## §14. Non Equilibrium Intensity Distribution of Multiplet Transition in Carbon-like Oxygen Ion

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The impurity spectral lines are often measured and are used for plasma diagnostics in laboratory plasma. Especially, as a plasma diagnostics in fusion plasma, the spectral line measurement using intrinsic impurities in the plasma provides capabilities of the doppler ion temperature, plasma rotation, impurity density and transport measurements. Recently, a parameter dependence of the spectral line intensity ratio is a noticeable phenomenon for the plasma diagnostics. The characteristics of spectral line intensity distribution of the multiplet transition in impurity spectra are theoretically and experimentally studied, and comparison calculation results using the collisional-radiative model (CRM) with measurement results in the laboratory plasma has been reported.

Anomalous spectral line intensity distribution on the triplet transition 3p  $^{3}D_{1,2,3}$ -3d  $^{3}F^{o}_{2,3,4}$  in carbon-like oxygen ion has been observed. When we make use of assumptions, all J-sublevels of excitation states are populated according to their statistical weights, and the intensity is determined by the statistical weight times the radiative transition probability, the intensity ratio between the spectral line from the lowest J-sublevel to that from the highest J-sublevel becomes of 0.46. However, this intensity ratio experimentally measured is taken of under 0.03 as shown in Fig. 1. For the purpose of explaining the causation for this anomalous intensity distribution, the intensity distributions of other multiplet lines in carbon-like oxygen ion have been studied using the Test Plasma by Direct current discharge II device (TPD-II) mixing O<sub>2</sub> gas into He working gas. Especially, characteristics of spectral line intensity distribution on neighboring triplet transitions as shown in Fig. 2 have been studied.

In order to study a feeding of population to 3d  $^3F^\circ$  state, the spectra with 3d  $^3F^\circ$  state as lower excitation state in OIII, 3d  $^3F^\circ$ -4p  $^3D$ , have been measured. Figure 3(a) shows those spectra measured in the TPD-II plasma. The intensity of two spectral lines of J=3->4 and J=2->3 transition are consistent with one determined by the statistical weight times the radiative transition probability. However, the intensity of the spectrum of J=1->2 is about 40 % to a determined value, which shows that

feeding of population to J=2 state is low. Those results express that upper excitation states from 3d  $^3F^o$  also have the anomalous population distribution.

Figure 3(b) shows the spectra with 3p <sup>3</sup>D state as upper excitation state, 3s <sup>3</sup>P-3p <sup>3</sup>D. The intensities of the spectral lines from two higher J-sublevels are consistent within the difference under of 0.5 % to one estimated value. The intensity from the lowest J-sublevel is about 65 % of estimated value. Therefore, for the anomalous population distribution, the cascade from upper state is contribution factor.

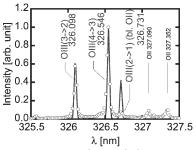


Fig.1 Triplet lines of 3p  $^{3}$ D-3d  $^{3}$ F $^{0}$  transition of O III measured with spectrometer system, (solid line) one determined by  $g_{i}$  times  $A_{ii}$ .

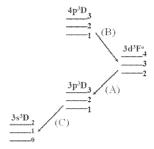


Fig.2 Grotrian diagram of triplet transition neighboring 3p <sup>3</sup>D-3d <sup>3</sup>F<sup>o</sup> transition in carbon-line ion

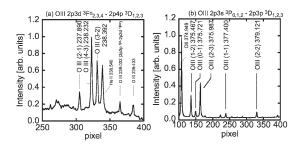


Fig.3 Spectral line intensity distribution of triplet transition with 3d <sup>3</sup>F state as lower state and 3p <sup>3</sup>D state as higher state in OIII measured in TPD-II