L–H STATE TRANSITIONS, HYSTERESIS, AND CONTROL PARAMETERS ON DIII–D*

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Numerous experimental observations and theoretical models suggest that hysteresis is a property of the H–mode. Comparisons of L–H and H–L transitions in the DIII–D tokamak are being examined for signs of hysteresis with the goal of determining the relationship between the physics controlling the forward and back transitions. On a global level, substantial hysteresis is found in the loss power. For a wide variety of experimental conditions, the power flow through the separatrix at the back transition P_{HL} is typically 50% or less of that required to produce the forward transition P_{LH}. Furthermore, while P_{LH} increases linearly with B_T, P_{LH} shows little or no scaling with B_T, indicating that the degree of power hysteresis increases with B_T. Similarly, the forward transition power approximately doubles when B_T is reversed whereas P_{LH} is unaffected by the field reversal. This result implies large power hysteresis in reversed B_T discharges with P_{LH} being a factor of 4–5 larger than P_{LH}. In addition to these global studies, studies of local edge parameters are being made in an effort to isolate the edge parameter which controls the H–mode state. The most successful predictor found for the H–mode state is the edge electron temperature T_e (possibly a proxy for T_i). The L–H transition occurs when T_e achieves a critical value and the H–L transition occurs when T_e falls to near its value at the forward transition. Furthermore, as B_T is increased, the values of T_e observed at the forward and back transitions also increase; nevertheless, the relationship between T_e at the forward and back transition is maintained. The observation of power hysteresis at the global level and lack of hysteresis of T_e at the local level appear to be contradictory. However, this contradiction may result from the fact that it is difficult to maintain all parameters identical at the forward and back transitions. By following the dynamics of the plasma state through the forward and back transitions, we can represent the evolution of various control parameter candidates as a trajectory in various parametric spaces. The shape of these control curves can illustrate the specific nonlinearities governing the L–H transition problem. Such experimental comparisons can give “sufficient” and “necessary” local conditions for plasma state transitions beyond that obtained from simple threshold scaling tests. Further studies are planned to examine other local parameters which are predicted to control the transition, particularly the radial electric field.

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