§2. Dielectronic Recombination Rate Coefficients to the Excited States of C I from C II

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In order to estimate the line emission of carbon atom in a plasma, we have to know the population of the excited states. The populations of the excited states are determined mainly by the excitation from the ground state and the recombination from the ions in low density plasmas. In the case of a recombining plasma, the recombination to each excited state is necessary to estimate the line emissions. These data are also necessary to obtain the effective recombination rate coefficients at high electron densities. The effective ionization and recombination rate coefficients are important to determine the ion abundances in high density plasmas. There are several calculations of the total dielectronic recombination from C II to C I, but there are no data for the excited states. In this paper we calculate the dielectronic recombination rate coefficients to the excited states of carbon atom with AUTOLSJ method by Dubau et al [1].

We have considered the following transitions as the dielectronic recombination processes.

a) α_d ($1s^2\ 2s^2\ 2p^2$ (^{3}P, ^{1}S, ^{1}D))

The main dielectronic recombination process to the ground configuration levels is,

$2s^2\ 2p\ (^2P) + e \rightarrow 2s\ 2p^2\ np\ (^{2S+1}L)$

$2s\ 2p^2\ np\ (^{2S+1}L) \rightarrow 2s^2\ 2p^2\ (^{2S+1}L')$.

b) α_d ($1s^2\ 2s\ 2p^3$ ($^{2S+1}$L))

The main dielectronic recombination process to the $2s\ 2p^3$ excited states is,

$2s^2\ 2p\ (^2P) + e \rightarrow 2s\ 2p^2\ ns, nd\ (^{2S+1}L)$

$2s\ 2p^2\ ns, nd\ (^{2S+1}L) \rightarrow 2s\ 2p^3\ (^{2S+1}L')$.

c) α_d ($1s^2\ 2s^2\ 2pnl$ ($^{2S+1}$L))

The dielectronic recombination process to the $2s^2\ 2pnl$ excited states is,

$2s^2\ 2p + e \rightarrow 2s\ 2p^2\ nl(\ ^{2S+1}L)$

$2s\ 2p^2\ nl\ (\ ^{2S+1}L) \rightarrow 2s^2\ 2pnl\ (\ ^{2S+1}L')$.

With the use of the atomic data of dielectronic recombination processes (energy levels, radiative transition probability and autoionization rate) for the levels with the principal quantum number n = 2 and 3 of C I, the dielectronic recombination rate coefficients from C II ($2s^2\ 2p$) to the excited states are calculated. Some of the result are shown in Fig.1. The rate coefficients are fitted to an analytical formula and the fit parameters are given. The values for higher excited states than n = 3 are extrapolated and the total dielectronic recombination rate coefficient are derived[2].

We have derived the effective recombination rate coefficients as a function of the electron density and the electron temperature by a collisional radiative model of carbon atom including the sub-levels up to the principal quantum number n = 4 using our new data.

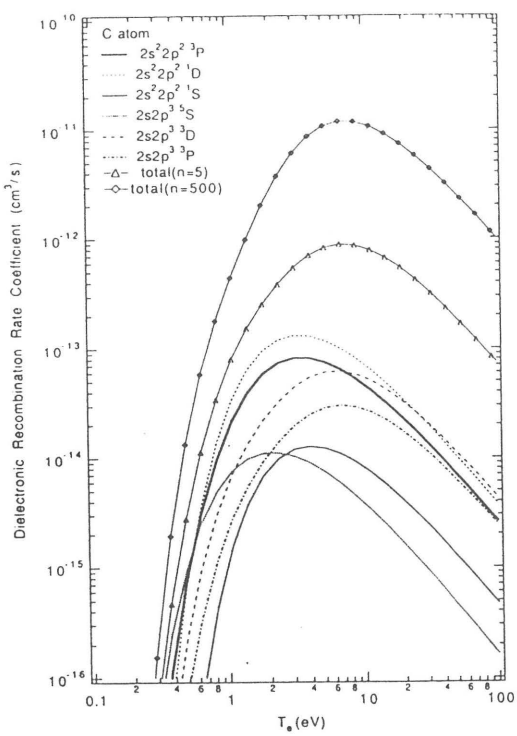

Fig. 1 The dielectronic recombination rate coefficients to excited states of C I.

Reference
1) J. Dubau et al, Mon. Not. R. Astron. Soc. 195, 705(1981)
2) J. Dubau and T. Kato, NIFS-DATA (1994)