

Energy Exchange Dynamics across L-H transitions in NSTX

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H-mode is planned for future devices such as ITER, and is preceded by a low (L) to high (H) transition. A key question remains. What is the mechanism behind the L-H transition? Most theoretical descriptions of the L-H transition are based on the shear of the radial electric field and coincident ExB poloidal flow shear, which is thought to be responsible for the onset of the anomalous transport suppression that leads to the L-H transition. This talk will focus on the analysis of the flow dynamics across the L-H transition in NSTX [1].

We analyze the L-H transition dynamics using the velocimetry of 2D edge turbulence data from gas-puff imaging (GPI). Figure 1 displays a snapshot of the D-alpha emission in NSTX.

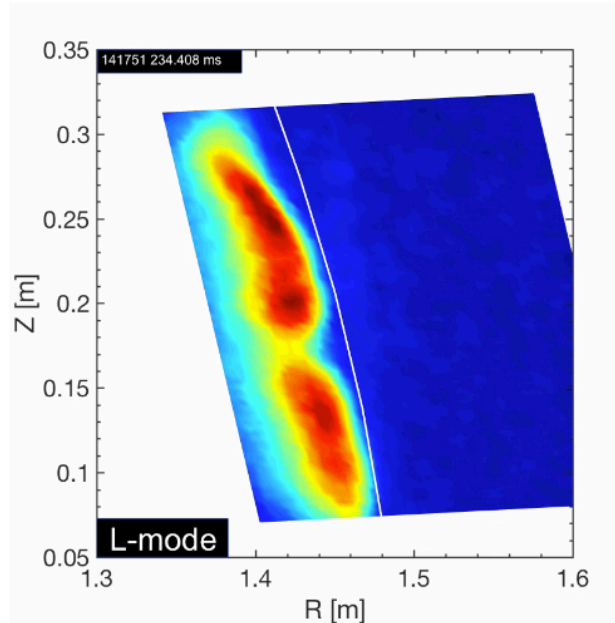


Figure 1 Example of a gas puff image during the L-mode phase.

We determine the velocity components at the edge across the L-H transition for 17 discharges with three types of heating power (NBI, ohmic, and RF). Figure 2 displays an example of the 2D flow pattern.

Using a reduced model equation of edge flows and turbulence, the energy transfer dynamics is compared with the turbulence depletion hypothesis of the predator-prey model. In order for Reynolds work to suppress the turbulence, it must deplete the total turbulent free energy, including

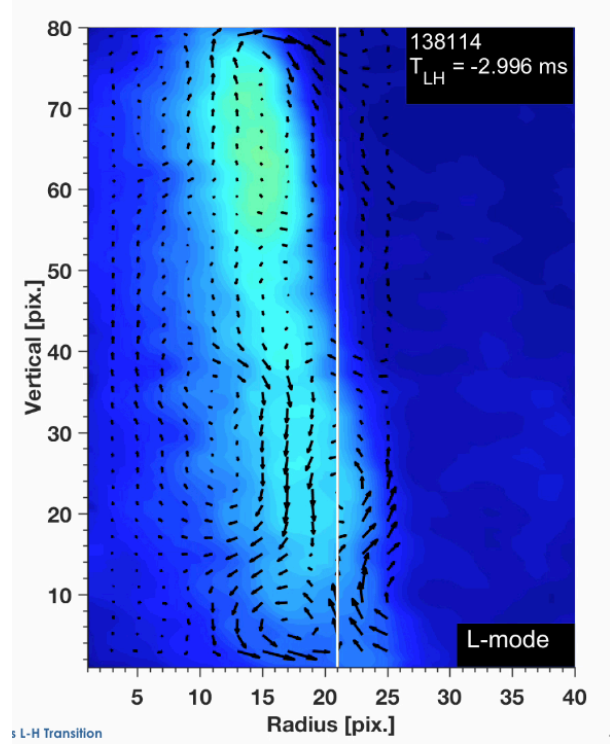


Figure 2: Example 2 D velocity field determined using a robust generalization of optical flow that enforces divergence free velocity

the thermal free-energy term. For this to occur, the increase in kinetic energy in the mean flow over the L-H transition must be comparable to the pre-transition thermal free energy. However, this ratio was found to be of order 10^{-2} . Although there are significant simplifications in the theoretical model, they are unlikely to cause inaccuracy by two orders of magnitude, suggesting that direct turbulence depletion by the Reynolds work may not be large enough to explain the L-H transition on NSTX, contrary to the predator-prey model.

References

- [1] A. Diallo, S. Banerjee, S. J. Zweben, and T. Stoltzfus-Dueck. Energy exchange dynamics across L-H transitions in NSTX. Nuclear Fusion, 57(6), Jun 2017.