§25. Development of Magnetic Island in the Strongly Inward Shifted Configuration

Yamada, H., Nagayama, Y.

Dynamics of a magnetic island have been investigated intensively in LHD. In spite of external application of significantly large resonant (m/n=1/1) perturbation, the corresponding magnetic island is often invisible in profile measurements, for example Thomson scattering diagnostics. In contrast to this healing phenomenon, development of a magnetic island and consequent confinement degradation occurs under a specific condition[1]. LHD has a magnetic island ($W_{max}/a \approx 0.1$, where W_{max} is the maximum island width) intrinsically due to ambient error fields in the vacuum condition.

In the configuration with a strongly inward shifted magnetic axis, i.e., $R_{ax} \leq 3.53$ m, a clear local flattening of temperature profile, which seems to correspond to generation of the island, is observed after pellet injection. This island is not rotating and its phase, presumably m/n=1/1, is consistent with the vacuum island. Typical waveforms of a discharge with this phenomenon are shown in Fig.1. A hydrogen ice pellet is injected at t=1.4s. Immediately after pellet injection, the island width, which is estimated from the width of the electron temperature flattening zone (see Fig.2), develops and simultaneously the stored energy drops. The island shrinks with the additional heating power. When the heat power decreases, the island width is enhanced and its size becomes more than the double of the vacuum condition. Confinement is also degraded significantly in this phase.

In contrast, when the vacuum seed island is cancelled by the external perturbation with the anti phase, the island development is not observed under the same density and heating power (see Fig.3). However, if the heating power is half of this condition, the island growth is observed even the seed island is cancelled out. These experimental observations suggest that there exists a specific parameter region where the island development is triggered and a seed island plays a key role. In the high temperature and low density regime, the island growth is suppressed. There is a hysteresis of the island growth. For example, once the island develops, it remains in the low density region where the island growth is not triggered by a pellet injection. This also suggests importance of the existence of the seed island.

The same operational condition as shown in Fig.1 except for the magnetic axis position (R_{ax}=3.6 m) does not lead to this behavior. After pellet injection, the island does not emerge and energy confinement is improved by density increase. A strongly inward shifted configuration is characterized by an enhanced magnetic hill, however, its physical linkage of the island dynamics reported here has not been clarified yet.

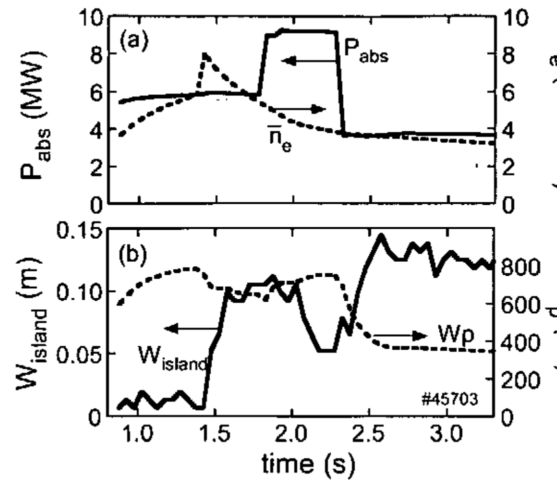

Fig.1 A discharge with island growth. (a) NBI heating power (solid line) and line averaged density (dotted line). (b) Magnetic island width (solid line) and stored energy (dotted line).

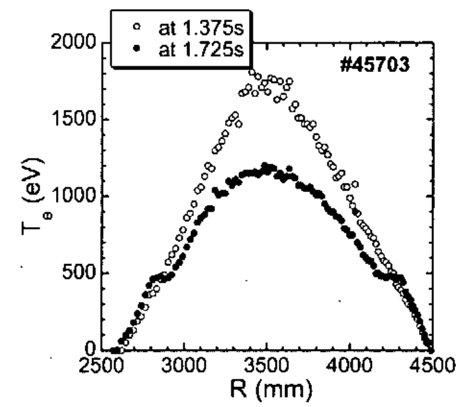

Fig.2 Electron temperature profile before (open circles) and after (solid circles) the pellet injection in the discharge shown in Fig.1.

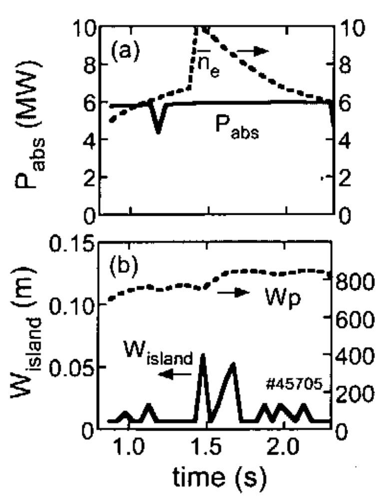

Fig.3 A discharge without island growth. (a) NBI heating power (solid line) and line averaged density (dotted line). (b) Magnetic island width (solid line) and stored energy (dotted line).

Reference

1) Ohyabu, N., et al. Phys. Rev. Lett. **88** (2002) 055005.