§18. Study on Neutral Hydrogen and Impurity Behavior in Heliotron J Plasmas

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In order to investigate the velocity distribution function of deuterium atoms, which gives information about the recycling process, in the Heliotron J edge plasma region, spectral line shapes of Dα emitted in font of a carbon limiter have been measured with a high resolution spectrometer. Measured spectral profiles have an asymmetric structure and are decomposed into the broad and narrow Gaussian components. The central wavelengths of each component shift toward the blue side. The intensity distribution is similar to the footprint of the magnetic field lines on the limiter surface. The reflected atoms affects the intensity distribution of the broad component.

The D□ spectral profiles emitted in front of the carbon limiter are measured in 70 GHz ECH plasmas. The plasmas are produced in the standard configuration and pulse duration is 100 ms. The gas puffing is controlled to keep the electron density almost constant during the discharge. Figure 1 shows the Dα spectral profile measured from the top port. The spectral profile has an asymmetric structure and can be decomposed into three Gaussian components. Since deuterium atoms have two components, cold and warm, at the edge plasma region, it is necessary to consider the sum of two components. But as can be seen in the figure, the intensity of Ha line is smaller than that of Dα line and too weak to be treated as a composition of two components. In the Dα spectral profile, the central wavelengths of each component shift toward the blue side. The flow velocities corresponding to the shifts are 4.6×10^4 m/s and 6.2×10^3 m/s in the broad and narrow components, respectively. The errors caused by the fitting process are less than 1.8×10^3 m/s. The energy of clearly distinguished shoulder in the blue wing ranges from 26 eV to 147 eV. The half widths of the broad and narrow components are equal to the Doppler widths of deuterium atoms at the temperatures of 19.6 eV and 3.5 eV, respectively. It seems that the broad component is due to the emission from charge exchanged and reflected atoms and that the narrow component is due to the emission from dissociated atoms.

Most of the emission attributed to the reflected atoms is distributed in the blue side because the reflected atoms move away from the limiter surface and most of them move towards the spectrometer. Figure 2 shows the dependence of the intensity of the broad component on the edge electron density for the sightline #2-3, #2-5 and #2-8. The intensities increase with the edge electron density. The intensity measured at the sightline #2-5 has a maximum value and largest rate of increase. The sightline #2-5 is viewing strike points of the divertor legs. The connection length of the divertor legs is about 80 m. on the other hand, intensities of the sightline #2-3 and #2-8 have similar rate of increase. Sine the emission due to reflected atoms has a large contribution to the intensity of the broad component, it is our expectation that the broad component intensity will increase with the particle flux coming to the limiter surface. In the measurement, the edge electron temperature is almost constant (Teedge≈20 eV) with changes in the edge electron density. Thus incident energies of the deuterium ion flux caused by the sheath acceleration also remain constant. The ion flux estimated from the ion saturation current linearly increases with the edge electron density. In Fig.2, the intensities of the broad component are in propotion to the edge electron density. This result indicates that the intensity of the broad component is caused by an increase of the incident ion flux.

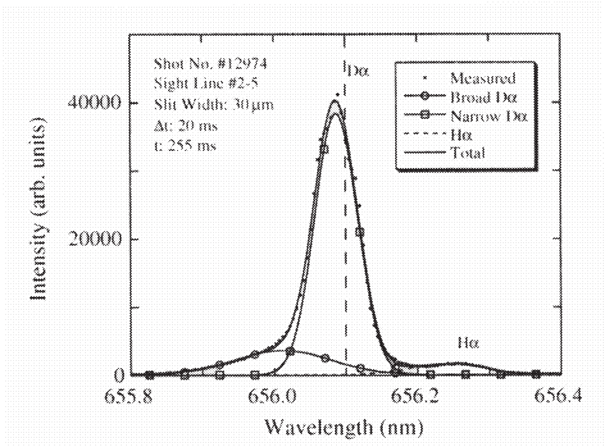

Fig.1 The Dα spectral profile emitted in front of the carbon limiter. The spectral profile has an asymmetric structure and can be decomposed into three Gaussian components. The Dα line is fitted a sum of two components, broad and narrow. The Hα line is fitted by a single component.

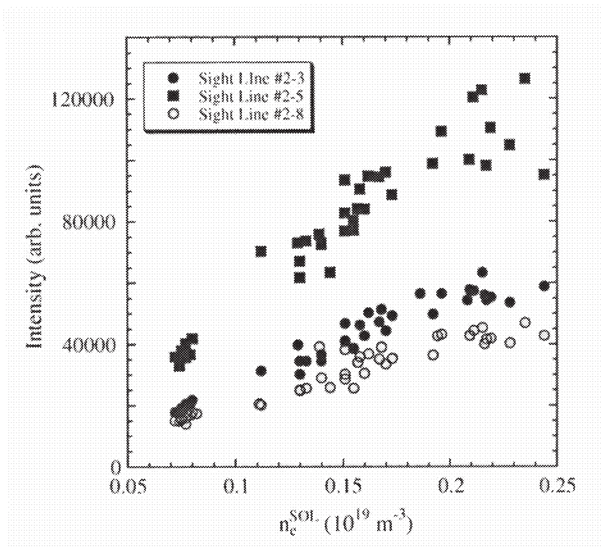

Fig.2 Dependence of the broad component intensity on the edge electron density for the sight lines＃2−3、＃2−5 and ＃２−８．

References
[1] H.Kawazome et al., J. Nucl. Mater. 337-339, 490 2005