§39. Comparative Study of MHD Instability in LHD and JT-60U

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It is generally recognized that in helical systems plasma current in counter direction is favorable to the Mercier stability. However, in LHD experiments, instability localized at ι/2π~0.5 was observed during neutral beam injection in counter direction. The objective of this study is to investigate the characteristics of this instability such as onset condition and spatial structure, and to clarify similarities and differences between the instability and that in tokamaks.

Previous analysis clarified that sinusoidal oscillations and sawtooth oscillations localized at ι/2π~0.5 are observed under similar discharge conditions. In this study, onset condition of these oscillations, classification of the mode behavior at the onset, and the period of the sawtooth oscillations have been investigated. Typical experimental parameters are as follows: magnetic axis location R_{ax}=3.60 m, magnetic field B_{ax}=2.75 T, γ=1.254, B_q=100%.

Figure 1 shows relation between line-averaged electron density and electron temperature at ρ~0.5 (ι/2π~0.5) at the onset of sawtooth oscillations and sinusoidal oscillations. It can be seen that the sinusoidal oscillations appear at high density and low temperature regime, and that the sawtooth oscillations appear at low density and high temperature regime. Although the onset regime is fairly well separated, the two regimes are laying side-by-side. Actually, in some cases, sinusoidal oscillations appear soon after sawtooth oscillations. It is also found that the magnitude of plasma current does not seem to have a significant effect on the mode onset.

Temporal evolution of sinusoidal oscillations has been investigated in detail by using electron cyclotron emission (ECE) diagnostics. Figure 2 shows electron temperature near ι/2π~0.5 at the mode onset. In this series of discharges, three types of onset and evolution have been observed: (a) fast growth (Fig. 2(a)), (b) slow growth (Fig. 2(b)), and (c) onset triggered by a sawtooth crash. The cause for the difference is under investigation.

Investigation on sawtooth period has found that the period changes irregularly in time even under a fixed experimental conditions. This feature is quite different from sawtooth oscillations in tokamak (sawteeth with *m/n*=1/1), where the period is proportional to $T_e^{1.5}$. This suggests that mechanism of the sawtooth oscillations in LHD may be different from those in tokamaks.

Temporal evolution of mode location has been investigated with ECE diagnostics by tracing the inversion radius of the sawtooth oscillations and the location of the maximum amplitude of the sinusoidal oscillations. It has been found that the location can be changed in time when the direction of neutral beam is changed. This suggests that current profile is actually changed by neutral beam injection as in the case in tokamaks. It is expected that the information can be also used to calibrate the motional Stark effect diagnostic.

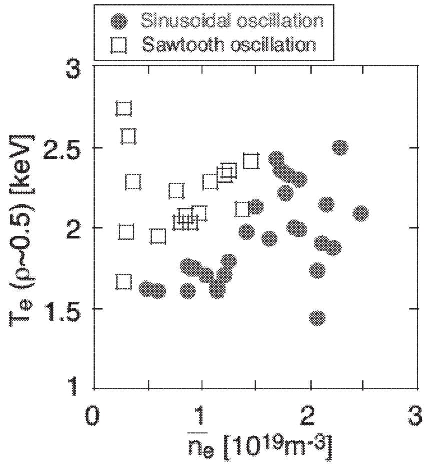

Fig. 1. Relation between line-averaged electron density and electron temperature at the onset of sawtooth oscillations and sinusoidal oscillations. Closed circles and open squares correspond to the sinusoidal oscillations and the sawtooth oscillations, respectively.

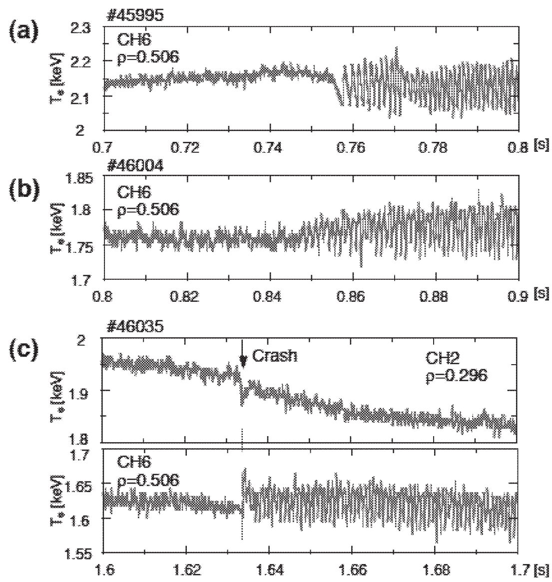

Fig. 2. Temporal evolution of electron temperature near ι/2π~0.5 at the onset of sinusoidal oscillations: (a) fast growth, (b) slow growth, (c) sawtooth-triggered oscillations.