§21. Study of Edge Plasma Perturbations Induced by Sawtooth Oscillations on CHS

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Sawtooth oscillation is a typical magnetohydro-dynamic (MHD) phenomenon and plays an important role in core plasma confinement. Heat and density pulses produced by a sawtooth crash may provide important information about heat and particle transport in the sense of perturbative transport. It is also known that a major part of the particle and heat transport in edge plasma is due to the transport driven by fluctuations. Heat and density pulses transiently modify temperature and density profiles in the edge plasma region. This may enhance edge turbulence and provide important information on edge plasma transport. In the CHS heliotron/torsatron, sawtooth oscillations are often observed in neutral beam heated plasmas. The change in edge plasma turbulence induced by sawtooth oscillations is studied, using a Langmuir probe array which can be inserted beyond the last closed flux surface (LCFS) [1].

The Langmuir probe array consists of multiple electrodes for measuring floating potentials (Vf1, 2, 3) and ion saturation currents (Iis1, 2, 3) arranged in the radial direction. Figure 1 shows a typical time evolution of plasma parameters in a sawtoothing plasma heated by co-injected neutral beams (NBI). As seen from the time trace of the soft X-ray signal of the central chord, the sawtooth oscillations are clearly observed from t = 110 ms. In Fig. 2, the ion saturation current <Iis1> at $\rho = 0.95$ begins to increase just after the sawtooth crash, but <Iis3> at slightly outer region $\rho = 0.98$ begins to decrease. Figure 3 shows time evolutions of ion saturation current <Iis>, the fluctuation level $\tilde{V}f$ and $\tilde{I}is$, and relative fluctuation level $\tilde{I}is$/<Iis> during one cycle of a sawtooth oscillation at $\rho = 0.95$. In this figure, the root mean square of fluctuating components of f > 50 kHz are estimated. The fluctuation level is clearly modulated by a sawtooth crash. The similar behavior is observed in relatively higher frequency components in the range of f > 90 kHz. The increase in fluctuation levels might be caused by the change in equilibrium profile of electron density near the edge, that is, the change in the gradient (cf. Fig. 2).

These characteristics of propagation and radial profiles of fluctuation level and equilibrium parameters will give us important information about edge plasma transport. Correlation between the change in fluctuation level and the modification of the quasi-stationary density profile associated with a sawtooth crash is left for a future study.

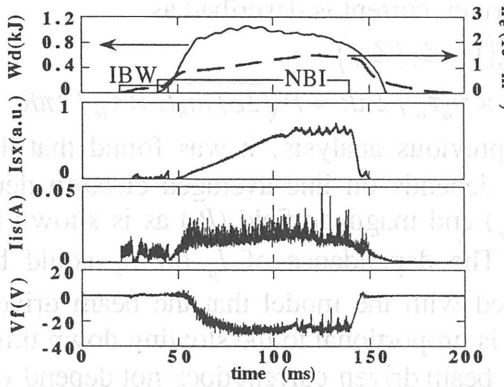

Fig. 1. Time evolution of plasma parameters, soft X-ray signals, ion saturation current and floating potential measured by a Langmuir probe array placed at $\rho = 0.95$, in a typical sawtoothing discharge.

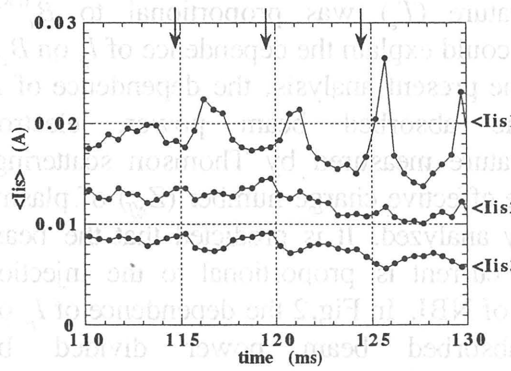

Fig. 2. Quasi-stationary profile of the ion saturation current, where the data are averaged over 0.5 ms.

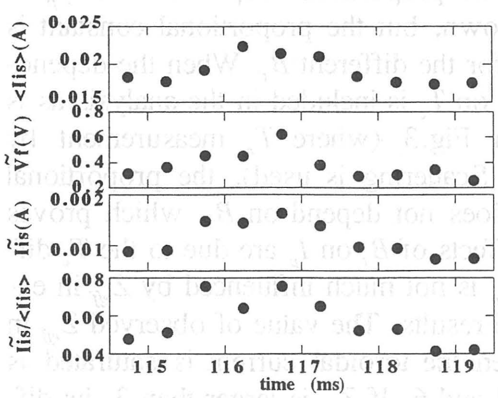

Fig. 3. Modulation of fluctuation levels during one cycle of a sawtooth oscillation at $\rho = 0.95$, where the data are averaged over 0.5 ms.

Reference

1) K. Ohkuni, et al. , J. Plasma Fusion Res. , 1, 295 (1998)