§1. High Density Plasma Experiment HYPER-I

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High Density Plasma Experiment-I (HYPER-I) is a linear device for various basic plasma experiments (Fig. 1), which consists of a cylindrical vacuum chamber (30 cm in diameter, 200 cm in axial length) and ten magnetic field coils. Plasmas are produced by electron cyclotron resonance (ECR) heating with a 2.45 GHz microwave injected along the magnetic field line from the open end of the chamber (high-filed side). This microwave injection method has an advantage that the propagation of excited electron cyclotron wave (ECW) is not subjected to any density cutoff. Therefore the highest attainable density of the HYPER-I plasma easily exceeds the cutoff density of ordinary mode with the same frequency by two orders of magnitude. A high power klystron amplifier (80kW CW max.) is available for the microwave source, which provides us a wide-range control of microwave input power in low density and high density ($\sim 10^{13}$cm^{-3}) experiments. Five probe-driving systems, which can be readily relocated to the different axial positions, are also available to measure the various plasma parameters such as electron temperature, plasma density, space potential and ion flow velocity field. Moreover a tunable extended-cavity diode laser system and a pulsed tunable dye laser system have been installed recently to carry out absolute flow velocity measurements of argon neutrals and ions using laser induced fluorescence (LIF) Doppler spectroscopy technique.

Thanks to the accessibility and adaptability of the HYPER-I device, a number of collaborative researches are being underway. The research activities of the HYPER-I experimental group is mainly focused on the physics of flow and structure formation in plasmas as well as the development of new diagnostic systems.

(i) *Anti-ExB vortex*

A peculiar vortex which rotates to the direction opposite to that of the ExB drift has been observed in a relatively high neutral pressure discharge. The vortex always accompanies with deep depletion in background neutral-density, which suggests that the interaction between neutrals and ions may play an important role in its formation. In order to evaluate the effect of neutral flow on ion dynamics, a high-precision LIF Doppler spectroscopy system has been under development. In this fiscal year, we introduced improved collection optics and an electro-optical modulator to increase the S/N ratio of the LIF signals. Furthermore, the absolute wavelength calibration unit utilizing saturated absorption spectroscopy has been implemented into the system. As a result of these efforts, the system has become capable of resolving quite a slow velocity of neutrals of the order of a few m/sec.

(ii) *Plasma hole*

Spontaneous formation of a vortex with a cylindrical density cavity in its core (referred to as plasma hole) has been observed. In order to clarify the formation mechanism of the plasma hole, a precise measurement on velocity field is needed. Since there is a suitable LIF scheme for argon ions in visible light range, we employed it to measure the azimuthal and radial ion flow velocity profiles associated with the plasma hole in an argon plasma. An LIF measurement of a plasma hole in a helium plasma in which a small amount of argon gas is introduced as an impurity has also been started.

(iii) *Development of novel diagnostics using probes*

We have been developing a novel method to measure plasma flow velocity along the magnetic-field line using a face-to-face double probe (FDP), where the design of the probe head was modified to improve measurement accuracy in this fiscal year.

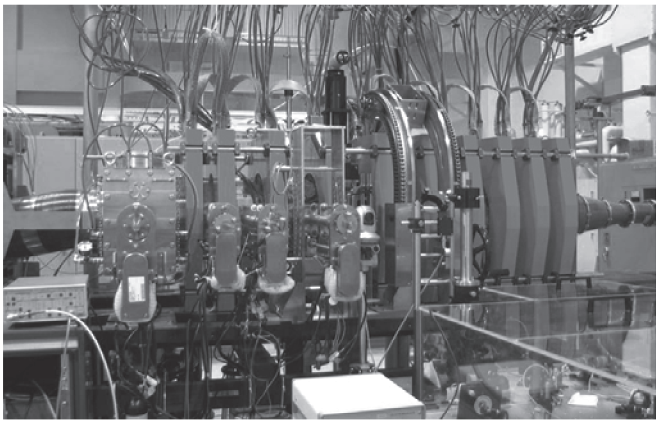

Fig.1 The HYPER-I device