

NATIONAL INSTITUTE FOR FUSION SCIENCE**Dielectronic Recombination Rate Coefficients to
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Dielectronic Recombination Rate Coefficients to the Excited States of CIII from CIV

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Abstract.

Energy levels, radiative transition probabilities and autoionization rates for CIII including $1s^2 2pnl'$ ($n=2\div 6$, $l'\leq(n-1)$) and $1s^2 3lnl'$ ($n=3\div 6$, $l'\leq(n-1)$) states were calculated by using multi-configurational Hartree-Fock (Cowan code) method. Autoionizing levels above the $1s^2 2s$ and $1s^2 2p$ thresholds were considered and their contributions were computed. Branching ratios on the autoionization rate to the first threshold and intensity factor were calculated for satellite lines of CIII ion.

The dielectronic recombination rate coefficients to the excited states for $n=2-6$ were calculated. The values for the excited states higher than $n=6$ were extrapolated and the total dielectronic recombination rate coefficients were also derived. The rate coefficients to the excited states were fitted to an analytical formula and the fitting parameters are given.

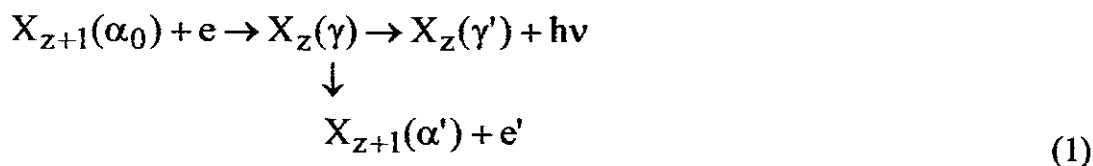
Key words;

autoionizing level, dielectronic recombination rate coefficient, carbon ion, excited states, autoionization rate, radiative transition probabilities, satellite spectra.

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1. Introduction

Dielectronic recombination (DR) is defined by the following sequence of processes [1]:



Here γ is the autoionizing state of an ion X_z , $\alpha' = \alpha_c n l S J$ is the stationary state of an ion X_{z+1} , z is the degree of ionization. The first step is a free electron collisional capture into a doubly excited state γ and the second step is either radiative or non-radiative autoionizing stabilization. In many papers [2-23] the $\Delta n_i = 0$ electron - capture processes were considered, as $\alpha_0 = 1s^2 2s^k 2p^m$, $\gamma = 1s^2 2s^k 1^2 p^{m+1} n l$, $\gamma' = 1s^2 2s^k 2p^m n l$, $\alpha' = 1s^2 2s^k 2p^m [LSJ]$, where LSJ as usual describe the quantum numbers for the ground state. In this case we have the 2s electron excited to 2p while a continuum electron is captured to a high Rydberg state $n l$. Since a large number of these states ($n \leq 500$, $l \leq 10$) can be involved, special care is required to estimate their contribution. Namely this problem was solved for ions with different k , m and Z by different methods in [2-21].

In a series of papers of Nussbaumer and Storey [2-5] the total and effective dielectronic recombination rate coefficients were calculated for ions of C, N, O and Ne. The following configuration bases (γ) were chosen for different isoelectronic systems:

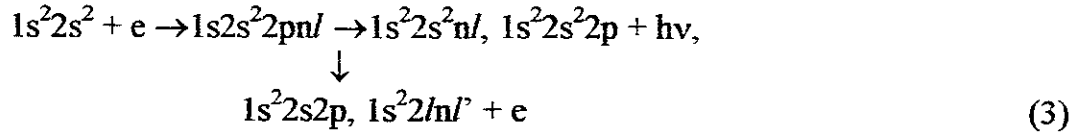
$$\begin{array}{ll}
 \text{B-like: } 1s^2 2s^2 n l, 1s^2 2s 2p n l, 1s^2 2p^2 n l & \text{with } 2 \leq n \leq 6, l \leq 4, \\
 \text{C-like: } 1s^2 2s^2 2p n l, 1s^2 2s 2p^2 n l, 1s^2 2p^3 n l & \text{with } 2 \leq n \leq 5, l \leq 4, \\
 \text{N-like: } 1s^2 2s^2 2p^2 n l, 1s^2 2s 2p^3 n l, 1s^2 2p^4 n l & \text{with } 2 \leq n \leq 7, l \leq 3, \\
 \text{O-like: } 1s^2 2s^2 2p^3 n l, 1s^2 2s 2p^4 n l, 1s^2 2p^5 n l & \text{with } 2 \leq n \leq 5, l \leq 4
 \end{array} \quad (2)$$

Energies and radiative transition probabilities between these states were calculated in [2] by SUPERSTRUCTURE code. The accuracy of the obtained data is not so high and were not recommended for use of identifying spectral features [3,4]. To calculate the autoionization probabilities collision strengths were used. These data were obtained in the distorted wave approximation. Total dielectronic recombination coefficients were given in [3] for ions C^+ , C^{2+} , C^{3+} , N^{3+} , N^{4+} , O^{2+} , O^{3+} , O^{4+} and O^{5+} over the temperature range of $T=10^3K - 6 \times 10^4K$ in fitted formulas. Effective dielectronic recombination coefficients were calculated in [4] for selected lines and ground and metastable terms of these ions. Their data were also fitted in the range $10^3 - 6 \times 10^4K$. The same method was used in [5] for calculation of effective dielectronic recombination coefficients for selected lines and ground and metastable terms of ions Ne^{2+} , Ne^{3+} , Ne^{4+} , Ne^{5+} , Ne^{6+} .

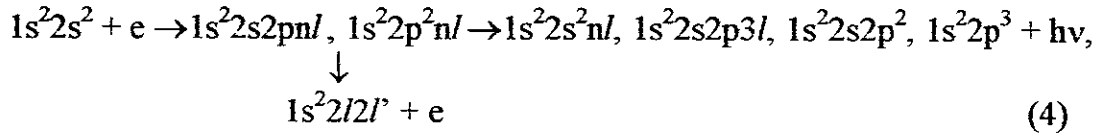
In a series of papers, Badnell [6-9] and Badnell and Pindzola [10] studied the influence of core fine-structure interaction on dielectronic recombination at low temperatures for the same ions as Nussbaumer and Storey [2-5]. The dielectronic rate coefficient were computed for Be-like ions with $Z=6-42$. The code SUPERSTRUCTURE which was used in [2-5] gives the radiative transition probabilities. From this code the code AUTOSTRUCTURE which also calculated configuration-mixing LS-coupling or intermediate - coupling autoionization rates was developed by Badnell [6-10]. In a paper by Badnell [8] the detailed comparison for B-like C, N and O with data obtained by Nussbaumer and Storey [4] was given. The effective dielectronic recombination rate coefficients agree within 10-20% with those of Nussbaumer and Storey [4] except for some lines. The disagreement (a factor of 6) for these lines was explained in [8] by the different values of autoionization rates used in [4] and [8]. The Be- and B-like Fe ions were considered in [6]. Dielectronic recombination rate coefficients for Fe^{22+} and Fe^{23+} were calculated in [6] by the code AUTOSTRUCTURE using a

multiconfiguration LS-coupling expansion and allowing the $\Delta n_i=0$ and $\Delta n_i=1$ autoionizing transition into the excited states. For Be-like target the following 1-2 and 2-3 core transitions except for 2-2 transitions discussed above were considered in [6].

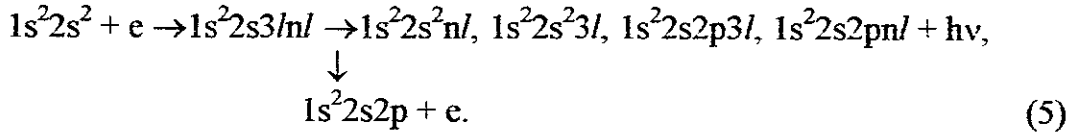
1-2 core transitions:



2-2 core transitions:



2-3 core transitions:



DR rate coefficients were calculated separately for each value of n up to $n=5$ ($l=0, 1, 2$); and for $n>5$ the sum over n was made using the n^{-3} asymptotic dependence of the autoionization rate (A_a). These configurations were used in [7] for calculations of the total dielectronic rate coefficient for the ground state of sixteen Be-like ions (C^{2+} , N^{3+} , O^{4+} , Ne^{6+} , Mg^{8+} , Si^{10+} , S^{12+} , Ar^{14+} , Ca^{16+} , Ti^{18+} , Cr^{20+} , Fe^{22+} , Ni^{24+} , Zn^{30+} , Mo^{38+}). The contribution of three core transitions (eqs.(3-5)) was different for different ions in the range of Z (C^{2+} - Mo^{38+}). Comparison with experimental measurements of dielectronic recombination cross sections for N^{2+} , O^{3+} and F^4 ions was given by Badnell and Pindzola [10].

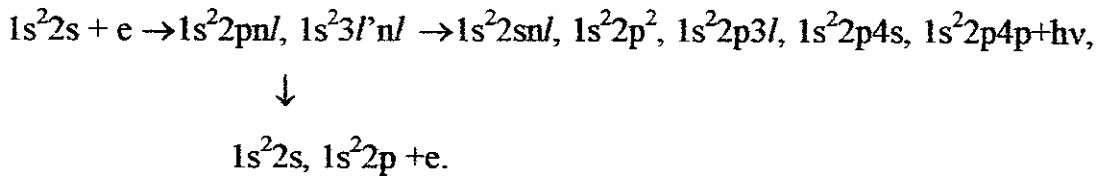
Theory of dielectronic recombination was given in two reviews [11, 14] by Hahn. It was underlined in [11] that complete calculation of DR rate coefficients for a given isoelectronic sequence is often lengthy, due to multi-step nature of the

DR process. Free-electron capture to a doubly excited intermediate states has to be incorporated. Further complications arise when these states decay to final states which are themselves unstable against further autoionization and radiative decays (i.e. cascade effect). As a result, only a limited number of ions have been treated theoretically, and various semiempirical formulas are employed in practical applications. And B-like ions were studied by Ramadan and Hahn [13] by using a different code from those in [3] and [8]. It employed the single-configuration, nonrelativistic Hartree-Fock wave functions and LS coupling in evaluating the necessary amplitudes. The Bethe approximation was used for calculation of autoionizing rates in [13]. By this approximation a radial integral with four radial functions can be factorized for two independent radial integrals. From our point of view this procedure does not work for many radial integrals. They [13] used non-relativistic Hartree-Fock functions for high Z ions with $Z=18$ and $Z=26$ for which relativistic effect is important. The DR rate coefficients were calculated with the same nonrelativistic single-configuration code of Froese-Fisher for the Li-like ions O^{5+} , Ar^{15+} , Fe^{23+} and Mo^{39+} in [12]. And A_a values were evaluated in the distorted-wave Born approximation and the continuum wave function was calculated with Hartree-Fock direct and explicit nonlocal exchanging potentials. The calculation of the DR rate coefficients of Ne^{7+} , Ar^{15+} , Fe^{23+} , Kr^{33+} , O^{5+} and O^{2+} was reported by Rosman [15, 16] and was used a non-relativistic, single configuration, LS-coupled, frozen-core atomic structure model in which the continuum orbitals were computed in a distorted wave approximation. The DR rate coefficients for ions in the He, Li, Be and Ne isoelectronic sequences of astrophysically abundant elements (C, N, O, Ne, Mg, Si, S, Ar, Ca, Fe, Ni) were calculated by Romanik [17]. Many approximations were made in order to give the total DR rate coefficients for so many ions: the autoionization rate A_a was obtained from the threshold value of the partial electron-impact excitation cross section; energy levels were extrapolated along

isoelectronic sequence; oscillator strengths were interpolated or obtained from Coulomb-Born calculations using Bates-Damgaard wavefunction; LS coupling for the recombining ion and average over the coupling of the captured electron.

The DR rates coefficients to the excited states of C atom for C⁺ target ion were computed by Dubau and Kato in [18] by AUTOLSJ code which was developed on the base of SUPERSTRUCTURE code by Dubau [19]. Data on the rate coefficients for the recombination of SXV, CaXX and FeXXV ions were reviewed in [20] to recommend a comprehensive set of values. All the recommended rate coefficients were expressed in an analytical form of the electron temperature [20].

In the present paper we renew data for Li like C obtained by Nussbaumer and Storey [4] and Badnell [9]. We used the Cowan code [22] which gives more accurate data for energy than SUPERSTRUCTURE code used in [4] and [9]. Probably the Cowan code gives data for autoionization rates of the same accuracy than AUTOSTRUCTURE code [9] (we could not compare results for autoionization rates since their data were not given in [4] and [9]). We included the following transitions up to n=6 .



(6)

We calculated the DR rate coefficient for the excited states of CIII and the total DR rate coefficient taking into account contribution from configurations with $6 < n < 500$ using scaling formula. The importance of these contributions for DR rate coefficients was pointed out by Kato et al [21]. We show the contribution of each n to the total DR coefficient. Our $\alpha_d(\text{total})$ data are compared with results in [4] and [9].

2. Energy levels, radiative widths and autoionization rates

We carried out detailed calculations of radiative and autoionization rates for the intermediate states $1s^2 2snl$, $1s^2 2pnl$ ($n=2-6$, $l = 0-(n-1)$) and $1s^2 3snl$, $1s^2 3pnl$, $1s^2 3dnl$ ($n=3-6$, $l = 0-(n-1)$). The atomic energy levels and bound-state wave functions were obtained by using the atomic structure code of Cowan [22]. The perturbation theory method (MZ code) was also used for calculation energy and radiative transition probabilities. This method was in detail described in [23, 24].

Table Ia lists data for the energy and radiative rates for $1s^2 2lnl$ (LSJ) states Be-like carbon ion under the first threshold ($I = 386213.9\text{cm}^{-1}$). Theoretical results for energy obtained by two codes, Cowan and MZ, are compared with recommended data from [25]. We can see that perturbation theory method (MZ code) gives data which agree better with [25] than scaled multiconfiguration Hartree-Fock method (Cowan code). This conclusion is right for $1s^2 2snl$ (LSJ) and $1s^2 2p3l$ (LSJ) levels. The agreement is not good for $1s^2 2p4l$ (LSJ) levels. Sometimes ($2p4s\ ^3P_J$, for example) all three results disagree in 10000cm^{-1} . Probably, this disagreement should be explained by the difference in identification of levels. We put “?” in data from [25] for a such results. The fourth columns in Table I lists the Hartree-Fock transition probabilities summed over all the lower levels multiplied on statistical weight (g) of the upper level (weighted radiative widths - $\text{sum}(gA_r)$). These data are compared with recommended data (c) by Wiese et al [25] for some levels which was possible to take out from [25]. We can see from Table I that the data of “a” and “c” agree in the range of 20 - 40% which is rather good for gA_r data.

Table Ib lists data for the energy above the threshold $1s^2 2s$ and additional data comparison as in Table Ia are included: autoionization rate (A_a) and branching ratio K ,

$$K(\gamma, \alpha_0) = \frac{A_a(\gamma, \alpha_0)}{(A_r(\gamma) + A_a(\gamma))}, \quad (7)$$

where

$$A_r(\gamma) = \sum_{\gamma''} A_r(\gamma, \gamma''), \quad A_a(\gamma) = \sum_{\alpha'} A_a(\gamma, \alpha') \quad (8)$$

We can see that K is different from 1 only for some levels: $2p4d$ (3D_1), $2p4f$ (3F_1), $2p5p$ (3P_2), $2p5f$ (3F_2), $2p5g$ (3G_3 , 3G_4), $2p6g$ (3G_3 , 3G_4), $2p6h$ (3H_5). The autoionization levels given in Table Ib ($2pn/(LSJ)$ with $n=4-6$) are situated under the second threshold $1s^22p$.

Tables IIa and IIb list energy data above the threshold $1s^22p$: $1s^23l'n/l$ levels of even parity (Table IIa) and $1s^23l'n/l$ levels of odd parity (Table IIb). We can see from Table II that the energies of the $1s^23l'n/l$ states ($n=3-6$, $l=0-(n-1)$) are between two thresholds: $1s^22p$ and $1s^23s$. The energy interval among $1s^23l$ states is very small: $E_s(1s^23s)=37.538\text{eV}$, $E_s(1s^23p)=39.673\text{eV}$, $E_s(1s^23d) = 40.270\text{eV}$. Two columns list autoionization rates A_a : $A_a(\gamma, \alpha_0)$ and $\sum_{\alpha'} A_a(\gamma, \alpha')$ with $\alpha_0=1s^22s$ and $\alpha'=1s^22s, 1s^22p$. We can see from Table II that the decay channel from many $1s^23l'n/l$ states to the $1s^22p$ has larger A_a value than the decay channel to the $1s^22s$ and therefore the branching ratio K (see eq.(8)) differs from 1. There are direct (allowed in LS coupling scheme) decays for $1s^23sns$, $1s^23snd$, $1s^23sng$, $1s^23dns$, $1s^23dnd$, $1s^23dng$, $1s^23pnp$, $1s^23pnf$, $1s^23pnh$ states to $1s^22sk/[LS]$ with $LS=^1,^3S$, $^1,^3D$, $^1,^3G$ and to $1s^22pk/[LS]$ with $LS=^1,^3P$, $^1,^3F$, $^1,^3H$. We have completely opposite situation for odd parity states: decays from $1s^23pns$, $1s^23pnd$, $1s^23png$, $1s^23snp$, $1s^23snf$, $1s^23snh$, $1s^23dnp$, $1s^23dnf$, $1s^23dnh$ states to $1s^22sk/[LS]$ states with the terms with $LS=^1,^3S$, $^1,^3D$, $^1,^3G$ and to $1s^22pk/[LS]$ with the terms $LS=^1,^3S$, $^1,^3D$, $^1,^3G$ are allowed in LS coupling. There are some deviations from this rule because of the mixing between terms by CI (configuration interaction) but it is usual (see Table II) that such contribution to the value of A_a is much smaller than the value for the channels allowed in LS pure LS-coupling scheme.

The branching ratio K for Be-like C ion depends mainly on the autoionization decay ratio $A_a(\gamma, \alpha_0) / \sum_{\alpha'} A_a(\gamma, \alpha')$, since the radiative decay rate is much smaller than the autoionization decay rate by $10^2 - 10^4$ times. However, the autoionization decay channel for $1s^2 2pn/l$ states is the only one to the first threshold $1s^2 2s$. The branching ratio is determined by the radiative decay although the contribution is generally small. There is one additional decay channel ($1s^2 2p$) for $1s^2 3sn/l$ states. It is necessary to add one more decay channel ($1s^2 3s$) for $1s^2 3pn/l$ states and one else ($1s^2 3p$) for $1s^2 3dn/l$ states. We included only the $1s^2 2p$ channel for $1s^2 3pn/l$ and $1s^2 3dn/l$ states since these states with $n=3, 4, 5, 6$ are under the $1s^2 3s$ threshold.

Table II c gives comparison of Cowan and MZ data for $1s^2 3l' n/l$ states with $n=3$ for the energies and autoionization rates of Be-like C ion. It should be noted that the hydrogenic function were used in MZ code to calculate autoionization rates. This approximation is not good for the ions with small Z and we can see that the Cowan and MZ data for autoionization rare differ in 2-4 times for some levels.

3. Dielectronic satellite spectra

Autoionizing levels $1s^2 2p4d$, $1s^2 2p4f$, $1s^2 2pn/l$ with $n>4$ create satellite spectra to the resonance lines $1s^2 2s - 1s^2 2p$ in the region of 1540 Å. There are other transitions changing the principle quantum numbers such as the $1s^2 2sn/l - 1s^2 2pn'/l'$, $1s^2 2p4s - 1s^2 2pn/l$ and $1s^2 2p4p - 1s^2 2pn/l$ lines. Tables IIIa, b list wavelengths (WL), weighted radiative transition probabilities (gA_r), branching ratio (K) and intensity factors of the dielectronic satellite lines:

$$Q_d(\gamma, \gamma' | \alpha_0) = g_\gamma A_r(\gamma, \gamma') K(\gamma, \alpha_0) \quad (9)$$

There are huge number of such lines but we chose lines with largest value of gA_r for illustration. We discovered that there are only 13 and 180 lines with $gA_r > 10^{10} \text{ s}^{-1}$ and 10^9 s^{-1} respectively. Tables IIIa, b include these strong lines. We did not

find lines with large values of gA_r for some types of transitions so we added lines with $gA_r < 10^9 \text{ s}^{-1}$ in these cases. Table IIIa includes transitions to the configurations of even parity (1-2s², 2-2p², 3-2s3s, 4-2s3d, 5-2p3p, 6-2s4s, 7-2s4d, 8-2p4p, 10-2s5s, 11-2s5d, 12-2s5g, 15-2s6s, 16-2s6d, 17-2s6g). Table IIIb includes transitions to the configurations of odd parity (1-2s2p, 2-2s3p, 3-2p3s, 4-2p3d, 5-2s4p, 6-2s4f, 7-2p4s, 9-2s5p, 10-2s5f, 14-2s6p, 15-2s6f, 16-2s6h). We can see that the values of Q_d for the transitions to 2s², 2s3s, 2s3d, 2s4s, 2p4p states (Table IIIa) are smaller than $< 10^9 \text{ s}^{-1}$. Transitions to 2p² states have the largest values of $Q_d (> 10^{10} \text{ s}^{-1})$. For the transitions from states of odd parity (Table IIIb) we found the smallest and largest values of Q_d for 2s3p, 2p3s, 2s4p, 2p4s states and 2p4f states respectively.

Tables IVa, b list wavelengths (WL), the energies from the first threshold (1s²2s) (E_s), weighted radiative transition probabilities (gA_r), branching ratios (K), intensity factors of the dielectronic satellite lines from 1s²3l'n/ states. There are more than several thousands lines created from these states and we chose lines with largest value of radiative transitions probabilities ($gA_r > 10^{10} \text{ s}^{-1}$) for illustrations. We can see from Table IV that almost 20% of these lines do not contribute to satellite spectra since the autoionization rates are equal to zero and consequently Q_d are equal to zero.

