Impact of Stochastization of Magnetic Fields on Internal Transport Barrier in LHD

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It is widely recognized that the magnetic topology is one of the most basic factor of plasma confinement in magnetized plasma including tokamak and helical devices. Since the formation of internal transport barrier associated with the transition from the stochastic state to helical state was demonstrated in RFP [1], the significant impact of magnetic topology on transport has been recognized. In helical system, the magnetic topology in the core region is originally nesting state. However, in LHD, core temperature flattening is often observed in the plasma with internal transport barrier by formation of the core stochastic field and this flattening prevents the achievement of high central ion temperature. Controlling the bifurcation of magnetic topology would leads to the achievement of the high ion temperature plasma. The heat pulse propagation [2] method is used for a tool to measure the magnetic topology [3]. The heat pulse propagates outward with the time scale of heat transport coefficient in nesting surface region. In the magnetic island, the heat pulse produced by modulated ECH propagates from the boundary to the O-point of the magnetic island. However, when the magnetic filed becomes stochastic, fast heat pulse propagation is observed in the stochastic region.

It has been found that the bifurcation of magnetic topology is sensitive to magnetic shear and transition to the stochastic state take place only in the certain range of magnetic shear. Therefore the control of magnetic shear using the neutral beam driven current has been applied to avoid the core temperature flattening in the plasma with internal transport barrier in LHD. The core flattening of temperature profile is observed when co-NBs (2 beam, 10.5MW) are injected. In the core region, the radial profile of the delay time of the heat pulse is flat, which indicates the magnetic field is stochastic. On the other hand, when the additional counter-NB (2.3MW) is injected, the stochastic region of magnetic field disappears and the ion temperature profile becomes peaked.

References

[1] R. Lorenzini et al., Nature Phys. 5 (2009) 570.
[2] S. Inagaki et al., Phys. Rev. Lett. 92 (2004) 055002.
[3] K. Ida et al., N.J. Phys. 15 (2013) 013061.