§10. Effect of Recombination Processes on Line Intensities of Be-like Ions

Murakami, I., Kato, T.
Moribayashi, K.(JAERI)
Safronova, U. (Institute of Spectroscopy, Russian Academy of Sciences, Russia)

We have constructed a collisional-radiative model (CRM) for Be-like ions to calculate the spectral line intensities in non equilibrium ionization plasma. In the CRM we take into account recombination processes from the ground state of a Li-like ion to the excited states of a Be-like ion as well as ionization process from the excited states of the Be-like ion [1,2].

The dielectronic recombination (DR)is an important process to determine the population densities in a low density and high temperature recombining plasma. We have calculated the DR rate coefficient to each excited state of Be-like ions with using the Cowan's code considering the doubly excited state $2pnl$ and $3ln'l'$ [3,4].

In the CRM we take into account many excited states: $2snl$ states with n up to 70 and $2pnl$ states which are below the ionization threshold (e.g. $n \leq 6$ for Ne^{6+}), because cascades from upper levels to lower levels are important for recombining plasma as well as high temperature ionizing plasma. Using the CRM we have calculated the population density of each excited state, the spectral line intensities, and the radiative power loss for Ne^{6+} and Fe^{22+}, especially for low temperature plasma. Figures 1 and 2 show the radiative power loss per electron per ion by line radiation (bound-bound transition) as a function of the electron density. The collisional excitation from the metastable state 2s2p ^{3}P is important for intermediate density region even for recombining plasma. This is one of the characteristics of Be-like ions. This effect is clearly seen in the power loss at low temperature for both Ne^{6+} and Fe^{22+} ions in Figs.1 and 2. The power loss is dominated by the resonance line, 2s^2 ^{1}S – 2s2p^{1}P, in ionizing plasma, but by $n = 2 - n'(n' \geq 3)$ transitions such as 2s2p^{3}P – 2s3d^{3}D in recombining plasma. In recombining plasma, the power loss by bound-bound transitions is larger than those of the DR satellite lines and free-bound transitions by radiative recombination. The radiative power loss in non equilibrium ionization plasma is then obtained as a combination of two plasma components: $\{P_{loss}(\text{ionizing})n(\text{Be-like}) + P_{loss}(\text{recombining})n(\text{Li-like})\}n_e$.

We have also examined the effect of the radiative recombination process from the excited state, 2p^{2}P, of Li-like Fe ions to the 2pnl states of Be-like Fe ions, assuming arbitrary population densities of the state 2p^{2}P. Preliminary results show that the population density of $2pnl$ states are enhanced significantly by this process. This indicates necessity to take into account the DR process from the excited state as well. Because, the DR rate coefficients from the 2p^{2}P state becomes larger than that from the ground state of the Li-like ions at higher temperature [5].

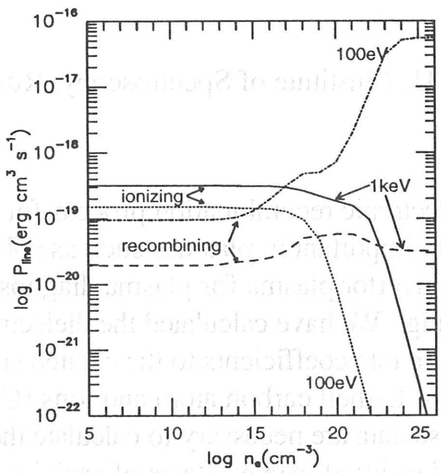

Figure 1: Radiative power loss per electron per ion for Be-like Fe ion as a function of then electron density. Ionizing plasma component and recombining plasma component are shown.

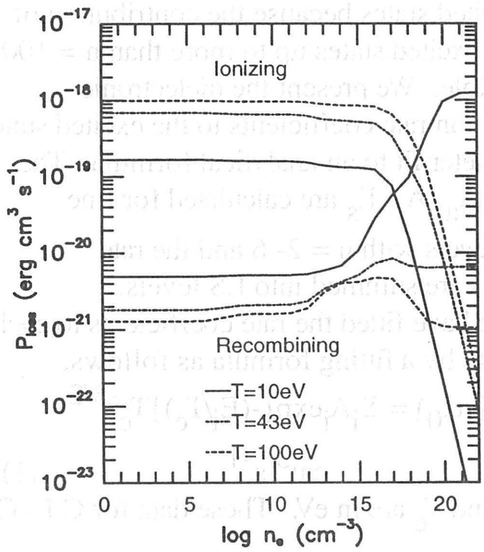

Figure 2: The radiative power loss per electron per ion for Be-like Ne ion as a function of then electron density.

References
1) Murakami, I. and Kato, T., Physica Scripta 54 (1996) 463.
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3) Moribayashi, K. and Kato, T., NIFS-DATA-41 (1997)
4) Murakami, I., Kato, T., and Safronova, U., in preparation.
5) Chen, M.H., Phys. Rev. A, 44 (1991) 4215.