§13. Comparisons of Edge Pedestal Structure in Tokamak and Helical Systems

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It is important for integrated understanding of toroidal system to compare the edge pedestal structure in fusion plasmas between tokamak and helical devices and investigate the process of the formation of the edge pedestal structure. It has been well known in H-mode plasmas observed in tokamaks that the edge pedestal structure is formed by the improvement of the reduced heat and particle transport. However, a plasma parameter determining the spatial width of the edge transport barrier (ETB) has been unknown, and thus this is one of the most crucial issues in the international tokamak physics activity (ITPA). Main difficulties of identifying a decisive factor which determines the edge pedestal structure are as follows: (1) Since the edge magnetic shear, radial electric field, rotation profile, edge current, pressure profile, and particle orbit loss are strongly correlated in physics and/or in experimentally accessible region, it is hard to separate the process of the ETB formation; (2) While temperature profile is determined by the heat transport, density profile is strongly influenced by the particle source profile (neutral penetration). Therefore, the ETB formation is related to both plasma process and atomic process; (3) The ETB formation is affected by the transport and MHD instability (ELM).

On the other hand, a priority of Japan which owns both large tokamak and helical devices is a large capability of understanding of the toroidal system using these plasmas in reactor size devices by dimensionless parameters, such as, collisionality, Lamor radius and beta value. Comparison of spatial structure of temperature, density, rotation and ELM perturbation in a similar edge pedestal condition between LHD and JT-60 enables us to separate several processes correlated to each other and to examine the physics process predicted by theory based model. In addition, understanding of the edge pedestal structure in H-mode accompanied by the ergodic layer in peripheral flux surfaces could largely contribute to the mitigation and stabilization of type-I ELM observed in tokamaks.

In LHD, characteristics of the edge MHD mode localized in ETB region are studied. A clear correlation between the steepened edge pressure gradient and the excitation of edge MHD modes is observed. In H-mode plasmas in LHD, a pulsated oscillation which is similar to ELM is observed in Dα signal in the divertor region. The frequency of this pulsated oscillation is increased in proportion to the heating power. In addition, the amplitude of this oscillation is decreased with increased frequency. These characteristics are similar to type-I ELM observed in tokamaks including JT-60.

In JT-60, it is found that the spatial width of the ETB in H-mode plasmas depends strongly on the beta value through the dimensionless transport experiment using hydrogen and deuterium plasmas. On the other hand, the dependence of the height and spatial width of the ETB on the edge parameters are investigated in LHD. It is observed that the spatial width of the ETB tend to depend on the edge beta value. This result is similar to that obtained in JT-60. In addition, the dependence of the spatial width of the ETB on the edge density is weak. It is observed that the spatial width of the ETB does not depend on the influx of neutral particles. A detailed analysis on the edge pedestal structure, such as, the spatial width of the ETB and density and temperature at the shoulder of ETB, will be compared between LHD and JT-60.

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