§13. MHD Instabilities Observed in the Core Region of Outward-shifted Plasmas

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The MHD stability of the LHD plasma strongly depends on the location of the magnetic axis. When the magnetic axis is shifted outward, a deep magnetic well is formed. Therefore, the core region is considered to be stable against the pressure driven modes. In the edge hill region, ELM-like activities have observed. However, the core activities reported here are clearly distinguished from them.

Two types of core instabilities have been observed with the magnetic axisp position of $R_{ax} = 3.9m$ and $3.95m$ by the new SX array system[1]. One is the low frequency (f ∼1.1kHz) coherent oscillations. The typical radial profile of amplitude and the relative phase of the modes are shown in Fig. 1.

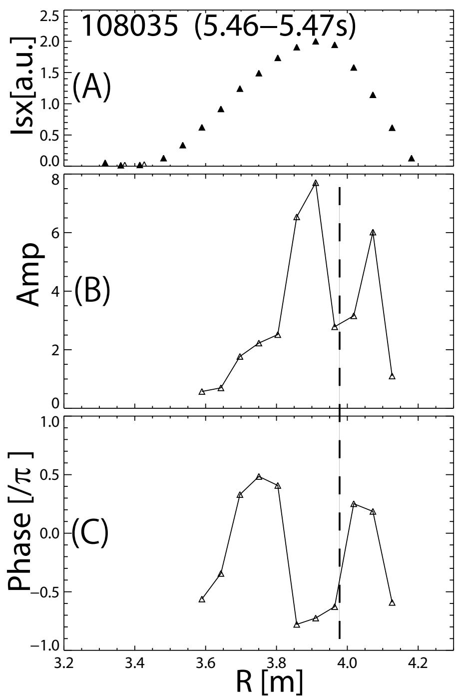

Fig. 1: Fig.1: Profile of SX radiation (A), aptitude (B) and phase (B) of the modes are shown. $B_t = -0.9T, R_{ax} = 3.9m, , <\beta> \sim 1\%$

There are two peaks around $R_a x = 3.9m$ and $4.05m$. The phase is reversed between them (dashed line). It is supposed that the poloidal mode number is odd. No magnetic fluctuations related with these instabilities are observed. Since the amplitude is asymmetric and localized in the outward region, it is possible that this type of instabilities is the ballooning mode. It is consistent with the observation that no magnetic fluctuations are observed with magnetic probes which are located in the high-field region.

Another phenomenon is sawtooth-like oscillations. Usually normal/reversed sawtooth-like waveform is observed in inner/outer region of tokamks with sawtooth crashes. In this type of activities normal/reversed sawtooth-like waveform is observed in outboard/inboard region as shown in Fig. 2(A). Thus, the location of the magnetic axis is shifted inward/outward repeatedly with these events.

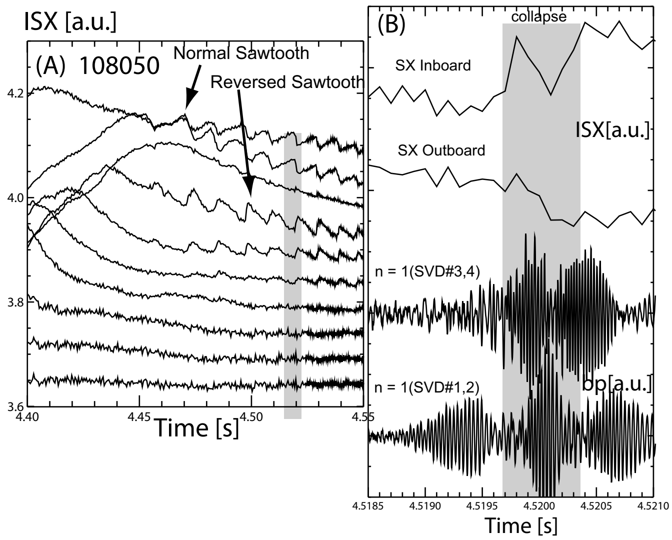

Fig. 2: Fig.2: Time evolution of SX radiation profile (A). Extend view of an event (shaded region in (A)) and magnetic fluctuations are shown in (B)). $B_t = -1.0T, Rax = 3.95m, , <\beta> \sim 1\%, \overline{n_e} \sim 3 \times 10^{19}$

The magnetic fluctuations related with these activities are analyzed using the singular value decomposition method. The two larger components with different frequency are shown in Fig. 2(B). Since the magnetic oscillations are synchronized the events, the collapse might be caused by this activities. However, the activities have not been clarified. The rotational transform profile in this configuration is rather flat and between $\frac{1}{2} \sim 1$. There is no $\iota = 1$ rational surface. However the toroidal mode number is unity. Detailed stability analysis including the effects of the energetic particles might be required to interpret the observation Activities with m = 1 is also observed in core region of IDB/SDC plasmas when the collisionality is relatively low[2]. The location of the magnetic axis is almost similar. The relation of m=1 oscillations and this sawtooth-like phenomena should be also investigated further.

1) X. D. Du, et. al. 'Development of an Array System of Soft X-ray Detectors with Large Sensitive Area on the Large Helical Device' Plasma Fus. Res, Plasma Fus. Res(2012). to be published.

2) S. Ohdachi, et. al., Contrib. Plasma Phys. **50** 552 (2010)