4. Dielectronic recombination rate coefficients for the excited states

The DR rate coefficients $\alpha_d(\gamma'|\alpha_0)$, for the excited states are obtained by summing the intensity factor $Q_d(\gamma, \gamma'|\alpha_0)$ multiplied the exponential factor over γ as follows,

$$\alpha_d(\gamma'|\alpha_0) = 3.3 \times 10^{-24} \left(\frac{I_H}{T_e} \right)^{3/2} \sum_{\gamma} e^{-\frac{E_s}{T_e}} Q_d(\gamma, \gamma'|\alpha_0) / g(\alpha_0) \quad (10)$$

where

$$Q_d(\gamma, \gamma' | \alpha_0) = \frac{g_\gamma A_r(\gamma, \gamma') A_a(\gamma | \alpha_0)}{\sum_{\gamma''} A_r(\gamma, \gamma'') + \sum_{\alpha'} A_a(\gamma | \alpha')} \quad (11)$$

Here $\gamma' = 1s^2 2snl, 1s^2 2p3l, 1s^2 2p4s, 1s^2 2p4p(^3S, ^3P, ^3D, ^1P), \gamma = 1s^2 2p4p(^1D, ^1S), 1s^2 2p4f, 1s^2 2pnl (n > 4), 1s^2 3l'nl, \alpha' = 1s^2 2s, 1s^2 2p$. The values of $(\sum A_r), A_a, (\sum A_a)$ and E_S are given in Tables I and II for all excited and autoionized states ($1s^2 2l'n'l$ and $1s^2 3l'n'l$). In eq.(10) I_H is a hydrogen ionization potential (13.606eV) and E_S is the energy of the autoionizing states counted from the threshold ($1s^2 2s$ in our case) and $g(\alpha_0)$ is statistical weight of the threshold which is equal to 2 in our case.

Sum over γ means sum over all autoionization levels. We calculated $Q_d(\gamma, \gamma' | \alpha_0)$ values only up to $n=6$ by Cowan code and summed all the values up to $n=6$ to obtain $\alpha_d(\gamma' | 2s)$. For CIII ions, $1s^2 2snl, 1s^2 2p3l, 1s^2 2p4s, 1s^2 2p4p$ states are under the ionization limit. There are three kinds of radiative decay in the dielectronic recombination processes, i) $2p-2s$ transition such as $2pn'l - 2sn'l$, ii) $nl - 2l'$ transition such as $2pn'l - 2p^2, 2pn'l - 2s2p, 2sn'l - 2s^2, 2sn'l - 2s2p$ and iii) $3p-2s$ transition such as $3pn'l - 2sn'l$. For the highly excited $2sn'l (n > 6)$ states we should consider the $2pn'l - 2sn'l$ and $3pn'l - 2sn'l$ transitions to obtain $\alpha_d(2sn'l | 2s)$ since these transitions are dominant for $n \gg 6$.

$$\alpha_d(2sn'l \ ^{1,3} \ell_J | 2s \ ^2S) = 1.65 \times 10^{-24} \left(\frac{I_H}{T_e} \right)^{3/2} \times \sum_{n'=2,3} \sum_{L,J'} e^{-\frac{E_S}{T_e}} Q_d(n'pn'l \ ^{1,3} L_{J'}, 2sn'l \ ^{1,3} \ell_J | 2s \ ^2S) \quad (12)$$

For $2pn'l-2sn'l$ and $3pn'l-2sn'l$ transitions, we extrapolate our calculated data beginning from $n=6$ to obtain the values for $n > 6$ using the asymptotic formulas:

$$A_r(n'pn\ell \ ^1\text{L}_{J'} - 2sn\ell \ ^1\text{L}_J) = A_r(n'p6\ell \ ^1\text{L}_{J'} - 2s6\ell \ ^1\text{L}_J)$$

$$A_r(n'pn\ell \ ^1\text{L}_{J'}) = A_r(n'p6\ell \ ^1\text{L}_{J'}) = \sum_{\gamma''} A_r(n'p6\ell \ ^1\text{L}_{J'} - \gamma'')$$

(13)

where $n'=2$ and 3 , sum over γ'' includes all autoionizing states with $2pn/\ell \ ^1\text{L}_{J'}$ and $3pn/\ell \ ^1\text{L}_{J'}$ levels.

$$A_a(n'pn\ell \ ^1\text{L}_{J'} | 2s \ ^2\text{S}) = A_a(n'p6\ell \ ^1\text{L}_{J'} | 2s \ ^2\text{S}) \left(\frac{6}{n}\right)^3$$

$$A_a(2pn\ell \ ^1\text{L}_{J'}) = A_a(2p6\ell \ ^1\text{L}_{J'}) \left(\frac{6}{n}\right)^3 = A_a(2p6\ell \ ^1\text{L}_{J'} | 2s \ ^2\text{S}) \left(\frac{6}{n}\right)^3$$

$$A_a(3pn\ell \ ^1\text{L}_{J'}) = A_a(3p6\ell \ ^1\text{L}_{J'}) \left(\frac{6}{n}\right)^3 = \sum_{\alpha'} A_a(3p6\ell \ ^1\text{L}_{J'} | \alpha') \left(\frac{6}{n}\right)^3$$

(14)

Sum over α' includes two thresholds $1s^22s$ and $1s^22p$. There are no sum over α' for $2pn\ell$ states since these states are between the first and second thresholds ($1s^22s$ and $1s^22p$). As a result the intensity factor Q_d can be equal to (see eq.(11))

$$Q_d(n'pn\ell \ ^1\text{L}_{J'}, 2sn\ell \ ^1\text{L}_J | 2s \ ^2\text{S}) = (2J'+1) \frac{f_n(n=6)}{1 + (n/6)^3 f'_n(n=6)} \quad (15)$$

where

$$f_2(n=6) = A_r(2p6\ell \ ^1\text{L}_{J'} - 2s6\ell \ ^1\text{L}_J), \quad f'_2(n=6) = \frac{A_r(2p6\ell \ ^1\text{L}_{J'})}{A_a(2p6\ell \ ^1\text{L}_{J'})}$$

$$f_3(n=6) = A_r(3p6\ell \ ^1\text{L}_{J'} - 3s6\ell \ ^1\text{L}_J) \frac{A_a(3p6\ell \ ^1\text{L}_{J'} | 2s \ ^2\text{S})}{A_a(3p6\ell \ ^1\text{L}_{J'})}, \quad (16)$$

$$f'_3(n=6) = \frac{A_r(3p6\ell \ ^1\text{L}_{J'})}{A_a(3p6\ell \ ^1\text{L}_{J'})}$$

The values of A_r and A_s for these transitions with $n=6$ are given in Table V ($2pn/l - 2sn/l$) and Table VI ($3pn/l - 3sn/l$). We obtain

$$\begin{aligned}\alpha_d^{(2)}(2sn\ell^{1,3} \ell_J | 2s^2S) &= 1.65 \times 10^{-24} \left(\frac{I_H}{T_e}\right)^{3/2} \sum_{LSJ'} e^{-\frac{E_s}{T_e}} \frac{(2J'+1)f_2(n=6)}{1+(n/6)^3 f_2'(n=6)} \\ \alpha_d^{(3)}(2sn\ell^{1,3} \ell_J | 2s^2S) &= 1.65 \times 10^{-24} \left(\frac{I_H}{T_e}\right)^{3/2} \sum_{LSJ'} e^{-\frac{E_s}{T_e}} \frac{(2J'+1)f_3(n=6)}{1+(n/6)^3 f_3'(n=6)}\end{aligned}\quad (17)$$

where $\alpha_d^{(2)}$ and $\alpha_d^{(3)}$ are the DR rate coefficients from $2pn/l$ and $3pn/l$ respectively.

The energy difference between the second ($2p^2P_{1/2}$, $2p^2P_{3/2}$) and the first threshold ($2s$) is equal to 7.993eV and 8.006 eV respectively or 8.002eV as a average over J value. We can see from Table V that the values of E_s change from 4.375eV to 4.850eV for $2p6/l$ states with different l . Then the states with $n>6$ are in the small interval of energy: 3.152eV - 3.627eV. We used asymptotic formula given in paper [26] in order to obtain E_s for $2pn/l$ and $3l'n/l$ states as a function of n/l . We obtain for the energy of our states counted from the threshold [26]

$$E(1s^2n'\ell'n\ell) - E(1s^2n'\ell') = -\frac{Z^2}{2n^2} + 2ZE_1(1s,n\ell) + ZE_1(n'\ell',n\ell) \quad (18)$$

where $E_1(1s,n\ell)$, $E_1(n'\ell',n\ell)$ is the first order correction which can be represented for the large n in the form:

$$E_1(1s,n\ell) = \frac{1}{n^2} - \frac{a(1s,\ell)}{n^3}, \quad E_1(n'\ell',n\ell) = \frac{1}{n^2} - \frac{a(n'\ell',\ell)}{n^3} \quad (19)$$

where numerical data for $a(1s,l)$, $a(2p,l)$, $a(3s,l)$, $a(3p,l)$ and $a(3d,l)$ are given in [26]. Finally we can rewrite eq.(18) by using screening constant method [26]:

$$E(1s^2n'\ell'n\ell) - E(1s^2n'\ell') = -\frac{1}{2n^2} \left(Z - 3 + \frac{1}{n} b(\ell) \right)^2 \quad (20)$$

where for $b(l)=2a(1s,l)+a(n'\ell',l)$. In the case of $l=s$ we obtain from [26] $b(s)=1.435$. Then for $2pns$ -state of Be-like Carbon ion ($Z=6$)

$$E(1s^22pns) - E(1s^22p) = -\frac{1}{2n^2} \left(3 + \frac{1.435}{n} \right)^2 \quad (21)$$

that gives $-0.1457 \text{ at. un} = -3.965 \text{ eV}$ for $n=6$. We obtain $E_S = (8.002 - 3.965) = 4.037 \text{ eV}$ for $n=6$ and which agree very well with data obtained by Cowan code given in Table V (the four first lines). We can conclude that we can use eq.(20) for estimation of E_S as a function of n . We simplify eq.(20) for high n using only the first term:

$$\begin{aligned} E_S(n' \ell' n \ell) &= E(1s^2 n' \ell' n \ell) - E(1s^2 2s) = \\ &= E(1s^2 n' \ell') - E(1s^2 2s) - \frac{1}{2n^2} (Z-3)^2 \end{aligned} \quad (22)$$

This formula gives for $n' \ell' = 2p$ and $Z=6$ the next value for E_S :

$$E_S(2pn\ell) = 8.002 - \frac{122.4}{n^2} \quad \text{in eV} \quad (23)$$

Results of our calculations of $\alpha_d(\gamma' | \alpha_0)$ in eq.(10) for 45 excited levels are shown on Fig. 1a,b,c,d (even complex) and Fig. 2a,b,c,d (odd complex) as function of T_e . These values are obtained including states with $n \leq 6$ but without including $n > 6$. The contribution from $3pn\ell$ is not included. We can see that the form of curves depends on γ' . The curves of $\alpha_d(\gamma' | 2s)$ for $\gamma' = 2s^2(^1S)$, $2p^2(^3P, ^1D, ^1S)$, $2p3p(^1,3S, ^3P)$, $2p3d(^1,3P, ^1,3D, ^1,3F)$ have maximums for very small T_e around 0.2 - 0.3 eV (Fig. 1a,b and Fig. 2b). For these γ' transitions with $\gamma = 2p4\ell$ (see Tables IIIa, b) give the largest contribution into $Q_d(\gamma, \gamma' | 2s)$. All energies of $2p4\ell$ states are in the interval 0.3 eV. In this case the $\alpha_d(\gamma' | 2s)$ curves for these states have maximum in this interval of energy for these autoionization states $2p4\ell$. $\alpha_d(\gamma' | 2s)$ has the largest maximum ($> 10^{-11} \text{ cm}^3/\text{s}$) for $\gamma' = 2p^2(^3P)$. Figs. 1c, d show two additional maximums for $\alpha_d(\gamma' | 2s)$ around 2.5 eV (for $\gamma' = 2s5d, 2s5s$) and 4.5 eV (for $\gamma' = 2s6d, 2s6s$). These maximum values of $\alpha_d(\gamma' | 2s)$ can be explained by the largest values of $Q_d(\gamma, \gamma' | 2s)$ for $\gamma = 2pns(^3P)$, $2pnd(^3F)$ with $n=5, 6$. We can see from Table Ib that E_S for these states are equal to 2.5, 3.1 eV ($n=5$) 4.4, 4.7 eV ($n=6$) respectively. The curves for $\alpha_d(\gamma' | 2s)$ for odd states (Fig. 2a,b,c,d) demonstrate the same T_e - dependencies that we already described above for even

states. There is a strong maximum for all the 2p3d (LS) states shown on Fig.2b. We can see from Table IIIb that the largest Q_d for these states is found for $\gamma=2p4f$ (LS) ($Q_d(2p3d \text{ LS}, 2p4f \text{ L'S}|2s) > 10^{-9} \text{ s}^{-1}$). The value of E_s for these states is equal to 0.3 - 0.4 eV.

It should be noted that the contribution of $1s^2 3l' n l$ states in sum over γ in eq. (10) for $\alpha_d(\gamma'|2s)$ is important only for excited states with small value of $\alpha_d(\gamma'|2s)$. The contributions of $3pn l$ states to $2sn l$ states are shown in Figs.2a and 2b for $\alpha_d(\gamma'|2s)$ with $\gamma'=2s3p \text{ }^1\text{P}$ and $\gamma'=2p3d \text{ }^1\text{D}$ when the $1s^2 3l' n l$ states ($n \leq 6$) were taken into account in the sum of γ in eq.(10). We can see that the maximum of two curves for these states in Figs.2a, 2b is around 20eV. It does not exceed $10^{-14} \text{ cm}^3/\text{s}$. In this case the contribution of $1s^2 3l' n l$ states can be important for $\alpha_d(\gamma'|2s)$ which maximum is less than $10^{-14} \text{ cm}^3/\text{s}$ for $T_e \geq 20\text{eV}$. We found such situation for $2s3p \text{ }^1\text{P}$ level for which $\alpha_d(\gamma'|2s) < 10^{-14} \text{ cm}^3/\text{s}$ and its maximum is around 1eV. The value of $\alpha_d(2p3d \text{ }^1\text{D}|2s)$ is more than $10^{-12} \text{ cm}^3/\text{s}$ in maximum around 0.3eV. And we can see from Fig.2b that the curve of $\alpha_d(2p3d \text{ }^1\text{D} |2s)$ from $3ln l'$ do not change the values $\alpha_d(2p3d \text{ }^1\text{D} |2s)$ from $2pn l'$.

5. Total dielectronic recombination rate coefficients

The total dielectronic recombination rate coefficient is obtained by the sum of all the levels,

$$\begin{aligned} \alpha_d^t = & \sum_{n=7}^{\infty} \sum_{\ell \text{ SJ}} \alpha_d^{(2)} \left(2sn \ell \text{ }^1\text{ }^3 \ell_J | 2s \text{ }^2\text{S} \right) + \sum_{n=7}^{\infty} \sum_{\ell \text{ SJ}} \alpha_d^{(3)} \left(2sn \ell \text{ }^1\text{ }^3 \ell_J | 2s \text{ }^2\text{S} \right) + \\ & + \sum_{n=2}^6 \sum_{\ell \text{ SJ}} \alpha_d \left(2sn \ell \text{ }^1\text{ }^3 \ell_J | 2s \text{ }^2\text{S} \right) + \sum_{\text{LSJ}} \sum_{\ell} \alpha_d \left(2p3\ell(\text{LSJ}) | 2s \text{ }^2\text{S} \right) + \\ & \sum_{\text{LSJ}} \left[\alpha_d \left(2p^2(\text{LSJ}) | 2s \text{ }^2\text{S} \right) + \alpha_d \left(2p4s(\text{LSJ}) | 2s \text{ }^2\text{S} \right) + \alpha_d \left(2p4p(\text{LSJ}) | 2s \text{ }^2\text{S} \right) \right] \end{aligned} \quad (24)$$

The summation in the first and second terms eq.(24) is done up to $n = 500$ to obtain the total dielectronic recombination rate coefficient.

Fig.3 demonstrates n -dependencies of dielectronic recombination rate coefficient $\alpha^{(2)}(2sn\ell|2s)$ (Fig.3a) and $\alpha^{(3)}(2sn\ell|2s)$ (Fig.3b)

$$\begin{aligned}\alpha_d^{(2)}(2sn\ell|2s) &= \sum_{SJ} \alpha_d^{(2)}(2sn\ell^{1,3}\ell_J|2s^2S), \\ \alpha_d^{(3)}(2sn\ell|2s) &= \sum_{SJ} \alpha_d^{(3)}(2sn\ell^{1,3}\ell_J|2s^2S)\end{aligned}\quad (25)$$

calculated by using eqs.(16), (17) and (25) for $T_e=6\text{eV}$. We can see that those contributions are different for the different l . The contributions of high l are larger for small n as can be seen in Fig.3b. The values of $\alpha^{(2)}(2sn\ell|2s)$ are almost constant for $n=7 - 50$ because the term $n^3 f(n=6)/6^3$ is very small in this interval of n which means that A_a is much larger than A_r . For example, the values of $f(n=6)$ for $(2p6s)$ 3P_0 , 3P_1 , 3P_2 , 1P_1 levels are equal to 9.463×10^{-4} , 4.181×10^{-4} , 1.004×10^{-3} , 8.019×10^{-6} respectively (see Table V). We obtain $f(n/6)^3 = 4.381, 1.935, 4.650, 0.0380$ for $(2p6s)$ 3P_0 , 3P_1 , 3P_2 , 1P_1 levels with $n=100$. As a result the ratio $\alpha^{(2)}(2s100s|2s)/\alpha^{(2)}(2s6s|2s)$ is equal to 0.235 for $T_e=6\text{eV}$. The same estimation for the contributions of $3p6s$ autoionizing levels gives 0.164 for the ratio $\alpha^{(3)}(2s100s|2s)/\alpha^{(3)}(2s6s|2s)$ with $T_e=20\text{eV}$. The values of $\alpha^{(3)}(2sn\ell|2s)$ for $l=d, g, f$ sharply decrease towards the larger value of n that can be explained by increasing the contribution of radiative channels comparison to the ones of autoionizing channels for these states.

Fig.4 gives the sum of $[\alpha^{(2)}(2sn\ell|2s) + \alpha^{(3)}(2sn\ell|2s)]$ over n from $n=7$ to $n=N_0$ for the same value of T_e as in Fig.3a ($T_e=6\text{eV}$). We can see that $\alpha_d^N(2s\ell|2s)$

$$\alpha_d^N(2s\ell|2s) = \sum_{n=7}^N [\alpha_d^{(2)}(2sn\ell|2s) + \alpha_d^{(3)}(2sn\ell|2s)] \quad (26)$$

become constant for $n \geq 500$. Sum of $\alpha_d^N(2s\ell|2s)$ over $l=s, p, d, f, g, h$ is less stable (see Fig.4) and 1% error as found for $N=500$ comparing to the total for $N=1000$.

Fig.5a and 5b show the values of

$$\alpha_d^{(3)}(2s\ell \ ^{1,3}\ell|2s) = \sum_{n=7}^{500} \sum_J \alpha_d^{(3)}(2sn\ell \ ^{1,3}\ell|2s) \quad (27)$$

separately for singlet (Fig.5a) and triplet (Fig.5b) terms for different l . We can see in average the similar contribution for singlet and triplet states, although the values for different l differs considerably.

The total DR rate coefficients summed from $n=2$ to $n=500$ levels are shown in Fig.6 by solid line. The contribution from $2pn'l$ ($\sum_{\ell} \sum_{n=7}^{500} \alpha_d^{(2)}(2sn\ell|2s)$) and $3pn'l$

($\sum_{\ell} \sum_{n=7}^{500} \alpha_d^{(3)}(2sn\ell|2s)$) are shown by circles and squares, respectively. The maximum value of the contribution from $3pn'l$ is less than that of the contribution from $2pn'l$. The maximum of α_d around $T_e = 0.2\text{eV}$ is mainly due to the contribution of $2p4d$ and $2p4f$ autoionizing states which situated very near threshold. These states give the largest contribution to α_d for the $2s3d \ ^{1,3}D$, $2s4d \ ^{1,3}D$, $2s4f \ ^{1,3}F$ and $2s5f \ ^{1,3}F$ excited states (see Figs.1 and 2). The peak temperature for $3pn'l$ is around 20eV , whereas the peak temperature for $2pn'l$ is near 6 eV . Consequently the contribution of $3pn'l$ changes total DR rate coefficients to $T_e > 10\text{eV}$.

The total dielectronic recombination rate coefficients calculated by Nussbaumer and Storey (1983) [3] are shown in Fig. 5 for comparison. We can see that agreement with our data is within 50%. The contributions of $2sn'l$ states with $n > 6$ were not taken into account in [3]. This conclusion should be confirmed by a good agreement of the values of effective dielectronic recombination rate coefficients for some lines given in Table VII. As usual our data and Nussbaumer and Storey (1984) [4] data disagree by no more than 20-30% except for the α_d value for $2p3d \ ^3P - 2p4f \ ^3D$ transitions which disagree in two times. It is rather strange since the α_d value for transitions with the same autoionizing level $2p4f \ ^3D$

(2p3d ³D - 2p4f ³D transition) agree very well and the transition energy of 2p3d ³P - 2p4f ³D are also very close (2017.4Å and 1949 Å).

