§7. Study of Nonlinear Behavior of Low-Frequency Fluctuations Caused by Transition of Radial Electric Field in the Edge LHD Plasma

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The edge radial electric field (E_r) structure of magnetized confinement plasmas[1] is an important issue because the E_r has a significant impact on plasma fluctuations. Furthermore, the fluctuations have been considered as a primary origin of the plasma transport. Therefore, a study of the response of the fluctuations in the transition of E_r will help to understand the mechanism of plasma fluctuations driven transport. Recently, the transition of the edge E_r in the LHD plasmas occurred by suddenly increasing the neutral beam injection (NBI) power.

Figure 1 shows the temporal evolutions of wavelet spectra with (a) the density fluctuations and (b) the magnetic fluctuations. The bar on the right indicates the spectra power (the linear scales). The density fluctuations are obtained with a microwave reflectometer in edge plasma region ($R \simeq$ 4.59 m). The low-frequency fluctuation (f <3 kHz) is destabilized at $t \simeq$ 4.1s, as shown in Fig. 1(a). Moreover, the magnetic fluctuation with $f \simeq$ 2–5 kHz is suddenly appeared at $t \simeq$ 4.1s, which is obtained with a magnetic probe, as shown in Fig. 1(b).

Figure 2 indicates the time evolution of (a) the density fluctuations, (b) the magnetic fluctuations, and (c) the poloidal flow signals at $R \simeq$ 4.57 m. The poloidal rotation velocity is estimated by the charge exchange recombination spectroscopy (CXRS) signals (black circles) and the high time-resolution of the poloidal flow signal is obtained by the reflectometer (gray circles) in the edge plasma region, as shown in Fig. 2(c). The signals from the reflectometer have a significant change, which is caused by the transition of the E_r. Therefore, it is possible to confirm a precise timing of transition E_r in the edge LHD plasmas. Finally, it can be figured out for the first time that the density and the magnetic low frequency fluctuations are suddenly enhanced at the transition timing of E_r ($t \simeq$ 4.1s).

The response of low-frequency fluctuations in a transition of the E_r is investigated in the edge region of LHD plasmas. Consequently, the amplitude of a density fluctuations with f <3 kHz is destabilized at the transition timing of E_r. In addition, the amplitude of a magnetic fluctuation with $f \simeq$ 2–5 kHz is suddenly enhanced at the transition timing of E_r, and then disappeared after the transition of E_r.[2] Furthermore, it is found that the amplitude of H_α signals is enhanced, corresponding to the abrupt diminishing of the magnetic fluctuation with $f \simeq$ 2–5 kHz.

1) Kamiya, K. et al.: Nucl. Fusion **53** (2013) 013003.
2) Moon, C. et al.: Plasma Fusion Research **10** (2015) 3402053.

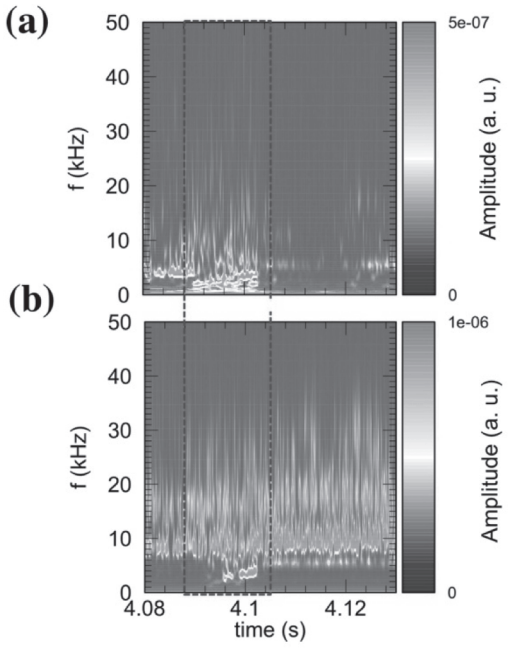

Fig. 1. Temporal evolutions of wavelet spectra with (a) the density fluctuations ($R \simeq$ 4.59 m) and (b) the magnetic fluctuations as a function of frequency.

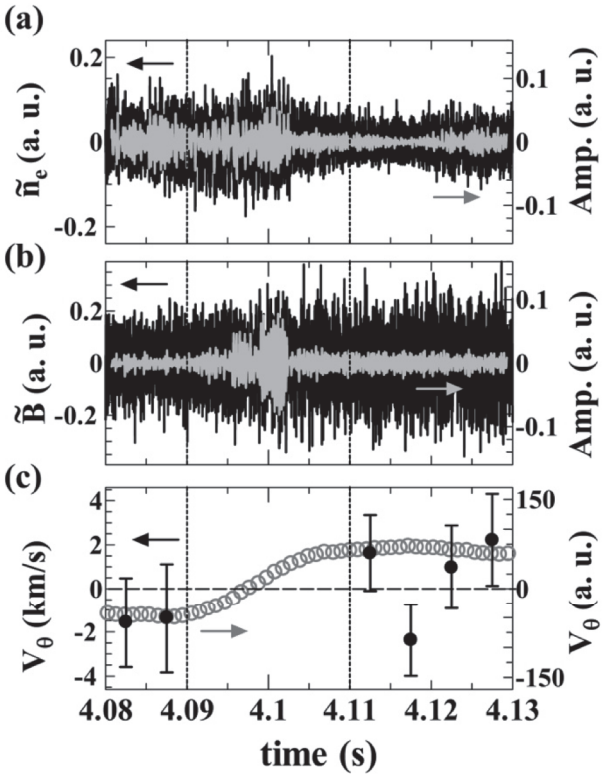

Fig. 2. Time evolutions of (a) the density fluctuations, (b) the magnetic fluctuations (The gray lines indicate the fluctuations in the frequency band 2–5 kHz.), and (c) the poloidal flow signals from the CXRS (black circles) and the reflectometer (gray circles) at the transition timing.