§14. Island Dynamics in LHD Plasmas (II)

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Neoclassical tearing mode is one of the major concerns in the tokamak research. For LHD configuration with positive shear (= $(r/\iota)(d\iota/dr)$), however, bootstrap current effect is to suppress the island, a favorable mechanism. We demonstrate that the island (n/m=1/1) with full width of 10 % of the minor radius is suppressed when the plasma is collisionless. The suppression mechanism in the LHD may not be due to bootstrap current since the predicted bootstrap current density flowing around $\iota/2\pi=1$ surface is too small.

Figure 1 shows that island structure is seen in the ion temperature profiles. For the case with w_{ex} = -0.08, no flattening is seen, demonstrating that some kind of island suppression mechanism exists. For the cases with w_{ex} = -0.125, the island structure (local flattening) appears. It is more clear at higher density ($1.6\times10^{19}m^{-3}$) than the low density ($1.1\times10^{19}m^{-3}$). Figure 2 shows the parameter space for the island suppression for two quite different cases. We believe that temperature and density (or possibly their gradients) at the $\iota/2\pi=1$ surface are important parameters for the island suppression and growth. The points (o) correspond to the cases with undetected island (which means that w< 0.5 w_{ex}) and the points (•) correspond to those with clear island with $w \geq w_{ex}$. Suppression of the island occurs in lower density and high temperature region. Instead of temperature and density, it may be more appropriate to use dimensionless quantities β and ν [= $\nu_e(2\pi/\iota)(R/v_e^{th})(Z_{eff}/\varepsilon^{3/2})$) at $\iota/2\pi=1$. The parameter space for clear suppression of the island for Fig. 2(a) case (R_{ax} = 3.5 m, w_{ex} = -0.125, B = 1.59 T) is $\nu^*<1.4$ and β > 0.05 %. A quite different parameter case (R_{ax} = 3.6 m, w_{ex} = +0.085, B = 2.8 T) is shown in Fig.2 (b) and the parameter space for the suppression is ν^*< 1.7 and β > 0.09 %, similar to Fig.2 (a) case. Even though a more complete parametric study for the island behavior needs to be done, the data obtained so far shows that the collisionless (ν^*< 1) and finite β (> 0.1 %) plasma suppresses the island. On the other hand, the enhancement of the island ($w \geq 2w_{ex}$) described in the preceding report occurs when the plasma is more collisional, e.g., ν= 4, β= 0.15 %.

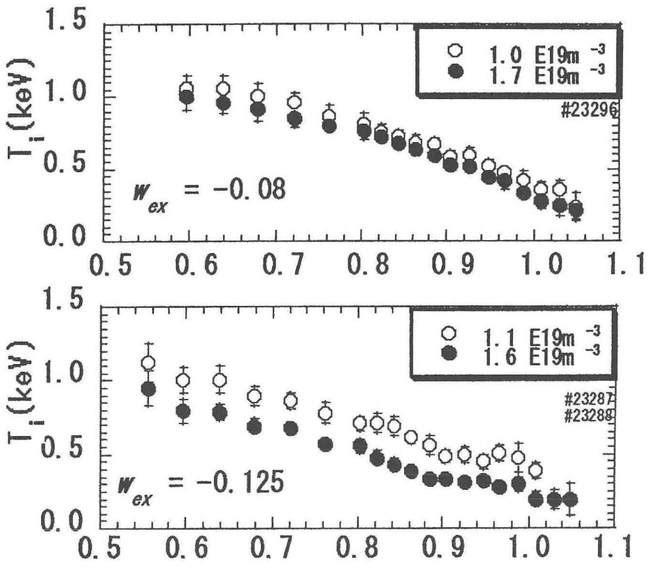

FIG. 1 The Ion temperature profiles for two different vacuum island widths (w_{ex}=-0.08, w_{ex} =-0.125)(B = 1.59 T, R_{ax} = 3.5 m, P_{beam} = 2.66 MW). The ion temperature is measured by charge exchanged recombination method

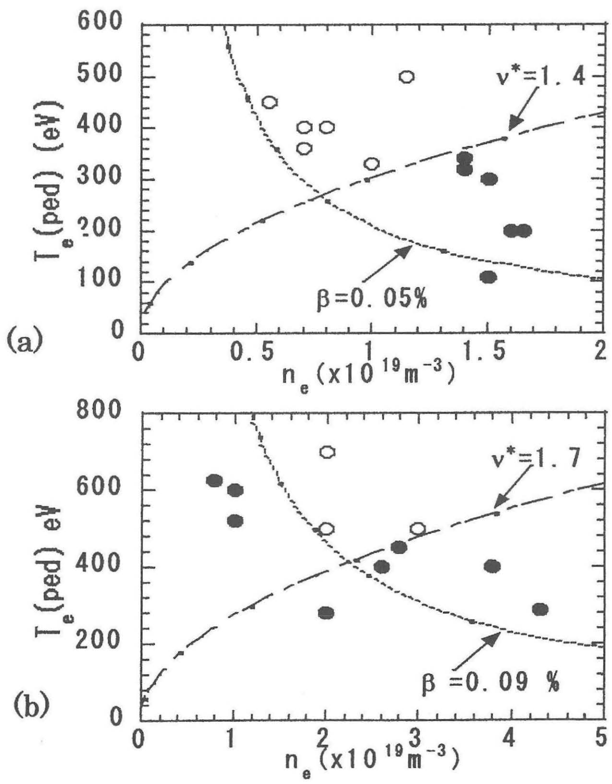

FIG. 2 Parameter space for island suppression for two different conditions, (a) w_{ex}=-0.125, B = 1.59 T, R_{ax} = 3.5 m, (b) w_{ex}= +0.085, B = 2.5 T. R_{ax} = 3.6m.