§16. Correlation between Heat and Density Pulse Propagations in a Sawtoothing Discharge

Toi, K., Ohkuni, K.[1], Ohdachi, S., Morisaki, T., Takagi, S.[1] and CHS Group
1) Dep. Energy Eng. Science,Nagoya Univ.

A sawtooth observed in CHS considerably modifys edge plasma by launching heat and density pulses towards LCFS[1]. Figure 1 shows time evolution of ion saturation current measured at two radial positions just outside LCFS by a set of single Langmuir probes (LP). The heat pulse monitored through a Be-foil of 8 μm thickness by a soft X-ray detector array arrives at the radial position of $\rho \sim 0.7$ in ~1.5 ms after the crash. Moreover, the time delay of the peak of SX-pulse at $\rho \sim 0.8$ is estimated to be ~2.2 ms, although the signal-to-noise ratio of the signal is not sufficiently large. This time delay is in the order of global energy confinement time. However, the pulse of ion saturation current measured by single Langmuir probes arrives at the location just outside LCFS (i.e., $\rho \sim 1.02$) in ~1.2 ms. The density pulse measured at just outside LCFS by a thermal lithium beam probe(LIBP) also shows similar time delay to the LP-data. The density pulse produced by the sawtooth crash propagates rapidly from the core region towards LCFS much faster than the heat pulse. This phenomenon suggests that the density pulse has no contribution to heat transfer even if the pulse is launched from the plasma core. The rapid increase in floating potential is also observed just outside LCFS, suggesting enhanced ion loss(Fig.2).

Three possibilities to explain this peculiar phenomenon may be speculated: (1) propagation of the electron heat pulse differs from that of the density pulse, (2) a different type of sawtooth crash is induced near the LCFS by the sawtooth crash which takes place near the plasma center, and (3) prompt loss of injected fast ions enhanced by a large sawtooth crash may considerably modify the density pulse observed near the edge. If the particle source generating the density pulse is the bulk plasma near the plasma center, enhanced particle transport due to large off-diagonal transport contribution is required for the first possibility. Concerning with the second possibility, so far, there is no evidence that any different types of sawteeth are excited near the edge, synchronizing with the sawteeth excited in the plasma core. The second possibility is unlikely. The last possibility seems to be plausible, because promptly lost energetic ions will not contribute heat transport of a bulk plasma. The rapid increase of floating potential shown in Fig.2 also may support the last idea. Further study is necessary to elucidate this peculiar heat and particle transport by paying attention to complex magnetic field structure near the edge of a heliotron/torsatron plasma.

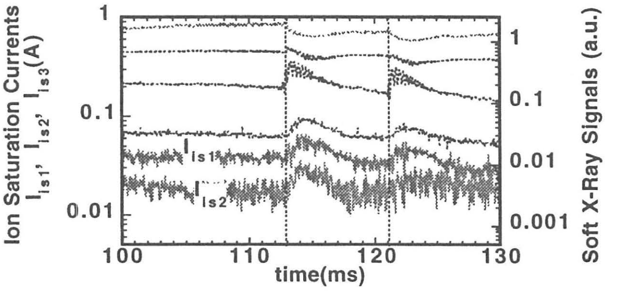

Fig.1 Comparison of soft X-ray pulse (heat pulse) propagation with ion saturation current pulse(approximately density pulse) in NBI heated plasma. Solid curves denote ion saturation currents, where Iis1 and Iis2 are measured outside LCFS(i.e., at ρ=1.02, and 1.03 respectively). Dotted curves denote soft X-ray signals at various chord radii(ρ=0.04, 0.35, 0.52 and 0.70 from upper traces).

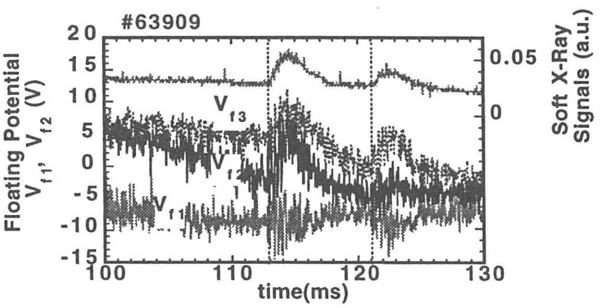

Fig.2 Time evolution of floating potential outside LCFS in a sawtoothing plasma, where Vf1, Vf2 and Vf3 are measured at ρ= 1.02, 1.03, and 1.04, respectively. Upper solid curve shows the soft X-ray signal measured at ρ=0.70.

References
[1] K. Toi et al., in the 24th EPS Conf. on Plasma Physics and Nuclear Fusion, Berchtesgaden, 1997.