§16. A System for Alfvén-Eigenmode-Spectroscopy using Electrodes Inserted in the CHS Plasma

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Recently, much attention is paid to Alfvén eigenmodes (AEs) destabilized by fast ions in tokamak and helical plasmas.1),2),3) Interaction between fast ions and MHD perturbations in these toroidal plasmas is very complicated. This makes difficult to estimate the damping rates of AEs. Therefore, the excitation of AEs without fast ions is required and leads to clarifying the structure of shear Alfvén spectra experimentally. It is particularly important for helical plasma to investigate characteristics of AEs in the case without energetic ions and to measure the drive and damping rates in a three dimensional magnetic configuration.

From this motivation, we have constructed a system for Alfvén-eigenmodes-spectroscopy in CHS. This system consists of four electrodes for AE-excitation and a set of magnetic probe and Langmuir probe array for AE-detection. These electrodes in the poloidal cross-section are shown in Fig. 1. A pair of electrodes are inserted into the plasma edge r/ <a>~ 0.9 to induce the alternating current there. The paths of alternating current are generated along the confinement magnetic field line of CHS. This current can effectively induce magnetic perturbations perpendicular to the magnetic field line, because the current is just parallel to the field line. This method using the alternating current induced in the plasma edge is very effective for the excitation of shear Alfvén waves and AEs.

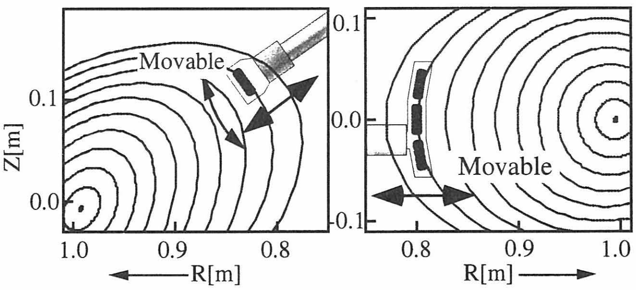

Fig. 1 Electrodes in the poloidal cross-section.

The toroidal mode number of excited perturbations is specified by adjusting the direction of two current paths. When both current paths are adjusted in the opposite or the same direction, the toroidal mode number is specified as n=1,3,... (odd mode operation) or n=0,2,... (even mode operation), respectively. The Fourier spectra of excited magnetic fluctuations are calculated from the spectra of the alternating currents. This result shows that the component of m=2n are dominant in the Fourier components of excited perturbations.

For the AE spectroscopy, measurements of excited fluctuation are also important factors. A magnetic probe array and Langmuir probes are installed to measure the internal structure of the fluctuations. The probe array can be inserted up to the plasma center because of a low temperature and low density ECH plasma. The magnetic probe array can simultaneously measure three components (toroidal, poloidal and radial) of magnetic fluctuations.

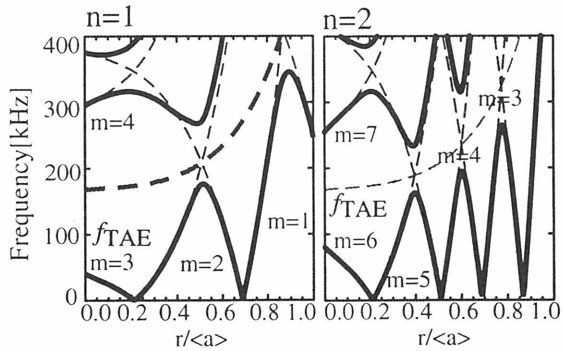

Fig. 2 The Alfvén continua in a typical 2.45 GHz ECH plasma for n=1 and n=2.

As the first step, experiments for the AE-excitation are planned in a low temperature plasma produced by 2.45 GHz electron cyclotron wave heating (ECH) at the toroidal field Bt = 0.0875 T. The typical plasma parameters are predicted as follows: electron density is ~ 10^{16} m^{-3}, which is the cut-off density of 2.45 GHz ECH, and electron temperature of several eV. In this plasma, the expected gap frequency of the toroidal Alfvén eigenmodes (TAEs) is in the range of 100 ~ 200 kHz (Fig. 2). Due to low temperature and density plasma, we can investigate detailed internal structures of the excited AEs, inserting magnetic probes and Langmuir probes up to the plasma center.

In near future, however this excitation method would be extended straightforwardly to high temperature plasmas of CHS at Bt = 0.9 ~ 1.8 T, although the fluctuation measurements are limited in the plasma edge region.

Reference

1) K.L.Wong et al., Phys. Rev. Lett. **66**, 1874 (1991).
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3) K.Toi et al., to be published in Nucl.Fusion **40**, (2000).