§ 1. Basic Plasma Experiments Using HYPER-I

Tanaka, M.Y., Yoshimura, S., Nagaoka, K.
Okamoto, A., Hara, K., Nakano, H. (Nagoya Univ.)
Tsushima, A. (Yokohama National Univ.)
Saitou, Y. (Utsunomiya Univ.)
Vranjes, J. (K.U. Leuven)
Kono, M. (Chuo 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, vortices, and particle accelerations in a rotating magnetized plasma. HYPER-I plasmas are produced and sustained by electron cyclotron resonance heating with a microwave 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 power, high density experiments. The maximum density of HYPER-I plasma is 10^{13} cm^{-3} , and 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, and experiments are carried out without serious influence of the boundary conditions. A set of movable probe systems have been installed to measure the vector field plot of plasma flow on a plane perpendicular to the magnetic field. Velocity vector measurements can be carried out over 80% of the whole cross section. The ongoing experiments are as follows;

(ii) dissipative vortices and velocity field measurement

We have observed a vortex with cylindrical density cavity in its center (plasma hole), and identified as a Burgers vortex. This is the first experimental observation of dissipative vortex (Burgers vortex) in a plasma. To precisely measure the super sonic flow velocity by Doppler shift, we are planning to introduce a laser induced fluorescence (LIF) system, which consists of a pump laser (Nd:YAG 532nm) and a narrow spectrum dye laser (0.06 cm^{-1}).

(ii) anti-ExB tripolar vortex

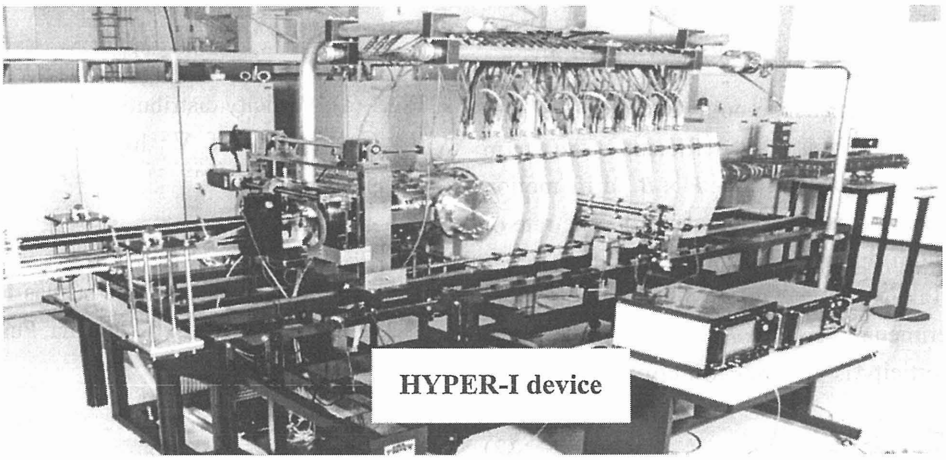
Tripolar vortex is made up of two co-rotating satellite vortices in both sides and of a counter-rotating center vortex. It was first found in a rotating ordinary fluid in 1990's. We have observed a tripolar vortex in a HYPER-I plasma. It revealed that the direction of rotation of each vortex is opposite to that of *E*x*B* drift. It is found that the effective force due to directed neutral flow dominates the radial electric field, and drives the plasma into anti-*E*x*B* motion. In this circumstance, the logarithm of neutral density profile, $\log[n_n(\mathbf{r})]$, becomes the stream function of the velocity field.

(iii) annular electron acceleration

We have observed anomalous electron acceleration in a HYPER-I 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 remarkable lobes at ±45degree against the magnetic field. It has been found that the high energy electrons are intermittently released in the annular region and there is a synchronized pulsation in magnetic fluctuation.

(iv) Alfven wave experiment

Experiment on magnetohydrodynamic waves has been carried out using a high-density HYPER-I plasma. This program has been conducted under the collaboration from Shizuoka Univ. and Yokohama National Univ. A three-turn loop antenna was used to excite an Alfven wave. We have confirmed the propagation of a compressional Alfven wave by measuring the magnetic field oscillations.



HYPER-I device