§15. Dielectronic Recombination Rate Coefficients to Excited States of Carbonlike Oxygen and Dielectronic Satellite Lines

Safronova, U.I. (Univ. of Nevada, Reno, USA)
Ralchenko, Yu (NIST, USA)
Murakami, I., Kato, T., Kato, D.

Energy levels, radiative transition probabilities, and autoionization rates for C-like oxygen (O^{2+}) including $1s^2\ 2s^2\ 2pnl$, $1s^2\ 2s2p^2\ nl$, and $1s^2\ 2p^3\ nl$ (n= 2-8, $l \leqq$ n-1) states are calculated by the Hartree-Fock-Relativistic method (Cowan code), Autoionizing levels above the thresholds $1s^2\ 2s^2\ 2p\ ^2P$, $1s^2\ 2s2p^2\ ^4P$, ^2S, ^2S, ^2P, and $1s^2\ 2p^3\ ^4S$, ^2D are considered. Configuration mixing $2s^2\ 2pnl + 2p^3\ nl$ plays an important role for all atomic characteristics. Branching ratios relative to the first threshold and intensity factors are calculated for satellite lines, and dielectronic recombination rate coefficients are presented for the excited 218 odd-parity and 218 even-parity states. The dielectronic recombination (DR) rate coefficients are calculated including 1s2 2s2 2pnl, $1s^2\ 2s2p^2\ nl$, estimated by extrapolation of all atomic characteristics to derive the total DR rate coefficient. It is found that the orbital angular momentum quantum number l distribution of the rate coefficients shows a peak at l=4. The total DR rate coefficient is derived as a function of electron temperature. The state-selective DR rate coefficients to excited states of C-like oxygen, which are useful for modeling O III spectral lines in a recombining plasma, are calculated as well.

Dielectronic recombination from O^{3+} to the excited states of O^{2+} is defined by the following sequence of processes:

$O^{3+}(2s^22p) + e \text{ ----> } O^{2+}(2s2p^2nl_1 + 2p^3nl_2)$

$\text{---> } O^{2+}(2s^22pnl+2s2p^3+2p^4+2s2p^23l)+h\nu.$

As an initial state we consider the ground state of O^{3+}, $2s^22p$. The doubly excited states, $2s2p^2nl$ and $2p^3nl$, are taken into account as intermediate states.

The DR rate coefficients $\alpha(\gamma' \mid \alpha_0)$ to the excited state of O^{2+} are obtained by summing up the intensity factor $Q_d(\gamma,\gamma' \mid \alpha_0)$ multiplied by the exponential factor, over the autoionization levels γ as follows:

$$\alpha_d(\gamma' \mid \alpha_0) = 3.3\times10^{-24}\left(\frac{I_H}{T_e}\right)^{3/2}\sum_{\gamma} e^{-\frac{Es}{Te}} Q_d(\gamma,\gamma' \mid \alpha_0)/g(\alpha_0)$$

where

$$Q_d(\gamma,\gamma' \mid \alpha_0) = g_\gamma A_r(\gamma,\gamma')K(\gamma,\alpha_0),$$

$$K(\gamma,\alpha_0) = \frac{A_a(\gamma,\alpha_0)}{(A_r(\gamma)+A_a(\gamma)},$$

$$A_r(\gamma) = \sum_{\gamma} A_r(\gamma,\gamma'),$$

$$A_a(\gamma) = \sum_{\alpha'} A_a(\gamma,\alpha').$$

Here $A_r(\gamma,\gamma')$ are radiative transition probabilities and $A_a(\gamma, \alpha_0)$ are autoionization rates.

The total DR rate coefficient is obtained by summation of the rate coefficients of DR processes through all possible intermediate singly and doubly excited states. For the total DR rate coefficient we need to consider contribution from doubly excited states $2p^3nl$ with high n levels and also the contribution from singly excited states with high n, $2s^2\ 2p\ nl$ states.

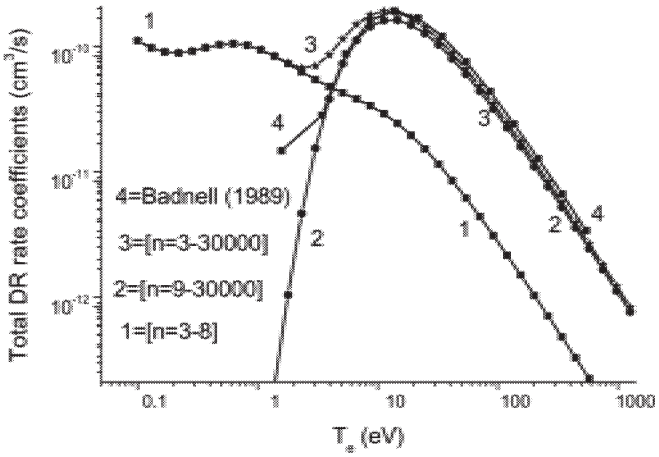

Fig.1 Total DR rate coefficient as a function of electron temperature (no. 3), compared with rate coefficient obtained by Badnell and Pindzola [1] (no.4). Line with no. 2 is the sum of the state selective DR rate coefficients with $2s^22pnl$ – $2s2p^2\ nl$ transitions, which agrees with the result of Badnell and Pindzola.

References

1) N. R. Badnell and M. S. Pindzola, Phys. Rev. **39**, 1685 (1989).