§17. Measurements of Fine Spectral Profile of Hα in LHD Steady State Plasmas

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It is an important task to study the behavior of neutral hydrogen atoms in the edge plasma region for achieving a good confinement. Essential parameters of the neutral hydrogen atoms are their velocity distribution function and flow velocity. In this study, Hα line spectral profiles are measured with a high-resolution spectroscopic measurement system. The system consists of object optics, optical fiber bundle, an echelle grating spectrometer and a CCD detector. The achieved reciprocal linear dispersion of 0.0024 nm/pixel is confirmed by precise calibration experiments.

Figure 1 shows schematic drawings of the viewing chords and the measurement area. As shown in Fig. 1(a) and 1(b), three chords in the toroidal direction and ten in the poloidal direction are arranged at regular intervals. Any sets of seven chords are available for simultaneous measurements. The rectangle in Fig. 1(c) indicates the measurement area. Several viewing chords in the upper region can view inner divertor plates.

Since Hα emissions are mainly from the inboard side of the torus, a linear polarizer is inserted to measure only the Zeeman π component of the inboard emissions. Figure 2 shows the Hα line spectral profiles obtained at the viewing chord #2–9, which spots on an inner divertor plate, at the different magnetic field configuration. Figure 2(a) and 2(b) show the profiles measured at the magnetic axis position R_{ax}=3.60 m and 3.75 m, respectively. These profiles can be decomposed into two Gaussian components, a narrow and a broad component. The former represents the contributions of atoms produced by dissociations of molecules and molecular ions, and the latter represents the contributions of reflected atoms and atoms produced by charge exchange reactions. At R_{ax}=3.60 m, the central wavelength of each component shifts significantly toward the blue side and the profile of the total emission exhibits an asymmetric feature, while little shifts are observed at R_{ax}=3.75 m. At R_{ax}=3.60 m, 4.6×10^3 m/s and 1.8×10^4 m/s of the flow velocity are estimated corresponding to the shift of the central wavelength of the narrow and the broad component, respectively. There exist the hydrogen atoms which have the large velocity component along the viewing chords in consequence of the remarkably large shifts of the broad component. The divertor flux concentrates at the inboard side of the torus at R_{ax}=3.60 m [1]. Therefore, the asymmetric feature of Hα line spectral profiles at R_{ax}=3.60 m is ascribed to the contribution of the atoms reflected by the inner divertor plates.

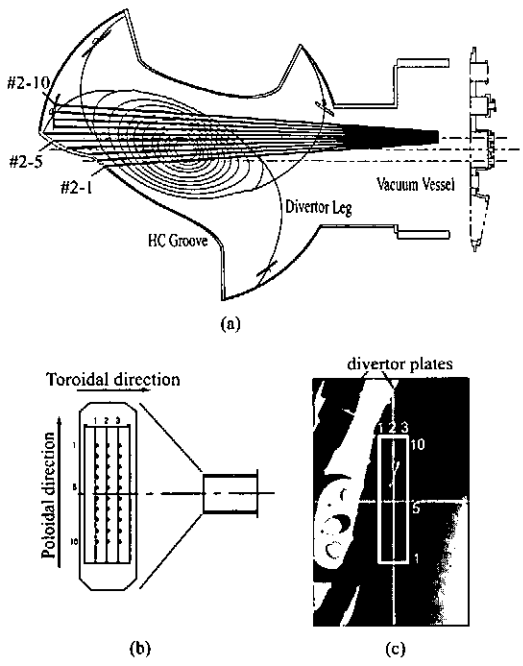

Fig. 1: Schematic drawings of the viewing chords and the measurement area. (a)The viewing chords projected on the poloidal cross section, (b)the 2-D imaging optical fiber array and (c)the view from the measurement port.

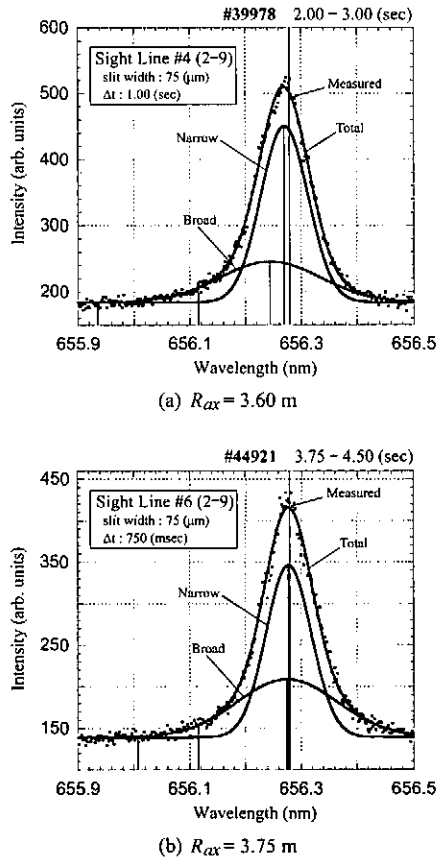

Fig. 2: Hα line spectral profiles obtained at magnetic axis position (a)R_{ax}=3.60 m and (b)R_{ax}=3.75 m. An asymmetric feature is observed at R_{ax}=3.60 m.

Reference

1) T. Morisaki *et al.*, Contirb. Plasma Phys. **42** (2002) 2–4 321