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LHDにおけるロックトモード様不安定性の急激な周波数低下の特徴とその物理機構

Characteristics of rapid slowing down of locked-mode-like instability and its physical mechanism in LHD

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The locked-mode-like instability, which is one of MHD instabilities observed in LHD, is characterized by the slowing down of its precursor. Based on the LHD experimental analysis, the slowing down mechanism of the precursor has been investigated. The figure 1 shows behavior of the frequency of the precursor (the maximum amplitude component of the magnetic fluctuation with m/n = 1/1). After excitation of the precursor, its frequency is constant but the precursor slows down since 4.28 s. Two types of the deceleration are observed in the slowing down phase. One is the continuous deceleration from 4.34 s to 4.68 s. The other is the discontinuous deceleration at 4.28 s and 4.34 s. This study focused on the deceleration near 4.34 s in order to clarify the physical mechanism for the discontinuous deceleration. The black dashed lines in the figure 2 (a) show the frequency of peak components in the wavelet spectrum. Fluctuations of ~1.5 kHz and ~3.0 kHz appears simultaneously. The figure 2 (b) shows waveforms of the 3 kHz fluctuations at the different toroidal angles separated by 180 degrees. The phase difference varies at 4.3538 s. According to a contour map of waveforms of the 3 kHz fluctuations (Fig. 2 (d)), the n = 1 structure disappears and the n = 2 structure appears at 4.3538 s. In case of the 1.5 kHz fluctuations (Fig. 2 (e)), coherent fluctuations are not observed at 4.353 s but the n = 1 fluctuations appear at 4.3534 s. The red/blue lines in Fig. 2 (a) show the frequency of the n = 1 fluctuation. As behavior of the precursor at the discontinuous deceleration, it is found that (i) in the situation where the m/n = 1/1 fluctuation has already appeared, a low frequency m/n = 1/1 fluctuation appears, (ii) fluctuations with the different frequency but the same mode number coexist, (iii) the high frequency fluctuation disappears and (iv) the low frequency fluctuation rapidly grows. In addition, the discontinuous deceleration occurs when the high frequency fluctuation disappears or the amplitude of the low frequency fluctuation becomes larger that that of the high frequency fluctuation.

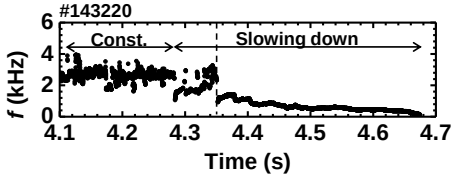

Fig. 1. Frequency of precursor of locked-mode-like instability.

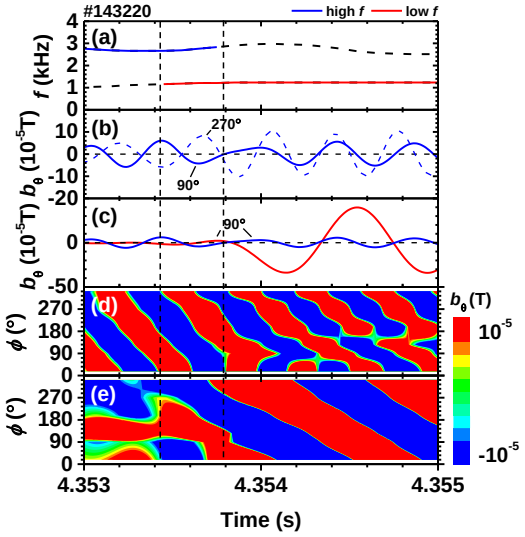

Fig. 2. (a) Frequency of peak components in wavelet spectrum (dashed black) and of 1.5 kHz/3.0 kHz (low/high frequency) fluctuations (red/blue), (b) waveforms of 3.0 kHz fluctuations at different toroidal angles, (c) waveforms of 1.5 kHz/3.0 kHz fluctuations, (d) contour map of waveforms of 3.0 kHz fluctuation and (e) of 1.5 kHz fluctuation.