View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by National Institute for Fusion Science (NIFS-Repository)

§20. Dielectronic Recombination Rate Coefficients to Excited States of Na-like Fe and Dielectronic Satellite Lines

Murakami, I., Kato, T.,
Safronova, U.I. (Univ. of Nevada, Reno, USA)

Energy levels, radiative transition probabilities, and autoionization rates for Na-like Fe (Fe^{15+}) including $1s^2$ $2s^2$ $2p^5$ $3l'nl$, and $1s^2$ $2s2p^6$ $3l'nl$ (n= 3-8, $l \le n-1$) states are calculated by the Hartree-Fock-Relativistic method (Cowan code). Autoionizing levels above the thresholds $1s^2$ $2s^2$ $2p^5$ $3l$ (l=s, p, d) are considered. Branching ratios relative to the first threshold and intensity factors are calculated for satellite lines, and dielectronic recombination (DR) rate coefficients are obtained for the excited states. It is found that the contribution of the highly excited states is important for the DR rates. The contributions from the excited $1s^2 2s^2 2p^5 3l'nl$ states with $n \ge 9$ to the DR rate coefficients are estimated by extrapolation of all atomic characteristics. The total DR rate coefficient is derived as a function of electron temperature. The state-selective DR rate coefficients to excited states of Na-like Fe, which are useful for modeling Fe XVI spectral lines in a recombining plasma, are calculated as well.

Dielectronic recombination from Fe^{16+} to the excited states of Fe^{15+} is defined by the following sequence of processes:

Fe^{16+} $(2s^2 2p^6)$ + e

----> Fe^{15+} $(2s^2 2p^5 3l n_1 l_1 + 2s2p^6 3l n_2 l_2)$

----> Fe^{15+} $(2s^2 2p^6 3l) + h\nu$.

As the initial state we consider the ground state of Fe^{16+}, $2s^2 2p^6$. The doubly excited states, $2s^2 2p^5 3l n_1 l_1$ ($n_1 \ge 3$) and $2s2p^6 3l n_2 l_2$ ($n_2 \ge 3$) are taken into account as autoionizing intermediate states.

The DR rate coefficients $\alpha(j, i_0)$ to the excited state of Fe^{15+} are obtained by summing up the intensity factor Q_d (j, i, i_0) multiplied by the exponential factor, over the autoionizing levels i as follows:

$$\alpha_d(j,i_0) = 3.3\times 10^{-24}\left(\frac{I_H}{T_e}\right)^{3/2}\sum_i e^{-\frac{Es_i}{Te}} Q_d(j,i,i_0)/g(i_0)$$

where

$$Q_d(j,i,i_0) = g_i A_r(i,j) K(i,i_0),$$

$$K(i,i_0) = \frac{A_a(i,i_0)}{A_r(i) + A_a(i)},$$

$$A_r(i) = \sum_k A_r(k,i), \text{ and}$$

$$A_a(i) = \sum_{i0'} A_a(i,i_0').$$

Here $A_r(k,\ i)$ are radiative transition probabilities, $A_a(i,\ i_0)$ are autoionization rates, and $Es(i)$ is the level energy of autoionizing level i measured from the first ionization threshold.

The total DR rate coefficient is obtained by the summation of the rate coefficients of DR processes through all possible intermediate states (Fig.1). Our results are compared with other results and agree well with recent results. Jacobs et al.

Obtained state-selective DR rate coefficients of low excited states are compared with results of other previous calculations and agree well.

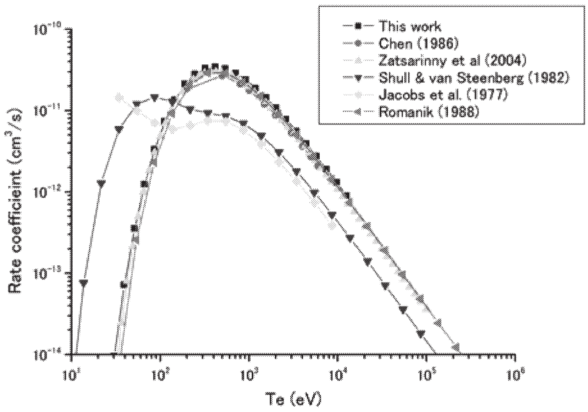

Fig.1 Total DR rate coefficient as a function of electron temperature. Squares are present results and other symbols are other theoretical results with different methods.