§15. Current Path for Alfvén Eigenmode Excitation using Inserted Electrodes in CHS

Matsunaga, G. (Dep. Energy Eng. Science, Nagoya Univ.), Toi, K., CHS Group

Recently, Alfvén eigenmodes (AEs) such as toroidicity-induced Alfvén eigenmodes (TAEs), global Alfvén eigenmodes (GAEs) and ellipticity-induced Alfvén eigenmodes (EAEs) are investigated in tokamak and helical plasmas.1),2),3) These AEs are destabilized by fast ions produced by NBI and ICRF heating. 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 to experimentally clarify the structure of shear Alfvén spectra. In such experiment, it is essential to know the structure of AEs inside the plasma.

For this reason, we have constructed a system which is composed of four electrodes for AE-excitation and a set of magnetic probe and Langmuir probe array for AE-detection in CHS.4) Magnetic and Langmuir probes of this system can be most effectively applied to a low density and low temperature plasma produced by 2.45 GHz ECH system, of which arrangement in CHS is shown in Fig.1. The TE_{10} mode microwave is launched from a 2.45 GHz magnetron and is converted into TE_{11} mode with a mode convertor. The maximum microwave output is 1.3 kW (CW) and 2 kW (pulse). At the toroidal magnetic field B_t = 0.0875 T, a plasma of $T_e \sim 10$ eV and $n_e \sim 4\times10^{16}$ m^{-3} was produced by ~0.3 kW of 2.45 GHz ECH in CHS. For this plasma, the expected TAE gap frequency is in the range of 100 ~ 200 kHz. Detailed internal structures of the excited AEs can be measured by inserting magnetic and Langmuir probes up to the plasma center with the low density and low temperature.

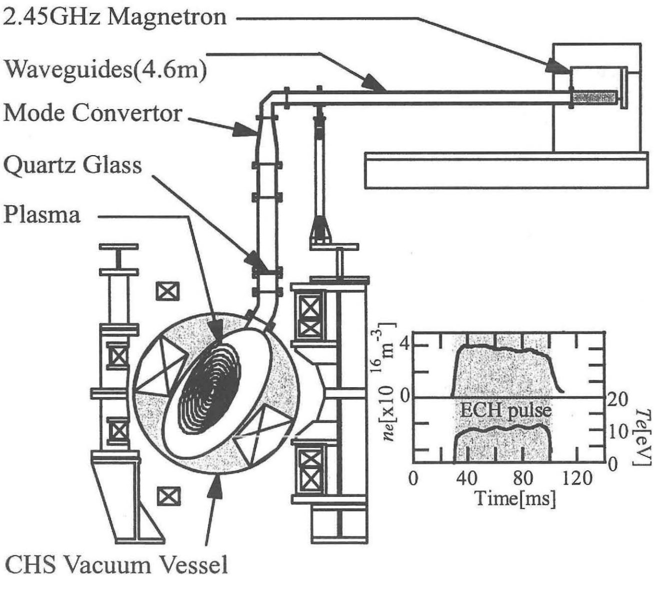

Fig.1 2.45 GHz ECH system in CHS. An insert shows time evolution of electron temperature and electron density near the edge of the plasma produced by this system.

A pair of electrodes inserted into the plasma edge ($r/\langle a\rangle \geq 0.9$) will be employed to induce the alternating current there. The length of alternating current path along the confinement magnetic field line of CHS may be determined by a so-called free streaming length for electrons $L_{//}$:

$$L_{//} = \frac{V_{//} d^2}{16 D_\perp}$$

where $V_{//}$ is the electron thermal speed parallel to the magnetic field line, d^2 the collecting area of the electrode and $D_\perp$ the diffusion coefficient perpendicular to the magnetic field line.5) The characteristic length for electrons is calculated for the expected parameter range of the 2.45 GHz ECH plasmas (Fig.2). The maximum and minimum values of $L_{//}$ are determined by the classical and Bohm diffusion coefficient, respectively. For both cases, $L_{//}$ is longer than the length between inserted electrodes of about 1 m, so that the alternating current could flow between a pair of electrodes. This method using the alternating current induced in the plasma edge is expected to be very effective for the excitation of shear Alfvén waves and AEs.

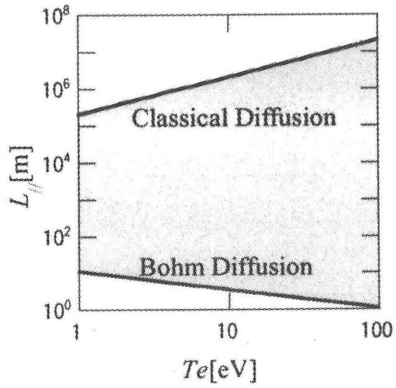

Fig.2 Free streaming length for electrons estimated for the classical and Bohm diffusions.

Reference
1) K.L.Wong et al., Phys. Rev. Lett. **66**, (1991) 1874
2) M.Takechi et al., Phys. Rev. Lett. **83**, (1999) 312
3) K.Toi et al., Nucl. Fusion **40**, (2000) 1349
4) G. Matsunaga et al., Rev. Sci. Instrum. **72**, (2001) 402
5) S.A.Cohen, J. Nucl. Mater. **76**,**77**, (1978) 68