§15. Magnetic Fluctuation Measurement Using Movable Magnetic Probe Array

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The relation between the plasma transport and the plasma turbulence has been studied extensively on many devices. It has been found that the magnetic fluctuations play important roles as well as electrostatic fluctuations. However, the present means of the measuring are far from satisfactory. Magnetic fluctuations are usually measured with Mirnov coil array located outside the LCFS in auxiliary heated plasmas; the radial structure of the magnetic fluctuation and the fluctuation with higher m/n mode number can not be measured in this way.We developed a new type of insertable magnetic probe array, of which head is covered by a cap made of C/C composite with 20% Boron to prevent from the damage by the plasma bombardment[1]. When this probe is inserted toward the r/a ~0.7, unfavorable effects, e.g. increase of the impurity radiation, are hardly observed. Therefore, we can measure the radial dependence of the magnetic fluctuation with this probe well inside the LCFS.

Typical frequency spectra and the coherences of the magnetic fluctuation measured by this system are shown in Fig. 1. The head of the probe is set about r/a ~0.7. Thought the spectrum is a broad one, we can identify several MHD modes((I)-(II)) which have longer correlation length. It is clear that the magnitude of the fluctuation decay faster as the observing position goes outside at the higher frequency than at lower frequency. This decay rate depends on the poloidal mode number of the fluctuation. If we assume the cylindrical plasma, [2] $\tilde{B}_\theta \propto r^{-(m+1)}(1 + (\frac{r}{b})^{2m})$, where a and b are the radius of the plasma column and the vacuum vessel, respectively. As is shown in Fig.2, coherent low frequency mode is found to have a low m number. It is consistent with the mode analysis using the Mirnov coil array. Fluctuation of m=2, 3 is observed commonly and that of m=4 is observed current ramp-up experiments.

Beside the coherent modes, there is incoherent fluctuation up to 100 kHz. Estimated mode number(~10) is larger than the low frequency MHD mode(Fig.2). Though we did not identify the mode, preliminary experiments shows that the amplitude of this higher component is related to the global confinement time of JIPP TII-U, $\tilde{B}_p^{rms} \propto \tau_E^{-1}$.

In summary, we measure the radial dependence of the magnetic fluctuation inside the LCFS using a magnetic probe with C/C composite head successfully. Further work toward the relation with the fluctuation induced transport is still needed.

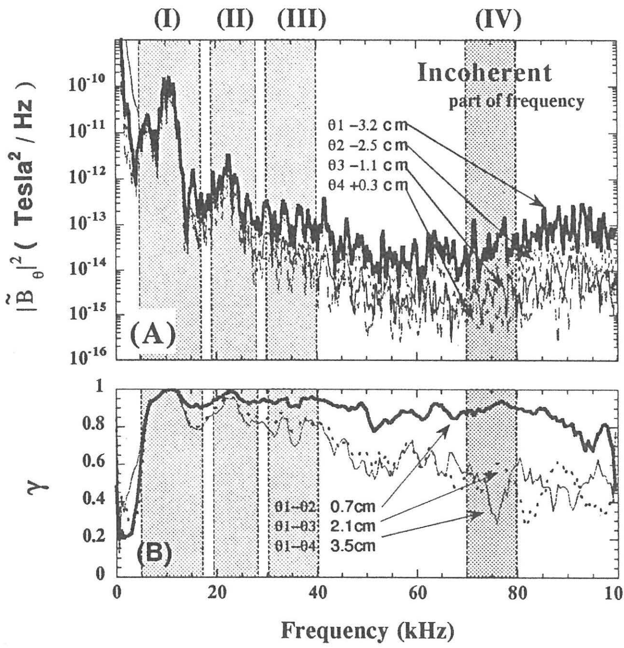

Fig.1: Auto power spectra(A) of the poloidal magnetic field fluctuation measured by radial array of the insertable magnetic probe and coherence(B) spectra between two coils separated radially. (B_t=2.8T, I_p=230 kA)

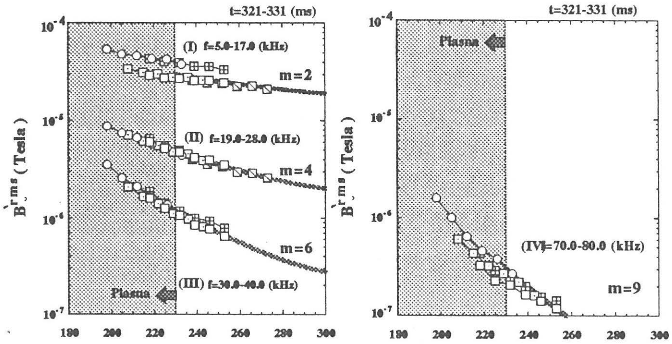

Fig.2: Radial profile of the coherent(A) and incoherent(B) magnetic fluctuation. Using fitted lines, the mode number of the fluctuation are estimated

Reference

1) Kitachi, K. *et al.*, NIFS Report NIFS-407.
2) Kim, Y. J. *et al.*, Phys. Fluids, 3(1991)674.