Let us explain disagreement of our data for total dielectronic recombination rate coefficients with the data calculated by Romanik [17] shown in Fig.5. We can see that our data agree very well with data from [17] for small $T_e \leq 1\text{eV}$ and disagree for $T_e > 1\text{eV}$. The largest contribution for these T_e gives sum over n (see eqs.(15), (16) and (24)). In our approximation we use asymptotic values for $A_r(2p6\ell \ ^1L_J - 2s6\ell \ ^1L_J)$, $A_r(2p6\ell \ ^3L_J)$, $A_a(2p6\ell \ ^3L_J)$ without averaging over LSJ for the calculation of f_2 and f'_2 in eq.(15). In [17] the scheme averaging over LSJ was used. This averaging can change the total DR rate coefficient by more than 20% which was pointed out in [17]. Let us illustrate our statement by one example. It was already shown that the ratio $\alpha^{(2)}(2s100s|2s)/\alpha^{(2)}(2s6s|2s)$ is equal to 0.235 for $T_e=6\text{eV}$. The data for 2s6s -2p6s transitions from Table V were used to calculate this ratio. We have the values for $A_a(2p6s \ ^3P_0)=0.0726$, $A_a(2p6s \ ^3P_1)=0.1656$, $A_a(2p6s \ ^3P_2)=0.0699$, $A_a(2p6s \ ^1P_1)=16.02$ in units 10^{+13} s^{-1} . Averaging over J gives $A_a(2p6s)=4.081$ in the same units. The same procedure gives $A_r(2p6s)=8.403 \times 10^8 \text{ s}^{-1}$. As a result we obtain $f'_2(n=6)=2.059 \times 10^{-5}$ instead 9.463×10^{-4} for 3P_0 , 4.181×10^{-4} for 3P_1 , 1.004×10^{-3} for 3P_2 and 8.019×10^{-6} for 1P_1 . We can see that there are six 2s6s-2p6s transitions with gA_r in 10^{+8} s^{-1} unit equal to 2.648, 7.908, 13.30, 0.0475, 0.0495 and 8.633. Sum of these data gives 32.61 and for $\alpha^{(2)}(2s6s|2s)$ we obtain $8.820 \times 10^{-15} \text{ cm}^3/\text{s}$ with $E_s = 4.4\text{eV}$ and $T_e=6\text{eV}$. In order to obtain $\alpha^{(2)}(2s100s|2s)$ by using averaging scheme we have to multiply this value (the value of E_s should be changed to 8eV) by $[1+2.059 \times 10^{-5}(100/6)^3]^{-1}$. As a result we obtain $\alpha^{(2)}(2s100s|2s)=4.418 \times 10^{-15} \text{ cm}^3/\text{s}$ instead of $2.069 \times 10^{-15} \text{ cm}^3/\text{s}$ with calculation without averaging what was done in the present paper. We can see from Fig.6 that the value of α_d obtained by Romanik is two times as large as α_d computed in the present paper.

6. The parametrization of the DR rate coefficients

It is convenient to give the rate coefficients in analytical formulae for the use in the various application codes. We have fitted the rate coefficients in the following formula,

$$\alpha_d(\gamma' | \alpha_0) = \sum_i A_i e^{-\frac{E_i}{T_e}} T_e^{-3/2} \quad \text{in cm}^3 \text{s}^{-1} \quad (28)$$

where E_i and T_e are in eV. The four fitting parameters for each excited states are listed in Table VIII. It should be noted that a little bit different formula with five fitting parameters was used by Nussbaumer and Storey (1983) [3]

7. Effect of external electric field on DR rate coefficient

The effect of external electric field on dielectronic recombination have been studied for Li-like ions B^{2+} , C^{3-} and O^{5+} by Griffin et al [27]. They pointed out that for high-temperature plasmas, recombination through the multitude of doubly excited Rydberg states with very high principle quantum numbers will normally dominate the total DR process. Therefore, the cross section will be very sensitive to the existence of external electric fields, which surely present in plasmas and electron-ion beam experiments. First of all, such fields can ionize electrons in high Rydberg states and thereby decrease the DR rate. Secondly, electric fields redistribute the angular momentum among the doubly excited states which tends to open up more recombination channels and enhance the rate of DR. In [27] the results of extensive distorted wave calculations of DR as a function of electric field strength was presented. The intermediate-coupled, field-mixed eigen vectors were used to represent the doubly excited Rydberg states and determined by diagonalizing a Hamiltonian which includes the spin-orbit, internal electrostatic, and Stark matrix elements. The calculations in [27] were included the mixing between individual doubly excited states with the same value of n but different values of l due to presence of external electric field. Code DRFEUD (for DR field

enhanced using diagonalization) was developed by Griffin et al [27]. The energies, radial wave functions for the doubly excited configurations and for the initial and final bound state configurations were generated using the radial-wave function code developed by Cowan [22]. All angular coefficients and radial parameters for the Hamiltonian matrix elements and autoionizing and radiative rates were first determined and stored. Then for each value of n and M_j , the program DRFEUD generated the matrix elements, diagonalized the Hamiltonian, and finally used the eigenvectors to determine the rates and cross sections. This program was used in paper by Griffin and Pindzola [28] for calculation DR of the iron ions (Fe^{15+} , Fe^{23+} , Fe^{25+}). The cross section calculations included the dielectronic transitions associated with the $3s-3l$ and $3s-4l$ excitation in Fe^{15+} , the $2s-2p$ and $2s-3l$ excitation in Fe^{23+} and the $1s-2l$ excitation in Fe^{25+} . The effect of external electric fields were included by employing intermediate-coupled, field-mixed eigenvectors for doubly excited Rydberg states, determined by diagonalizing a Hamiltonian matrix which includes the internal electrostatic and spin-orbit terms, as well as the Stark matrix elements. Theoretical calculations of DR rate coefficients for carbon and oxygen ions were reviewed by Griffin in [29]. The effect of electric fields and electron density on DR rates was considered in [29].

DR rates for $2s-2p$ excitation were measured for Li-like ions B^{2+} , C^{3+} , N^{4+} , and O^{5+} in [30]. The measured rates agree very well with data predicted by Griffin et al [27] where the effect of electric fields on the DR cross section was considered. The first measurements of DR rate coefficients associated with the $2s-2p$ excitation in Be-like ions (N^{2+} , O^{3+} , and F^{4+}) were reported by Dittner et al [31] with the same technique used in [30]. The experimental results were in a reasonably agreement with the rate coefficients calculated using a modified version of the isolated resonance distorted-wave method [11]. They used a simple

method to estimate the effect of field ionization that ions ionize for all values of $n > n_m$ where the cutoff is given by the semiclassical formula

$$n_m = (6.2 \times 10^8 q^3 / E)^{1/4} \quad (29)$$

where the electric field E in V/cm, and q is the initial charge of the ion before recombination.

New measurements of DR rate coefficients for Li-like ions of N, F and Si were reported by Anderson et al in [32]. The measurements were performed with a single-pass merged-beam technique. The rate coefficients was given as a function of electron energy for 1.25MeV/amu N^{4+} , F^{6-} and Si^{11+} . The experimental data were compared with distorted-wave calculations that include the influence of static electric fields in the interaction region [32].

8. Conclusion

Wavelengths, weighted radiative transitions probabilities and branching ratios together with intensity factor were calculated in order to estimate the dielectronic satellite spectra and to obtain dielectronic rates coefficients into the excited states. From the comparison with available theoretical and experimental data we can be sure that accuracy of our data for energies is 1%. This is very important since the energies have to be very accurate for dividing level for non-autoionizing and autoionizing for sum over all states to calculate the DR rate coefficients. The accuracy of data for radiative and non-radiative transition probabilities is much less, especially for last one since these data depend on the energy of a free electron.

The dielectronic recombination rate coefficient has two maximum in large interval of T_e . The contribution of the transitions ($n \leq 6$) gives the first maximum around the first threshold and transition with $n=7-500$ creates the second maximum near the second threshold. The transitions with $n \leq 6$ give only 10% to

the total dielectronic recombination rate coefficient at $T_e=8\text{eV}$ and including the contribution from higher levels ($n\leq 500$) provides another 90% that confirm conclusion that it is very important to take into account these transitions.

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Table Ia. Energy (E), radiative (gAr) for $1s^2 2lnl'$ [LSJ] levels.

Comparison of different methods and recommended data from [25]: a-Cowan code, b-MZ code, c-[25]

$2lnl'$	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}	
		a	b	c	a	c
$2s^2$	1S_0	0.000	0.000	0.000	0.000+00	
$2s2p$	3P_0	51.604	52.372	52.367	0.000+00	
$2s2p$	3P_1	51.631	52.399	52.391	0.000+00	
$2s2p$	3P_2	51.686	52.465	52.447	0.000+00	
$2s2p$	1P_1	100.555	102.570	102.352	5.354+09	5.7+09
$2p^2$	3P_0	137.006	137.354	137.425	1.407+09	1.3+09
$2p^2$	3P_1	137.033	137.386	137.454	4.224+09	3.7+09
$2p^2$	3P_2	137.087	137.436	137.527	7.047+09	6.2+09
$2p^2$	1D_2	148.080	145.776	145.876	9.984+08	1.2+09
$2p^2$	1S_0	182.074	182.617	182.520	2.332+09	1.8+09
$2s3s$	3S_1	238.087	238.192	238.213	1.231+10	6.3+09
$2s3s$	1S_0	246.537	247.089	247.170	1.374+09	2.2+09
$2s3p$	1P_1	259.497	259.120	258.931	1.362+10	
$2s3p$	3P_0	260.020	259.606	259.706	8.716+07	7.8+07
$2s3p$	3P_1	260.026	259.613	259.711	2.649+08	2.3+08
$2s3p$	3P_2	260.038	259.629	259.724	4.369+08	3.9+08
$2s3d$	3D_1	269.838	270.780	270.011	3.131+10	2.4+10
$2s3d$	3D_2	269.840	270.782	270.012	5.216+10	4.0+10
$2s3d$	3D_3	269.842	270.786	270.015	7.297+10	5.5+10
$2s3d$	1D_2	276.577	275.678	276.483	3.564+10	3.2+10
$2p3s$	3P_0	307.898	308.150	308.217	2.934+09	
$2p3s$	3P_1	307.930	308.186	308.249	8.809+09	
$2p3s$	3P_2	307.995	308.262	308.317	1.470+10	
$2p3s$	1P_1	310.921	312.487	310.006	1.155+10	
$2s4s$	3S_1	310.921	310.107	309.457	8.017+09	
$2s4s$	1S_0	313.112	311.290	311.721	1.128+09	
$2p3p$	1P_1	318.855	319.678	319.720	9.091+09	
$2s4p$	3P_0	319.304	318.697	317.794	2.999+08	
$2s4p$	3P_1	319.307	318.700	317.796	9.000+08	
$2s4p$	3P_2	319.312	318.707	317.801	1.501+09	
$2p3p$	3D_1	321.061	322.319	323.077	9.765+09	
$2p3p$	3D_2	321.095	322.363	323.101	1.641+10	
$2p3p$	3D_3	321.145	322.431	323.140	2.326+10	
$2s4f$	3F_2	323.557	323.341	322.004	4.549+09	
$2s4f$	3F_3	323.563	323.341	322.010	6.380+09	
$2s4f$	3F_4	323.571	323.341	322.018	8.222+09	

Table Ia. (continued)

2nl'	LSJ	E(10 ³ cm ⁻¹)			Sum(gAr), s ⁻¹
		a	b	c	
2s4d	³ D ₁	323.842	323.300	321.411	6.903+09
2s4d	³ D ₂	323.847	323.300	321.427	1.137+10
2s4d	³ D ₃	323.857	323.302	321.450	1.563+10
2s4f	¹ F ₃	324.134	323.2003	324.134	1.497+10
2s4p	¹ P ₁	324.919	320.600	322.702	5.876+09
2p3p	³ S ₁	325.600	335.695	327.278	4.572+09
2s4d	¹ D ₂	325.877	322.257	324.212	2.130+10
2p3p	³ P ₀	330.935	329.693	329.685	1.813+09
2p3p	³ P ₁	330.955	329.716	329.907	5.439+09
2p3p	³ P ₂	330.994	329.757	329.744	9.069+09
2p3d	¹ D ₂	332.441	332.649	332.691	2.713+10
2p3d	³ F ₂	334.269	328.668	333.387	3.301+09
2p3d	³ F ₃	334.296	328.707	333.342	4.605+09
2p3d	³ F ₄	334.333	328.760	333.447	5.882+09
2p3p	¹ D ₂	335.498	332.926	333.118	1.111+10
2p3d	³ D ₁	336.586	338.597	337.656	3.966+10
2p3d	³ D ₂	336.598	338.612	337.669	6.608+10
2p3d	³ D ₃	336.617	338.633	337.688	9.248+10
2p3d	³ P ₂	339.352	344.241	340.102	3.504+10
2p3d	³ P ₁	339.379	344.220	340.128	2.104+10
2p3d	³ P ₀	339.393	344.183	340.142	7.016+09
2s5s	³ S ₁	340.010	340.362	338.514	4.240+08
2s5s	¹ S ₀	341.492	341.030	339.935	2.388+09
2p3d	¹ F ₃	342.587	331.775	341.371	6.269+10
2p3d	¹ P ₁	344.608	348.258	346.712	1.603+10
2s5p	³ P ₀	345.490	344.613	344.233	5.007+08
2s5p	³ P ₁	345.490	344.614	344.236	1.496+09
2s5p	P ₂	345.491	344.618	344.239	2.474+09
2s5p	¹ P ₁	346.912	346.343	343.258	1.175+10
2s5d	³ D ₁	347.132	346.961	345.497	6.417+09
2s5d	³ D ₂	347.132	346.961	345.497	1.069+10
2s5d	³ D ₃	347.133	346.962	345.497	1.496+10
2p3p	¹ S ₀	347.182	345.622	345.095	1.083+09
2s5g	³ G ₃	348.314		346.579	2.653+09
2s5g	³ G ₄	348.314		346.579	3.411+09
2s5g	³ G ₅	348.315		346.579	4.169+09
2s5g	¹ G ₄	348.315	346.579		3.404+09
2s5d	¹ D ₂	348.525	346.343	346.658	9.525+09
2s5f	³ F ₂	348.537	346.925	347.152	4.474+09

Table Ia. (continued)

2lnl'	LSJ	E(10 ³ cm ⁻¹)			Sum(gAr), s ⁻¹
		a	b	c	
2s5f	³ F ₃	348.538	346.925	347.153	6.266+09
2s5f	³ F ₄	348.539	346.925	347.155	8.061+09
2s5f	¹ F ₃	350.034	346.825	348.860	2.537+10
2s6s	³ S ₁	356.592	355.856	354.858	1.578+09
2s6s	¹ S ₀	357.637	356.258	357.637	8.077+08
2s6p	³ P ₀	358.736	358.264	357.050	1.010+08
2s6p	³ P ₁	358.737	358.265	357.050	3.029+08
2s6p	³ P ₂	358.738	358.267	357.050	5.046+08
2s6p	¹ P ₁	358.928	358.941	357.110	6.015+09
2s6d	³ D ₁	359.797	359.616	358.098	3.569+09
2s6d	³ D ₂	359.797	359.616	358.098	5.947+09
2s6d	³ D ₃	359.798	359.616	358.098	8.322+09
2s6g	³ G ₃	360.433		358.692	1.472+09
2s6g	³ G ₄	360.433		358.692	1.892+09
2s6g	³ G ₅	360.433		358.692	2.313+09
2s6g	¹ G ₄	360.433		358.692	1.880+09
2s6f	³ F ₂	360.442	359.580	358.850	2.417+09
2s6f	³ F ₃	360.443	359.580	358.850	3.384+09
2s6f	³ F ₄	360.443	358.581	358.851	4.353+09
2s6h	¹ H ₅	360.549		360.549	1.501+09
2s6h	³ H ₄	360.549		358.776	1.228+09
2s6h	³ H ₅	360.549		358.776	1.501+09
2s6h	³ H ₆	360.549		358.776	1.774+09
2s6d	¹ D ₂	360.617	359.238	358.733	8.356+09
2s6f	¹ F ₃	360.702	359.516	359.121	6.535+09
2p4s	³ P ₀	377.607	377.572	367.404?	1.613+09
2p4s	³ P ₁	377.640	377.604	367.404?	4.845+09
2p4s	³ P ₂	377.707	377.686	367.404?	8.097+09
2p4s	¹ P ₁	380.735	378.180	380.735	6.315+09
2p4p	¹ P ₁	382.416	382.423	381.105	6.681+09
2p4p	³ D ₁	383.160	383.081	381.950	3.251+09
2p4p	³ D ₂	383.195	383.119	381.971	5.412+09
2p4p	³ D ₃	383.250	383.182	382.010	7.585+09
2p4p	³ S ₁	384.571	386.694	384.571	4.962+09
2p4p	³ P ₀	386.182	384.536	384.345?	1.148+09
2p4p	³ P ₁	386.201	384.557	384.365	3.446+09
2p4p	³ P ₂	386.237	384.597	384.405	5.745+09

Table Ib. Energy (E), radiative (gAr) and autoionization (Aa) rates, branching ratio (K) for $1s^2 2lnl'$ [LSJ] levels. Comparison of different methods and recommended data from [25]:
a-Cowan code, b-MZ code, c-[25]

$2lnl'$	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}		Aa, 10^{13} s^{-1}	K
		a	b	c	a	a	a	
2p4d	1D_2	387.228	387.787	385.817	1.282+10	0.2972	0.9991	
2p4d	3F_2	387.442	386.173	385.826?	4.474+09	11.998	1.0000	
2p4d	3F_3	387.471	386.214	385.826?	5.976+09	12.294	1.0000	
2p4d	3F_4	387.518	386.266	385.826?	7.656+09	12.299	1.0000	
2p4p	1D_2	388.148	385.020	385.638	7.678+09	5.9806	1.0000	
2p4d	3D_1	388.746	390.260	387.697?	1.777+10	0.0053	0.8995	
2p4d	3D_2	388.758	390.268	387.697?	2.959+10	0.0143	0.9603	
2p4d	3D_3	388.778	390.301	387.697?	4.145+10	0.0101	0.9446	
2p4f	1F_3	389.326	387.343		1.261+10	0.0099	0.9821	
2p4f	3F_2	389.369	387.543	388.172?	8.639+09	0.0001	0.3666	
2p4f	3F_3	389.379	387.558	388.184	1.211+10	0.0176	0.9903	
2p4f	3F_4	389.389	387.569	388.214	1.555+10	0.0244	0.9930	
2p4d	3P_2	389.596	390.432	388.493	1.877+10	4.3093	0.9999	
2p4d	3P_1	389.626	390.462	388.493	1.128+10	4.3159	0.9999	
2p4d	3P_0	389.641	390.476	388.493	3.759+09	4.3213	0.9999	
2p4f	3G_3	390.160	388.043	388.125?	1.145+10	8.8374	1.0000	
2p4f	3G_4	390.188	388.006	388.125?	1.467+10	8.8593	1.0000	
2p4f	3G_5	390.235		388.125?	1.800+10	8.8650	1.0000	
2p4f	1G_4	390.447	386.977		1.214+10	9.5032	1.0000	
2p4f	3D_3	390.645	386.546	389.668?	1.138+10	0.0664	0.9976	
2p4f	3D_2	390.675	386.586	389.668?	8.128+09	0.0666	0.9976	
2p4f	3D_1	390.699	386.613	389.668?	4.881+09	0.0064	0.9752	
2p4f	1D_2	390.925	387.869		7.635+09	0.1128	0.9986	
2p4d	1F_3	391.912	388.178	388.773	4.988+10	33.334	1.0000	
2p4d	1P_1	392.442	394.292		1.321+10	3.8889	0.9999	
2p4p	1S_0	392.801	392.188		7.335+08	41.155	1.0000	
2p5s	3P_0	406.578	407.337		9.878+08	0.0129	0.9924	
2p5s	3P_1	406.610	407.351		2.972+09	0.0532	0.9981	
2p5s	3P_2	406.679	407.452		4.969+09	0.0118	0.9916	
2p5s	1P_1	407.799	407.497		4.618+09	24.707	1.0000	
2p5p	1P_1	409.067	409.816	407.431	5.628+09	0.0047	0.9616	
2p5p	3D_1	409.351	410.064	407.826?	2.441+09	0.0298	0.9973	
2p5p	3D_2	409.382	410.096	407.826?	4.002+09	0.0305	0.9974	
2p5p	3D_3	409.436	410.159	407.826?	5.609+09	0.0301	0.9973	
2p5p	3S_1	409.979	411.881		4.473+09	4.2365	1.0000	

Table Ib. (continued)

2lnl'	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}		K
		a	b	c	a	a	
2p5p	$^3\text{P}_0$	410.736	410.856	408.925?	6.966+08	0.0064	0.9892
2p5p	$^3\text{P}_1$	410.757	410.876	408.925?	2.097+09	0.0100	0.9931
2p5p	$^3\text{P}_2$	410.790	410.915	408.925?	3.488+09	0.0010	0.9348
2p5d	$^1\text{D}_2$	411.327	412.534	409.683	6.227+09	1.1771	0.9999
2p5d	$^3\text{F}_2$	411.402	411.649		4.223+09	3.4878	1.0000
2p5d	$^3\text{F}_3$	411.416	411.692		4.483+09	4.6631	1.0000
2p5d	$^3\text{F}_4$	411.464	411.742		5.701+09	4.6703	1.0000
2p5p	$^1\text{D}_2$	411.803	411.113	409.506	5.527+09	1.8417	0.9999
2p5d	$^3\text{D}_1$	412.049	413.773	410.585?	9.687+09	0.0189	0.9832
2p5d	$^3\text{D}_2$	412.061	413.764	410.585?	1.608+10	0.0436	0.9927
2p5d	$^3\text{D}_3$	412.083	413.822	410.585?	2.260+10	0.0161	0.9803
2p5f	$^1\text{F}_3$	412.328	412.302		7.199+09	0.0377	0.9973
2p5f	$^3\text{F}_2$	412.356	412.392	410.863	4.961+09	0.0001	0.5020
2p5f	$^3\text{F}_3$	412.365	412.411	410.863	6.952+09	0.0953	0.9990
2p5f	$^3\text{F}_4$	412.374	412.421	410.863	8.910+09	0.1097	0.9991
2p5d	$^3\text{P}_2$	412.404	413.854	410.892?	1.129+10	2.9123	0.9999
2p5d	$^3\text{P}_1$	412.433	413.867	410.892?	6.768+09	2.9344	0.9999
2p5d	$^3\text{P}_0$	412.448	413.872	410.892?	2.252+09	2.9520	0.9999
2p5f	$^3\text{G}_3$	412.656	410.946	410.819?	6.512+09	5.8525	1.0000
2p5f	$^3\text{G}_4$	412.681	410.983	410.819?	8.315+09	5.9117	1.0000
2p5f	$^3\text{G}_5$	412.726		410.819?	1.022+10	5.9853	1.0000
2p5g	$^3\text{G}_4$	412.806		411.104?	6.079+09	0.0002	0.7475
2p5g	$^3\text{G}_3$	412.806		411.104?	4.726+09	0.0002	0.7476
2p5g	$^1\text{G}_4$	412.819			6.050+09	0.0886	0.9992
2p5g	$^3\text{G}_5$	412.819		411.104?	7.390+09	0.0877	0.9992
2p5f	$^1\text{G}_4$	412.875	411.521		6.854+09	6.5698	1.0000
2p5f	$^3\text{D}_3$	412.975	411.859	413.003	7.171+09	0.0358	0.9972
2p5f	$^3\text{D}_2$	413.003	411.901	413.003	5.126+09	0.0367	0.9972
2p5f	$^3\text{D}_1$	413.028	411.929	413.028	3.077+09	0.0361	0.9972
2p5g	$^3\text{H}_4$	413.015		411.060?	5.503+09	1.4566	1.0000
2p5g	$^3\text{H}_5$	413.016		411.060?	6.709+09	1.4617	1.0000
2p5g	$^3\text{H}_6$	413.079		411.060?	7.905+09	1.5452	1.0000
2p5g	$^1\text{H}_5$	413.081			6.666+09	1.5508	1.0000
2p5g	$^3\text{F}_4$	413.118			5.930+09	0.0063	0.9896
2p5g	$^1\text{F}_3$	413.120			4.614+09	0.0033	0.9804
2p5g	$^3\text{F}_2$	413.170		411.433?	3.295+09	0.0070	0.9907
2p5g	$^3\text{F}_3$	413.171		411.433?	4.621+09	0.0040	0.9838
2p5f	$^1\text{D}_2$	413.203	412.577	411.433?	5.132+09	0.1135	0.9991
2p5d	$^1\text{F}_3$	413.711	410.912		3.129+10	18.288	1.0000
2p5d	$^1\text{P}_1$	414.045	415.847		9.241+09	2.2298	0.9999
2p5p	$^1\text{S}_0$	414.556	414.548		5.173+08	32.897	1.0000

