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L-H transition triggered by sawtooth-induced heat flux in EAST

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Since the discovery of H-mode at ASDEX in 1982[1] a lot of scrape-off layer and divertor conditions, i.e., 'downstream' conditions, have been considered for the L-H transition threshold power. These 'hidden conditions' [2-13] include ∇B drift direction, divertor compression, divertor magnetic geometry, first wall materials, wall conditioning, and so on. A 'upstream' condition of large sawtooth crashes at the plasma core triggering L-H or L-I transitions with reduced threshold power is also observed in EAST and several other tokamaks[5,14-17]. After a sawtooth crash the poloidal flow shear at the very plasma edge, increasing~25% up to the threshold value, is observed just before the L-H transition in an EAST deuterium plasma. Associated with the critical poloidal flow shear, the local turbulent decorrelation rate increases significantly. The increased turbulent decorrelation rate compensated by nonlinear energy transfer rate from the turbulence to the low-frequency shear flows, exceeding the turbulence energy input rate, is sustained for several hundred microseconds till the turbulence quench happening.

In a helium-dominant plasma with 'on-axis' electron cyclotron resonance heating (ECRH) both sawtooth cycles inside of q=1 surface and 'long-lived' small amplitude magnetic oscillations at q=2 are observed. These small amplitude magnetic oscillations are identified as small amplitude 2/1 tearing mode. Both the sawtooth-induced and small amplitude 2/1 tearing mode-induced heat flux are found to modify the edge perpendicular velocity, especially the shear of edge perpendicular velocity. This suggests that the sawtooth-induced L-H transition, i.e., L-H transition following by a sawtooth crash at the core, could be triggered either by the sawtooth-induced or small amplitude 2/1 tearing mode-induced heat flux.

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