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Limit Cycle Oscillations at the L-I-H Transition in TJ-II Plasmas: Triggering, Temporal Ordering and Radial Propagation

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The spatiotemporal evolution of the interaction between turbulence and flows has been studied close to the L-H transition threshold conditions in the edge of TJ-II plasmas. As in other devices the temporal dynamics of the interaction displays limit cycle oscillations (LCO) with a characteristic predator-prey relationship between flows and turbulence. Recently, some controversial results arise: two types of LCO are found in HL-2A showing opposite temporal ordering. The first type is the standard predator-prey model where the turbulence increase leads the zonal flow generation that suppresses the former. In the second type, the ExB flow grows first causing the reduction of the fluctuations. The later points to the pressure gradient as a candidate for maintaining the oscillations and eventually inducing the transition to the H-mode. At TJ-II, the turbulence-flow front is found to propagate radially outwards at the onset of the LCO and in some particular cases, after a short time interval without oscillations, a reversal in the front propagation velocity is observed. Associated to this velocity reversal, a change in the temporal ordering of the LCO is measured. However, the change in the temporal ordering is not related to an intrinsic change in the nature of the LCO. In both cases the turbulence increase leads the process and produces an increase in the ExB flow shear. TJ-II findings indicate that, in addition to the role of turbulence driven zonal-flow and pressure gradients, radial propagation mechanisms play an important role on the LCO dynamics. Dedicated experiments have been carried out to investigate the physical mechanisms triggering the onset and radial propagation of the LCO. At TJ-II the LCO are preferentially observed close to the transition threshold conditions at specific magnetic configurations having a low order rational close to the plasma edge. Preceding the onset of the oscillations, high frequency modes are often observed accompanying a low frequency MHD mode. These high frequency modes resemble those found in FTU plasmas interpreted as Alfven modes non-linearly coupled with a magnetic island. The mechanism by which the magnetic island is easing the onset of the LCO may be related to local changes in the radial electric field and/or in the turbulence that propagate towards the plasma edge driving the plasma to the threshold conditions.

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