Table Ib. (continued)

2lnl'	LSJ	E(10 ³ cm ⁻¹)			Sum(gAr), s ⁻¹ Aa, 10 ¹³ s ⁻¹		K
		a	b	c	a	a	
2p6s	³ P ₀	421.468	422.707		6.870+08	0.0726	0.9990
2p6s	³ P ₁	421.499	422.700		2.077+09	0.1656	0.9996
2p6s	³ P ₂	421.570	422.822		3.465+09	0.0690	0.9990
2p6s	¹ P ₁	422.131	422.811		3.855+09	16.019	1.0000
2p6p	¹ P ₁	422.932	424.148		6.796+09	0.0158	0.9859
2p6p	³ D ₁	423.056	424.267	421.432?	2.084+09	0.0659	0.9989
2p6p	³ D ₂	423.081	424.291	421.432?	2.871+09	0.0691	0.9992
2p6p	³ D ₃	423.135	424.354	421.432?	4.027+09	0.0688	0.9992
2p6p	³ S ₁	423.391	425.318		4.685+09	2.9149	1.0000
2p6p	³ P ₀	423.819	424.731	422.019?	4.053+08	0.0117	0.9965
2p6p	³ P ₁	423.841	424.752	422.019?	1.246+09	0.0210	0.9980
2p6p	³ P ₂	423.872	424.789	422.019?	2.036+09	0.0010	0.9609
2p6d	³ F ₂	424.159	425.173		3.295+09	1.1312	0.9999
2p6d	³ F ₃	424.220	425.219		3.095+09	2.0510	1.0000
2p6d	¹ D ₂	424.223	425.718		3.608+09	0.9224	0.9999
2p6d	³ F ₄	424.269	425.268		3.841+09	2.0579	1.0000
2p6p	¹ D ₂	424.540	424.897		5.236+09	0.8463	0.9998
2p6d	³ D ₁	424.564	426.411	422.932?	6.398+09	0.0389	0.9845
2p6d	³ D ₂	424.575	426.486	422.932?	1.054+10	0.0982	0.9979
2p6d	³ D ₃	424.600	426.467	422.932?	1.488+10	0.0228	0.9908
2p6f	¹ F ₃	424.725	425.585		4.796+09	0.0758	0.9991
2p6f	³ F ₂	424.744	425.625		3.478+09	0.0013	0.9492
2p6f	³ F ₃	424.748	425.647		4.760+09	0.2565	0.9997
2p6f	³ F ₄	424.757	425.656		6.109+09	0.2644	0.9997
2p6d	³ P ₂	424.765	426.398	423.109?	8.812+09	1.9912	0.9999
2p6d	³ P ₁	424.791	426.492	423.109?	5.276+09	2.0467	0.9999
2p6d	³ P ₀	424.804	426.492	423.109?	1.753+09	2.0835	0.9999
2p6f	³ G ₃	424.898	424.773		4.161+09	3.3362	1.0000
2p6f	³ G ₄	424.918	424.807		5.316+09	3.4604	1.0000
2p6f	³ G ₅	424.961			6.444+09	3.6683	1.0000
2p6g	³ G ₄	424.968		423.253?	4.585+09	0.0007	0.9322
2p6g	³ G ₃	424.968		423.253?	3.564+09	0.0010	0.9515
2p6g	¹ G ₄	424.975			4.390+09	0.2810	0.9998
2p6g	³ G ₅	424.976		423.253?	5.365+09	0.2796	0.9999
2p6f	¹ G ₄	425.056		425.132	5.076+09	4.1679	1.0000
2p6h	³ H ₅	425.076			4.731+09	0.0005	0.9207
2p6h	³ H ₄	425.076			3.871+09	0.0047	0.9909
2p6h	³ I ₅	425.078			4.275+09	0.0954	0.9996
2p6h	³ H ₆	425.078			5.052+09	0.0954	0.9997

Table Ib. (continued)

2lnl'	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}		K
		a	b	c	a	a	
2p6g	$^3\text{H}_4$	425.091			3.871+09	1.1914	1.0000
2p6g	$^3\text{H}_5$	425.092			4.717+09	1.2010	1.0000
2p6g	$^3\text{H}_6$	425.144			5.359+09	1.4757	1.0000
2p6f	$^3\text{D}_3$	425.097	425.304		6.007+09	0.0184	0.9954
2p6f	$^3\text{D}_2$	425.123	425.347		4.351+09	0.0188	0.9954
2p6f	$^3\text{D}_1$	425.146	425.377		2.588+09	0.0189	0.9955
2p6g	$^1\text{H}_5$	425.146			4.518+09	1.4821	1.0000
2p6g	$^3\text{F}_4$	425.161			4.970+09	0.0086	0.9936
2p6g	$^1\text{F}_3$	425.162			3.859+09	0.0084	0.9935
2p6g	$^3\text{F}_2$	425.206			2.782+09	0.0103	0.9946
2p6g	$^3\text{F}_3$	425.207			3.892+09	0.0076	0.9927
2p6h	$^3\text{I}_5$	425.173			4.076+09	0.1522	0.9998
2p6h	$^3\text{H}_6$	425.173			4.817+09	0.1523	0.9999
2p6h	$^3\text{G}_5$	425.200			5.037+09	0.0022	0.9796
2p6h	$^1\text{G}_4$	425.200			4.121+09	0.0036	0.9874
2p6h	$^3\text{I}_7$	425.211			5.082+09	0.2476	0.9999
2p6h	$^1\text{I}_6$	425.211			4.404+09	0.2477	0.9999
2p6h	$^3\text{G}_3$	425.235			3.276+09	0.0028	0.9836
2p6h	$^3\text{G}_4$	425.235			4.211+09	0.0038	0.9878
2p6f	$^1\text{D}_2$	425.289	425.749		6.380+09	0.0655	0.9981
2p6d	$^1\text{F}_3$	425.668	424.776		2.814+10	13.171	1.0000
2p6d	$^1\text{P}_1$	425.932	427.631		1.090+10	1.5444	0.9998
2p6p	$^1\text{S}_0$	427.261	426.814		1.252+09	52.191	1.0000

Table IIa. Energies (E , E_S), radiative (gAr) and autoionization (Aa) rates, branching ratio (K) for $1s^2 3lnl'$ [LSJ] even levels. $E_S = (E - 386.1597)$, $E(1s^2 2p_{1/2}) - E(1s^2 2s^2) = 450.6439$, $E(1s^2 2p_{3/2}) - E(1s^2 2s^2) = 450.7510$, $E(1s^2 3s) - E(1s^2 2s^2) = 689.0076$ in 10^3 cm^{-1} . $E(1s^2 2p_{1/2}) - E(1s^2 2s) = 7.9929 \text{ eV}$, $E(1s^2 2p_{3/2}) - E(1s^2 2s) = 8.0061 \text{ eV}$, $E(1s^2 3s) - E(1s^2 2s) = 37.538 \text{ eV}$

N	$3lnl'$	LSJ	$E(10^3 \text{ cm}^{-1})$	$E_S(\text{eV})$	Sum(gAr), s^{-1}	Aa, 10^{13} s^{-1} $1s^2 2s$	Aa, 10^{13} s^{-1} sum	K
21	$3s^2$	1S_0	526.037	17.338	7.000+09	6.1106	6.1892	0.9873
22	$3s3d$	1D_2	550.744	20.400	7.264+10	9.4895	18.3150	0.5181
22	$3s3d$	3D_1	553.651	20.761	5.541+10	1.3082	1.7243	0.7579
22	$3s3d$	3D_2	553.654	20.761	9.232+10	1.3082	1.7243	0.7579
22	$3s3d$	3D_3	553.658	20.761	1.292+11	1.3081	1.7242	0.7579
23	$3p^2$	3P_0	559.781	21.520	8.180+09	0	12.2347	0
23	$3p^2$	3P_1	559.789	21.521	2.454+10	0	12.2346	0
23	$3p^2$	3P_3	559.805	21.523	4.091+10	0	12.2348	0
23	$3p^2$	1S_0	569.382	22.710	1.250+10	8.8525	47.6885	0.1856
23	$3p^2$	1D_2	570.070	22.796	7.927+10	4.3541	17.0819	0.2551
25	$3d^2$	3F_2	580.124	24.042	1.418+11	0	4.1372	0
25	$3d^2$	3F_3	580.128	24.042	1.985+11	0	4.1372	0
25	$3d^2$	3F_4	580.133	24.043	2.551+11	0	4.1372	0
25	$3d^2$	1G_4	585.472	24.705	2.617+11	6.5100	30.2622	0.2151
25	$3d^2$	3P_0	589.387	25.190	3.114+10	0	0.0434	0
25	$3d^2$	3P_1	589.390	25.190	9.340+10	0	0.0433	0
25	$3d^2$	3P_2	589.394	25.191	1.556+11	0	0.0431	0
25	$3d^2$	1D_2	591.814	25.491	1.420+11	0.0045	5.9298	0.0008
24	$3s4s$	3S_1	607.397	27.422	1.524+10	0.0650	0.0650	0.9922
24	$3s4s$	1S_0	610.880	27.854	7.117+09	4.8588	4.8592	0.9998
25	$3d^2$	1S_0	615.141	28.382	3.513+10	0.0323	0.2402	0.1325
26	$3s4d$	3D_1	619.196	28.885	2.748+10	0.5266	0.5848	0.8991
26	$3s4d$	3D_2	619.198	28.885	4.579+10	0.5268	0.5851	0.8990
26	$3s4d$	3D_3	619.202	28.886	6.411+10	0.5271	0.5855	0.8989
26	$3s4d$	1D_2	619.938	28.977	4.789+10	3.1654	4.4193	0.7161
27	$3p4p$	1P_1	629.915	30.214	2.140+10	0	0.0853	0
27	$3p4p$	3D_1	631.465	30.406	3.093+10	0.4760	0.8168	0.5820
27	$3p4p$	3D_2	631.473	30.407	5.157+10	0.4764	0.8188	0.5806
27	$3p4p$	3D_3	631.484	30.408	7.224+10	0.4762	0.8173	0.5816
29	$3d4s$	1D_2	631.945	30.465	7.400+10	2.2440	9.4674	0.2370
27	$3p4p$	3S_1	632.882	30.581	3.095+10	0.0240	0.1847	0.1292
27	$3p4p$	3P_0	635.526	30.909	7.203+09	0	9.3291	0
27	$3p4p$	3P_1	635.532	30.910	2.161+10	0	9.3291	0
27	$3p4p$	3P_2	635.544	30.911	3.603+10	0	9.3295	0
29	$3d4s$	3D_1	636.302	31.005	5.040+10	0.1733	0.2005	0.8600
29	$3d4s$	3D_2	636.307	31.006	8.395+10	0.1730	0.2001	0.8574
29	$3d4s$	3D_3	636.314	31.007	1.174+11	0.1725	0.1993	0.8583

Table IIa (continued)

N	3nl'	LSJ	E(10^3cm^{-1})	$E_S(\text{eV})$	Sum(gAr), s^{-1}	Aa, $10^{13}s^{-1}$ 1s ² 2s	Aa, $10^{13}s^{-1}$ sum	K
28	3p4f	³ G ₃	638.375	31.262	6.606+10	0.0070	0.0578	0.1092
28	3p4f	³ G ₄	638.383	31.263	8.498+10	0.0070	0.0577	0.1094
28	3p4f	³ G ₅	638.393	31.264	1.039+11	0.0070	0.0576	0.1096
28	3p4f	¹ F ₃	638.698	31.302	6.337+10	0	0.0561	0
28	3p4f	³ F ₂	640.827	31.566	2.962+10	0	0.0841	0
28	3p4f	³ F ₃	640.829	31.566	4.147+10	0	0.0840	0
28	3p4f	³ F ₄	640.833	31.567	5.330+10	0	0.0840	0
27	3p4p	¹ S ₀	640.958	31.582	9.794+09	1.7250	23.444	0.0736
30	3d4d	¹ F ₃	641.628	31.665	1.554+11	0	0.1321	0
27	3p4p	¹ D ₂	642.145	31.729	6.257+10	2.5923	9.7831	0.2649
30	3d4d	³ D ₃	642.315	31.751	9.892+10	0.0004	0.0277	0.0137
30	3d4d	³ D ₂	642.316	31.751	7.082+10	0.0006	0.0284	0.0201
30	3d4d	³ D ₁	642.316	31.751	4.256+10	0.0004	0.0273	0.0139
31	3s5s	³ S ₁	643.152	31.854	1.670+10	0.0583	0.0633	0.9130
30	3d4d	³ G ₃	643.572	31.906	1.211+11	0.0178	0.3200	0.0553
30	3d4d	³ G ₄	643.577	31.907	1.557+11	0.0178	0.3201	0.0553
30	3d4d	³ G ₅	643.584	31.908	1.901+11	0.0178	0.3201	0.0553
30	3d4d	¹ P ₁	643.991	31.958	6.507+10	0	0.0061	0
28	3p4f	¹ G ₄	644.487	32.020	7.395+10	3.2274	6.7703	0.4766
31	3s5s	¹ S ₀	645.110	32.097	6.492+09	5.8468	11.9436	0.4895
28	3p4f	³ D ₃	646.290	32.243	8.440+10	0.1470	0.4091	0.3583
28	3p4f	³ D ₂	646.291	32.243	6.017+10	0.1471	0.4095	0.3582
28	3p4f	³ D ₁	646.291	32.243	3.606+10	0.1471	0.4098	0.3579
30	3d4d	³ F ₂	648.324	32.495	1.023+11	0.0005	3.3448	0.0001
30	3d4d	³ F ₃	648.327	32.496	1.431+11	0	3.3447	0
30	3d4d	³ F ₄	648.332	32.496	1.840+11	0	3.3448	0
32	3s5d	¹ D ₂	648.504	32.518	4.306+10	3.5221	3.7507	0.9388
30	3d4d	³ S ₁	649.076	32.589	6.167+10	0	0.0111	0
32	3s5d	³ D ₁	649.867	32.687	2.158+10	0.4371	0.4540	0.9613
32	3s5d	³ D ₂	649.868	32.687	3.597+10	0.4373	0.4543	0.9611
32	3s5d	³ D ₃	649.869	32.687	5.037+10	0.4375	0.4544	0.9613
28	3p4f	¹ D ₂	650.204	32.728	5.722+10	0.5604	2.6302	0.2130
30	3d4d	¹ G ₄	650.668	32.786	1.587+11	2.5151	16.9191	0.1486
30	3d4d	³ P ₀	652.113	32.965	2.298+10	0	0.1825	0
30	3d4d	³ P ₁	652.115	32.965	6.893+10	0	0.1821	0
30	3d4d	³ P ₂	652.118	32.966	1.149+11	0	0.1815	0
33	3s5g	³ G ₃	653.749	33.168	3.489+10	0	0.0762	0
33	3s5g	³ G ₄	653.750	33.168	4.486+10	0	0.0763	0
33	3s5g	³ G ₅	653.751	33.168	5.484+10	0	0.0764	0
30	3d4d	¹ D ₂	653.920	33.189	8.056+10	0.0059	3.2701	0.0018
33	3s5g	¹ G ₄	656.606	33.522	6.743+10	0.0079	1.1616	0.0068
30	3d4d	¹ S ₀	659.350	33.862	1.977+10	0.5912	2.3668	0.2496

Table IIa (continued)

N	3 nl'	LSJ	E(10^3cm^{-1})	E _s (eV)	Sum(gAr),s ⁻¹	Aa,10 ¹³ s ⁻¹ 1s ² 2s	Aa,10 ¹³ s ⁻¹ sum	K
39	3s6s	³ S ₁	660.243	33.973	1.411+10	0.0236	0.0246	0.9414
39	3s6s	¹ S ₀	660.767	34.038	5.670+09	0.7186	1.0252	0.7005
34	3p5p	³ D ₁	662.702	34.278	2.021+10	0.0144	0.0552	0.2577
40	3s6d	³ D ₂	662.707	34.278	3.367+10	0.0148	0.0554	0.2639
40	3s6d	³ D ₃	662.714	34.279	4.709+10	0.0153	0.0553	0.2733
34	3p5p	¹ P ₁	663.190	34.338	1.793+10	0	0.0627	0
40	3s6d	¹ D ₂	663.519	34.379	3.026+10	0.8730	1.3972	0.6246
40	3s6d	³ D ₁	664.501	34.501	2.160+10	0.3899	0.5618	0.6931
34	3p5p	³ D ₂	664.502	34.501	4.359+10	0.3874	0.8582	0.4510
34	3p5p	³ D ₃	664.513	34.502	5.055+10	0.3894	0.5624	0.6915
34	3p5p	¹ D ₂	664.515	34.502	5.454+10	0.3490	4.9597	0.0704
34	3p5p	³ P ₀	664.987	34.561	6.471+09	0	4.7153	0
34	3p5p	³ P ₁	664.992	34.561	1.943+10	0.0001	4.7070	0
34	3p5p	³ P ₂	665.003	34.563	3.237+10	0.0001	4.7160	0
34	3p5p	³ S ₁	665.176	34.584	2.542+10	0.0240	0.1414	0.1687
41	3s6g	³ G ₃	665.411	34.613	3.184+10	0.0070	0.0076	0.8690
41	3s6g	³ G ₄	665.412	34.613	4.093+10	0.0070	0.0076	0.8690
41	3s6g	³ G ₅	665.413	34.614	5.002+10	0.0070	0.0076	0.8691
41	3s6g	¹ G ₄	665.601	34.637	4.310+10	0.0456	0.1029	0.4411
35	3p5f	¹ F ₃	667.401	34.860	3.740+10	0	0.0806	0
35	3p5f	³ F ₂	667.944	34.927	2.696+10	0.0014	0.0120	0.1116
35	3p5f	³ F ₃	667.946	34.928	3.780+10	0.0015	0.0122	0.1177
35	3p5f	³ F ₄	667.950	34.928	4.815+10	0	0.0106	0
36	3d5s	³ D ₁	667.969	34.930	5.062+10	0.1606	0.1967	0.8195
36	3d5s	³ D ₂	667.973	34.931	8.407+10	0.1590	0.1946	0.8101
36	3d5s	³ D ₃	667.978	34.932	1.175+11	0.1585	0.1939	0.8101
35	3p5f	³ G ₃	668.109	34.948	5.011+10	0.0048	0.0748	0.0636
35	3p5f	³ G ₄	668.118	34.949	6.447+10	0.0049	0.0747	0.0650
35	3p5f	³ G ₅	668.128	34.950	7.892+10	0.0048	0.0747	0.0636
34	3p5p	¹ S ₀	669.352	35.102	1.151+10	3.3611	19.2544	0.1746
35	3p5f	³ D ₃	669.689	35.144	5.117+10	0.0030	0.1095	0.0272
35	3p5f	³ D ₂	669.696	35.144	3.657+10	0.0030	0.1093	0.0273
35	3p5f	³ D ₁	669.701	35.145	2.195+10	0.0029	0.1090	0.0264
36	3d5s	¹ D ₂	669.881	35.167	6.966+10	2.6473	4.3577	0.6072
37	3d5d	¹ F ₃	671.085	35.317	1.307+11	0	0.0474	0
35	3p5f	¹ G ₄	671.145	35.324	8.245+10	2.1811	7.3015	0.2987
37	3d5d	¹ P ₁	672.165	35.450	5.890+10	0	0.0085	0
37	3d5d	³ G ₃	672.192	35.454	1.279+11	0.0137	0.2341	0.0581
37	3d5d	³ G ₄	672.197	35.454	1.643+11	0.0137	0.2344	0.0580
37	3d5d	³ G ₅	672.203	35.455	2.007+11	0.0137	0.2344	0.0580
37	3d5d	³ D ₁	672.250	35.461	5.314+10	0.0157	0.0995	0.1550
37	3d5d	³ D ₂	672.252	35.461	8.856+10	0.0158	0.0997	0.1557

Table IIa. (continued)

