

§37. 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 understanding the behavior of the hydrogen atoms near the plasma edge to improve plasma confinement. The most useful information is derived from the $H\alpha$ spectral profile. The shift of the central wavelength shows the velocity of the hydrogen atoms and the spectral shape can give the insight for the production processes. In order to measure spectral profile of the $H\alpha$, a high resolution spectroscopic system was constructed. It consists of an echell grating and a back-illuminated CCD detector. The spectral range is about 1.8 nm. Before installing the system to the LHD device, it needs the absolute calibration of the wavelength and dispersion. A spectral source with several line spectra distributed very closely is required for the calibration. A hollow cathode light source under the magnetic field of 1.13 T was constructed. Figure 1 shows the photo of the hollow cathode discharge system. The distance of the cathode plates is 7 mm and the anode is provided by two electrodes. The ratio of the hydrogen to deuterium density is controlled by gas valves. The operating pressure range is from 0.5 torr to 3 torr. The two line spectra of $H\alpha$ and $D\alpha$ are used for the calibration.

Figure 2 shows the spectrum of $H\alpha$ and $D\alpha$. The entrance slit width is 200 μm and integration time is 20 s. The obtained dispersion is 0.0022 nm/pixel. From this dispersion, the shift of the central wavelength can be measured less than 0.0022 nm, which means the resolution

of the velocity is 1.1×10^5 cm/s for hydrogen atoms. The spectral width is 20 pixels, which corresponds to 0.022 nm. The width of the entrance slit is same as the diameter of the fiber optics to guide $H\alpha$ from LHD plasma. If the light intensity is sufficiently large, the entrance slit width can narrow and the resolution will be improved.

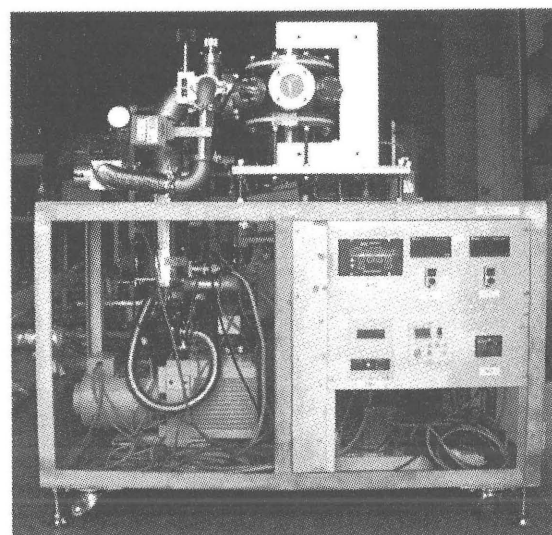


Fig.1 Hollow cathode discharge light source

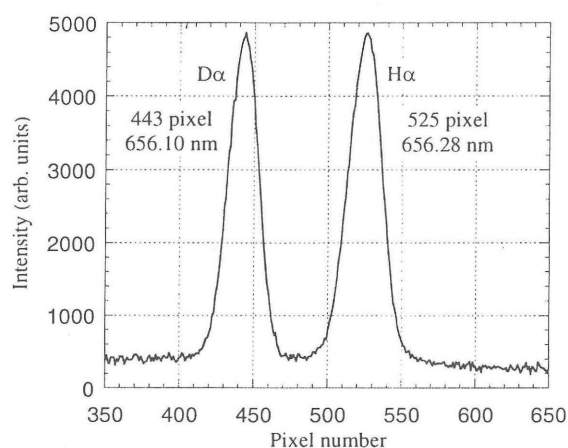


Fig.2 $H\alpha$ and $D\alpha$ spectrum by the hollow cathode discharge