§ 10. Measurement of Multiplet Transition Spectra for Light Elements

Kobuchi, T., Sato, K.

The line intensity ratio between multiplet lines is interested. So far, we have seen that this intensity distribution depends on $n_e$ and $T_e$. On OV, the dependence has been examined theoretically and experimentally. $I(1-2)/I(1-1)$ of OV 2s3s $^3S_1$ - 2s3p $^3P_{0,1,2}$ changes within the ratios 2-3 for $n_e=10^{10}$-$10^{14}$ cm$^{-3}$. In particular, since a transition between fine structure increases with $n_e$, it has been recognized that the population of fine structure depends on own statistical weight in high electron density conditions. Only few attempts have so far been made for other elements and ions. In order to use the relative line intensity between multiplet transitions for plasma diagnostics, a characteristic of intensity ratio needs to be investigated.

The triplet lines 2p3p $^3D_{1,2,3}$ - 2p3d $^3F_{2,3,4}$ of C-like oxygen are frequently observed in plasma diagnostics since they are strong and in the UV-Visible range. However, it is observed that these intensities have a singular distribution. In order to investigate the distinctive feature of this transition, we made an experiment using Test Plasma by Direct current discharge II (TPD-II).

Shown in Fig. 1 is the intensity distribution for 2p3p $^3D_{1,2,3}$ - 2p3d $^3F_{2,3,4}$ predicted by the statistical weight times transition probability ($g_j \times A_{ji}$) and the observed result (helium discharge mixed with O$_2$, $I_D$=100A, $B_e$=1.45kG). The line intensities are normalized by the strongest intensity line, $j-j'=3-4$. Agreement of intensity distribution between the experiment and the expectation has been confirmed in terms of $j-j'=2-3$ transition. However, the observed $j-j'=1-2$ transition line is different from the expected relative intensity and very weak.

The intensity distribution of other transitions on OIII has been observed with the same discharge condition. They agree with the expected distribution within the error of several percent. This suggests that the populations in multiplet levels are statistically populated. The population ratios of 2p3d $^3F_{2,3,4}$ of O$^{+2}$ have to agree with the ratios of statistical weights. The observed distinctive feature on 2p3p $^3D$-2p3d $^3F$ suggests that an extra atomic process affects the population of 2p3d $^3F_2$.

In order to investigate whether the similar phenomenon takes place in other light elements, spectra of the same transition in nitrogen have been observed. Since $j-j'=1-2$ and $j-j'=2-3$ of NII 2p3p $^3D$-2p3d $^3F$ are very close, the second order wavelength have been observed in order to separate these lines. The intensity distribution agrees with the expected ratios within the error of several percent. The observed anomalous intensity distribution in multiplet lines is limited in OIII 2p3p $^3D$-2p3d $^3F$ transition.