N	3nl'	LSJ	E(10^3cm^{-1})	$E_S(\text{eV})$	Sum(gAr), s^{-1}	Aa, $10^{13}s^{-1}$ $1s^22s$	Aa, $10^{13}s^{-1}$ sum	K
37	3d5d	3D_3	672.256	35.462	1.240+11	0.0157	0.0993	0.1553
35	3p5f	1D_2	672.507	35.493	3.967+10	0.5491	0.8686	0.6316
37	3d5d	3F_2	673.354	35.598	9.807+10	0	2.1087	0
37	3d5d	3F_3	673.357	35.598	1.373+10	0	2.1086	0
37	3d5d	3F_4	673.361	35.599	1.764+11	0	2.1086	0
37	3d5d	3S_1	673.819	35.656	5.609+10	0.0037	0.0294	0.1183
38	3d5g	1H_5	674.140	35.695	1.942+11	0	0.0160	0
38	3d5g	3H_4	674.299	35.715	1.591+11	0	0.0212	0
38	3d5g	3H_5	674.301	35.715	1.945+11	0	0.0211	0
38	3d5g	3H_6	674.304	35.716	2.298+11	0	0.0211	0
38	3d5g	3I_5	674.637	35.757	1.970+11	0.0317	0.0915	0.3398
38	3d5g	3I_6	674.641	35.757	2.328+11	0.0317	0.0915	0.3398
38	3d5g	3I_7	674.645	35.758	2.685+11	0.0317	0.0915	0.3398
38	3d5g	3G_3	674.715	35.767	1.251+11	0.0028	0.0250	0.1045
38	3d5g	3G_4	674.716	35.767	1.609+11	0.0037	0.0316	0.1108
38	3d5g	3G_5	674.718	35.767	1.966+11	0.0028	0.0249	0.1049
38	3d5g	1G_4	674.748	35.771	1.681+11	0.6435	4.6202	0.1392
38	3d5g	1I_6	675.084	35.812	2.326+11	0.0451	0.1659	0.2689
38	3d5g	1F_3	675.144	35.820	1.293+11	0	0.0005	0
37	3d5d	3P_0	675.206	35.827	2.095+10	0	0.3285	0
37	3d5d	3P_1	675.207	35.828	6.284+10	0	0.3278	0
37	3d5d	3P_2	675.210	35.828	1.047+11	0	0.3271	0
38	3d5g	3F_4	675.273	35.836	1.669+11	0	0.0160	0
38	3d5g	3F_3	675.274	35.836	1.298+11	0	0.0158	0
38	3d5g	3F_2	675.274	35.836	9.272+10	0	0.0159	0
37	3d5d	1D_2	675.503	35.864	9.440+10	0.0979	3.6036	0.0272
38	3d5g	3D_3	676.551	35.994	1.356+11	0.0004	0.0051	0.0568
37	3d5d	1G_4	676.573	35.997	1.477+11	0.2943	5.7650	0.0510
38	3d5g	3D_2	676.555	35.995	9.679+10	0.0004	0.0051	0.0569
38	3d5g	3D_1	676.558	35.995	5.806+10	0.0004	0.0050	0.0577
38	3d5g	1D_2	677.368	36.095	9.152+10	0.0318	0.4431	0.0715
42	3p6p	1S_0	678.269	36.207	1.418+10	0.6078	4.7877	0.1269
42	3p6p	1P_1	679.253	36.329	1.634+10	0	0.0320	0
42	3p6p	3D_1	679.541	36.365	2.008+10	0.0207	0.0841	0.2442
42	3p6p	3D_2	679.550	36.366	3.349+10	0.0208	0.0847	0.2436
42	3p6p	3D_3	679.565	36.368	4.690+10	0.0209	0.0843	0.2460
42	3p6p	3P_0	680.115	36.436	6.307+09	0	2.2685	0
42	3p6p	3P_1	680.120	36.437	1.892+10	0	2.2674	0
42	3p6p	3P_2	680.130	36.438	3.153+10	0	2.2700	0
42	3p6p	3S_1	680.497	36.483	2.397+10	0.0040	0.0536	0.0735
42	3p6p	1D_2	680.628	36.499	5.626+10	0.0321	3.1386	0.0102

Table IIa. (continued)

N	3nl'	LSJ	E(10^3cm^{-1})	E _s (eV)	Sum(gAr),s ⁻¹	Aa,10 ¹³ s ⁻¹ 1s ² 2s	Aa,10 ¹³ s ⁻¹ sum	K
43	3p6f	¹ F ₃	681.453	36.602	3.413+10	0	0.0551	0
43	3p6f	³ F ₂	681.658	36.627	2.460+10	0	0.0016	0
43	3p6f	³ F ₃	681.660	36.627	3.446+10	0.0001	0.0020	0.0401
43	3p6f	³ F ₄	681.663	36.628	4.431+10	0.0001	0.0022	0.0371
43	3p6f	³ G ₃	681.778	36.642	3.817+10	0.0091	0.0778	0.1162
43	3p6f	³ G ₄	681.788	36.643	4.909+10	0.0092	0.0778	0.1174
43	3p6f	³ G ₅	681.799	36.645	6.005+10	0.0092	0.0781	0.1170
43	3p6f	³ D ₃	682.526	36.735	4.069+10	0.0015	0.0868	0.0172
43	3p6f	³ D ₂	682.535	36.736	2.915+10	0.0014	0.0863	0.0161
43	3p6f	³ D ₁	682.541	36.737	1.752+10	0.0014	0.0859	0.0162
44	3p6h	¹ H ₅	682.987	36.792	5.313+10	0	0.0001	0
44	3p6h	³ H ₄	682.996	36.793	4.359+10	0	0.0002	0
44	3p6h	³ H ₅	682.998	36.793	5.327+10	0	0.0002	0
44	3p6h	³ H ₆	683.000	36.793	6.297+10	0	0.0002	0
43	3p6f	¹ G ₄	683.370	36.839	5.799+10	2.3694	3.3413	0.7090
45	3d6s	³ D ₁	683.652	36.874	5.305+10	0.1035	0.1858	0.5518
45	3d6s	³ D ₂	683.655	36.875	8.842+10	0.1034	0.1854	0.5524
45	3d6s	³ D ₃	683.660	36.875	1.239+11	0.1032	0.1846	0.5537
44	3p6h	³ G ₅	683.687	36.879	5.642+10	0.0001	0.0001	0.1632
44	3p6h	³ G ₄	683.695	36.880	4.620+10	0.0007	0.0016	0.3312
44	3p6h	³ G ₃	683.704	36.881	3.590+10	0.0001	0.0001	0.1632
44	3p6h	³ I ₅	683.716	36.882	5.917+10	0.0049	0.0092	0.5032
44	3p6h	³ I ₆	683.725	36.883	6.995+10	0.0049	0.0093	0.4981
44	3p6h	³ I ₇	683.737	36.885	8.066+10	0.0049	0.0092	0.5053
44	3p6h	¹ G ₄	683.753	36.887	4.789+10	0.0244	0.0601	0.4024
45	3d6s	¹ D ₂	683.768	36.889	5.533+10	0.1967	0.3602	0.5444
44	3p6h	¹ I ₆	683.813	36.894	7.207+10	0.0064	0.0150	0.4115
46	3d6d	¹ S ₀	683.890	36.904	1.554+10	1.4198	10.9065	0.1302
43	3p6f	¹ D ₂	685.460	37.098	6.580+10	1.9693	2.9053	0.6765
46	3d6d	¹ F ₃	685.497	37.103	1.310+11	0	0.0214	0
46	3d6d	³ G ₃	685.931	37.157	1.363+11	0.0094	0.1197	0.0773
46	3d6d	³ G ₄	685.935	37.157	1.752+11	0.0094	0.1198	0.0772
46	3d6d	³ G ₅	685.940	37.158	2.141+11	0.0094	0.1198	0.0772
46	3d6d	³ D ₁	685.982	37.163	5.754+10	0.0218	0.0688	0.3083
46	3d6d	³ D ₂	685.984	37.163	9.587+10	0.0219	0.0690	0.3088
46	3d6d	³ D ₃	685.988	37.164	1.342+11	0.0219	0.0689	0.3092
46	3d6d	¹ P ₁	686.047	37.171	5.825+10	0.0001	0.0058	0.0129
46	3d6d	³ F ₂	686.551	37.234	9.550+10	0	1.3573	0
46	3d6d	³ F ₃	686.554	37.234	1.337+11	0	1.3572	0
46	3d6d	³ F ₄	686.558	37.235	1.718+11	0	1.3571	0

Table IIa. (continued)

N	3lnl'	LSJ	E(10^3cm^{-1})	$E_S(\text{eV})$	Sum(gAr), s^{-1}	Aa, $10^{13}s^{-1}$ 1s ² 2s	Aa, $10^{13}s^{-1}$ sum	K
47	3d6g	¹ H ₅	687.195	37.313	1.951+11	0	0.0149	0
47	3d6g	³ H ₄	687.305	37.327	1.598+11	0.0002	0.0214	0.0086
47	3d6g	³ H ₅	687.308	37.327	1.953+11	0	0.0203	0
47	3d6g	³ H ₆	687.311	37.328	2.307+11	0	0.0203	0
46	3d6d	³ S ₁	687.056	37.296	6.020+10	0.0054	0.0241	0.2068
47	3d6g	³ G ₃	687.425	37.342	1.261+11	0.0032	0.0228	0.1301
47	3d6g	³ G ₄	687.427	37.342	1.622+11	0.0053	0.0380	0.1332
47	3d6g	³ G ₅	687.428	37.342	1.982+11	0.0032	0.0228	0.1301
47	3d6g	¹ G ₄	687.448	37.345	1.660+11	0.5841	4.2850	0.1363
47	3d6g	³ I ₅	687.565	37.359	1.960+11	0.0324	0.0965	0.3297
47	3d6g	³ I ₆	687.568	37.360	2.316+11	0.0324	0.0965	0.3297
47	3d6g	³ I ₇	687.573	37.360	2.671+11	0.0324	0.0965	0.3299
47	3d6g	¹ F ₃	687.618	37.366	1.287+11	0	0.0005	0
47	3d6g	³ F ₄	687.722	37.379	1.657+11	0.0001	0.0254	0.0037
47	3d6g	³ F ₃	687.722	37.379	1.289+11	0	0.0248	0
47	3d6g	³ F ₂	687.722	37.379	9.207+10	0	0.0247	0
46	3d6d	³ P ₀	687.910	37.402	2.165+10	0	0.1151	0
46	3d6d	³ P ₁	687.911	37.402	6.494+10	0	0.1149	0
46	3d6d	³ P ₂	687.913	37.402	1.082+11	0	0.1146	0
47	3d6g	¹ I ₆	687.982	37.411	2.320+11	0.0549	0.2056	0.2647
47	3d6g	³ D ₃	688.468	37.471	1.338+11	0.0016	0.0087	0.1508
47	3d6g	³ D ₂	688.471	37.472	9.559+10	0.0016	0.0091	0.1463
47	3d6g	³ D ₁	688.474	37.472	5.734+10	0.0016	0.0087	0.1508
46	3d6d	¹ D ₂	688.634	37.492	1.080+11	0.0212	2.8334	0.0075
46	3d6d	¹ G ₄	688.782	37.510	1.565+11	0.3120	7.4246	0.0420
47	3d6g	¹ D ₂	689.869	37.645	9.676+10	0.1306	2.1359	0.0611
37	3d5d	¹ S ₀	697.349	38.572	3.255+10	0.0715	0.0716	0.9552

Table IIb. Energies (E , E_S), radiative (gAr) and autoionization (Aa) rates, branching ratio (K) for $1s^2 3lnl'$ [LSJ] odd levels.

N	$3lnl'$	LSJ	$E(10^3 \text{cm}^{-1})$	$E_S(\text{eV})$	Sum(gAr), s^{-1}	Aa, $10^{13}s^{-1}$ $1s^2 2s$	Aa, $10^{13}s^{-1}$ sum	K
20	3s3p	3P_0	536.898	18.684	6.475+09	3.8900	7.8097	0.4981
20	3s3p	3P_1	536.906	18.685	1.943+10	3.8899	7.8098	0.4980
20	3s3p	3P_2	536.923	18.687	3.238+10	3.8896	7.8100	0.4980
20	3s3p	1P_1	550.483	20.368	2.490+10	10.6126	31.9570	0.3321
21	3p3d	3F_2	565.717	22.256	8.706+10	0.1790	0.2994	0.5944
21	3p3d	3F_3	565.728	22.258	1.218+11	0.1790	0.2994	0.5944
21	3p3d	3F_4	565.743	22.259	1.566+11	0.1790	0.2994	0.5944
21	3p3d	1D_2	566.443	22.346	8.193+10	0	0.4406	0
21	3p3d	3D_1	573.237	23.188	5.203+10	0	6.7576	0
21	3p3d	3D_2	573.242	23.189	8.670+10	0	6.7575	0
21	3p3d	3D_3	573.250	23.190	1.211+11	0	6.7576	0
21	3p3d	3P_2	574.911	23.396	9.371+10	0.3318	2.1486	0.1543
21	3p3d	3P_1	574.915	23.396	5.626+10	0.3316	2.1488	0.1542
21	3p3d	3P_0	574.916	23.396	1.876+10	0.3315	2.1488	0.1541
21	3p3d	1F_3	582.455	24.331	1.349+11	0.1790	0.2994	0.5940
21	3p3d	1P_1	591.823	25.492	6.600+10	0.2023	10.2093	0.0198
22	3s4p	1P_1	614.396	28.290	1.579+10	1.2845	2.0302	0.6325
22	3s4p	3P_0	616.154	28.508	5.984+09	2.2106	3.5950	0.6148
22	3s4p	3P_1	616.157	28.508	1.795+10	2.2103	3.5945	0.6148
22	3s4p	3P_2	616.162	28.509	2.992+10	2.2096	3.5935	0.6148
23	3s4f	3F_2	624.052	29.487	2.364+10	0.2624	0.2680	0.9774
23	3s4f	3F_3	624.053	29.487	3.310+10	0.2624	0.2680	0.9774
23	3s4f	3F_4	624.054	29.487	4.254+10	0.2624	0.2680	0.9774
24	3p4s	3P_0	626.127	29.744	7.212+09	0.7295	2.0833	0.3500
24	3p4s	3P_1	626.135	29.745	2.164+10	0.7298	2.0837	0.3501
24	3p4s	3P_2	626.152	29.747	3.607+10	0.7301	2.0843	0.3502
23	3s4f	1F_3	626.209	29.754	5.708+10	0.0607	2.5185	0.0241
24	3p4s	1P_1	630.323	30.264	2.227+10	6.6765	18.6148	0.3587
25	3p4d	3D_1	633.380	30.643	3.584+10	0	0.2374	0
25	3p4d	3D_2	633.384	30.644	5.973+10	0	0.2374	0
25	3p4d	3D_3	633.390	30.644	8.359+10	0	0.2374	0
25	3p4d	1F_3	634.689	30.805	7.534+10	0.0047	0.1084	0.0429
25	3p4d	1D_2	636.107	30.981	5.492+10	0	0.2441	0
25	3p4d	1P_1	636.466	31.026	4.079+10	0.1121	0.9434	0.1187
25	3p4d	3F_2	638.746	31.308	5.547+10	0.0034	0.0089	0.3397
25	3p4d	3F_3	638.755	31.309	7.765+10	0.0034	0.0089	0.3397
25	3p4d	3F_4	638.767	31.311	9.984+10	0.0034	0.0089	0.3397
25	3p4d	3P_2	640.173	31.485	6.489+10	0.0289	1.0029	0.0288
25	3p4d	3P_1	640.176	31.485	3.896+10	0.0291	1.0008	0.0290
25	3p4d	3P_0	640.178	31.486	1.299+10	0.0291	0.9998	0.0291

Table IIb. (continued)

N	3nl'	LSJ	E(10^3cm^{-1})	E _S (eV)	Sum(gAr),s ⁻¹	Aa,10 ¹³ s ⁻¹ 1s ² 2s	Aa,10 ¹³ s ⁻¹ sum	K
26	3d4p	¹ D ₂	640.459	31.521	8.513+10	0	0.2709	0
26	3d4p	³ F ₂	641.255	31.619	9.646+10	0.0991	0.2455	0.4005
26	3d4p	³ F ₃	641.261	31.620	1.350+11	0.0991	0.2455	0.4005
26	3d4p	³ F ₄	641.269	31.621	1.735+11	0.0991	0.2456	0.4004
26	3d4p	³ D ₁	644.392	32.008	4.525+10	0	4.4879	0
26	3d4p	³ D ₂	644.396	32.009	7.540+10	0	4.4878	0
26	3d4p	³ D ₃	644.402	32.009	1.090+11	0	4.4879	0
27	3d4f	¹ G ₄	644.488	32.020	1.487+11	0	0.1899	0
27	3d4f	³ H ₄	644.726	32.049	1.556+11	0.3210	0.9463	0.3386
27	3d4f	³ H ₅	644.730	32.050	1.901+11	0.3210	0.9464	0.3386
27	3d4f	³ H ₆	644.735	32.051	2.246+11	0.3211	0.9464	0.3387
26	3d4p	³ P ₀	645.211	32.110	1.795+10	0.0734	1.3335	0.0550
26	3d4p	³ P ₁	645.212	32.110	5.385+10	0.0737	1.3326	0.0552
26	3d4p	³ P ₂	645.214	32.110	8.973+10	0.0741	1.3306	0.0556
28	3s5p	¹ P ₁	646.332	32.248	2.264+10	1.7926	5.7697	0.3107
28	3s5p	³ P ₀	647.497	32.393	6.094+09	1.2484	1.4768	0.8450
28	3s5p	³ P ₁	647.498	32.393	1.828+10	1.2482	1.4767	0.8449
28	3s5p	³ P ₂	647.500	32.393	3.045+10	1.2480	1.4766	0.8448
27	3d4f	³ F ₂	647.626	32.409	8.784+10	0.0016	0.1409	0.0112
27	3d4f	³ F ₃	647.629	32.409	1.229+11	0.0016	0.1409	0.0112
27	3d4f	³ F ₄	647.633	32.410	1.580+11	0.0016	0.1408	0.0112
26	3d4p	¹ F ₃	648.099	32.467	8.111+10	1.1142	5.9620	0.1868
27	3d4f	¹ D ₂	648.955	32.574	9.025+10	0	0.0047	0
27	3d4f	³ G ₃	649.605	32.654	1.210+11	0	0.4456	0
27	3d4f	³ G ₄	649.608	32.655	1.575+11	0	0.4456	0
27	3d4f	³ G ₅	649.611	32.655	1.925+11	0	0.4456	0
29	3s5f	³ F ₃	651.267	32.860	3.322+10	0.1891	0.1927	0.9789
29	3s5f	³ F ₂	651.267	32.860	2.373+10	0.1891	0.1927	0.9789
29	3s5f	³ F ₄	651.268	32.860	4.271+10	0.1892	0.1927	0.9794
27	3d4f	³ D ₁	651.917	32.941	5.574+10	0	0	0
27	3d4f	³ D ₂	651.917	32.941	9.289+10	0	0	0
27	3d4f	³ D ₃	651.918	32.941	1.301+11	0	0.0017	0
27	3d4f	¹ F ₃	652.061	32.959	9.772+10	0.0110	4.9751	0.0022
27	3d4f	¹ H ₅	653.277	33.109	2.005+11	0.6444	2.9218	0.2204
26	3d4p	¹ P ₁	653.538	33.142	4.013+10	0.1017	3.5615	0.0285
27	3d4f	³ P ₂	654.313	33.238	9.627+10	0.0051	0.0392	0.1240
27	3d4f	³ P ₁	654.317	33.238	5.774+10	0.0052	0.0392	0.1264
27	3d4f	³ P ₀	654.318	33.238	1.924+10	0.0052	0.0392	0.1264
29	3s5f	¹ F ₃	655.254	33.354	9.047+10	0.2156	4.3623	0.0494
27	3d4f	¹ P ₁	658.780	33.791	6.440+10	0.0016	0.3121	0.0051

Table IIb. (continued)

N	3lnl'	LSJ	E(10^3cm^{-1})	$E_S(\text{eV})$	Sum(gAr), s^{-1}	Aa, $10^{13}s^{-1}$ $1s^22s$	Aa, $10^{13}s^{-1}$ sum	K
30	3p5s	1P_1	660.853	34.048	1.618+10	0.2667	0.9610	0.2774
30	3p5s	3P_0	660.978	34.064	6.387+09	0.5192	1.3303	0.3901
30	3p5s	3P_1	660.987	34.065	1.915+10	0.5187	1.3293	0.3900
30	3p5s	3P_2	661.004	34.067	3.194+10	0.5218	1.3348	0.3907
35	3s6p	3P_0	662.242	34.221	5.154+09	0.3211	0.4750	0.6753
35	3s6p	3P_1	662.242	34.221	1.546+10	0.3202	0.4737	0.6752
35	3s6p	3P_2	662.243	34.221	2.578+10	0.3184	0.4709	0.6754
35	3s6p	1P_1	663.763	34.409	1.935+10	3.9552	9.8058	0.4033
36	3s6f	3F_2	664.626	34.516	2.240+10	0.1151	0.1171	0.9792
36	3s6f	3F_3	664.626	34.516	3.136+10	0.1151	0.1171	0.9792
36	3s6f	3F_4	664.626	34.516	4.033+10	0.1152	0.1172	0.9792
36	3s6f	1F_3	664.969	34.559	5.647+10	0.0125	1.0823	0.0115
37	3s6h	3H_4	665.034	34.567	3.906+10	0.0058	0.0079	0.6953
37	3s6h	3H_5	665.035	34.567	4.774+10	0.0057	0.0078	0.6923
37	3s6h	3H_6	665.037	34.567	5.642+10	0.0057	0.0078	0.6923
37	3s6h	1H_5	665.140	34.580	4.848+10	0.0095	0.0191	0.4862
31	3p5d	3D_1	665.436	34.616	2.584+10	0	0.5574	0
31	3p5d	3D_2	665.440	34.617	4.306+10	0	0.5573	0
31	3p5d	3D_3	665.445	34.618	6.027+10	0	0.5573	0
31	3p5d	1D_2	666.101	34.699	3.556+10	0	0.2681	0
31	3p5d	1F_3	666.215	34.713	5.232+10	0.0418	0.0693	0.5967
31	3p5d	3F_2	666.864	34.793	4.463+10	0.0084	0.0163	0.4846
31	3p5d	3F_3	666.873	34.795	6.250+10	0.0084	0.0162	0.4914
31	3p5d	3F_4	666.886	34.796	8.038+10	0.0084	0.0162	0.4914
31	3p5d	1P_1	667.550	34.878	3.761+10	0.0555	0.4346	0.1273
31	3p5d	3P_2	668.564	35.004	4.664+10	0.0827	0.8497	0.0972
31	3p5d	3P_1	668.571	35.005	2.799+10	0.0826	0.8484	0.0973
31	3p5d	3P_0	668.574	35.005	9.333+09	0.0826	0.8478	0.0973
32	3p5g	1G_4	668.775	35.030	4.452+10	0	0.0008	0
32	3p5g	3G_3	669.100	35.071	3.371+10	0	0.0015	0
32	3p5g	3G_4	669.102	35.071	4.335+10	0	0.0015	0
33	3d5p	1D_2	669.707	35.146	9.270+10	0	0.0468	0
32	3p5g	3G_5	669.104	35.071	5.298+10	0	0.0015	0
33	3d5p	3F_2	670.470	35.240	8.038+10	0.0371	0.0904	0.4032
33	3d5p	3F_3	670.472	35.241	1.119+11	0.0367	0.0897	0.4020
33	3d5p	3F_4	670.475	35.241	1.429+11	0.0362	0.0885	0.4018
32	3p5g	3H_4	670.622	35.259	6.923+10	0.1084	0.2420	0.4465
32	3p5g	3H_5	670.629	35.260	8.468+10	0.1084	0.2425	0.4456
32	3p5g	3H_6	670.638	35.261	1.002+11	0.1087	0.2429	0.4461
33	3d5p	3D_1	671.022	35.309	4.906+10	0	2.2260	0
33	3d5p	3D_2	671.026	35.309	8.174+10	0	2.2260	0
33	3d5p	3D_3	671.031	35.310	1.144+11	0	2.2260	0

