§12. Density Fluctuation in Heliotron E Measured Using Laser Phase Contrast Method

Kado, S., Muraoka, K. (Kyushu Univ. Energy Conv.)
Kondo, K., Sano, F., Obiki, T. (Plasma Phys. Lab., Kyoto Univ.)

From the very beginning of fusion studies, the anomaly in particle and energy diffusion coefficients has been an important issue. One candidate which might cause this "anomalous diffusion" is fluctuations in density, potential, magnetic field or temperature.

In order to clarify this, we have been using the Laser Phase Contrast Method on Heliotron E device to measure electron density fluctuations. The schematic diagram of the optics is shown in Fig. 1. The beam from a TEM_{00} mode CW-CO_2 laser with a wavelength of 10.6 μm was expanded just before the input port. A 16 ch HgTeCd detector array was used to detect the signal from any 40 mm wide section of the beam in the plasma. The phase plate, situated where the beam focuses, acts to convert the phase disturbance into an amplitude disturbance of the beam on the detection plane. The slit attached to the phase plate selects the diffraction direction which enable this system to obtain spatially resolved signals utilizing the shared magnetic field[1].

Figure 2 shows spectra for real plasma discharges. The plasmas in this series of discharges were produced by 53 GHz ECH systems (270 kW), and sustained by an additional NBI heating (0.6MW), yielding a central electron density of $n_e(0) \sim 2\text{x}10^{19}$ m^{-3}. The LPC system detects the wave perpendicular to the probe beam, so that poloidal component, K_θ, at the top and bottom, and radial component, K_r, at the midplane are measured.

The spectra from the center and the edges are quite different. At the plasma center, the spectrum is in a relatively low frequency region and is incoherent, and it is hard to find the ridge of the contours which represents the dispersion function of the wave. On the other hand, at the edges, one can detect a rather coherent pair of counter propagating modes. The solid lines in Fig. 2 (a) and (c) are believed to indicate the same wave component propagating in the electron diamagnetic direction (electron mode) with the phase velocities of about 1500 (a) and 1600 (c) m/s. On the other hand, the dashed lines are believed to indicate the same component propagating in the ion diamagnetic direction (ion mode) with the phase velocities of about 5000 (a) and 3600 (c) m/s.

From now on, we are planning to analyze further the features of each mode and examine the differences between the center(K_r) and the edge (K_θ) in order to identify the instabilities which occurred in different discharge conditions.

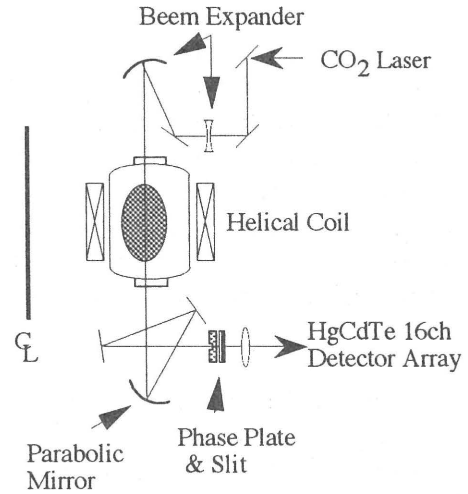

Fig. 1. Optical system of Laser Phase Contrast Method installed on Heliotron E device

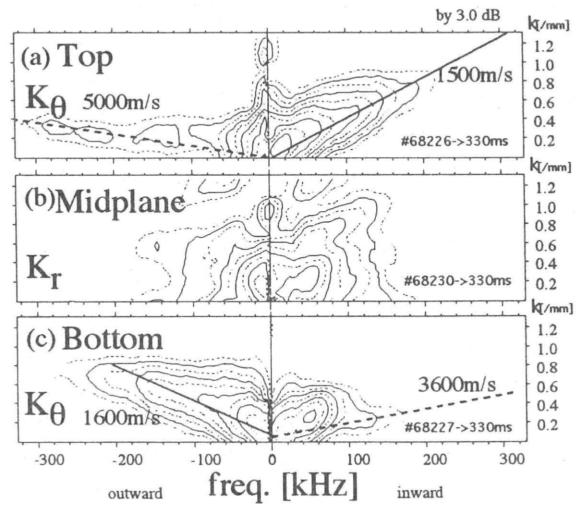

Fig. 2. K-Ω/2π spectra of (a)r/a=+0.9, (b)r/a=0, and (c)r/a=-0.9.

Reference

1) Kado, S., et al. submitted to Jpn. J.Appl.Phys.