§6. Propagation of Electron Cyclotron Waves


We have measured the propagation of electron cyclotron wave (ECW) in a HYPER-I plasma to study the mechanism of macroscopic flow generation. Spontaneous flow pattern formation has been observed in the resonance region of the HYPER-I plasma. However, the mechanism of this pattern formation has not been clear yet. We have been studying the relation between the flow structure and the plasma production.

In order to obtain the energy deposition profile of the ECW, the Poynting flux measurements were carried out. Two components of the wave magnetic fields, which are perpendicular to each other, have been measured to experimentally determine the component of Poynting flux along the magnetic field. We have developed an antenna, which has a sufficient directivity and is usable in the circumstances with the presence of high power microwaves (2.45GHz, 15kW). The antenna must be protected from the heat flux of the plasmas and should be as small as possible to minimize the disturbance to the plasmas. In order to satisfy these requirements, we have developed a slit antenna, schematic of which is shown in Fig. 1. The antenna is composed of three parts: (1) the heatproof coaxial cable, in which MgO is used for insulation, (2) the stainless steel tube with the slits, which allow the penetration of wave magnetic field, (3) the ceramic (Al₂O₃) tube for the heat protection. Because of the slits, this antenna detects only one component of the wave magnetic fields (the vertical direction in Fig. 1). The dimension of the antenna is 8mm in diameter and is smaller than the usual loop antenna.

Figure 2 shows the typical interferometric wave patterns, which are measured by the new antenna at an angle of 0 degree and 90 degree. An electromagnetic wave with a short wavelength (~2cm) is excited in the plasma. Furthermore, the phase shift between the two traces can be clearly seen. The polarization plot of these wave forms is shown in Fig. 3. The wave is found to be a right-hand circularly polarized one. Then, we have confirmed that the dispersion relation of the observed wave well agrees with theoretical dispersion curve for ECW.

The validity of the new antenna for wave field measurements is established. Detailed measurements on the Poynting flux of ECW are now in progress.