Table IIb. (continued)

N	3nl'	LSJ	E(10^3cm^{-1})	E _s (eV)	Sum(gAr),s ⁻¹	Aa,10 ¹³ s ⁻¹ 1s ² 2s	Aa,10 ¹³ s ⁻¹ sum	K
32	3p5g	³ F ₄	671.153	35.325	7.689+10	0.0200	0.0363	0.5383
32	3p5g	³ F ₃	671.159	35.326	5.907+10	0.0195	0.0354	0.5380
32	3p5g	³ F ₂	671.164	35.326	4.181+10	0.0191	0.0345	0.5405
32	3p5g	¹ F ₃	671.618	35.383	5.150+10	0.0048	0.4633	0.0103
33	3d5p	³ P ₀	671.859	35.413	1.896+10	0.1245	0.5965	0.2081
33	3d5p	³ P ₁	671.861	35.413	5.687+10	0.1246	0.5957	0.2085
33	3d5p	³ P ₂	671.866	35.413	9.473+10	0.1246	0.5941	0.2091
32	3p5g	¹ H ₅	672.493	35.491	7.172+10	0.0369	0.0690	0.5298
34	3d5f	¹ G ₄	672.561	35.500	1.556+11	0	0.1187	0
34	3d5f	³ H ₄	673.371	35.600	1.392+11	0.0669	0.3267	0.2038
34	3d5f	³ H ₅	673.376	35.601	1.700+11	0.0668	0.3263	0.2038
34	3d5f	³ H ₆	673.381	35.601	2.007+11	0.0666	0.3258	0.2035
34	3d5f	³ F ₂	673.417	35.606	8.862+10	0.0008	0.1055	0.0075
34	3d5f	³ F ₃	673.419	35.606	1.240+11	0.0008	0.1055	0.0075
34	3d5f	³ F ₄	673.422	35.606	1.594+11	0.0008	0.1054	0.0075
34	3d5f	¹ D ₂	674.038	35.683	9.115+10	0	0.0090	0
33	3d5p	¹ F ₃	674.267	35.711	1.012+11	0.5626	7.7006	0.0730
34	3d5f	³ G ₃	674.349	35.721	1.250+11	0	0.3743	0
34	3d5f	³ G ₄	674.352	35.722	1.607+11	0	0.3741	0
34	3d5f	³ G ₅	674.355	35.722	1.964+11	0	0.3741	0
33	3d5p	¹ P ₁	675.032	35.806	3.698+10	0.0323	2.7908	0.0116
34	3d5f	³ D ₁	675.298	35.839	5.592+10	0	0.0322	0
34	3d5f	³ D ₂	675.298	35.839	9.321+10	0	0.0330	0
34	3d5f	³ D ₃	675.299	35.839	1.305+11	0	0.0330	0
34	3d5f	³ P ₂	675.966	35.922	9.168+10	0	0.1056	0
34	3d5f	³ P ₁	675.969	35.922	5.496+10	0	0.1056	0
34	3d5f	³ P ₀	675.971	35.922	1.831+10	0	0.1056	0
34	3d5f	¹ H ₅	676.506	35.989	1.894+11	0.5917	2.9081	0.2033
34	3d5f	¹ F ₃	676.535	35.992	1.263+11	0.5967	3.8203	0.1561
38	3p6s	³ P ₀	678.013	36.175	6.241+09	0.2186	0.4807	0.4542
38	3p6s	³ P ₁	678.021	36.176	1.872+10	0.2191	0.4820	0.4540
38	3p6s	³ P ₂	678.039	36.179	3.114+10	0.2185	0.4819	0.4528
38	3p6s	¹ P ₁	678.397	36.223	3.073+10	0.9260	2.7263	0.3395
34	3d5f	¹ P ₁	679.573	36.369	5.324+10	0.5397	1.3389	0.4026
39	3p6d	³ D ₁	680.617	36.498	1.985+10	0	0.6405	0
39	3p6d	³ D ₂	680.620	36.498	3.306+10	0	0.6375	0
39	3p6d	³ D ₃	680.625	36.499	4.631+10	0	0.6405	0
39	3p6d	¹ D ₂	680.668	36.504	2.994+10	0	0.1525	0
39	3p6d	¹ F ₃	681.044	36.551	5.690+10	0.0316	0.8590	0.0368
39	3p6d	³ F ₂	681.060	36.553	3.535+10	0.0009	0.0134	0.0638
39	3p6d	³ F ₃	681.073	36.555	5.050+10	0.0072	0.1885	0.0381
39	3p6d	³ F ₄	681.082	36.556	6.366+10	0.0009	0.0131	0.0652

Table IIb. (continued)

N	3nl'	LSJ	E(10^3cm^{-1})	E _s (eV)	Sum(gAr),s ⁻¹	Aa,10 ¹³ s ⁻¹ 1s ² 2s	Aa,10 ¹³ s ⁻¹ sum	K
39	3p6d	³ P ₂	681.938	36.662	4.071+10	0.0045	0.7109	0.0063
39	3p6d	³ P ₁	681.946	36.663	2.442+10	0.0045	0.7103	0.0063
39	3p6d	³ P ₀	681.950	36.663	8.141+09	0.0045	0.7099	0.0063
39	3p6d	¹ P ₁	682.327	36.710	3.581+10	0.0008	0.9214	0.0009
40	3p6g	¹ G ₄	682.180	36.692	4.244+10	0	0.0001	0
40	3p6g	³ G ₃	682.358	36.714	3.348+10	0	0.0031	0
40	3p6g	³ G ₄	682.360	36.714	4.305+10	0	0.0031	0
40	3p6g	³ G ₅	682.363	36.715	5.262+10	0	0.0031	0
40	3p6g	³ H ₄	682.781	36.766	4.591+10	0.0446	0.0744	0.5954
40	3p6g	³ H ₅	682.790	36.767	5.613+10	0.0446	0.0745	0.5946
40	3p6g	³ H ₆	682.802	36.769	6.636+10	0.0447	0.0745	0.5959
40	3p6g	³ F ₄	683.386	36.841	4.723+10	0.0027	0.0028	0.8121
40	3p6g	³ F ₃	683.396	36.843	3.675+10	0.0027	0.0028	0.8120
40	3p6g	³ F ₂	683.403	36.843	2.626+10	0.0027	0.0028	0.8120
40	3p6g	¹ H ₅	684.266	36.950	7.913+10	0.1491	0.3600	0.4133
40	3p6g	¹ F ₃	684.347	36.960	5.649+10	0.0064	0.2106	0.0303
41	3d6p	¹ D ₂	684.626	36.995	9.257+10	0	0.0207	0
41	3d6p	³ F ₂	685.107	37.055	9.590+10	0.0340	0.0676	0.4891
41	3d6p	³ F ₃	685.112	37.055	1.342+11	0.0340	0.0681	0.4856
41	3d6p	³ F ₄	685.117	37.056	1.725+11	0.0341	0.0664	0.4991
41	3d6p	³ D ₁	685.127	37.057	5.281+10	0	1.1952	0
41	3d6p	³ D ₂	685.131	37.058	8.801+10	0	1.1938	0
41	3d6p	³ D ₃	685.136	37.058	1.232+11	0	1.1935	0
41	3d6p	³ P ₀	685.818	37.143	1.997+10	0.1110	0.3804	0.2903
41	3d6p	³ P ₁	685.821	37.143	5.990+10	0.1110	0.3801	0.2905
41	3d6p	³ P ₂	685.825	37.144	9.977+10	0.1111	0.3794	0.2913
42	3d6f	¹ G ₄	686.289	37.201	1.602+11	0	0.0689	0
42	3d6f	³ H ₄	686.533	37.231	1.606+11	0.0585	0.2674	0.2173
42	3d6f	³ H ₅	686.537	37.232	1.962+11	0.0585	0.2673	0.2174
42	3d6f	³ H ₆	686.542	37.233	2.317+11	0.0584	0.2673	0.2170
42	3d6f	³ F ₂	686.640	37.245	9.127+10	0.0017	0.0703	0.0236
42	3d6f	³ F ₃	686.642	37.245	1.278+11	0.0017	0.0703	0.0236
42	3d6f	³ F ₄	686.644	37.245	1.642+11	0.0017	0.0702	0.0236
42	3d6f	¹ D ₂	686.974	37.286	9.245+10	0	0.0055	0
42	3d6f	³ G ₃	687.195	37.313	1.259+11	0	0.2783	0
42	3d6f	³ G ₄	687.197	37.314	1.618+11	0	0.2783	0
42	3d6f	³ G ₅	687.201	37.314	1.977+11	0	0.2783	0
41	3d6p	¹ F ₃	687.421	37.341	1.166+11	0.8825	8.9663	0.0984
43	3d6h	¹ I ₆	687.656	37.371	2.312+11	0	0.0007	0

Table IIb. (continued)

N	3nl'	LSJ	E(10^3cm^{-1})	$E_s(\text{eV})$	Sum(gAr), s^{-1}	Aa, $10^{13}s^{-1}$ $1s^22s$	Aa, $10^{13}s^{-1}$ sum	K
43	3d6h	3I_5	687.658	37.371	1.956+11	0	0.0007	0
43	3d6h	3I_6	687.662	37.371	2.311+11	0	0.0007	0
43	3d6h	3I_7	687.663	37.371	2.666+11	0	0.0007	0
42	3d6f	3D_1	687.707	37.377	5.619+10	0	0.0267	0
42	3d6f	3D_2	687.707	37.377	9.365+10	0	0.0267	0
42	3d6f	3D_3	687.708	37.377	1.311+11	0	0.0268	0
43	3d6h	3H_4	687.769	37.385	1.625+11	0	0.0018	0
43	3d6h	3H_5	687.770	37.385	1.985+11	0	0.0018	0
43	3d6h	3H_6	687.772	37.385	2.346+11	0	0.0018	0
43	3d6h	1H_5	687.788	37.387	1.984+11	0.0003	0.0101	0.0252
43	3d6h	1G_4	687.918	37.403	1.658+11	0	0.0001	0
43	3d6h	3G_5	687.921	37.403	2.027+11	0	0	0
43	3d6h	3G_4	687.922	37.404	1.658+11	0	0	0
43	3d6h	3G_3	687.922	37.404	1.290+11	0	0.0001	0
43	3d6h	3K_6	687.931	37.405	2.318+11	0.0018	0.0043	0.2959
43	3d6h	3K_7	687.933	37.405	2.674+11	0.0018	0.0044	0.2911
43	3d6h	3K_8	687.938	37.406	3.029+11	0.0018	0.0043	0.2960
43	3d6h	1K_7	687.952	37.407	2.674+11	0.0020	0.0054	0.2784
42	3d6f	3P_2	688.189	37.437	9.688+10	0.0163	0.0665	0.2382
42	3d6f	3P_1	688.193	37.437	5.810+10	0.0162	0.0661	0.2419
42	3d6f	3P_0	688.194	37.437	1.936+10	0.0161	0.0659	0.2373
43	3d6h	3F_4	688.354	37.457	1.701+11	0.0002	0.0004	0.0873
43	3d6h	3F_3	688.357	37.458	1.324+11	0.0129	0.0731	0.1720
43	3d6h	3F_2	688.360	37.458	9.447+10	0.0002	0.0004	0.0874
43	3d6h	1F_3	688.372	37.459	1.331+11	0.2610	1.4801	0.1748
41	3d6p	1P_1	688.909	37.526	5.301+10	0.0041	3.6710	0.0011
42	3d6f	1F_3	688.998	37.537	1.291+11	0.4749	2.2239	0.2134
42	3d6f	1H_5	689.507	37.600	1.948+11	1.0706	4.9809	0.2149
42	3d6f	1P_1	692.651	37.990	8.211+10	0.0066	3.7064	0.0018

Table IIc. Energy (E) and autoionization (Aa) rates for $1s^23l3l'$ [LSJ] levels. Comparison of results obtained by Cowan (a) and MZ (b) codes

N	$3l3l'$	LSJ	E(10^3cm^{-1})		Aa, 10^{13}s^{-1} $1s^22s$		Aa, 10^{13}s^{-1} sum	
			a	b	a	b	a	b
20	3s3p	3P_0	536.898	537.282	3.8900	6.41	7.8097	15.5
20	3s3p	3P_1	536.906	537.290	3.8899	6.41	7.8098	15.5
20	3s3p	3P_2	536.923	537.309	3.8896	6.40	7.8100	15.5
20	3s3p	1P_1	550.483	550.7451	0.61263	22.2	1.9570	70.9
21	3p3d	3F_2	565.717	564.823	0.1790	0.107	0.2994	0.341
21	3p3d	3F_3	565.728	564.838	0.1790	0.107	0.2994	0.341
21	3p3d	3F_4	565.743	564.858	0.1790	0.107	0.2994	0.341
21	3p3d	1D_2	566.443	566.492	0	7.99-06	0.4406	1.25
21	3p3d	3D_1	573.237	574.194	0	1.95-05	6.7576	20.1
21	3p3d	3D_2	573.242	574.200	0	2.52-05	6.7575	20.1
21	3p3d	3D_3	573.250	574.209	0	2.79-05	6.7576	20.1
21	3p3d	3P_2	574.911	575.814	0.3318	0.570	2.1486	8.92
21	3p3d	3P_1	574.915	575.820	0.3316	0.569	2.1488	8.92
21	3p3d	3P_0	574.916	575.825	0.3315	0.569	2.1488	8.92
21	3p3d	1F_3	582.455	582.209	0.1790	14.4	0.2994	89.8
21	3p3d	1P_1	591.823	592.230	0.2023	0.464	10.2093	29.4
21	$3s^2$	1S_0	526.037	525.239	6.1106	17.0	6.1892	17.8
22	3s3d	1D_2	550.744	549.910	9.4895	14.9	18.3150	26.1
22	3s3d	3D_1	553.651	553.712	1.3082	2.23	1.7243	4.41
22	3s3d	3D_2	553.654	553.715	1.3082	2.23	1.7243	4.41
22	3s3d	3D_3	553.658	553.719	1.3081	2.23	1.7242	4.41
23	$3p^2$	3P_0	559.781	559.408	0	5.26-05	12.2347	28.7
23	$3p^2$	3P_1	559.789	559.417	0	2.43-08	12.2346	28.7
23	$3p^2$	3P_2	559.805	559.433	0	5.81-05	12.2348	28.7
23	$3p^2$	1S_0	569.382	569.382	8.8525	11.2	47.6885	112
23	$3p^2$	1D_2	570.070	570.385	4.3541	22.6	17.0819	65.6
25	$3d^2$	3F_2	580.124	578.824	0	3.07-06	4.1372	22.6
25	$3d^2$	3F_3	580.128	578.828	0	2.35-10	4.1372	22.6
25	$3d^2$	3F_4	580.133	578.833	0	1.20-05	4.1372	22.6
25	$3d^2$	1G_4	585.472	583.609	6.5100	29.0	30.2622	166
25	$3d^2$	3P_0	589.387	584.860	0	2.34-06	0.0434	0.0683
25	$3d^2$	3P_1	589.390	584.863	0	5.70-11	0.0433	0.0680
25	$3d^2$	3P_2	589.394	584.867	0	8.14-07	0.0431	0.0673
25	$3d^2$	1D_2	591.814	593.008	0.0045	2.28	5.9298	29.5
25	$3d^2$	1S_0	615.141	617.659	0.0323	2.58	0.2402	4.82

Table III. Wavelengths (WL) radiative transition probabilities (gAr), branching ratio (K) and factor intensities (Qd) for satellites lines CIII.

a) Transitions: even-odd

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
1	2s ² (¹ S ₀)	2p4d(¹ P ₁)	254.8	4.072+08	0.9999	4.072+08
1	2s ² (¹ S ₀)	2p5d(¹ P ₁)	241.5	3.089+08	0.9999	3.089+08
1	2s ² (¹ S ₀)	2p6d(¹ P ₁)	234.7	1.973+08	0.9998	1.973+08
2	2p ² (³ P ₂)	2p4d(³ D ₃)	397.3	3.530+10	0.9446	3.334+10
2	2p ² (³ P ₁)	2p4d(³ D ₂)	397.2	1.964+10	0.9603	1.886+10
2	2p ² (³ P ₂)	2p4d(³ P ₂)	396.0	1.158+10	0.9999	1.158+10
2	2p ² (³ P ₂)	2p5d(³ D ₃)	363.6	1.743+10	0.9803	1.709+10
2	2p ² (³ P ₁)	2p5d(³ D ₂)	363.5	1.017+10	0.9927	1.010+10
2	2p ² (³ P ₂)	2p6d(³ D ₃)	347.8	1.016+10	0.9908	1.007+10
2	2p ² (¹ D ₂)	2p4d(¹ D ₂)	418.1	8.376+09	0.9991	8.368+09
2	2p ² (¹ D ₂)	2p4d(¹ F ₃)	410.1	4.348+10	1.0000	4.348+10
2	2p ² (¹ D ₂)	2p5d(¹ D ₂)	379.8	2.797+09	0.9999	2.797+09
2	2p ² (¹ D ₂)	2p5d(¹ F ₃)	376.4	2.628+10	1.0000	2.628+10
2	2p ² (¹ D ₂)	2p6d(¹ F ₃)	360.2	2.298+10	1.0000	2.298+10
2	2p ² (¹ S ₀)	2p4d(¹ P ₁)	475.3	9.823+09	0.9999	9.822+09
2	2p ² (¹ S ₀)	2p5d(¹ P ₁)	431.0	6.014+09	0.9999	6.011+09
2	2p ² (¹ S ₀)	2p6d(¹ P ₁)	410.0	5.789+09	0.9998	5.788+09
3	2s3s(¹ S ₀)	2p6d(¹ P ₁)	557.4	1.432+08	0.9998	1.431+08
4	2s3d(³ D ₃)	2p4d(³ P ₂)	835.0	1.056+08	0.9999	1.056+08
4	2s3d(³ D ₂)	2p5d(³ P ₂)	701.4	2.257+08	0.9999	2.257+08
4	2s3d(³ D ₂)	2p5d(³ P ₁)	701.2	1.222+08	0.9999	1.222+08
4	2s3d(¹ D ₂)	2p6d(¹ P ₁)	669.5	1.030+09	0.9998	1.030+09
4	2s3d(³ D ₃)	2p6d(³ D ₂)	646.2	1.057+08	0.9979	1.055+08
4	2s3d(³ D ₃)	2p6d(³ D ₃)	646.1	1.617+08	0.9908	1.602+08
4	2s3d(³ D ₃)	2p6d(³ P ₂)	645.4	7.440+08	0.9999	7.439+08
4	2s3d(³ D ₂)	2p6d(³ P ₂)	645.4	1.932+08	0.9999	1.932+08
4	2s3d(³ D ₂)	2p6d(³ P ₁)	645.3	4.143+08	0.9999	4.143+08
4	2s3d(³ D ₁)	2p6d(³ P ₁)	645.3	1.723+08	0.9999	1.723+08
4	2s3d(³ D ₁)	2p6d(³ P ₀)	645.2	1.988+08	0.9999	1.988+08
5	2p3p(¹ S ₀)	2p4d(¹ P ₁)	2209.4	5.879+08	0.9999	5.878+08
5	2p3p(¹ D ₂)	2p4d(¹ F ₃)	1772.6	3.858+09	1.0000	3.858+09
5	2p3p(³ P ₂)	2p4d(³ D ₃)	1730.5	3.133+09	0.9446	2.959+09

Table IIIa (continued)

