§36. High-Resolution Measurements of Hα Spectral Line Profiles in LHD Steady State Plasmas

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The sustainable detachment has been obtained[1]. The line–averaged electron density $\overline{n}_e$ dependences of the parameters deduced from the Hα line profile have been investigated to discuss the differences in the neutral hydrogen behavior in the attachment and detachment plasmas.

Figure 1 shows the Hα spectral line profiles in the (a)attachment and (b)detachment discharges obtained at the sight line which view the inner divertor plate. These profiles can be decomposed into two Gaussian components of a narrow shape and a broad shape. The narrow component is considered to be the contribution of the dissociated atoms and the broad component represents the reflected and charge–exchanged atoms. The center of the broad component shows significant blue shift in attachment, while the shift is much smaller in detachment. The blue shift in attachment is due to the reflection by the divertor plates and corresponds to the inward flow velocity of up to 1.5×10^4 m/s.

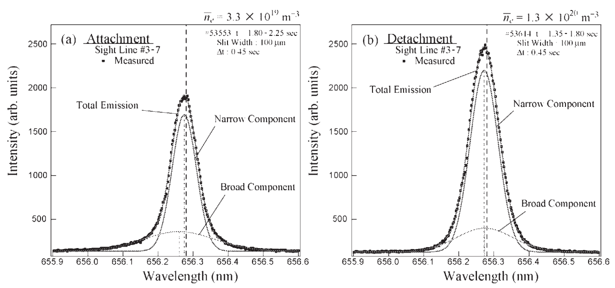

Fig. 1: The Hα spectral line profiles in the (a)attachment and (b)detachment discharges.

Figure 2 shows the $\overline{n}_e$ dependences of the (a)Hα line intensity, (b)flow velocity along the sight line, (c)temperature of the hydrogen atoms, (d)ion saturation current measured by the 6–I divertor probe and (e)T$_e$ at $\rho = 0.9$ measured by the Thomson scattering system. The filled and open symbols indicate the narrow and the broad component, respectively, except for Fig. 2(d) and (e). As shown in Fig. 2(a), the line intensities of both components are almost proportional to $\overline{n}_e$ in attachment. A similar dependence is found in the ion saturation current in Fig. 2(d). This means a clear correlation between the neutral hydrogen generation and the divertor flux in attachment. While in detachment, the line intensities are independent of the divertor flux and tend to increase in the higher $\overline{n}_e$ conditions. As shown in Fig. 2(b) and (c), the flow velocity and the temperature of the narrow component do not depend on $\overline{n}_e$, and take almost constant value of $\sim3.0\times10^3$ m/s and ~3 eV, respectively, regardless whether attachment or detachment. Those parameters of the broad component in attachment strongly depend on $\overline{n}_e$. The flow velocity drops from $\sim1.5\times10^4$ m/s to ~0 m/s with the increase of $\overline{n}_e$. The broad component in this condition is considered to be mainly the reflected atoms by the divertor plates. The drop of the flow velocity with $\overline{n}_e$ can be partly attributed to the decrease of the sheath potential and the energy of the incident ions due to the decrease of the edge electron temperature shown in Fig. 2(e). The temperature of the atoms is considered to be also affected by the edge electron temperature. In detachment, the contributions of the reflection are scarce because of the drastic decrease of the divertor flux. The flow velocity and the temperature are seemed not to depend on $\overline{n}_e$. The flow along the sight line can be regarded as almost isotropic with a little data scattering and the temperature ranges from about 7 eV to about 13 eV. The broad component in detachment could be qualitatively ascribed to the emissions from the charge–exchanged atoms around the shrunk core plasma. The difference in the broad component between attachment and detachment can be attributed to the significant differences in the divertor flux and the edge electron temperature[2].

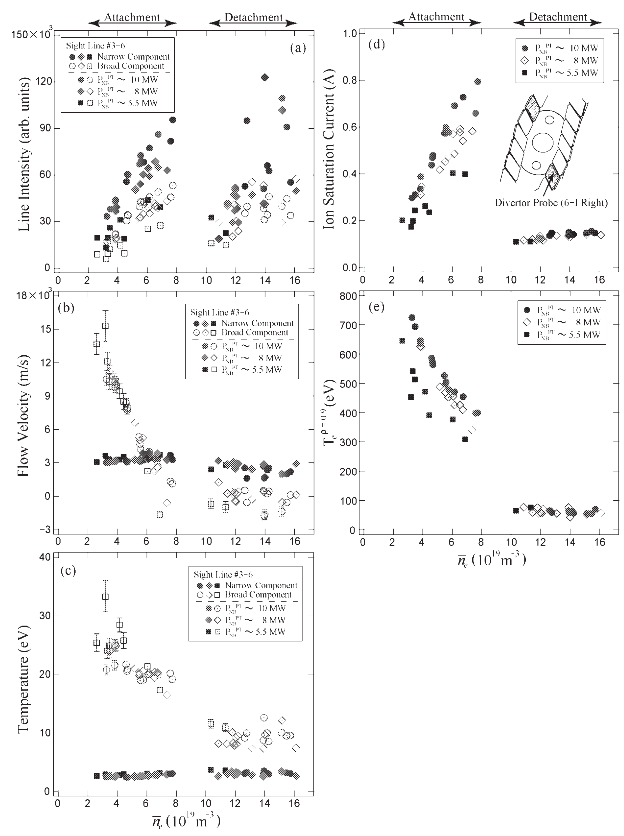

Fig. 2: $\overline{n}_e$ dependence of (a)Hα line intensity, (b)flow velocity, (c)temperature of the hydrogen atoms, (d)ion saturation current by divertor probe and (e)T$_e$ at $\rho = 0.9$ by Thomson scattering.

References
1) Miyazawa, J. *et al.* : Nuc. Fusion **46** (2006) 532–540.
2) Arimoto, H. *et al.* : submitted to J. Nuc. Mater.