§9. Radial Phase Shift of the EHO Measured Using Beam Emission Spectroscopy in ETB Discharge in CHS (NIFS02KZPD003)

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Accompanied by the formation of the edge transport barrier (ETB) in the compact helical system (CHS)1), a coherent MHD mode which has the frequency around 4.5 kHz and its second harmonic appears. Beam emission spectroscopy (BES)2) has been developed in CHS to measure the local density fluctuations and gradients simultaneously.3,4) The BES measurement has shown that this coherent mode has similar characteristics to the edge harmonic oscillations (EHO)5) in tokamaks.6,7)

Figure 1 shows the power spectra of (a) the magnetic fluctuation and (b) the density fluctuation measured using BES for observation region $\rho = 0.95$. They are averaged over 8 msec. Thin and bold trace is for the period just after the ETB formation (64 – 72 msec) and of the later half of the discharge (80 – 88 msec), respectively. The noise level of the density fluctuation is evaluated from the signal of BES before the beam is injected. In the latter half of the discharge, an oscillation with a fundamental frequency around 4.5 kHz and its 2nd harmonic frequency appear clearly in both the magnetic fluctuation and the density fluctuation, which we call "EHO".

The radial structure of the fundamental mode of EHO with the frequency of 4.5 kHz was investigated by mean of BES.8) Figure 2(a) shows the density profile at the ETB transition and at the onset of EHO. The density gradient around the last closed flux surface (LCFS) is steepened at the transition. The steep gradient is maintained at almost constant value during the period in which the EHO appears. The solid line of Fig. 2(b) shows the radial profile of the root mean square (RMS) value of the density fluctuation at the frequency of the mode 4.5 kHz. This value represents summation of the intensity of the mode and that of the background turbulence at this frequency. Dotted line in Fig. 2(b) shows the level of turbulence. The fundamental mode of the EHO was observed in four channels covering $\rho = 0.85$ - 1.10. The peak value of the amplitude of the mode locates $\rho = 0.95$, where the rational surface, rotational transform $\iota = 1$, locates. We have found that the position of this mode follows that of the $\iota = 1$ surface in the case that the $\iota = 1$ surface locates inside LCFS.7) Figure 2(c) shows the spatial coherence of the mode. Spatial coherence of more than 0.8 is observed for $\rho = 0.85$ - 1.10. Figure 2(d) shows the phases of the fluctuation for the region where coherence is high. The convention for the phases is that their trend decreasing in the radial direction corresponds to the outward propagation. If we could interpret this phase shift shown in Fig. 2(d) as the radial propagation, the mode propagates in the outer radial direction with the apparent phase velocity of several hundreds of m/s. That is a similar characteristic to the radial phase shift of EHO in tokamaks.9,10) However, there is also a possibility that the phase shift is caused simply by the rigid rotation of the mode. A preliminal phase analysis of the magnetic fluctuation measurement showed that EHO has a mode number of 2/1 in the poloidal/toroidal direction.11) More detailed measurements for the mode structure and the rotation will be needed to investigate the relationship between the plasma rotation and the radial phase shift.

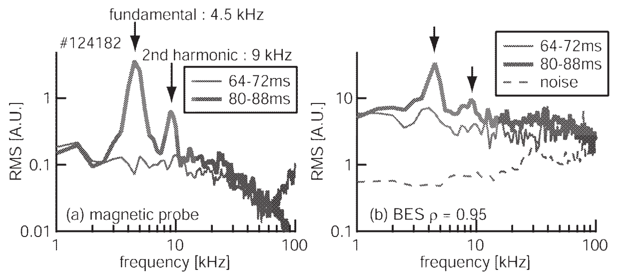

Fig. 1. The power spectra of (a) the magnetic fluctuation and (b) the density fluctuation measured using BES for observation region $\rho = 0.95$.

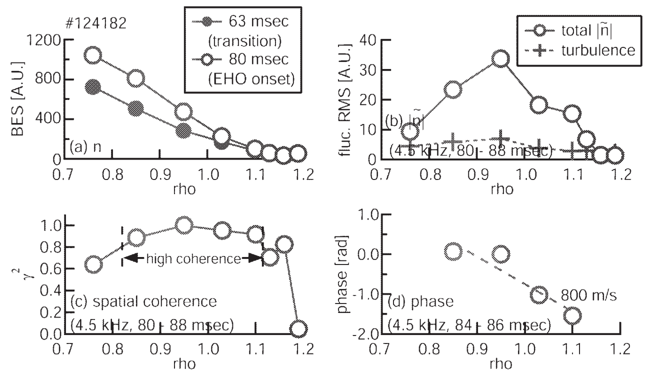

Fig. 2. (a) Density profiles at the ETB transition and at the onset of EHO. (b) RMS value of the density fluctuation at 4.5 kHz which is the frequency of the fundamental mode of EHO. (c) Spatial coherence and (d) phase of EHO. In (c) and (d), the channel for $\rho = 0.95$ is reference of the coherence and the phase.

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