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
5	2p3p(³ P ₁)	2p4d(³ D ₂)	1729.9	1.735+09	0.9603	1.666+09
5	2p3p(³ S ₁)	2p4d(³ P ₂)	1562.6	1.236+09	0.9999	1.236+09
5	2p3p(³ D ₃)	2p4d(³ F ₄)	1506.6	7.222+09	1.0000	7.222+09
5	2p3p(³ D ₂)	2p4d(³ F ₃)	1506.5	4.986+09	1.0000	4.986+09
5	2p3p(³ D ₁)	2p4d(³ F ₂)	1506.4	3.291+09	1.0000	3.291+09
5	2p3p(¹ S ₀)	2p5d(¹ P ₁)	1495.5	3.777+08	0.9999	3.777+08
5	2p3p(¹ P ₁)	2p4d(¹ D ₂)	1462.5	2.089+09	0.9991	2.087+09
5	2p3p(¹ S ₀)	2p6s(¹ P ₁)	1334.2	1.972+08	1.0000	1.972+08
5	2p3p(¹ D ₂)	2p5d(¹ F ₃)	1278.5	1.899+09	1.0000	1.899+09
5	2p3p(¹ S ₀)	2p6d(¹ P ₁)	1269.8	5.451+08	0.9998	5.450+08
5	2p3p(³ P ₂)	2p5d(³ D ₃)	1233.2	1.757+09	0.9446	1.660+09
5	2p3p(³ P ₁)	2p5d(³ D ₂)	1232.9	1.016+09	0.9927	1.009+09
5	2p3p(¹ D ₂)	2p6d(¹ F ₃)	1109.0	2.363+09	1.0000	2.363+09
5	2p3p(³ D ₃)	2p5d(³ F ₄)	1107.1	2.186+09	1.0000	2.186+09
5	2p3p(³ D ₂)	2p5d(³ F ₃)	1107.1	1.544+09	1.0000	1.544+09
5	2p3p(³ P ₂)	2p6d(³ D ₃)	1068.3	1.300+09	0.9908	1.288+09
6	2s4s(³ S ₁)	2p4d(³ P ₂)	1271.0	1.246+08	0.9999	1.246+08
7	2s4d(¹ D ₂)	2p4d(¹ D ₂)	1629.9	1.417+09	0.9991	1.416+09
7	2s4d(³ D ₂)	2p4d(³ D ₂)	1540.5	1.380+09	0.9603	1.325+09
7	2s4d(³ D ₃)	2p4d(³ D ₃)	1540.3	2.574+09	0.9446	2.431+09
7	2s4d(¹ D ₂)	2p4d(¹ F ₃)	1514.3	1.811+09	1.0000	1.811+09
8	2p4p(¹ P ₁)	2p5s(¹ P ₁)	3939.5	1.072+08	1.0000	1.072+08
8	2p4p(¹ P ₁)	2p5d(¹ D ₂)	3458.8	2.476+08	0.9999	2.476+08
8	2p4p(³ D ₂)	2p5s(³ P ₁)	4270.7	1.796+08	0.9981	1.793+08
8	2p4p(³ D ₃)	2p5s(³ P ₂)	4268.1	3.308+08	0.9916	3.280+08
8	2p4p(³ D ₃)	2p5d(³ F ₄)	3544.2	7.899+08	1.0000	7.899+08
8	2p4p(³ D ₂)	2p5d(³ F ₃)	3543.3	5.544+08	1.0000	5.544+08
8	2p4p(³ D ₁)	2p5d(³ F ₂)	3540.8	2.945+08	1.0000	2.945+08
8	2p4p(³ D ₃)	2p5d(³ D ₃)	3468.1	1.334+08	0.9803	1.308+08
8	2p4p(³ D ₃)	2p6s(³ P ₂)	2609.5	1.432+08	0.9990	1.431+08
8	2p4p(³ D ₃)	2p6d(³ F ₄)	2437.8	4.153+08	1.0000	4.153+08
8	2p4p(³ D ₂)	2p6d(³ F ₃)	2437.4	2.955+08	1.0000	2.955+08
8	2p4p(³ D ₃)	2p6d(³ D ₃)	2418.3	1.015+08	0.9908	1.006+08
8	2p4p(³ S ₁)	2p5d(³ P ₂)	3592.8	2.196+08	0.9999	2.196+08
8	2p4p(³ S ₁)	2p5d(³ P ₁)	3589.0	1.275+08	0.9999	1.275+08
8	2p4p(³ S ₁)	2p6d(³ P ₂)	2487.9	1.555+08	0.9999	1.555+08
8	2p4p(³ P ₂)	2p5s(³ P ₂)	4891.7	2.879+08	0.9916	2.855+08

Table IIIa (continued)

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
8	2p4p(³ P ₂)	2p5d(³ D ₃)	3869.0	5.763+08	0.9803	5.649+08
8	2p4p(³ P ₁)	2p5d(³ D ₂)	3866.9	3.305+08	0.9927	3.281+08
8	2p4p(³ P ₀)	2p5d(³ D ₁)	3865.7	1.482+08	0.9832	1.457+08
8	2p4p(³ P ₂)	2p5d(³ P ₂)	3821.5	1.645+08	0.9999	1.645+08
8	2p4p(³ P ₂)	2p6s(³ P ₂)	2830.1	1.396+08	0.9990	1.395+08
8	2p4p(³ P ₂)	2p6d(³ D ₃)	2606.6	4.334+08	0.9908	4.294+08
8	2p4p(³ P ₁)	2p6d(³ D ₂)	2605.9	2.578+08	0.9979	2.573+08
8	2p4p(³ P ₀)	2p6d(³ D ₁)	2605.3	1.172+08	0.9845	1.154+08
8	2p4p(³ P ₂)	2p6d(³ P ₂)	2595.4	1.427+08	0.9999	1.427+08
10	2s5s(¹ S ₀)	2p5s(¹ P ₁)	1475.1	1.195+09	1.0000	1.195+09
10	2s5s(³ S ₁)	2p5s(³ P ₂)	1534.0	1.272+09	0.9916	1.261+09
11	2s5d(³ D ₂)	2p5d(³ F ₃)	1555.5	1.402+09	1.0000	1.402+09
11	2s5d(³ D ₃)	2p5d(³ F ₄)	1554.4	2.118+09	1.0000	2.118+09
11	2s5d(³ D ₃)	2p5d(³ F ₃)	1539.6	1.782+09	1.0000	1.782+09
11	2s5d(³ D ₃)	2p5d(³ P ₂)	1532.0	1.270+09	0.9999	1.270+09
11	2s5d(¹ D ₂)	2p5d(¹ F ₃)	1534.0	2.074+09	1.0000	2.074+09
11	2s5d(¹ D ₂)	2p5d(¹ P ₁)	1526.2	1.054+09	0.9999	1.054+09
12	2s5g(³ G ₄)	2p5g(³ G ₄)	1550.5	1.340+09	0.7475	1.002+09
12	2s5g(³ G ₃)	2p5g(³ G ₃)	1550.5	1.735+09	0.7476	1.297+09
12	2s5g(³ G ₅)	2p5g(³ G ₅)	1550.2	3.053+09	0.9992	3.051+09
12	2s5g(³ G ₃)	2p5g(³ H ₄)	1545.5	1.894+09	1.0000	1.893+09
12	2s5g(³ G ₄)	2p5g(³ H ₅)	1545.5	1.680+09	1.0000	1.679+09
12	2s5g(³ G ₅)	2p5g(³ H ₆)	1544.0	2.815+09	1.0000	2.814+09
12	2s5g(³ G ₅)	2p5g(³ F ₄)	1543.1	2.226+09	0.9896	2.203+09
12	2s5g(³ G ₃)	2p5g(³ F ₂)	1541.8	1.421+09	0.9907	1.408+09
12	2s5g(³ G ₄)	2p5g(³ F ₃)	1541.8	1.240+09	0.9838	1.220+09
12	2s5g(¹ G ₄)	2p5g(¹ G ₄)	1550.2	1.577+09	0.9992	1.576+09
12	2s5g(¹ G ₄)	2p5g(¹ H ₅)	1544.0	1.611+09	1.0000	1.611+09
12	2s5g(¹ G ₄)	2p5g(¹ F ₃)	1543.0	1.250+09	0.9804	1.226+09
15	2s6s(³ S ₁)	2p6s(³ P ₂)	1538.9	1.330+09	0.9990	1.329+09
15	2s6s(¹ S ₀)	2p6s(¹ P ₁)	1550.5	8.653+08	1.0000	8.653+08
16	2s6d(³ D ₂)	2p6d(³ F ₃)	1552.2	1.350+09	1.0000	1.350+09
16	2s6d(³ D ₃)	2p6d(³ F ₄)	1551.0	2.116+09	1.0000	2.116+09
16	2s6d(³ D ₃)	2p6d(³ D ₃)	1543.1	1.718+09	0.9803	1.684+09
16	2s6d(³ D ₃)	2p6d(³ P ₂)	1539.2	1.210+09	0.9999	1.210+09

Table IIIa (continued)

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
16	2s6d(¹ D ₂)	2p6d(¹ F ₃)	1537.2	1.501+09	1.0000	1.501+09
16	2s6d(¹ D ₂)	2p6d(¹ P ₁)	1531.0	1.237+09	0.9998	1.237+09
17	2s6g(³ G ₄)	2p6g(³ G ₄)	1549.5	1.272+09	0.9322	1.186+09
17	2s6g(³ G ₃)	2p6g(³ G ₃)	1549.5	1.585+09	0.9515	1.508+09
17	2s6g(³ G ₅)	2p6g(³ G ₅)	1549.3	2.781+09	1.0000	2.781+09
17	2s6g(³ G ₃)	2p6g(³ H ₄)	1546.6	1.563+09	1.0000	1.563+09
17	2s6g(³ G ₄)	2p6g(³ H ₅)	1546.5	1.564+09	1.0000	1.564+09
17	2s6g(³ G ₅)	2p6g(³ H ₆)	1545.3	2.478+09	1.0000	2.478+09
17	2s6g(³ G ₅)	2p6g(³ F ₄)	1544.9	2.342+09	0.9936	2.327+09
17	2s6g(³ G ₃)	2p6g(³ F ₂)	1543.8	1.627+09	0.9946	1.618+09
17	2s6g(³ G ₄)	2p6g(³ F ₃)	1543.8	1.526+09	0.9927	1.515+09
17	2s6g(¹ G ₄)	2p6g(¹ G ₄)	1549.3	1.470+09	0.9998	1.470+09
17	2s6g(¹ G ₄)	2p6g(¹ H ₅)	1545.2	1.524+09	1.0000	1.524+09
17	2s6g(¹ G ₄)	2p6g(¹ F ₃)	1544.9	1.433+09	0.9935	1.424+09

Table III. Wavelengths (WL), radiative transition probabilities (gAr), branching ratio (K) and factor intensities (Qd) for satellites lines CIII.

b) Transitions: odd-even

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
1	2s2p(³ P ₂)	2p5p(³ D ₃)	279.5	2.137+09	0.9973	2.131+09
1	2s2p(³ P ₁)	2p5p(³ D ₂)	279.5	1.170+09	0.9974	1.167+09
1	2s2p(³ P ₂)	2p5p(³ S ₁)	279.1	1.425+09	1.0000	1.425+09
1	2s2p(³ P ₂)	2p5p(³ P ₂)	278.4	1.138+09	0.9348	1.064+09
1	2s2p(³ P ₂)	2p6p(³ D ₃)	269.2	1.127+09	0.9992	1.126+09
1	2s2p(³ P ₂)	2p6p(³ S ₁)	269.0	1.556+09	1.0000	1.556+09
1	2s2p(³ P ₁)	2p6p(³ S ₁)	268.9	1.009+09	1.0000	1.009+09
1	2s2p(¹ P ₁)	2p4p(¹ D ₂)	347.7	5.479+09	1.0000	5.478+09
1	2s2p(¹ P ₁)	2p5p(¹ P ₁)	324.1	3.691+09	0.9616	3.549+09
1	2s2p(¹ P ₁)	2p5p(¹ D ₂)	321.2	3.223+09	0.999	3.223+09
1	2s2p(¹ P ₁)	2p6p(¹ P ₁)	310.1	4.598+09	0.9859	4.533+09
1	2s2p(¹ P ₁)	2p6p(¹ D ₂)	308.6	2.229+09	0.9998	2.229+09
1	2s2p(¹ P ₁)	2p6f(¹ D ₂)	307.9	2.332+09	0.9981	2.328+09
2	2s3p(¹ P ₁)	2p6p(¹ P ₁)	611.8	2.164+08	0.9859	2.133+08
2	2s3p(¹ P ₁)	2p6p(¹ D ₂)	605.9	1.633+08	0.9998	1.633+08
3	2p3s(³ P ₂)	2p4f(³ D ₃)	1209.9	1.285+08	0.9976	1.282+08
3	2p3s(³ P ₂)	2p5p(³ D ₂)	986.3	1.114+08	0.9974	1.111+08
3	2p3s(³ P ₁)	2p5p(³ D ₁)	985.9	1.124+08	0.9973	1.121+08
3	2p3s(³ P ₂)	2p5p(³ D ₃)	985.8	6.589+08	0.9973	6.571+08
3	2p3s(³ P ₁)	2p5p(³ D ₂)	985.6	3.595+08	0.9974	3.586+08
3	2p3s(³ P ₀)	2p5p(³ D ₁)	985.6	1.589+08	0.9973	1.585+08
3	2p3s(³ P ₂)	2p5p(³ S ₁)	980.5	1.121+08	1.0000	1.121+08
3	2p3s(³ P ₂)	2p5p(³ P ₂)	972.8	2.037+08	0.9348	1.904+08
3	2p3s(³ P ₂)	2p6p(³ D ₃)	868.5	3.162+08	0.9992	3.160+08
3	2p3s(³ P ₁)	2p6p(³ D ₂)	868.4	1.750+08	0.9992	1.749+08
3	2p3s(¹ P ₁)	2p4p(¹ D ₂)	1294.8	1.261+09	1.0000	1.261+09
3	2p3s(¹ P ₁)	2p4p(¹ S ₀)	1221.2	1.111+08	1.0000	1.111+08
3	2p3s(¹ P ₁)	2p5p(¹ P ₁)	1018.8	1.699+08	0.9616	1.634+08
3	2p3s(¹ P ₁)	2p5p(¹ D ₂)	991.2	3.882+08	0.9999	3.882+08
3	2p3s(¹ P ₁)	2p6p(¹ P ₁)	892.7	1.346+08	0.9859	1.327+08
3	2p3s(¹ P ₁)	2p6p(¹ D ₂)	880.1	2.457+08	0.9998	2.457+08
4	2p3d(¹ D ₂)	2p4f(¹ F ₃)	1757.9	9.008+09	0.9821	8.847+09
4	2p3d(¹ D ₂)	2p4f(¹ D ₂)	1709.8	1.230+09	0.9986	1.228+09

Table IIIb (continued)

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
4	2p3d(¹ D ₂)	2p5f(¹ F ₃)	1251.7	3.008+09	0.9973	3.000+09
4	2p3d(¹ D ₂)	2p6f(¹ F ₃)	1083.6	1.207+09	0.9991	1.206+09
4	2p3d(³ F ₂)	2p4f(³ G ₃)	1789.1	1.024+10	1.0000	1.024+10
4	2p3d(³ F ₃)	2p4f(³ G ₄)	1789.1	1.317+10	1.0000	1.317+10
4	2p3d(³ F ₄)	2p4f(³ G ₅)	1788.8	1.763+10	1.0000	1.763+10
4	2p3d(³ F ₃)	2p5f(³ G ₄)	1275.7	2.262+09	1.0000	2.262+09
4	2p3d(³ F ₂)	2p5f(³ G ₃)	1275.7	1.785+09	1.0000	1.785+09
4	2p3d(³ F ₄)	2p5f(³ G ₅)	1275.6	3.239+09	1.0000	3.239+09
4	2p3d(³ F ₃)	2p6f(³ G ₄)	1103.4	1.027+09	1.0000	1.027+09
4	2p3d(³ F ₄)	2p6f(³ G ₅)	1103.4	1.628+09	1.0000	1.628+09
4	2p3d(³ D ₃)	2p4f(³ F ₄)	1894.9	1.099+10	0.9930	1.091+10
4	2p3d(³ D ₂)	2p4f(³ F ₃)	1894.6	7.423+09	0.9903	7.351+09
4	2p3d(³ D ₁)	2p4f(³ F ₂)	1894.5	5.201+09	0.3666	1.907+09
4	2p3d(³ D ₃)	2p4f(³ D ₃)	1850.9	1.512+09	0.9976	1.508+09
4	2p3d(³ D ₃)	2p5f(³ F ₄)	1320.0	3.504+09	0.9991	3.501+09
4	2p3d(³ D ₂)	2p5f(³ F ₃)	1319.8	2.334+09	0.9990	2.332+09
4	2p3d(³ D ₁)	2p5f(³ F ₂)	1319.7	1.703+09	0.5020	8.549+08
4	2p3d(³ D ₃)	2p6f(³ F ₄)	1134.5	1.564+09	0.9997	1.564+09
4	2p3d(³ D ₂)	2p6f(³ F ₃)	1134.4	1.026+09	0.9997	1.026+09
4	2p3d(³ P ₂)	2p4f(³ D ₃)	1949.5	7.109+09	0.9976	7.092+09
4	2p3d(³ P ₁)	2p4f(³ D ₂)	1949.5	3.769+09	0.9976	3.760+09
4	2p3d(³ P ₀)	2p4f(³ D ₁)	1949.0	1.700+09	0.9752	1.658+09
4	2p3d(³ P ₁)	2p4f(³ D ₁)	1948.5	1.291+09	0.9752	1.259+09
4	2p3d(³ P ₂)	2p4f(³ D ₂)	1948.4	1.286+09	0.9976	1.283+09
4	2p3d(³ P ₂)	2p5f(³ D ₃)	1358.2	2.500+09	0.9972	2.493+09
4	2p3d(³ P ₁)	2p5f(³ D ₂)	1358.2	1.322+09	0.9972	1.318+09
4	2p3d(³ P ₂)	2p6f(³ D ₃)	1166.2	1.281+09	0.9954	1.275+09
4	2p3d(¹ F ₃)	2p4f(¹ G ₄)	2089.4	9.035+09	1.0000	9.034+09
4	2p3d(¹ F ₃)	2p5f(¹ G ₄)	1433.8	1.395+09	1.0000	1.395+09
4	2p3d(¹ P ₁)	2p4f(¹ D ₂)	2159.0	2.857+09	0.9986	2.853+09
5	2s4p(¹ P ₁)	2p4p(¹ D ₂)	1581.5	1.621+08	1.0000	1.621+08
5	2s4p(¹ P ₁)	2p4p(¹ S ₀)	1473.1	1.345+08	1.0000	1.345+08
5	2s4p(¹ P ₁)	2p5p(¹ P ₁)	1188.3	1.212+08	0.9616	1.165+08
5	2s4p(¹ P ₁)	2p5p(¹ D ₂)	1150.9	2.748+08	0.9999	2.748+08
5	2s4p(¹ P ₁)	2p6p(¹ P ₁)	1020.2	2.833+08	0.9859	2.793+08

Table IIIb (continued)

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
5	2s4p(¹ P ₁)	2p6p(¹ D ₂)	1003.8	4.544+08	0.9998	4.543+08
5	2s4p(¹ P ₁)	2p6f(¹ D ₂)	996.3	1.368+08	0.9981	1.365+08
6	2s4f(³ F ₂)	2p4f(³ F ₂)	1519.4	2.030+09	0.3666	7.443+08
6	2s4f(³ F ₃)	2p4f(³ F ₃)	1519.3	2.589+09	0.9903	2.564+09
6	2s4f(³ F ₄)	2p4f(³ F ₄)	1519.3	3.892+09	0.9930	3.865+09
6	2s4f(³ F ₄)	2p4f(³ D ₃)	1490.8	1.300+09	0.9976	1.297+09
6	2s4f(³ F ₃)	2p4f(³ F ₂)	1519.6	2.807+08	0.3666	1.029+08
6	2s4f(³ F ₄)	2p4f(³ F ₃)	1519.5	2.799+08	0.9903	2.772+08
6	2s4f(³ F ₂)	2p4f(³ F ₃)	1519.2	2.509+08	0.9903	2.485+08
6	2s4f(³ F ₃)	2p4f(³ F ₄)	1519.1	2.640+08	0.9930	2.622+08
6	2s4f(³ F ₃)	2p4f(³ D ₃)	1490.7	1.517+08	0.9976	1.513+08
6	2s4f(³ F ₃)	2p4f(³ D ₂)	1490.0	8.855+08	0.9976	8.834+08
6	2s4f(³ F ₂)	2p4f(³ D ₂)	1489.9	1.424+08	0.9976	1.404+08
6	2s4f(³ F ₂)	2p4f(³ D ₁)	1489.3	6.245+08	0.9752	6.090+08
6	2s4f(³ F ₃)	2p5f(³ F ₃)	1126.1	1.028+08	0.9990	1.027+08
6	2s4f(³ F ₄)	2p5f(³ F ₄)	1126.0	1.654+08	0.9991	1.653+08
6	2s4f(³ F ₂)	2p5f(³ G ₃)	1122.3	4.829+08	1.0000	4.829+08
6	2s4f(³ F ₃)	2p5f(³ G ₄)	1122.1	6.136+08	1.0000	6.136+08
6	2s4f(³ F ₄)	2p5f(³ G ₅)	1121.6	8.645+08	1.0000	8.645+08
6	2s4f(³ F ₄)	2p6f(³ F ₄)	988.2	1.023+08	0.9997	1.023+08
6	2s4f(³ F ₂)	2p6f(³ G ₃)	986.7	1.984+08	1.0000	1.984+08
6	2s4f(³ F ₃)	2p6f(³ G ₄)	986.6	2.513+08	1.0000	2.513+08
6	2s4f(³ F ₄)	2p6f(³ G ₅)	986.2	4.036+08	1.0000	4.035+08
6	2s4f(³ F ₄)	2p6f(³ D ₃)	984.9	1.564+08	0.9954	1.557+08
6	2s4f(³ F ₃)	2p6f(³ D ₂)	984.6	1.063+08	0.9954	1.058+08
7	2p4s(³ P ₂)	2p5p(³ D ₃)	3151.7	2.163+08	0.9973	2.157+08
7	2p4s(³ P ₁)	2p5p(³ D ₂)	3150.4	1.175+08	0.9974	1.172+08
7	2p4s(³ P ₂)	2p6p(³ D ₃)	2201.2	1.327+08	0.9992	1.326+08
7	2p4s(¹ P ₁)	2p5p(¹ P ₁)	3529.5	2.251+08	0.9616	2.165+08
7	2p4s(¹ P ₁)	2p6p(¹ P ₁)	2369.8	2.051+08	0.9859	2.022+08
9	2s5p(¹ P ₁)	2p4f(¹ D ₂)	2272.0	1.774+09	0.9986	1.772+09
9	2s5p(¹ P ₁)	2p4p(¹ D ₂)	2425.0	2.141+08	1.0000	2.141+08
9	2s5p(¹ P ₁)	2p5p(¹ P ₁)	1608.8	3.467+08	0.9616	3.334+08
9	2s5p(¹ P ₁)	2p5p(¹ D ₂)	1541.0	2.880+08	0.9999	2.880+08
9	2s5p(¹ P ₁)	2p5f(¹ D ₂)	1508.5	8.046+08	0.9991	8.039+08
9	2s5p(¹ P ₁)	2p6p(¹ D ₂)	1288.2	1.829+08	0.9998	1.829+08

