§13. Island Dynamics in LHD Plasmas (I)

Ohyabu, N., Ida, K., Morisaki, T., Narihara, K.

We have found that a significant enhancement of the externally imposed island with n/m=1/1 occurs in the LHD discharges with collisional, finite beta plasma. For the collisionless plasmas, on the other hand, suppression of the island has been observed.

Figure 1(a) shows that when the density is ramped up slowly, a transition takes place from a normal state to equilibrium with a large island. The stored energy (W_p) initially increases and nearly saturates and at t = 1.6 s, the transition takes place. The electron temperature profiles before and after the transition are shown in Fig. 1(b). After the transition, local flattening of the temperature profile at $\iota/2\pi = 1$ (R = 4.20 m) is seen and leads to a nearly uniform drop (~150 eV) in the temperature in the core, resulting in a significant reduction in W_p. The flatting region of ~120 mm in R, corresponding to w = 0.12 is much wider than that in the vacuum configuration (40 mm in R). The edge profile beyond the island (R > 4.25 m), however, remains almost unchanged. From the transition, the amplitude of the magnetic fluctuation increases, indicating that some MHD activities are involved.

In Fig. 2, the stored energy (W_p) is plotted as a function of density for various w_{ex}. For w_{ex} = +0.045, no clear island is detected at any density. The W_p scales as $(n)^{1/2}$, but saturates and drops at high density, very typical density dependence in LHD. For w_{ex} = -0.07 (the minus sign means that the spatial phase of the island is different by π compared with that with plus sign), the island starts to appear when the density exceeds a threshold value and at the same time W_p starts to become lower than that with w_{ex} = +0.045. This threshold value decreases with increasing $|w_{ex}|$. For a large vacuum island (w_{ex} = -0.11), however, an island is seen at any density, as expected. For high-density regime, W_p and hence τ_E depend on w_{ex} strongly. When n is below $1.5\times10^{19}m^{-3}$, the stored plasma energy (W_p) is insensitive to w_{ex}.

Data in Fig.1, 2 clearly shows that under certain plasma conditions (i.e., higher density and larger vacuum island), plasma can generate a large island, larger than that in the vacuum configuration, which in turn deteriorate the energy confinement severely. Such plasma effects are the strongest for the most inward shifted configuration (R_{ax} = 3.5 m). For R_{ax} = 3.6 m, this effect is much weaker and the threshold density is much higher.

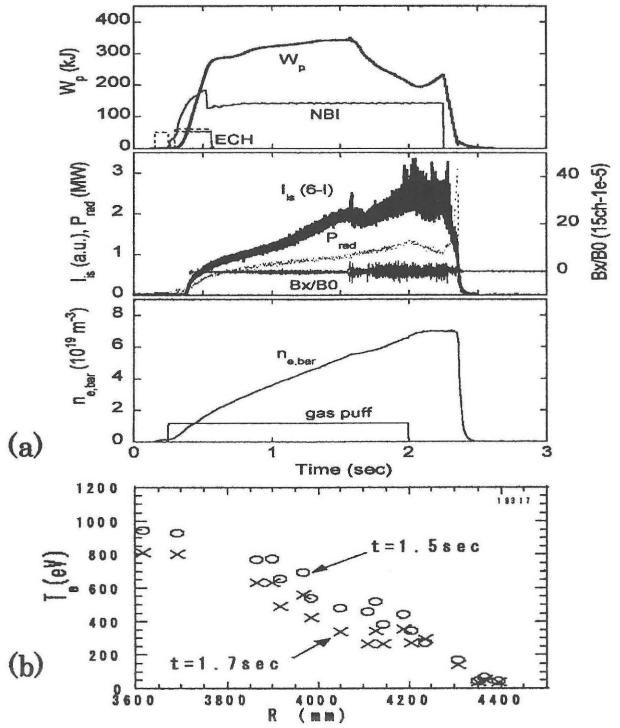

FIG. 1. (a) Time evolution of the stored energy in an LHD discharge (Rax=3.5m, B=2.8T) shows a transition from a normal state to an equilibrium with a large island. (b) The electron temperature profiles before (t=1.5 sec) and after (t=1.7 sec) the transition.

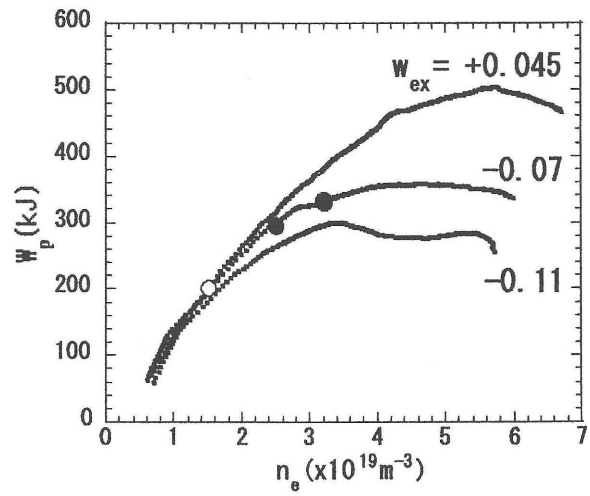

FIG. 2. The stored plasma energy is plotted as a function of the density for various vacuum island sizes (B =2.83 T, R_{ax} = 3.5 m). For w_{ex} = -0.07 case, island appears at higher density, (o : no island), (• : island)