§11. Electrostatic Plasma Responses to Externally Applied Potential Perturbations

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There is a broad consensus that turbulent transport plays a crucial role in determining plasma confinement of magnetically confined toroidal plasmas such as tokamaks and helical devices. A lot of experimental results suggest that a hot plasma itself regulates plasma turbulence and generates structural formation connecting to improved confinement. On the other hand, plasma fluctuations might be suppressed by feedback control techniques.

As a first step, plasma responses to externally applied potential perturbations were investigated in a plasma produced by 2.45 GHz ECH at the toroidal field of Bt=0.0875T, where AC voltages of 5 to 30 kHz were applied to the driver electrode inserted near the edge (ρ =0.9-0.95). The electrode is placed by 60 degrees away in the toroidal direction for a triple probe array. The diameter and length of the driver electrode are respectively 3 mm and 8 mm. The applied voltage is 150 V peak-to-peak and the peak electrode current reaches about 35 mA for a positive voltage phase, where electron density and temperature are ~ $2.5x10^{16}$ m^{-3} and ~7 eV.

When 10 kHz potential perturbations are applied to the electrode, both electron density and floating potential fluctuations at the location away from the electrode in the toroidal direction are considerably enhanced as shown in Fig.1 However, electron temperature fluctuations are only slightly enhanced. The radial profiles of ratio of fluctuation level of the case with 10 kHz drive to that without the drive are shown in Fig.2, where the electrode is inserted in the region of ρ=0.90 to 0.95. It should be noted that the responses in density and floating potential fluctuations appear over a fairly wide zone up to ρ~0.4(Fig.2). The responses for 5 kHz drive are similar to those for 10 kHz drive.

The applied AC voltage to the electrode acts as AC biasing of the inserted electrode. The applied 10 kHz potential perturbations mainly reduce the low frequency part less than 10 kHz of poloidal electric fluctuations in the region ρ=0.9-1.0. The turbulence-induced particle flux is clearly reduced in the edge region of ρ=0.90-1.0, as seen Fig.3. The information on plasma responses to externally applied potential perturbations is very useful for realization of feedback suppression of plasma turbulence.

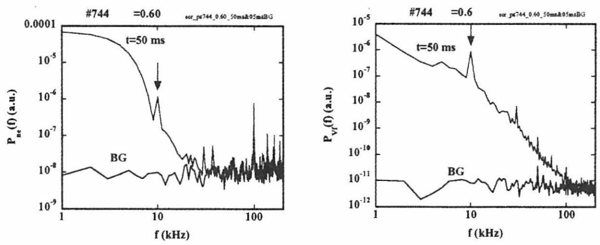

Fig.1 Power spectra of electron density and floating potential fluctuations at ρ=0.6 in the case with 10 kHz drive.

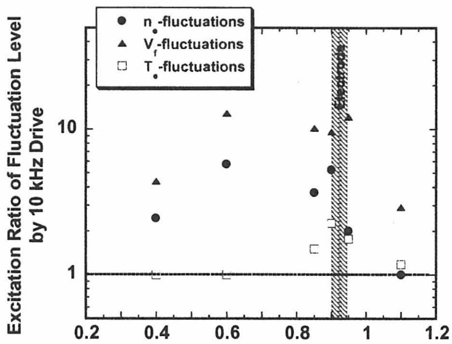

Fig.2 Radial profile of responses in density, floating potential and electron temperature fluctuations to externally applied 10 kHz potential perturbations. The driver electrode is placed in the region from ρ=0.90 to 0.95.

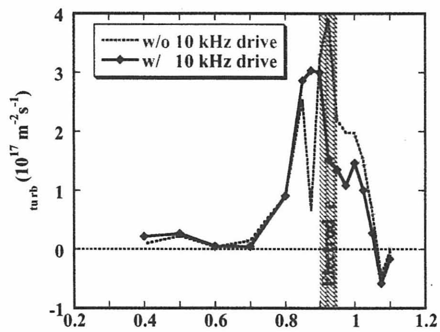

Fig.3 Comparison of turbulence-induced particle flux in the cases with and without 10 kHz drive.