L-H Transition Threshold Physics for Weakly Collisional Plasmas

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H-mode operation is the regime of choice for good confinement. This renders the questions of access to, and remaining in, H-mode to be critical. Foremost of these issues is the L→H transition power threshold and the related problem of hysteresis. To predict ITER transitions, one must understand the threshold in low collisionality, electron heated regimes where the physics may differ significantly from present day discharges. In this paper, we discuss new transition scenarios, characterized by the sensitivity of transition evolution to pre-existing L-mode profiles.

Ongoing studies are concerned with understanding the transition in the *collisionless regime*. This challenging regime presents at least two problems

a.) the electon-ion coupling is now *anomalous,* due to $\langle \mathbf{E} \cdot \mathbf{J} \rangle$ work

b.) the shear flow damping is turbulent, and not due to collisional drag.

To address a.) we have utilized a model of collisionless power coupling between electrons and ions. Most notable in this model are the absence of coupling simply proportional to $T_e - T_i$, and intensity dependence of the power coupling. To address b.) we have extended a recently developed theory of minimum enstrophy relation which predicts that the flow damping should have the form of a turbulent *hyper-viscosity*. In addition, the nor viscous heating of the ions.

Preliminary results of studies of collisionless regimes suggest that L→H transition occurs as the endstate of an *anomalous electron-ion thermal coupling front.* This front is attached to a propagating turbulence intensity front. The transition occurs when the front arrives at the edge and impulsively raises T_i there, thus raising ∇P_i, and the diamagnetic electric field shear, and so triggering the transition. Further studies of this interesting and relevant phenomenon are ongoing. This study highlights the importance of collisionless energy transfer process to transitions in regimes of ITER relevance.

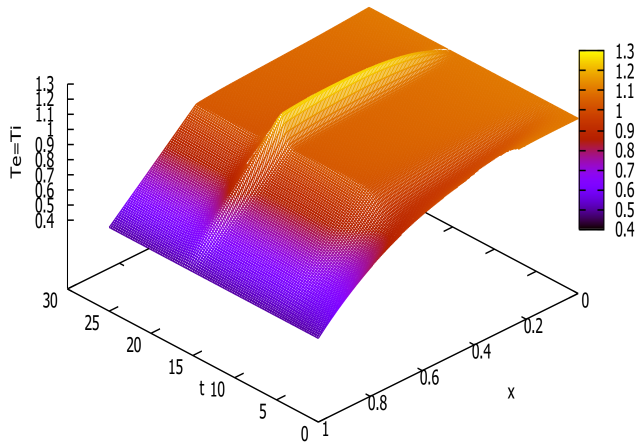

Figure 1: Preliminary results on spontaneous LH transition with suppressed shear flow. The heat pulse applied mid-time of integration with no effect on the H-state established spontaneosly.

Finally, we are exploring new transition scenarios. Recent studies have revealed that a spontaneous transition can occur *in the absence of turbulence driven shear flow.* Shown in Fig.1 is an example of such transition. The key point here is the sensitivity of the transition to the pre-existing L-mode density profile. Ongoing work is focused on elucidating this sensitivity and understanding how to exploit it to optimize the access to H-mode. Our aim is to map the basins of attraction for different transitions.

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