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Energy Exchange Dynamics across L-H transitions in NSTX

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The physical mechanism governing the L-H transition has been a long standing theoretical and experimental challenge. Understanding its trigger mechanism is critical for the operation of future fusion devices and ITER. This work is motivated by the need to test L-H transition models (e.g., predator-prey, and ExB flow suppression) and explore possible new L-H transition dynamics. This paper presents detailed analysis of the L-H transition on three sets (NBI, RF, and Ohmic) of NSTX discharges using the gas-puff-imaging diagnostics for high temporal and spatial resolutions. The analysis studies the edge velocities and energy dynamics across the L-H transition using an implementation of the othogonal decomposition programming for high temporal resolution velocity fields. One motivation is recent work by Cziegler et al., in Plasma Phys. Control. Fusion 56 075013 (2014) on C-Mod, where a time sequence was suggested for the L-H transition, namely, the peaking of the Reynolds power and then a collapse of the turbulence and finally the rise of the diamagnetic electric field. In contrast, in all the investigated NSTX discharges, the production term (computed 1 cm inside the sepratrix) is negative, pointing to transfer from the DC flows to the fluctuations, even immediately before the L-H transition. This suggests that depletion of turbulent fluctuation energy via transfer to the mean flow may not play a key role in the L-H transition. In addition, for the three sets of discharges, we observe that the thermal free energy is consistently much larger than the kinetic energy produced by the mean poloidal flow across the L-H transitions. These observations are inconsistent with the predator-prey model. The paper will describe the analysis including error estimations. Furthermore, analysis of the radial correlation dynamics across the L-H transition will be discussed. Work supported by U.S. DoE contract #DE-AC02-09CH11466.

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