§ 3. Effect of Inner-Shell Ionization from B-like Oxygen Ions on OV Spectra Measured in LHD Plasma

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OV spectral lines were measured by VUV and UV-visible spectrometers in the LHD plasmas in the Third Cyle. We constructed a collisional-radiative model (CRM) for OV line intensities and compared calculated intensity ratios with the LHD measurements. The measured intensity ratio of the triplet transition 2s2p ^{3}P-2p^2 ^{3}P (75.8-76.2nm) to the resonance line 2s^2 ^{1}S-2s2p ^{1}P (63.0nm) in the steady state phase was always larger than 1 (i.e. the triplet transition was stronger than the resonance line). This large ratio was difficult to be explained by our model with ionizing component of Be-like ion and recombining component from Li-like ion for steady state phase [1].

The intensity ratio of these transitions for Be-like ions in ionizing plasma or ionization equilibrium plasma is usually smaller than 1 at least for Be-like C, O, Ne, and Fe ions, as calculated by CRMs, and the resonance line is stronger than the triplet transition. Some other mechanism is required to enhance the intensity of the triplet transition.

We then consider the effect of inner-shell ionization from B-like to Be-like oxygen ions, i.e. B-like 2s^{2}2p $\rightarrow$ Be-like 2s2p. Ionization from B-like excited states to Be-like excited states, for example, B-like 2s2p^2 $\rightarrow$ Be-like 2s2p, B-like 2s2p^2 $\rightarrow$ Be-like 2p^2, and B-like 2p^3 $\rightarrow$ Be-like 2p^2, also should be accounted for. These transition can enhance the population densities of 2s2p and 2p^2 levels of the Be-like ion.

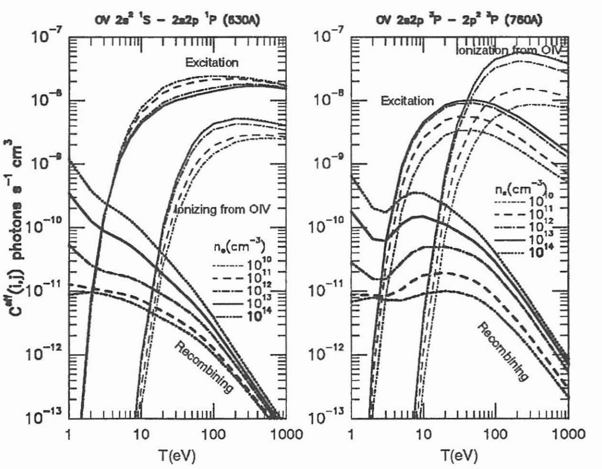

Figure 1: Line intensity coefficients for the resonance line (left) and the triplet transition (right). Excitation component, recombining component, and inner-shell ionization component are shown as a function of electron temperature.

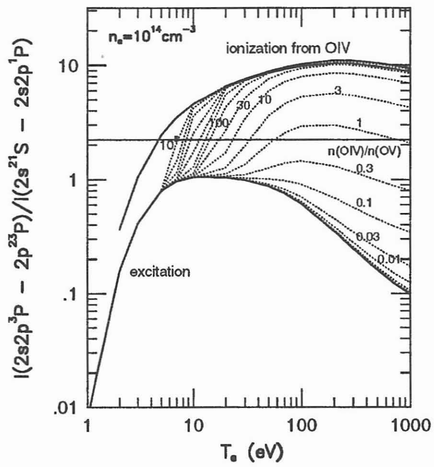

Figure 2: Calculated intensity ratio I(2s2p ^{3}P $-$ 2p^2 ^{3}P)/I(2s^2 ^{1}S $-$ 2s2p ^{1}P) for excitation component (lower solid line) and inner-shell ionization component (upper solid line) as a function of electron temperature. Dotted lines are calculated with fixed ion abundance ratio, n_B/n_1. Horizontal solid line at ratio=2.2 is averaged ratio from the LHD measurement at steady state phase [1].

The effect of such ionization is included into our CRM as the third component: the population density of Be-like excited state i is obtained as $n^{Be}(i) = N_I n_1 + N_R n_{Li} + N_S n_B$, where N_I, N_R, N_S are excitation component (usually called as ionizing plasma component), recombining plasma component, and inner-shell ionization component, respectively, and n_1, n_{Li}, and n_B are the ground state densities of Be-like, Li-like, and B-like ions, respectively.

The rate coefficients of ionization from B-like ion are calculated by Hullac code [2]. We also construct a CRM for B-like ion to get the population densities of the excited states. The atomic data necessary for the B-like CRM are also calculated by Hullac code. We take into account 2s^{2}2p, 2s2p^2, 2p^3, 2s^{2}3l, 2s^{2}4l, 2s2p3l states in the B-like CRM.

As Fig.1 shows the effect of inner-shell ionization on the triplet transition is significant at high temperature. Figure 2 indicates that the measured intensity ratio can be explained if we can determine the ion abundance ratio, n_B/n_1 or electron temperature. Information from OIV lines near the Be-like resonance line and the B-like CRM will help to determine the physical condition of the plasma.

References

[1] I. Murakami et al., J. Plasma Fusion Res. SERIES, **5** (2002) 171.
[2] A.Bar-Shalom et al., Phys. Rev. A **38**, 1773 (1988).