§12. MHD Mode Frequency on 3-dimensional Magnetic Configuration

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The relationship between plasma rotation and MHD mode has been investigated in LHD. The m/n=1/1 mode rotation becomes slow before the occurrence of the minor collapse in the low magnetic shear experiment. Plasma flows were measured when the m/n=1/1 mode slows down in order to compare with the mode frequency.

The poloidal/toroidal carbon flows are measured by the charge exchange spectroscopy. Both of flows are measurable in the edge plasma region. The low magnetic shear experiment was performed in the outward shifted magnetic configuration with magnetic axis R_{ax}=3.75 m because the resonance is difficult to be moved to the core region where both flows can not be measured.

The minor collapse occurs in case of R_{ax}=3.75 m configuration as shown in figure 1 when the plasma current exceeds the threshold. The m/n=1/1 mode rotated with f=~1 kHz is excited at t=~4.0 s and its rotation is decreased with time. The m/n=1/1 mode disappear just after the minor collapse and appears again at t=~4.7 s.

Figure 2 shows the result of the experiment. A peak position of the radial displacement is defined as the m/n=1/1 resonance ρ. The radial displacement is evaluated from the radial profile of soft X-ray emission measured by photo diode arrays. The paper[1] refers to the detail of this analysis. Before t=4 s, there is no data of the m/n=1/1 resonance because the m/n=1/1 fluctuation is not excited. The m/n=1/1 resonance at t=~4.65 s is assumed to be same as at t=~4.45 s because of the lack of data. The radial profile of poloidal/toroidal carbon flows is not largely deformed during the discharge. So the flows at the resonance are almost constant. The electron pressure gradient, related with the electron diamagnetic drift flow, is evaluated by the electron pressure profile around the resonance. The pressure gradient is decreased with time from the beginning of the discharge and is increased before the minor collapse. Finally the gradient is almost zero. Then the expansion of the flattening structure of the electron pressure profile is found. The growing m/n=1/1 mode affects the flattening structure at the resonance.

The m/n=1/1 mode rotates together with the electron flows defined as the sum of the **E**×**B** drift and the electron diamagnetic drift, which is consistent with the previous result in ref.[2]. In this experiment, the deceleration process around the minor collapse event is estimated as below. At first, the expansion of the flattening structure at the resonance occurs by the growing mode. And then the electron diamagnetic drift is decreased to zero with the electron pressure gradient. Finally, mode frequency is decreased with plasma rotation.

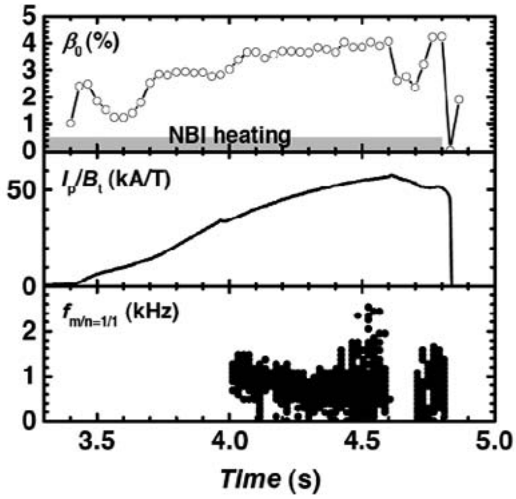

Fig. 1. A typical waveform in the low magnetic shear experiment. Rotational frequency of m/n=1/1 mode in the laboratory flame is displayed.

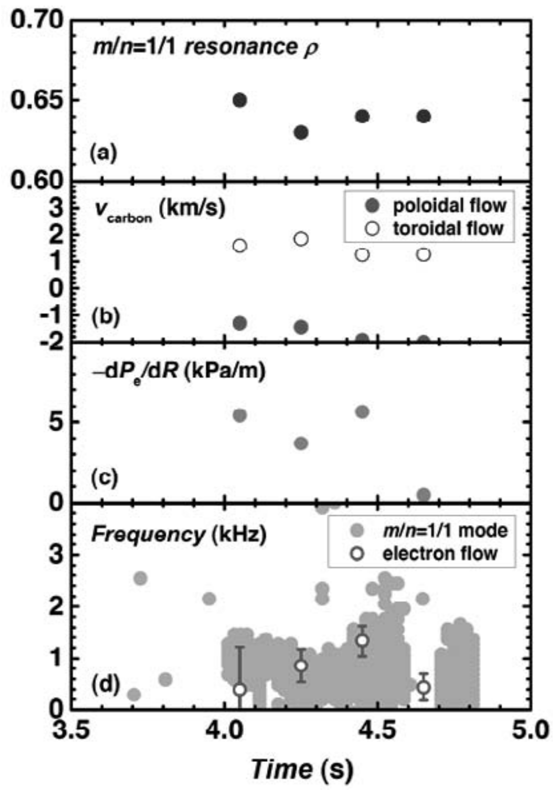

Fig. 2. Time evolution of (a) m/n=1/1 resonance, (b) poloidal/toroidal carbon velocity, (c) electron pressure gradient and (d) m/n=1/1 mode frequency and the electron flow. The electron flow is defined as the sum of the **E**×**B** drift and the electron diamagnetic drift.

1) Watanabe, K.Y. et al.: Phys. Plasmas **18** (2011) 056119.
2) Takemura, Y. et al.: Plasma and Fusion Research **8** (2013) 1402123.