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L-H Transition Triggered by Fishbone Mode in the NBI Heated HL-2A Plasmas

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The L-H transition physics is one of the most important subjects for realizing a controlled nuclear fusion.In this paper, we present new results to show the nature of L-H transition and related mechanisms that trigger its onset. A novel feature, i.e., the coupling between the fishbone mode and the edge transport during NBI heated discharges, is found. Some of the results are similar to the fishbone-triggering on internal transport barrier while others are unique and appear to be pertinent to edge transport barrier. In some discharges a burst of a large fishbone is followed immediately by an L-H transition or shortly followed by an edge localized mode (ELM). Furthermore, an I-phase triggered by 'persistent EPMs'or sawtooth is also observed.
The measurement of edge plasma poloidal rotation, using reflectometry, has been performed to elucidate the correlation between the nonlinear evolution of fishbone instability and the edge radial electric field. I was found that a sudden increase in the plasma poloidal rotation happened immediately after the onset of each fishbone and ultimately the last fishbone triggered the transition to I-phase when the poloidal rotation velocity reaches 2km/s. Thus, the enhancement in plasma poloidal rotation leads to the radial electric field, which subsequently suppresses the turbulent fluctuations and results in the transition. Further experimental results suggest that the fishbone could provide a locally enhanced shear in the plasma flow by fast ion redistribution and/or heat propagation, and act as a trigger for the L-H or L-I transition.
We present evidence showing that EPMs can affect bulk plasma confinement through flow generation & kinetic effects. The finding of triggering phenomena by fishbone activities should be emphasized since the resultant shear of electric field in a future burning plasma could reach a sufficiently large level to reduce the turbulence transport. This gives us a hope that the alpha-particle losses induced by the alpha-particle driven MHD instabilities in a burning plasma may cause a sudden change of the plasma confinement by resultant structured electric field.

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