§28. Two Dimensional Ion Temperature and Velocity Measurements by Use of Visible Light Tomography Technique

Ono, Y., Balandin, A.L., Imazawa, R., Kawamori, E., Murata, Y., Itagaki, T., Yamanoue, T., Sato, K., Arimoto, K., Timura, T., Tawara, T. (Univ.Tokyo, High Temperature Plasma Cent. / Dept. Electr. Eng.), Narushima, Y., Nagayama, Y., Yamazaki, K.

For the past five years, we have been developing a new visible-light tomography system for two dimensional (2-D) measurements of ion temperature and velocity. In 2005, we developed, 1) a new reconstruction software for 2-D plasma velocity measurement and 2) a part of optical fiber system and optical lens system for this system. As for (1), we reconstructed the local 2-D plasma velocity profile from the measured line-integrated line spectrum with Doppler shift. The 2-D plasma velocity profile is composed of two components as shown in $\mathbf{v} = \nabla \times \psi + \nabla \phi$ ------------(1),
so that we obtain the following Radon transformation form:

$$R\{\zeta\}(u,\eta) = -\int_{-\infty}^{u} \mathbf{v}\{\theta\}(u',\eta)du' \text{-----------(2)},$$

based on an assumption that our plasma is incompressible as $\nabla \bullet \mathbf{v} = 0$. We solved the equation (2) using the maximum entropy method. Figure 2 shows the 2-D velocity profiles (vectors plot) (a) and the 2-D volticity ψ contours (b) for an assumed toroidal velocity profile of low aspect ratio torid which was peaked at the magnetic axis. Artificially, 10% white noises (n=1 component) were added to the line-integrated signals of line spectrum. Figures 2 indicate that the assumed 2-D velocity profile was reconstructed successfully within the error of 20%. As for (2), we installed the initial set of optical fibers: 9 channels to complete the 1-D velocity measurement system in order to test one section of the 2-D measurement system. Figure 3 shows the measured radial velocity profile of two merging spheromaks with counter helicity. It indicates that the bipolar toroidal velocity by the counter helicity reconnection was reconstructed successfully using our 1-D velocity measurement system.

References

[1] A.Balandin, Y.Ono, J Comp. Phys. 202, (2005), 52.

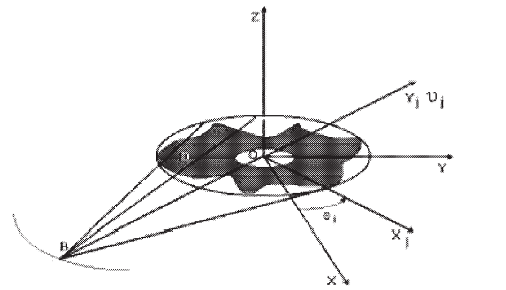
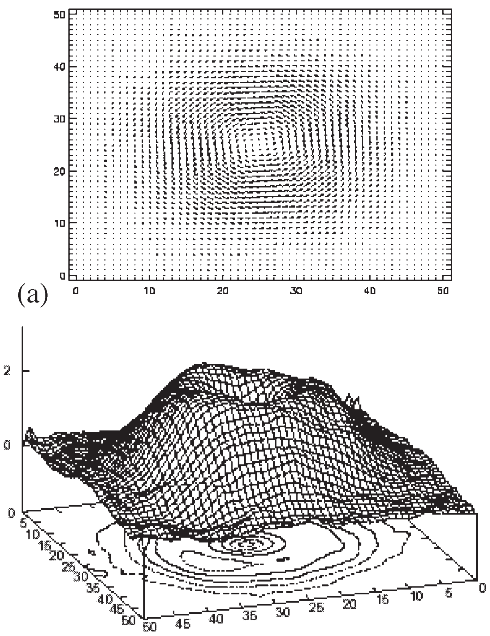


Fig. 1 Ion flow measurement by the vector tomography technology for visible light Doppler spectroscopy.



(a)

(b)

Fig. 2 2-D contours of plasma velocity (a) and volticity (b) for a low aspect ratio toroid.

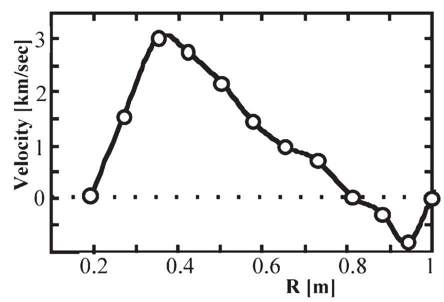


Fig. 3 Radial velocity profile of the two merging spheromaks with counter-helicity, which was measured by Doppler shift of ArII line.