§30. High-resolution Measurements of Hα Line Spectral Profiles in LHD Steady State Plasmas

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Hα line spectral profiles in LHD hydrogen discharges have been measured with a high wavelength resolution spectroscopic measurement system. The system is designed to distinguish a few eV difference of neutral hydrogen energy along the sight lines.

In this experimental campaign, we investigated $\overline{n}_e$ dependence of the neutral hydrogen behavior in the helical divertor configuration with $R_{ax} = 3.60$m. With the density feedback gas-puffing and the series injection of NB, steady state hydrogen discharges were performed. The discharge duration was ∼6s and $\overline{n}_e$ was varied in the range of $2.0{\sim}6.0{\times}10^{19}$ m^{-3} in shot by shot. The spectral profiles can be decomposed into narrow and broad Gaussian components and the asymmetric profiles due to the blue shift of the broad component were obtained. This blue shift can be attributed to the atoms reflected on the inner divertor plates because the particle deposition is intensive at the inboard side of the torus in $R_{ax} = 3.60$m[1]. Figure 1 shows $\overline{n}_e$ dependence of the line intensity and the flow velocity of the hydrogen atoms deduced from the spectral profiles obtained at the sight line viewing an inner divertor plate. In the $\overline{n}_e$ range of $2.0{\sim}6.0{\times}10^{19}$ m^{-3}, the line intensity of the narrow and broad component increases with $\overline{n}_e{}^{2.1}$ and $\overline{n}_e{}^{2.6}$, respectively. The intensity ratio of broad/total increase from 0.3 to 0.5 with the increase of $\overline{n}_e$ from 2.0 up to $6.0{\times}10^{19}$ m^{-3}. The ion saturation current measured by the 6I divertor probe depends on $\overline{n}_e{}^{2.3}$. The similarity in $\overline{n}_e$ dependence of the line intensity and the ion saturation current indicates that the interactions with the inner divertor plates such as desorptions and reflections

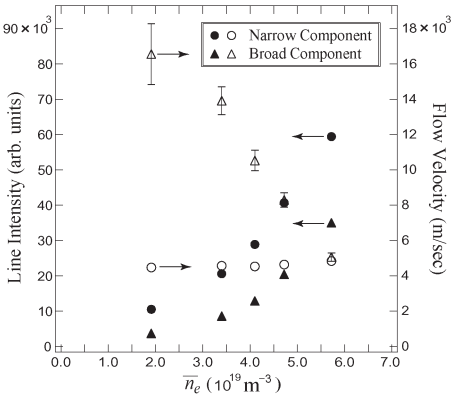

Fig. 1: Line-averaged electron density dependence of Hα line intensity and flow velocity of hydrogen atoms.

are progressed caused by the increasing outflux with $\overline{n}_e$. On the other hand, the flow velocity and the temperature of the hydrogen atoms deduced from the broad component decrease with the increase of $\overline{n}_e$. Especially in the flow velocity, the rapid decrease is observed as shown in Fig. 1 and the asymmetric feature of the spectral profiles gradually vanishes. This is considered to be due to the falloff of the sheath acceleration, because the edge electron temperature become lower(∼50%) with the increase of $\overline{n}_e$ from 2.0 up to $6.0{\times}10^{19}$ m^{-3}.

In the high density detachment experiment[2], line spectral profiles of Hα were also investigated. Figure 2 shows the spectral profiles in the attachment(a) and the detachment(b) phase obtained at the sight line viewing an inner divertor plate. In the detachment phase, the contribution of the broad component decreases and the spectral profile of total emission exhibit narrower shape than in the attachment phase. The line-averaged electron density is $\sim 6.0{\times}10^{19}$ m^{-3} in the attachment and $\sim 1.4{\times}10^{20}$ m^{-3} in the detachment phase. Despite the significant increase in $\overline{n}_e$, the difference in the total line intensity between the attachment and the detachment phase is not significant(∼7 % lower in the detachment phase). This is considered to be due to the suppression of the neutral hydrogen generation by the detachment. In the measurement duration of 0.45sec(1.35∼1.80sec), about 30 ELM-like spikes are observed by Hα monitor. These spikes are thought to be deeply concerned with the rotating radiation belt[3] which appears during the detachment. Emissions from a rotating radiation belt will be investigated in next campaign.

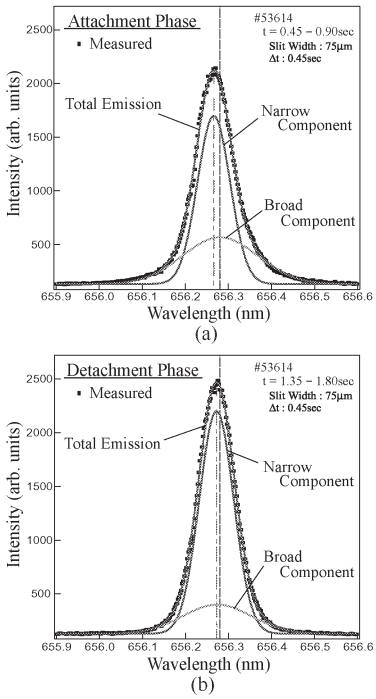

Fig. 2: Hα line spectral profiles observed in (a)attachment phase and (b)detachment phase.

References

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2) Miyazawa, J. *et al.* : J. Plasma Fusion Res. **81** (2005) 5 331.
3) Masuzaki, S. *et al.* : submitted to J. Plasma Fusion Res.