§1. High Density Plasma Experiment HYPER-I

Tanaka, M.Y., Yoshimura, S., Nagaoka, K.,
Okamoto, A., Hara, K., Nakano, H. (Nagoya Univ.),
Tsushima, A. (Yokohama National Univ.)

High Density Plasma Experiment-I (HYPER-I) is a linear device with magnetic fields designed for various basic plasma experiments. Main research activities are focused on flow and structure formation, vortex and its interaction, and particle accelerations in a rotating magnetized plasma. HYPER-I plasmas are produced and sustained by electron cyclotron resonance heating with an electron cyclotron wave (ECW) of frequency 2.45GHz. Two microwave sources are available; one is a magnetron oscillator with 15 kW output, and is used for low power experiments. A klystron amplifier with 80 kW output (CW) is also available for high density experiments. The maximum density is two orders of magnitude higher than the cutoff density of ordinary mode with the same frequency. Characteristic features of HYPER-I plasma are large diameter (30 cm) and high density, which permit us various experiments without noticing the effect of boundary or boundary layer. A set of probe driving systems have been newly installed to measure the vector field plot of plasma flow on a plane perpendicular to the magnetic field. Velocity vector measurements are possible over 80% of the whole cross section of the plasma. The ongoing experiments are as follows;

(i) high-density plasma production

High density plasmas produced by the high power microwave source are available for the experiment on magnetohydrodynamic waves. This program is in progress with collaboration from Shizuoka Univ. and Yokohama National Univ. Since the electron temperature of HYPER-I plasma is controllable, our interest is focused on excitation of kinetic Alfven wave.

(ii) anomalous viscosity and dissipative vortex

We have observed a vortex with cylindrical density cavity (referred to as plasma hole). The experiments revealed that the plasma hole is a Burgers vortex, and the viscosity is 4 orders of magnitude higher than the classical value. This is the first experimental observation of dissipative vortex (Burgers vortex) in a plasma. It is also found that the quasi-neutrality breaks down in the hole region, in which the quantity $\delta n / n$ is three orders of magnitude higher than that of ambient plasma.

(iii) anti-ExB multipole vortex

This vortex pattern is stationary in time, and consists of two co-rotating vortices in both sides, and a counter-rotating vortex between them. The remarkable characteristic of tripolar vortex is that the direction of rotation is opposite to that of *ExB* drift. It is found that the charge exchange process acts as a momentum source, and thus the inhomogeneity of neutral density profile produces an effective pressure, dominating the radial electric field.

(iv) annular electron acceleration and flow

We have observed anomalous electron acceleration in a plasma. The energy of accelerated electrons is ~200eV, which is 10 times the bulk electron temperature. The spatial distribution is annular, and the anisotropic energy distribution has two lobes at ± 45degree against the magnetic field. A one-sided flow along the filed line has been found.