§18. Study on Local Parameters within an Ablation Cloud by the Measurement of Stark Broadening of H_β Line

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In various experiments ice pellet injections have been widely carried out as on-axis injection. A pellet injection system with controllability of the injection angle has been developed and installed to the JIPP T-IIU tokamak, as a useful tool for the study of various fundamental properties of toroidal plasmas. This system makes it possible to carry out experiments with off-axis pellet injection.

Details of an ice pellet ablation structure within a hot plasma have been studied by using the injection-angle controllable system, CCD cameras and a high speed framing photograph. An interesting phenomenon, "a long helical tail of ablation light", has been observed, and has been confirmed to rotate to the electron diamagnetic direction poloidally and to the opposite to plasma current direction toroidally in most cases[1].

In the present report, detailed structures of the tail-shaped phenomena have been studied by using a new spectroscopic method.

Figure 1 shows an H_β line (4861.3 Å) profile of the ablation light obtained by the spectroscopy system. Since the time resolution in this particular case is 500 μsec, the obtained spectrum contains the information with wide range of time history during the pellet ablation. Therefore, the spectrum might be better to be fitted by a multiple Lorentzian function. From a double Lorentzian fitting shown in equation (1),

$$I = \frac{2.1 \times 10^4}{(4861.3 - \lambda)^2 + 5.0^2} + \frac{5.6 \times 10^4}{(4861.3 - \lambda)^2 + 30.0^2} \quad (1)$$

the FWHM of each component of the spectra is obtained to be 10.0 Å and 60.0 Å, and each of these corresponds to be about ne = 1.0×10^{16} and 1.0×10^{17} cm^{-3}, respectively. In this analysis, the double Lorentzian fitting has been found to be better than the single Lorentzian fitting, and the triple Lorentzian fitting has sometimes been identical with the double one, but sometimes been too marginal for the stable convergence of the fitting.

From ratios of values obtained by integrating a line spectra (4861.3 ± 100 Å) and those obtained by integrating continuum spectra from 4550.0 to 4650.0 Å (which is not influenced by H_β line), the electron temperature is estimated to be about 1 and 4 eV, respectively, for each component of the equation (1). These results on ne and Te are essentially the same as the results in TFTR[3], although both the pellet sizes and the volumes of the plasmas are different from each other.

The main error of spectral data depends on photon shot noises, and error bars are decided by the formula, $(\text{Intensity} / 40)^{1/2} \times 40$; here, 40 means the number of counts by photoelectrons when a gain level of an image intensifier is 8.5.

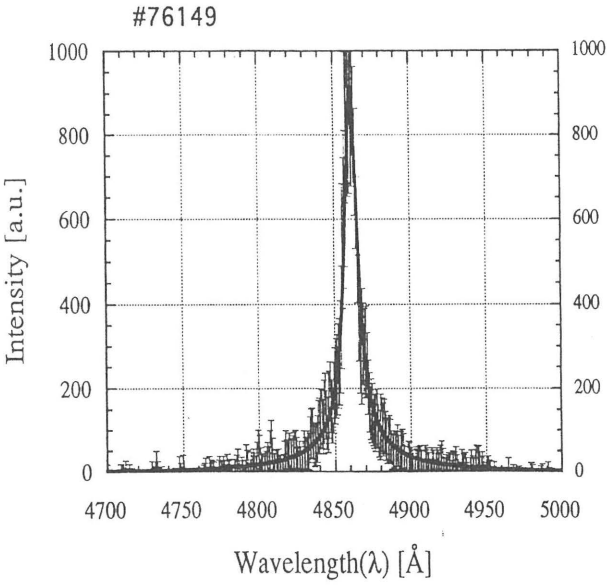

Fig.1. A typical example of H_β line (4861.3 Å) profile in an ablation cloud.

References
1) H. Sakakita et al, Proc. 22nd EPS Conf. on Controlled Fusion and Plasma Physics, (Bournemouth,1995) 19C, I-125.
2) H.R.Griem, Plasma Spectroscopy, (McGraw-Hill, 1964).
3) D.H. McNeill, Phys. Fluids B3 (1991) 1994.