§13. Dynamics of Hydrogen Atoms and Molecule in the Periphery Plasma Studied by Means of Polarization Separated Spectra

Iwamae, A., Sakaue, A., Sakaue, M. (Dept. Mech. Eng. Sci. Kyoto Univ.),
Sawada, K. (Faculty of Eng., Shinshu Univ.),
Goto, M., Morita, S.

Plasma transport studies in the open field line regions are of great importance for understanding how to transfer heat fluxes to the diverter, and how to secure the core plasma from being contaminated.

Emission from a plasma in the Large Helical Device (LHD) was observed from 1-O port with ten lines-of-sights equipped with polarization separation optics[1)] as shown in Fig. 1. The emission from a cylindrical region of 70 mm in diameter in the plasma collimated by lenses was transmitted through optical fibers to a spectrometer (f = 1.33 m, 1800 grooves/mm).

Figure 2 show an example of the polarization separated line profiles of the Hα emission observed at z = -0.026 m, slightly below the equatorial plane. The peak of the -37° polarized component is located at the longer wavelength direction from the stationary Hα line position, and the peak of the 53° polarized component is slightly shifted to the shorter wavelength direction. The π polarized light ($\Delta m_J = 0$ transitions) of the line is parallel to the magnetic filed direction. We interpret above spectral structures as that the Ha line is emitted at two locations, the inner and the outer points, on the line-of-sight and there are two atom temperature components at each point, which move with a certain velocity component along the line-of-sight. Least-squares fitting is performed on the observed both polarized components simultaneously, with four set of Zeeman profiles, cold and warm components in inner and outer regions, pulse a broad Gaussian profile with a magnetic field structure of the magnetic field axis R_{ax} = 3.70 m and the strength at the axis B_{ax} = -2.676 T. Hyper-fine structures are considered to synthesis line profiles. The result of the fitting is shown in Fig. 2. Table I summarizes the parameters deduced from the fitting. From the parameter values of the magnetic field vectors, the emission locations are identified to be R_{in} = 2.89 m and R_{out} = 4.83 m. These locations are shown in Fig. 1 with the consistent results of the fitting for other line-of-sights. It is difficult to reach reasonable convergence of the fitting with two emission locations for the upper and lower line-of-sights. This is likely to be reflected light from the divertor plates or the vacuum vessel because of the unbalanced intensity of the two polarized components.

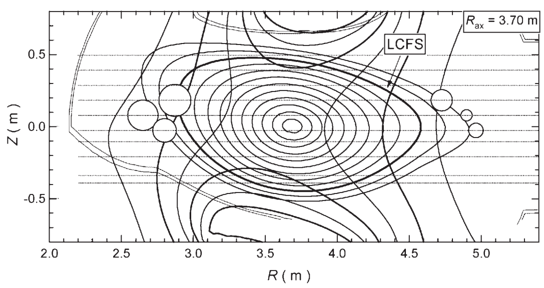

Fig. 1. Locations of the Hα emission obtained by means of the fitting to the polarization separated spectra.

The polarization separated spectra are synthesized with a fully three-dimensional neutral transport code including molecular dissociation processes. Figure 3 shows the observed and synthesized Hα spectra. The synthesized spectra are obtained by summing the Hα emission along horizontal lines on the line-of-sight. The polarization of Hα emission by Zeeman effect is considered. The synthesized spectra show the reasonable agreement with the observed. The profile is explained as composed of cold and warm components: dissociative excitation and electron collisional excitation of the atoms produced by dissociation, and hot component: electron collisional excitation of atoms produced by charge exchange.

Table I. The determined parameters by the fitting.

	Inner		Outer	
	cold	warm	cold	warm
R (m)	2.89		4.83	
B (T)	2.06		1.35	
T_a (eV)	0.4	1.0	2.8	11.8
v (km/s)	4.1		-7.2	

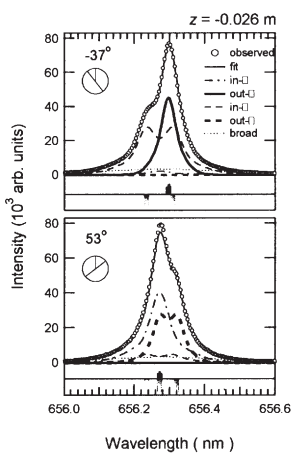

Fig. 2. The observed Hα spectra and the fitting results.

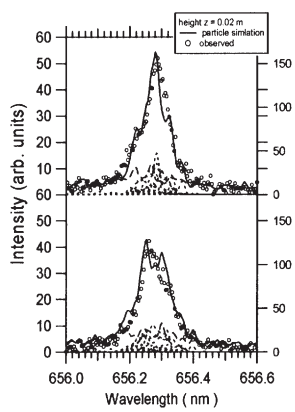

Fig. 3. The observed and synthesized polarization separated spectra.

1) A. Iwamae, *et. al.*, Phys. Plasmas **12**, 042501 (2005).