## §11. Edge Plasma Modulation by Particle and Heat Pulses Induced by a Sawtooth Crash

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In tokamak and stellarator plasmas, electrostatic fluctuations usually dominate the particle and energy transport near the edge. On the other hand, it is well known in several tokamaks that the particle and heat pulses produced by the sawtooth oscillations modulate the edge plasma parameters and often trigger the improved plasma confinement regime called H-mode. We focus on discussing the turbulent fluctuations and particle transport near the edge during the sawtooth oscillations.

Sawtooth oscillations are often observed in CHS[1]. Time evolution of soft X-ray intensity during the sawtooth oscillations is shown in Fig.1, where toroidal magnetic field $B_t$ = 1.4 T, averaged electron density $\bar{n}_e = 1.4\times10^{19}$ m$^{-3}$ and absorbed NBI heating power $P_{NBI} \sim 0.5$ MW. Edge plasma parameters $T_e$,

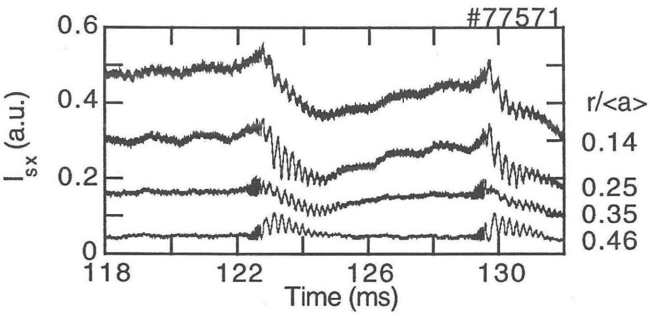


Fig.1 Time evolutions of the soft X-ray intensity Isx at r/<a> = 0.14, 0.25, 0.35 and 0.46 during the sawtooth oscillations.

$n_e$, $V_s$ and their fluctuation levels are enhanced by the sawtooth crash. The turbulent particle flux $\Gamma_{turb}$ averaged over 2 ms just before and after a sawtooth crash is shown in Fig.2 together with their frequency components. The change in $\cos(\alpha_{ncE\theta})$ leads to the inward particle flux, though $\gamma_{ncE\theta}$ is almost unchanged and both of spectral powers of $n_e$ and $E_\theta$ are enhanced. This effect has a possibility of leading to the improved plasma confinement regime such as H-mode, although the improved regime is not observed in this experimental campaign, so far.

Time evolution of radial electric field shear $E_r'$ and $\Gamma_{turb}$ during one period of a sawtooth oscillation is shown in Fig.3. This large inward particle flux seems to correlate with the positive shear of the radial electric field $E_r'$ (> $1\times10^6$ Vm$^{-2}$). This relationship between $E_r'$ and inward fluxes is consistent with the previously obtained results in NBI heated plasmas with and without edge electron cyclotron resonance heating on CHS[2,3]. A promising candidate mechanism for the reversal of the particle transport is the decorrelation of fluctuations by ExB velocity shear or the radial electric field shear. Many experiments and theories are dedicated for clari fying

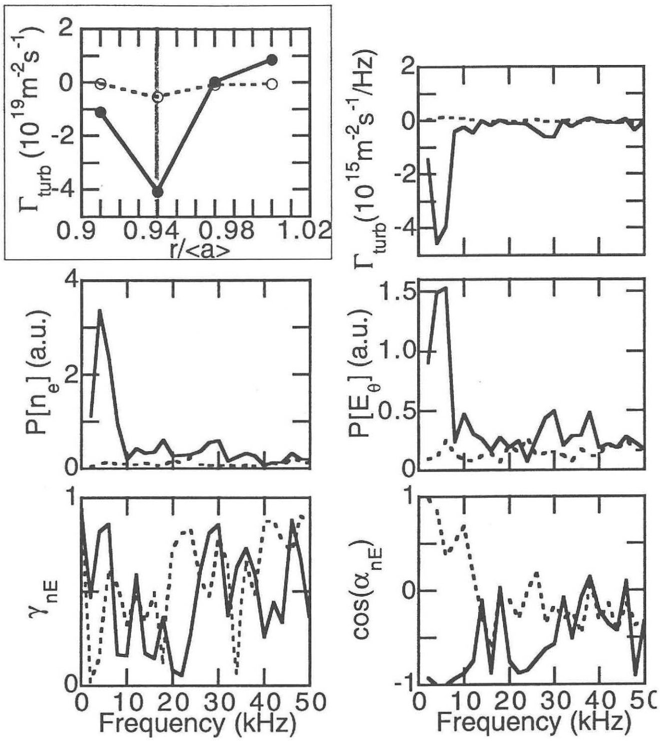


Fig.2 Frequency components of $\Gamma_{turb}$ at r/<a> = 0.94 just before (dotted curve) and after (solid curve) sawtooth crash, where these results are obtained in the time windows of 118 - 120 ms and 123 - 125 ms in the shot shown in Fig.1 The change in $\cos(\alpha_{ncE\theta})$ leads to the inward particle flux.

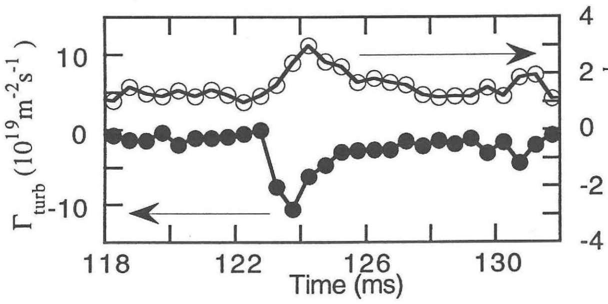


Fig.3 Time evolution of $\Gamma_{turb}$ and $E_r'$ at r/<a> = 0.94 during one period of a sawtooth oscillation. $\Gamma_{turb}$ directs inward in $E_r' > 1\times10^6$ Vm$^{-2}$.

the relationship between transport reduction and ExB shear effect. However, only Ware's theory discusses the relationship between $E_r'$ and the cross phase of fluctuations [4,5].

The inward flux is connected with the change in the phase between electron density and poloidal electric field fluctuations. This phenomenon induced by a sawtooth crash might lead to the transport reduction near the plasma edge on a certain plasma condition.

Reference

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