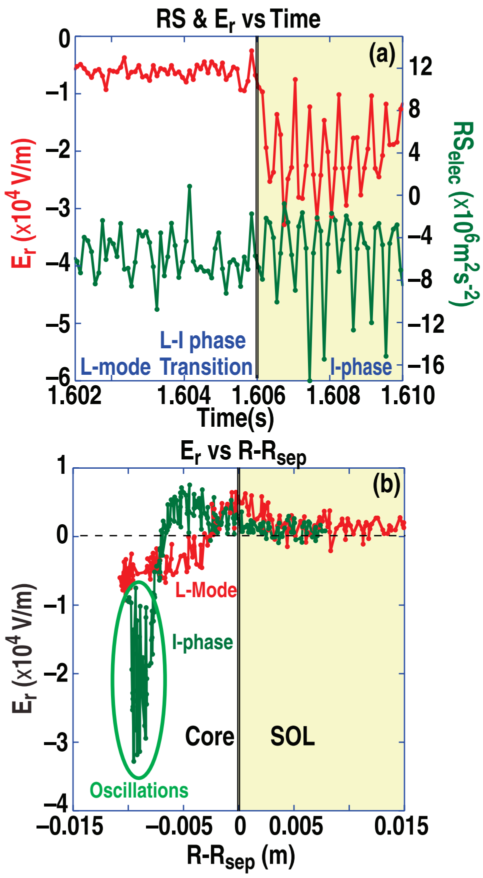

Figure 1: (a) Time evolution of E_r (red) and RS (green) during L-LCO transition and (b) E_r radial profile.

The L-H transition [1] in tokamak plasmas is traditionally connected to velocity shear decorrelation of turbulence [2], but the detailed physics, not fully understood, involves the presence of self-organized turbulence-generated, large scale flows [3]. The L-H transition can be studied by using discharge conditions that tether near the L-H transition and feature slow (1-2 kHz) oscillations, dubbed LCO-mode [4, 5] which can be interpreted as a prey-predator system between large scale flows and the turbulence, followed by another transition to full H-mode. These plasmas are obtained in DIII-D at $B_T = 2.1\,\mathrm{T}$, $I_p = 1\,\mathrm{MA}$, $n_e \sim 2.7 \times 10^{13}$, $P_{in} \sim 500\,\mathrm{kW}$ and keeping the LSN x-point at ∼10 cm from the floor [3]. The electrostatic RS, $\langle \tilde{v}_r \tilde{v}_\theta \rangle$, is a component of the momentum flux equation $\Pi = \langle n \rangle \langle \tilde{v}_r \tilde{v}_\theta \rangle + \langle v_\theta \rangle \langle n \tilde{v}_r \rangle + \langle \tilde{n} \tilde{v}_r \tilde{v}_\theta \rangle$.

References

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*This work was supported by the US Department of Energy under DE-FG02-07ER54917, DE-FG02-89ER53296, DE-FG02-08ER54999, DE-FG02-08ER54984, and DE-FC02-04ER54698.