§7. Hydrogen Atoms and Molecules Transport in the LHD Periphery Plasma Studied by Polarization Resolved Spectroscopy

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Plasma transport in the open field magnetic field line regions is important to understand heat flux to the diverter and to secure high performance core plasma from being contaminated[1].

Emission from a plasma confined in Large Helical Device (LHD) was observed at the 1-O port with two lines of sight equipped with polarization separation optics[2,3]. Atomic hydrogen emission collimated with lenses was transmitted through optical fibers and separated by fiber couplers to one spectrometer (McPherson model 209: f = 1.33 m, 1800 grooves/mm) for the Hα line observation and the other spectrometer (Jobin Yvon THR-1000: f = 1.00 m, 2400 grooves/mm) for the Hβ line. Both the spectrometer systems were remotely operated from Plasma Laboratory Building at Kyoto University via Super-Sinet.

Figure 1 shows an example of the polarization separated line profiles of the Hα and Hβ emission observed at z = 0.026 m, slightly below the equatorial plane. Least-squares fitting is performed on the observed Hα profiles with four set of Zeeman profiles, cold and warm components in inner and outer regions, and a broad Gaussian profile with a magnetic field structure of the magnetic field axis R_{ax} = 3.60 m and the strength at the axis B_{ax} = 2.64 T. The result of the fitting is shown in Fig. 1(left). From the fitted values of the magnetic field vectors, the emission locations are identified. Regarding the Hβ emission, we fitted the profiles with the intensities of inner and outer regions as the adjustable parameters adopting other parameters from the Hα profile fitting result. The result is shown in Fig. 1(right).

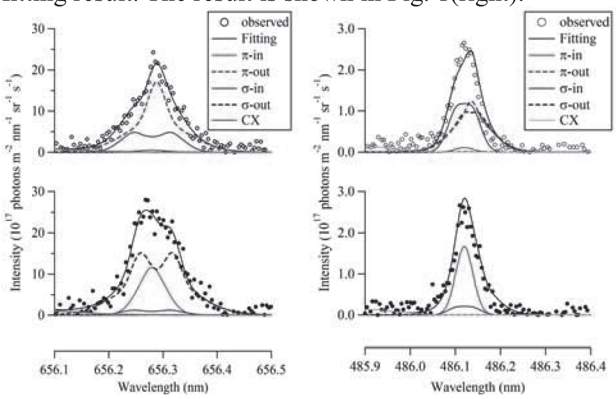

Fig. 1. The observed Hα (left) and Hβ (right) spectra and their fitting results.

The emission locations, the line intensities and atom velocities, which are estimated from the Doppler shift of the fitted profiles, are plotted in Fig. 2 for the observed two lines of sight. Near the equatorial plane (z = 0.026 m), the emission locations are deduced to be around the ergodic layer. At the line of sight of z = 0.39 m, the emission component of the outer component is deduced to be near the diverter leg. It is found that the Hβ/Hα intensity ratio, which is shown as the numbers in the figure, depends of the emission location.

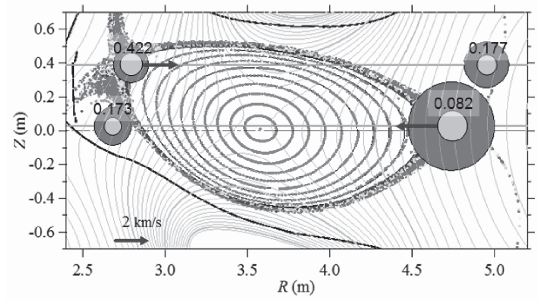

Fig. 2. Emission locations, intensities (area of the circles) and atom velocities (length of the arrows) are plotted for the magnetic axis of 3.60 m. The red and gray circles shows the Hα and Hβ emission, respectively

Figure 3 shows the Hβ/Hα intensity ratio as a function of n_e calculated from the collisional-radiative model for the hydrogen atoms and molecules system at T_e = 5 eV. We also show the experimental Hβ/Hα intensity ratios at the line of sight of z = 0. 026 m. At the present stage of the experiment, it is difficult to determine n_e, T_e and the H_2/H density ratio from the comparison of the experiment with the model. Simultaneous measurement of other hydrogen emission, such as Hγ line and H_2 emission band, may be useful not only to determine n_e, T_e and number densities of H and H_2 but also to investigate H and H_2 transport in the periphery region.

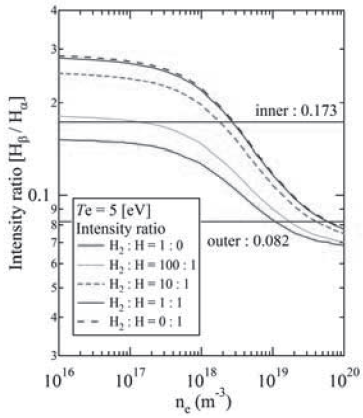

Fig. 3. Comparison of the experimental Hβ/Hα intensity ratio with that estimated from the radiative-collisional model for the hydrogen atoms and molecules system.

1) P. C. Stangeby, *The Plasma Boundary of Magnetic Fusion Device,* IOP (2000)
2) A. Iwamae, *et. al.*, Phys. Plasmas **12**, 042501 (2005).
3) A. Iwamae, *et. al.*, Phys. Plasmas **14,** 042504 (2007).