§18. Magnetic Fluctuations Detected Just Inside the Last Closed Flux Surface in NBI Heated Plasmas

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Ideal interchange modes may be destabilized in a heliotron/torsatron plasma, being dependent on combination of magnetic well and/or magnetic shear. However, resistive interchange mode is always unstable in the plasma edge region because of magnetic hill there. These instabilities may considerably degrade the plasma confinement. To study the effect on plasma confinement, it is required to clarify the characteristics of the interchange mode, which usually generates magnetic fluctuations. We have developed a movable magnetic probe array to detect magnetic fluctuations in the region from scrape-off layer to just inside the last closed flux surface[1].

We have measured magnetic fluctuations with the magnetic probe array in a neutral beam heated deuterium plasma with about 30kA plasma current Ip. The plasma current is induced by the inductive voltage to modify the rotational transform profile, where the rotational transforms at LCFS and the plasma center are estimated ~1.1 and ~0.7 at the peak of Ip, respectively[2]. The probe θ1 is inserted just inside LCFS, i.e., $<r>/<a>\approx 0.91$, and the probe R1 at $<r>/<a>\approx 0.90$, where <a> is the average minor radius. Figure 1 shows auto power spectrum of poloidal magnetic fluctuations obtained by the probe θ1 ($P[B_{\theta 1}(f)]$) and Iis ($P[I_{is}(f)]$) near the peak of Ip. Figure 1 also shows squared coherence $\gamma^2(f)$ of the θ1-probe signal $B_{\theta 1}$ with three other signals $B_{\theta 2}$, $B_{\theta 5}$, and Iis. The coherence between $B_{\theta 1}$ and $B_{\theta 2}$ is very high in the frequency range less than 100kHz, where the radial separation between the θ1- and θ2-probes is 7 mm. We recognize obvious peaks of $\gamma^2 \sim 1$ in the low frequency range (<40kHz), but there is no obvious peaks in the range of f>60kHz. Auto power spectrum of Iis exhibits strong turbulent nature and coherence with the magnetic fluctuation signal $B_{\theta 1}$ is fairly low. Figure 2 shows radial profile of magnetic fluctuation amplitude measured by the poloidal probes θ1, 2, 3, 5 and 7. Low frequency components correspond to the coherent peaks marked as **1** and **2** in Fig.1, and the other relatively high frequency one to incoherent components marked as **3**. The amplitude of incoherent components increase rapidly toward the plasma core region.

The coherent components have a large radial correlation length Lr, that is, Lr ≥ <a> (minor radius). But, it is fairly small for the incoherent one, that is, Lr ~ <a>/9. Correlation between incoherent magnetic fluctuations and plasma confinement is under investigation.

[1] T. Oike et al., NIFS Report NIFS-404 (1996).
[2] K. Toi et al., Proc. IAEA Conf. Plasma Physics and Controlled Nuclear Fusion, Seville, 1994, Vol. 2, IAEA, Vienna (1993) 461-468.

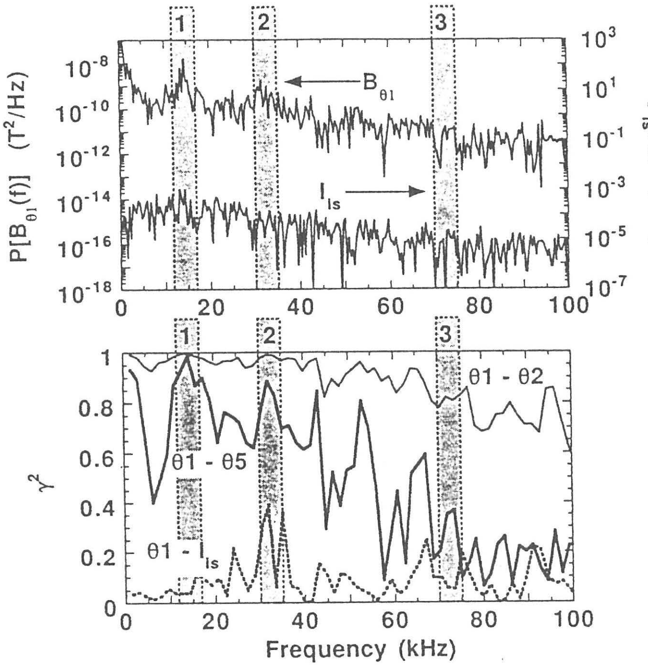

Fig.1 Auto power spectrum of the θ1-probe signal ($P[B_{\theta 1}(f)]$) and Iis ($P[I_{is}(f)]$) near the peak of Ip (120~125ms) in a NBI heated plasma, where the toroidal magnetic field Bt=1.2 T, and Ip=30 kA. , and squared coherence $\gamma^2(f)$ of the probe signal $B_{\theta 1}$ with three signals $B_{\theta 2}$, $B_{\theta 5}$ and Iis.

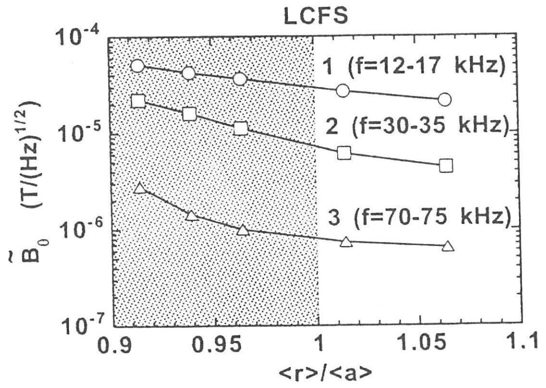

Fig.2 Radial profiles of magnetic fluctuation amplitudes measured by probes θ1, θ2, θ3, θ5 and θ7 for the three frequency ranges marked as **1**, **2** and **3** in Fig.1.