§46. Measurement and Analysis of Visible Line Spectra with Inhomogeneous Spatial Distribution in LHD

Hisamichi, Y. (Grad. Univ. Adv. Stud.),
Morita, S., Goto, M.

Since the vacuum vessel of LHD has a three-dimensionally complicated structure in addition to the magnetic field structure with ergodic layer, the study of the neutral behavior becomes basically important. It is found from Zeeman spectroscopy that the intensity around the inboard-side X-point in R_{ax}=3.6m is much higher than other locations [1]. Since the line intensity is a function of T_e and n_e as well as the atomic density, the two parameters must be determined in order to evaluate the poloidal distribution of the neutral density. The parameter evaluation is therefore attempted using intensity ratios among three neutral helium lines. The inhomogeneous distribution of the visible lines is drastically changed when the magnetic configuration is shifted outwardly. The plasma parameters at the emission locations are determined for the inwardly and outwardly shifted magnetic configurations.

Figure 1(a) shows the vertical distribution of HI (656.3nm), HeI (667.8nm) and CIII (464.7nm) intensities observed from R_{ax}=3.6m configuration with helium discharge. Strong emissions are observed at z=0.38m for all the three lines. In addition, another peak also appears at z=0.5m and may arise from line-integral effect due to the relatively long line-of-sight along the plasma edge. These peaks also appear in R_{ax}=3.9m shown in Fig.1(b) but not outstanding.

The evaluation of T_e and n_e is attempted at each line-of-sight to investigate the contribution of these parameters to the formation of inhomogeneous poloidal distribution. A set of three HeI emissions is used for the parameter measurement. The intensity ratios of I(667.8nm)/I(728.1nm) and I(728.1nm)/I(706.5nm) are dominantly sensitive to n_e and T_e, respectively. We derive these intensity ratios from the observed spectra at z=0.38m (near the inboard-side X-point), -0.17m (near the outboard-side X-point; see ref. [1]) and -0.48m (at the bottom-side O-point). The parameters T_e and n_e at such emission locations can be thus determined from those ratios. A similar measurement is also done for the R_{ax}=3.9m configuration.

Results on T_e and n_e analyzed in R_{ax}=3.6 and 3.9m are listed in Tables 1 and 2, respectively. As a result, those parameters are approximately the same for both configurations. It is concluded that the poloidal inhomogeneity originates in the neutral particle density itself, but not in the electron density or temperature.

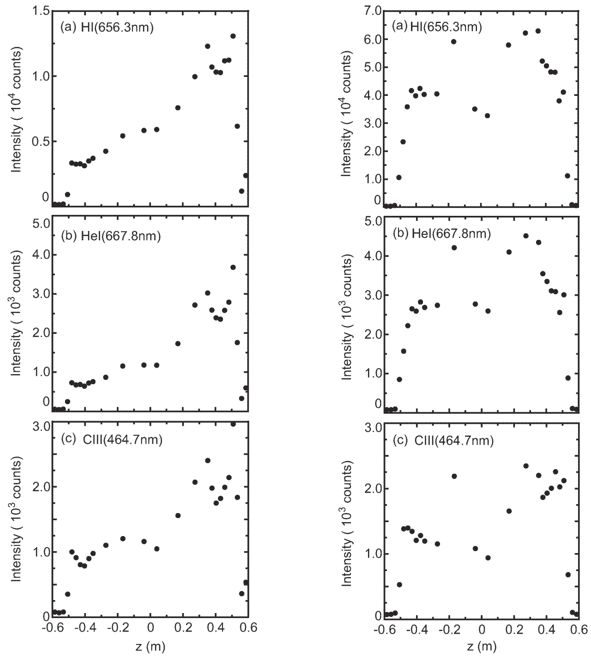

Fig.1 Poloidal distributions of H I, He I, C III in (a) R_{ax}=3.6m (left) and (b) R_{ax}=3.9m (right).

Table 1 T_e and n_e evaluated from the HeI ratio (R_{ax}=3.6m).

z	HeI ratio (I 728.1nm/I 706.5nm)	T_e (eV)	HeI ratio (I 667.8nm/I 728.1nm)	n_e ($10^{18}m^{-3}$)
(Inboard x-point) z=0.38m	0.43	60	1.94	1.8
(outboard x-point) z=-0.17m	0.43	50	3.01	4.2
(bottom O-point) z=-0.48m	0.58	75	3.11	5.0

z	HI ratio (I 656.3nm/I 434.1nm)	n_e ($10^{18}m^{-3}$)
(Inboard x-point) z=0.38m	32.6	2.8
(outboard x-point) z=-0.17m	33.1	3.0
(bottom O-point) z=-0.48m	42.7	5.0

Table 2 T_e and n_e evaluated from the HeI ratio (R_{ax}=3.9m).

z	HeI ratio (I 728.1nm/I 706.5nm)	T_e (eV)	HeI ratio (I 667.8nm/I 728.1nm)	n_e ($10^{18}m^{-3}$)
(Inboard x-point) z=0.38m	0.23	23	3.7	6.0
(outboard x-point) z=-0.17m	0.29	35	3.2	4.5
(bottom O-point) z=-0.41m	0.43	50	3.6	6.5

z	HI ratio (I 656.3nm/I 434.1nm)	n_e ($10^{18}m^{-3}$)
(Inboard x-point) z=0.38m	32.9	2.3
(outboard x-point) z=-0.17m	38.6	2.5
(bottom O-point) z=-0.41m	45.7	4.8

Reference

[1] M.Goto and S.Morita, Phys. Rev. **E65**, 026401 (2002).