# LIF measurement of neutral flow associated with formation of an anti-E×B vortex

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Flow structure formation in magnetized plasmas is generally dominated by electric force, which drives E×B drift. Recently, vortices which rotate opposite to the direction of E×B drift (anti-E×B vortices) have been observed in a magnetized argon plasma [1]. The vortices are considered to be caused by the interaction among ions and neutrals through charge exchange collisions. To experimentally verify the mechanism of the vortex formation, we have measured the flow velocity field of neutrals by laser induced fluorescence method.

The experiments have been performed in the high density plasma experiment-I (HYPER-I) device. Argon plasma is produced by ECR discharge with microwave the frequency of which is 2.45 GHz. Monopole-type anti-E×B vortex occurred when the input microwave power and the gas pressure were 5 kW and 10 mTorr, respectively.

For measurement of neutral flow velocity, we have developed a high velocity resolution LIF system with a diode laser [2]. A laser beam with the wavelength of 696.735 nm (in vacuum) excites the argon metastables to the upper energy level ($4s[3/2]^o_2 \rightarrow 4p[1/2]_1$), and then we detect the photons emitted by the $4p[1/2]_1 \rightarrow 4s[1/2]^o_1$ transition (826.679 nm). Since the expected flow velocity is much slower than that of the ions, high accuracy of velocity determination is required. We introduced the saturated absorption spectroscopy (SAS) technique into the LIF system for a wavelength criterion.

We measured LIF spectra and treated them as neutral velocity distribution functions (Fig. 1). We determined the radial profiles of radial and azimuthal flow velocity from the Doppler shifts of them. The radial flow is directed to the center of the plasma, and the maximum flow velocity is about 60 m/s. The position of the maximum velocity agreed with the region of steep neutral density gradient. The azimuthal flow is in the anti-E×B direction in the vortex and in the E×B direction in outer region of the vortex, which is similar to the ion azimuthal flow. This similarity implies the neutrals and the ions strongly interact in this regime.

[1] A. Okamoto, et al., Phys. Plasmas **10** (2003) 2211.
[2] M. Aramaki, et al., Rev. Sci. Instrum. **80** (2009) 053505

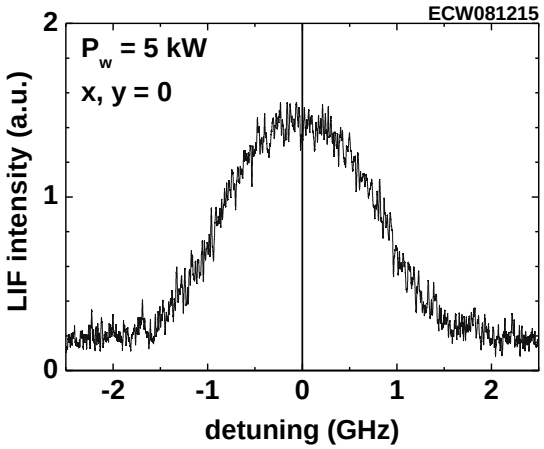


Fig. 1. LIF spectrum at the center of the plasma.