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

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

Plasma transport studies in the open field magnetic field line regions are of importance 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 eight lines of sight equipped with polarization separation optics[2]. Atomic hydrogen emission collimated with lenses was transmitted through optical fibers to a spectrometer (Jobin Yvon THR-1000: f = 1.00 m, 2400 grooves/mm) at the equipment compartment. The spectrometer system was remotely operated from Plasma Laboratory Building at Kyoto University via Super-Sinet.

Figure 1 show an example of the polarization separated line profiles of the Hα emission observed at z = 0.026 m, slightly below the equatorial plane. 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} = 3.75 m and the strength at the axis B_{ax} = 2.64 T. Hyper-fine structures are considered to synthesis line profiles. The result of the fitting is shown in Fig. 1. From the parameter values of the magnetic field vectors, the emission locations are identified. Emission locations and the line intensities are plotted in Fig. 2 with the consistent results of the fitting for other lines of sight of different magnetic axis configurations, R_{ax} = 3.60, 3.75 and 3.90 m. For R_{ax} = 3.60 m, the intensity of the emission are high around the inner X point. With the increase of the magnetic axis radii, the outer emission intensity increase. For R_{ax} = 3.90 m, the emission contribution at the inner divertor leg region are identified.

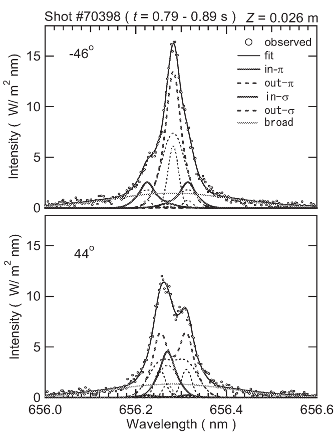

Fig. 1. The observed Hα spectra and the fitting results.

The polarization separated spectra are synthesized with a fully three-dimensional neutral transport code including molecular dissociation processes. Synthesized spectra are obtained by summing the Hα emission along horizontal lines on the line-of-sight. The polarization of Hα emission by the Zeeman effect is considered as shown in Fig. 3. 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.

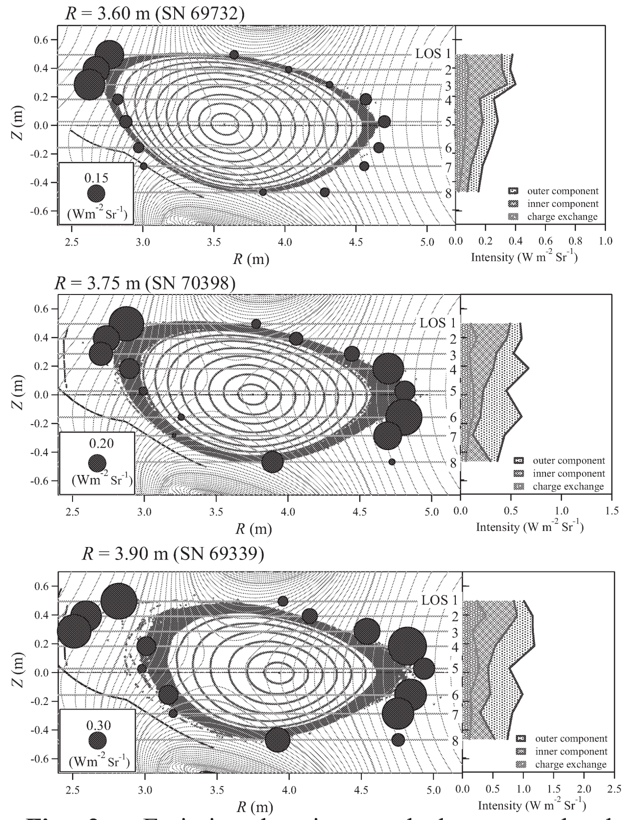

Fig. 2. Emission locations and the upper level population are plotted for the magnetic axis of 3.60, 3.75 and 3.90 m.

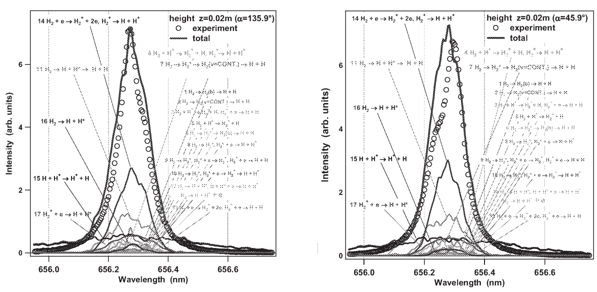

Fig. 3. Hα spectra observed and synthesized with the Monte-Carlo neutral transport code.

References

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