STUDY OF THE PHASE TRANSITION NATURE OF THE L TO H TRANSITION*

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We present the results of a study of the phase transition character of the L to H transition achieved by using an X–point ("core") MARFE to access the marginal transition regime in which $P_{sep} \approx P_{threshold}$, where P_{sep} is the power flow across the separatrix and $P_{threshold}$ is the L to H transition power threshold . Although it is generally accepted that the L to H transition is a phase transition, the detailed nature of the phase transition has not been studied. One characteristic of second order phase transitions is the existence for marginal transition conditions of a critical point for which the transition time approaches infinity. But demonstrating a critical point for $P_{sep} \approx P_{threshold}$ is difficult because "noise" in the plasma (sawtooth heat pulses, etc.) enhances P_{sep} enough to trigger a fast transition. To overcome this difficulty, we operate at high target densities for which an X–point ("core") MARFE exists just above the X–point, removing the sensitivity to local thermal fluctuations.

The temporal evolution of L to H transitions for which $P_{sep} \approx P_{threshold}$, progresses slowly over 20–50 ms—10–20× the typical transition time in DIII–D (0.1–1 ms), as indicated by the D_α drop, E_r increase, fluctuation response, and edge pressure gradient increase. Comparision with fast L to H transitions indicates that the evolution to the final ELM-free H–mode state inside the separatrix is identical in the two cases, except for the increase in transition time. These discharges are consistent with the existence a "critical point", but might also arise due to changes to the slope of the bifurcation curves at the transition point due to the differing target plasma conditions. The evolution of the transition is consistent with a phase transition containing both first and second order parts—portions of the transition in which parameters evolve continuously and portions in which parameters evolve discontinuously .

Because these L to H transitions occur at high target densities, they are potentially more ITER relevant. Under these conditions, the divertor plasma is detached in L–mode, and an X–point ("core") MARFE forms just above the divertor X–point (LSN divertor). During the L to H transition, the core MARFE is gradually extinguished on the same time scale as the D_α drop, providing a slow ramp in the power across the separatrix. These discharges display another feature of potential interest to ITER: a broad L–mode-like scrape-off layer in the ELM-free H–mode combined with a steep edge pedestal and H factors of 1.6.

Session Topic: Formation and Structure of Internal and Edge Transport Barriers

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