§36. Analysis of LHD Steady State Plasmas by Measuring Fine Structures of Hydrogen and Impurity Spectra

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It is of great importance for measuring of the velocity distributions of hydrogen and impurities near the wall for understanding the steady state plasmas in LHD. In order to estimate the velocity distributions of the edge neutral hydrogen, a high resolution spectroscopic system is constructed. The system is consisted of multi-channel fiber arrays, high resolution spectrometer with an echell grating, a back illuminated CCD detector and data processing computer. The fiber optics are able to observe 50 points simultaneously. The spatial resolution is 5 cm. The high resolution spectrometer has 1.2 m focal length and the available wavelength region is 500~700 nm. The grating has 56 × 128 mm ruled area, 31.6 grooves per mm and the blaze angle of 75 degrees. Hα line is observed by 37th orders. Figure 1 shows the optical layout of the high resolution spectrometer. A back-illuminated CCD detector is used for light detection. The effective area of the detector is 24.6 × 24.6 mm, and the element size is 24 × 24 μm. The inverse linear dispersion is 0.0018 nm/pixel. The Hα spectral components are calculated in the case of the magnetic field strength of 4 T. Figure 2 shows the spectral components from the transitions of 2^2P-3^2D, 2^2P-3^2S and 2^2S-3^2P. The horizontal axis is the pixel number of the detector. Figure 3 shows the same spectra but the neutral hydrogen temperature is assumed to be 1 eV. The central peak is π-component and the side peaks are σ-components. In this calculation the angle between the magnetic field lines and the sight line of the spectrometer is 90 degrees.

Figure 4 shows the shift of the Hα spectral line. The horizontal axis is the energy of the hydrogen atom and the vertical axis is the shift of the pixel number. Now the absolute wavelength calibration system is constructing using a hollow cathode lamp with permanent magnets of 1.2T.

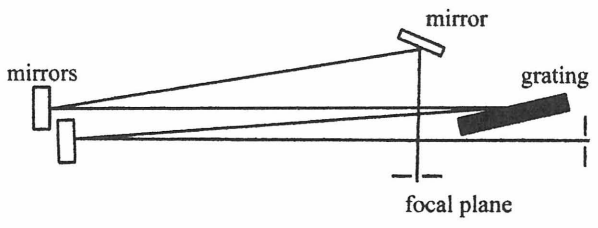

Fig. 1. Optical layout of the high resolution spectrometer with an echelle grating

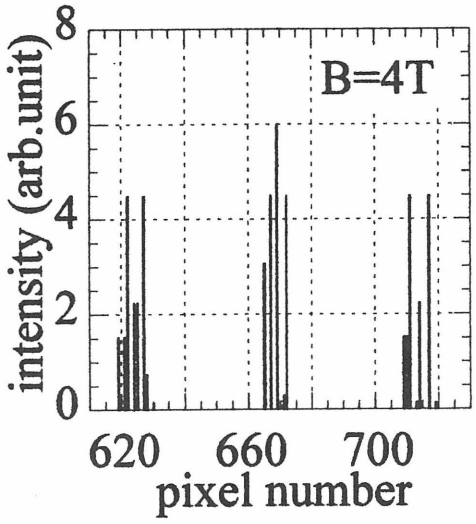

Fig.2. Spectral components of Hα line at B=4T

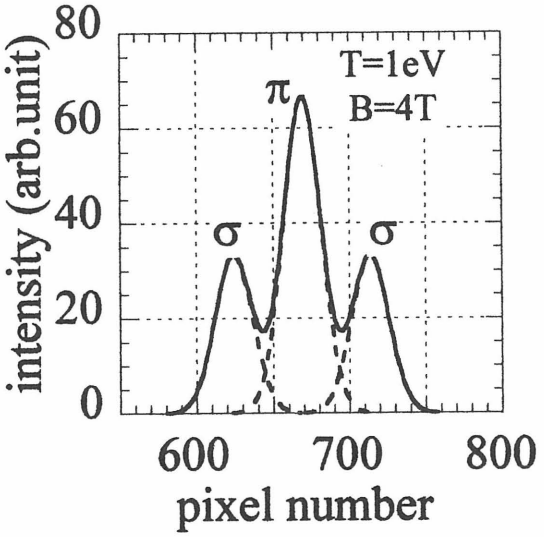

Fig.3. Spectral profile of Hα at B=4T and $T_{hydrogen}$=1eV

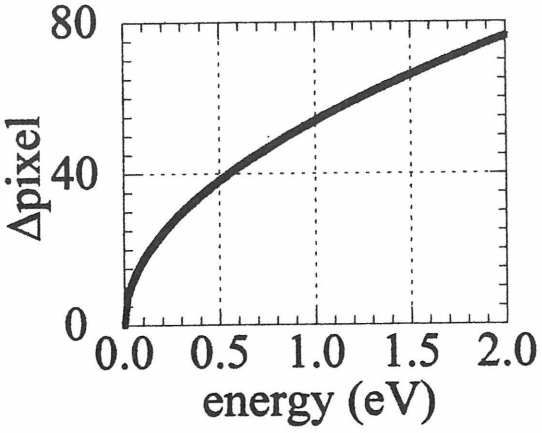

Fig.4. The shift of the pixel number and the hydrogen energy