Table IIIb (continued)

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
9	2s5p(¹ P ₁)	2p6f(¹ D ₂)	1275.8	2.731+08	0.9981	2.726+08
9	2s5p(³ P ₂)	2p4f(³ D ₃)	2214.6	3.389+08	0.9976	3.381+08
9	2s5p(³ P ₁)	2p4f(³ D ₂)	2213.1	1.813+08	0.9976	1.809+08
9	2s5p(³ P ₂)	2p5p(³ D ₃)	1563.8	1.765+09	0.9973	1.760+09
9	2s5p(³ P ₁)	2p5p(³ D ₁)	1565.9	3.139+08	0.9973	3.131+08
9	2s5p(³ P ₀)	2p5p(³ D ₁)	1565.9	4.048+08	0.9973	4.037+08
9	2s5p(³ P ₂)	2p5p(³ D ₂)	1565.1	3.363+08	0.9974	3.354+08
9	2s5p(³ P ₁)	2p5p(³ D ₂)	1565.1	9.209+08	0.9974	9.185+08
9	2s5p(³ P ₂)	2p5p(³ S ₁)	1550.6	4.304+08	1.0000	4.304+08
9	2s5p(³ P ₁)	2p5p(³ S ₁)	1550.6	2.203+08	1.0000	2.203+08
9	2s5p(³ P ₁)	2p5p(³ P ₀)	1532.6	2.489+08	0.9892	2.446+08
9	2s5p(³ P ₂)	2p5p(³ P ₁)	1532.1	2.749+08	0.9931	2.730+08
9	2s5p(³ P ₁)	2p5p(³ P ₁)	1532.1	1.996+08	0.9931	1.982+08
9	2s5p(³ P ₀)	2p5p(³ P ₁)	1532.1	2.727+08	0.9931	2.708+08
9	2s5p(³ P ₂)	2p5p(³ P ₂)	1531.4	9.117+08	0.9348	8.523+08
9	2s5p(³ P ₁)	2p5p(³ P ₂)	1531.4	3.350+08	0.9348	3.132+08
9	2s5p(³ P ₂)	2p5f(³ D ₃)	1481.8	1.320+08	0.9972	1.316+08
10	2s5f(³ F ₃)	2p5f(³ F ₃)	1566.7	1.348+09	0.9990	1.347+09
10	2s5f(³ F ₄)	2p5f(³ F ₄)	1566.5	2.068+09	0.9991	2.066+09
10	2s5f(³ F ₂)	2p5f(³ G ₃)	1559.6	2.232+09	1.0000	2.232+09
10	2s5f(³ F ₃)	2p5f(³ G ₄)	1559.0	2.869+09	1.0000	2.869+09
10	2s5f(³ F ₄)	2p5f(³ G ₅)	1557.9	3.729+09	1.0000	3.729+09
10	2s5f(³ F ₄)	2p5f(³ D ₃)	1551.9	1.854+09	0.9972	1.849+09
10	2s5f(³ F ₃)	2p5f(³ D ₂)	1551.2	1.262+09	0.9972	1.258+09
10	2s5f(¹ F ₃)	2p4f(¹ G ₄)	2474.4	2.346+09	1.0000	2.346+09
10	2s5f(¹ F ₃)	2p5f(¹ G ₄)	1591.3	3.867+09	1.0000	3.867+09
10	2s5f(¹ F ₃)	2p5f(¹ D ₂)	1583.0	1.026+09	0.9991	1.025+09
14	2s6p(³ P ₁)	2p6p(³ D ₂)	1554.1	1.014+09	0.9992	1.013+09
14	2s6p(³ P ₁)	2p6p(³ D ₃)	1552.8	1.982+09	0.9992	1.980+09
14	2s6p(³ P ₁)	2p6p(³ D ₁)	1554.7	3.278+08	0.9989	3.285+08
14	2s6p(³ P ₀)	2p6p(³ D ₁)	1554.7	4.260+08	0.9989	4.255+08
14	2s6p(³ P ₂)	2p6p(³ D ₂)	1554.1	3.974+08	0.9992	3.971+08
14	2s6p(³ P ₂)	2p6p(³ S ₁)	1546.7	6.458+08	1.0000	6.458+08
14	2s6p(³ P ₁)	2p6p(³ S ₁)	1546.7	3.110+08	1.0000	3.110+08
14	2s6p(³ P ₁)	2p6p(³ P ₀)	1536.5	2.677+08	0.9965	2.668+08
14	2s6p(³ P ₂)	2p6p(³ P ₁)	1536.0	2.572+08	0.9980	2.567+08

Table IIIb (continued)

N	Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)
14	2s6p(³ P ₁)	2p6p(³ P ₁)	1536.0	2.301+08	0.9980	2.296+08
14	2s6p(³ P ₀)	2p6p(³ P ₁)	1535.9	3.181+08	0.9980	3.175+08
14	2s6p(³ P ₂)	2p6p(³ P ₂)	1535.3	9.577+08	0.9609	9.203+08
14	2s6p(³ P ₁)	2p6p(³ P ₂)	1535.2	3.827+08	0.9609	3.677+08
15	2s6f(³ F ₂)	2p6f(³ F ₂)	1555.1	1.134+09	0.9492	1.076+08
15	2s6f(³ F ₃)	2p6f(³ F ₃)	1555.0	1.543+09	0.9997	1.543+09
15	2s6f(³ F ₄)	2p6f(³ F ₄)	1554.8	2.433+09	0.9997	2.432+09
15	2s6f(³ F ₂)	2p6f(³ G ₃)	1551.4	1.534+09	1.0000	1.534+09
15	2s6f(³ F ₃)	2p6f(³ G ₄)	1550.9	1.981+09	1.0000	1.981+09
15	2s6f(³ F ₄)	2p6f(³ G ₅)	1549.9	2.521+09	1.0000	2.520+09
15	2s6f(³ F ₄)	2p6f(³ D ₃)	1546.7	1.982+09	0.9954	1.973+09
15	2s6f(³ F ₃)	2p6f(³ D ₂)	1546.0	1.351+09	0.9954	1.345+09
15	2s6f(³ F ₂)	2p6f(³ D ₁)	1545.5	1.006+09	0.9955	1.001+09
15	2s6f(¹ F ₃)	2p6f(¹ F ₃)	1561.9	1.623+09	0.9991	1.622+09
15	2s6f(¹ F ₃)	2p6f(¹ G ₄)	1553.9	2.007+09	1.0000	2.007+09
15	2s6f(¹ F ₃)	2p6f(¹ D ₂)	1548.3	1.393+09	0.9981	1.390+09
16	2s6h(¹ H ₅)	2p6h(³ H ₅)	1549.7	2.019+09	0.9207	1.859+09
16	2s6h(¹ H ₅)	2p6h(³ H ₆)	1547.4	1.845+09	0.9996	1.844+09
16	2s6h(¹ H ₅)	2p6h(³ G ₄)	1545.9	2.811+09	0.9878	2.777+09
16	2s6h(³ H ₆)	2p6h(³ H ₅)	1549.7	1.141+09	0.9207	1.051+09
16	2s6h(³ H ₄)	2p6h(³ H ₄)	1549.7	1.647+09	0.9909	1.632+09
16	2s6h(³ H ₅)	2p6h(³ I ₅)	1549.6	2.150+09	0.9998	2.150+09
16	2s6h(³ H ₆)	2p6h(³ H ₆)	1549.6	2.576+09	0.9998	2.575+09
16	2s6h(³ H ₆)	2p6h(³ H ₆)	1547.4	1.041+09	0.9998	1.041+09
16	2s6h(³ H ₄)	2p6h(³ I ₅)	1547.4	1.646+09	0.9998	1.646+09
16	2s6h(³ H ₆)	2p6h(³ G ₅)	1546.7	2.432+09	0.9796	2.382+09
16	2s6h(³ H ₅)	2p6h(¹ G ₄)	1546.7	1.871+09	0.9874	1.847+09
16	2s6h(³ H ₆)	2p6h(³ I ₇)	1546.5	3.035+09	0.9999	3.035+09
16	2s6h(³ H ₅)	2p6h(¹ I ₆)	1546.5	2.499+09	0.9999	2.499+09
16	2s6h(³ H ₄)	2p6h(³ G ₃)	1545.9	2.323+09	0.9836	2.285+09

Table IVa. Wavelengths (WL), Ionization Potential (Es), radiative transition probabilities (gAr), branching ratio (K) and intensity factor(Qd) for satellites lines CIII.

Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)	Es(eV)		
2s3p	¹ P ₁	3s3d	¹ D ₂	343.3	2.969+10	0.5181	1.538+10	20.400
2s3p	³ P ₂	3p ²	³ P ₂	333.6	2.380+10	0	0	21.523
2p3s	¹ P ₁	3s3d	¹ D ₂	417.4	2.236+10	0.5181	1.158+10	20.400
2p3s	³ P ₂	3s3d	³ D ₂	407.1	1.982+10	0.7579	1.502+10	20.761
2p3s	³ P ₁	3s3d	³ D ₁	407.0	1.983+10	0.7579	1.503+10	20.761
2p3s	³ P ₁	3s3d	³ D ₂	407.0	5.950+10	0.7579	4.510+10	20.761
2p3s	³ P ₀	3s3d	³ D ₁	407.0	2.645+10	0.7579	2.005+10	20.761
2p3s	¹ P ₁	3p ²	¹ D ₂	386.2	2.073+10	0.2549	5.284+09	22.796
2p3s	¹ P ₁	3d ²	¹ D ₂	356.3	1.512+10	0.0008	1.210+07	25.498
2p3s	¹ P ₁	3s4d	¹ D ₂	323.8	1.691+10	0.7161	1.211+10	28.977
2p3s	³ P ₂	3s4d	³ D ₃	321.3	3.176+10	0.8989	2.855+10	28.886
2p3s	³ P ₁	3s4d	³ D ₂	321.3	1.701+10	0.8990	1.529+10	28.885
2p3s	³ P ₂	3s5d	³ D ₃	292.5	1.537+10	0.9613	1.478+10	32.687
2p3d	¹ D ₂	3p ²	¹ D ₂	420.5	3.749+10	0.2549	9.556+09	22.796
2p3d	³ D ₂	3d ²	³ F ₂	410.8	1.472+10	0	0	
2p3d	³ D ₁	3d ²	³ F ₂	410.8	8.163+10	0	0	
2p3d	¹ P ₁	3d ²	¹ D ₂	408.9	3.032+10	0.0008	2.426+07	25.491
2p3d	³ F ₂	3d ²	³ F ₂	406.7	3.015+10	0	0	
2p3d	¹ F ₃	3d ²	¹ D ₂	401.8	1.390+10	0.0008	1.112+07	25.491
2p3d	³ P ₀	3d ²	³ P ₁	400.3	1.988+10	0	0	
2p3d	³ P ₁	3d ²	³ P ₀	400.2	1.964+10	0	0	
2p3d	³ P ₁	3d ²	³ P ₁	400.2	1.511+10	0	0	
2p3d	³ P ₁	3d ²	³ P ₂	400.2	2.492+10	0	0	
2p3d	³ P ₂	3d ²	³ P ₁	400.2	2.430+10	0	0	
2p3d	³ P ₂	3d ²	³ P ₂	400.2	7.520+10	0	0	
2p3d	³ D ₃	3d ²	³ P ₂	395.8	3.723+10	0	0	
2p3d	³ D ₂	3d ²	³ P ₁	395.8	2.055+10	0	0	
2p3d	¹ D ₂	3d ²	¹ D ₂	385.3	4.722+10	0.0008	3.778+07	25.491
2p3d	¹ P ₁	3d ²	¹ S ₀	373.3	1.573+10	0.1325	2.084+09	28.382
2p3d	¹ D ₂	3d4d	¹ F ₃	323.2	1.359+10	0.0018	2.446+07	33.189
2p3d	³ F ₂	3d4d	³ G ₃	323.2	2.352+10	0.0553	1.301+09	31.906
2p3d	³ D ₂	3d4d	³ F ₃	320.9	1.282+10	0	0	
2p3d	³ P ₂	3d4d	³ P ₂	319.9	1.174+10	0	0	
2p3d	³ D ₃	3d ²	³ F ₃	410.9	1.457+10	0	0	
2p3d	³ F ₄	3d ²	³ F ₄	406.7	5.658+10	0	0	
2p3d	³ F ₃	3d ²	³ F ₃	406.7	3.995+10	0	0	
2p3d	¹ F ₃	3p4f	¹ G ₄	331.6	2.999+10	0.4766	1.429+10	32.020
2p3d	³ F ₄	3p4f	³ F ₄	326.2	1.592+10	0	0	
2p3d	³ F ₃	3p4f	³ F ₃	326.2	1.118+10	0	0	
2p3d	¹ F ₃	3d4d	¹ G ₄	324.9	1.414+10	0.1486	2.101+09	32.786
2p3d	³ F ₄	3d4d	³ G ₅	323.3	4.015+10	0.0553	2.200+09	31.908
2p3d	³ F ₃	3d4d	³ G ₄	323.3	3.085+10	0.0553	1.706+09	31.907
2p3d	³ D ₃	3d4d	³ F ₄	320.9	1.854+10	0	0	
2p3d	¹ F ₃	3p5f	¹ F ₃	308.2	1.238+10	0	0	
2p3d	³ D ₃	3d5d	³ F ₄	297.0	1.169+10	0	0	

Table IVa. (continued)

Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)	Es(eV)		
2s4p	¹ P ₁	3d4s	¹ D ₂	325.9	1.180+10	0.2370	2.797+09	30.465
2s4p	³ P ₂	3p4p	³ D ₃	320.4	1.617+10	0.5816	9.404+09	30.408
2s4p	³ P ₂	3p4p	³ P ₂	316.3	1.488+10	0	0	
2s4f	³ F ₂	3p4f	³ G ₃	317.5	2.698+10	0.1092	2.946+09	31.262
2s4f	³ F ₂	3p4f	³ F ₂	315.1	1.036+10	0	0	
2s4f	³ F ₄	3d ²	³ F ₄	389.7	1.581+10	0	0	
2s4f	³ F ₃	3d ²	³ F ₃	389.6	1.112+10	0	0	
2s4f	¹ F ₃	3d ²	¹ G ₄	382.6	2.565+10	0.2151	5.517+09	24.705
2s4f	¹ F ₃	3p4f	¹ F ₃	317.9	2.337+10	0	0	
2s4f	³ F ₃	3p4f	³ G ₄	317.5	3.541+10	0.1094	3.874+09	31.263
2s4f	³ F ₄	3p4f	³ G ₅	317.5	4.618+10	0.1096	5.061+09	31.264
2s4f	³ F ₄	3p4f	³ F ₄	315.1	1.980+10	0	0	
2s4f	³ F ₃	3p4f	³ F ₃	315.1	1.371+10	0	0	
2s4f	³ F ₄	3d4d	³ D ₃	313.6	1.256+10	0.0137	1.721+08	31.751
2s4f	¹ F ₃	3p4f	¹ G ₄	312.1	1.411+10	0.4766	6.725+09	32.020
2p4s	¹ P ₁	3d4s	¹ D ₂	398.3	4.689+10	0.2370	1.111+10	30.465
2p4s	³ P ₂	3p4p	³ D ₃	394.2	2.715+10	0.5816	1.579+10	30.408
2p4s	³ P ₁	3p4p	³ D ₂	394.1	1.451+10	0.5806	8.425+09	30.407
2p4s	³ P ₂	3d4s	³ D ₂	386.9	1.510+10	0.8574	1.295+10	31.000
2p4s	³ P ₂	3d4s	³ D ₃	386.9	8.452+10	0.8583	7.254+10	31.007
2p4s	³ P ₁	3d4s	³ D ₁	386.8	1.513+10	0.8600	1.301+10	31.005
2p4s	³ P ₁	3d4s	³ D ₂	386.8	4.536+10	0.8574	3.889+10	31.000
2p4s	³ P ₀	3d4s	³ D ₁	386.7	2.018+10	0.8600	1.735+10	31.005
2p4s	¹ P ₁	3p4p	¹ D ₂	382.8	2.079+10	0.2649	5.507+09	31.729
2p4d	³ F ₂	3p4f	³ G ₃	398.7	3.007+10	0.1092	3.284+09	31.262
2p4d	¹ D ₂	3p4f	¹ F ₃	397.8	2.254+10	0	0	
2p4d	¹ D ₂	3d4d	¹ F ₃	393.2	5.738+10	0	0	
2p4d	¹ D ₂	3p4p	¹ D ₂	392.4	1.848+10	0.2649	4.895+09	31.729
2p4d	³ F ₂	3d4d	³ G ₃	390.6	8.214+10	0.0553	4.542+09	31.906
2p4d	¹ D ₂	3d4d	¹ P ₁	389.6	1.372+10	0	0	
2p4d	³ F ₂	3d4d	³ F ₂	383.5	2.347+10	0.0001	2.347+06	32.495
2p4d	¹ D ₂	3d4d	¹ D ₂	375.1	1.978+10	0.0018	3.560+07	33.189
2p4d	³ F ₄	3p4f	³ G ₅	398.8	5.321+10	0.1096	5.832+09	31.264
2p4d	³ F ₃	3p4f	³ G ₄	398.7	4.074+10	0.1094	4.457+09	31.263
2p4d	³ F ₄	3d4d	³ F ₄	383.6	4.448+10	0	0	
2p4d	³ F ₃	3d4d	³ F ₃	383.5	3.182+10	0	0	
2s5p	¹ P ₁	3d ²	¹ D ₂	405.1	2.006+10	0.0008	1.605+07	25.491
2s5p	¹ P ₁	3d ²	¹ S ₀	370.1	1.371+10	0.1325	1.817+09	28.382
2s5p	³ P ₂	3s6d	³ D ₃	315.3	1.266+10	0.2733	3.460+09	34.279
2s5p	³ P ₂	3p5p	³ D ₃	313.6	1.113+10	0.6915	7.696+09	34.502
2s5p	³ P ₂	3p5p	³ P ₂	313.1	1.431+10	0	0	
2s6p	¹ P ₁	3p6p	¹ P ₁	312.3	1.264+10	0	0	
2s6p	³ P ₁	3p6p	³ D ₂	311.8	1.510+10	0.2436	3.678+09	36.366
2s6p	³ P ₂	3p6p	³ D ₃	311.8	2.861+10	0.2460	7.036+09	36.368
2s6p	³ P ₂	3p6p	³ P ₂	311.2	1.524+10	0	0	
2s6p	¹ P ₁	3p6p	¹ D ₂	311.0	1.447+10	0.0102	1.476+08	36.499

Table IVa. (continued)

Lower level		Upper level		WL(A)	$gAr(s^{-1})$	K	Qd(s^{-1})	Es(eV)
2s5f	3F_2	3p5f	3F_2	313.2	1.921+10	0	0	
2s5f	3F_2	3p5f	3G_3	313.0	1.963+10	0.0636	1.248+09	34.948
2s5f	3F_3	3p5f	3D_2	311.5	1.689+10	0.0273	4.611+08	35.144
2s5f	3F_2	3p5f	3D_1	311.5	1.145+10	0.0264	3.023+08	35.145
2s5f	1F_3	3p5f	1D_2	310.4	2.212+10	0.6316	1.397+10	35.493
2s5f	1F_3	3d 2	1G_4	425.4	6.276+10	0.2151	1.350+10	24.705
2s5f	1F_3	3p5f	1F_3	315.4	1.705+10	0	0	
2s5f	3F_3	3p5f	3F_3	313.2	2.595+10	0.1174	3.047+09	34.928
2s5f	3F_4	3p5f	3F_4	313.2	3.769+10	0	0	
2s5f	3F_3	3p5f	3G_4	313.0	2.572+10	0.0650	1.672+09	34.949
2s5f	3F_4	3p5f	3G_5	313.0	3.257+10	0.0636	2.071+09	34.950
2s5f	1F_3	3p5f	1G_4	311.7	4.727+10	0.2987	1.412+10	35.324
2s5f	3F_4	3p5f	3D_3	311.5	2.444+10	0.0272	6.648+08	35.144
2s5f	3F_4	3d5d	3G_5	309.1	1.088+10	0.0580	6.310+08	35.455
2s6f	3F_2	3p6f	3F_2	311.4	1.991+10	0	0	
2s6f	3F_2	3p6f	3G_3	311.3	2.876+10	0.1162	3.342+09	36.642
2s6f	3F_3	3p6f	3D_2	310.6	1.968+10	0.0161	3.168+08	36.736
2s6f	3F_2	3p6f	3D_1	310.6	1.337+10	0.0162	2.153+08	36.736
2s6f	1F_3	3d6s	1D_2	309.7	1.206+10	0.5444	6.565+09	36.889
2s6f	1F_3	3p6f	1D_2	308.1	1.216+10	0.6765	8.226+09	37.098
2s6f	1F_3	3p6f	1F_3	311.9	2.940+10	0	0	
2s6f	3F_3	3p6f	3F_3	311.4	2.737+10	0.0401	1.098+09	36.627
2s6f	3F_4	3p6f	3F_4	311.4	3.936+10	0.0371	1.460+09	36.628
2s6f	3F_3	3p6f	3G_4	311.3	3.766+10	0.1174	4.421+09	36.643
2s6f	3F_4	3p6f	3G_5	311.3	4.742+10	0.1170	5.548+09	36.645
2s6f	3F_4	3p6f	3D_3	310.6	2.850+10	0.0172	4.9-2+08	36.735
2s6f	1F_3	3p6f	1G_4	310.1	4.146+10	0.7090	2.940+10	36.839
2s6h	3H_5	3p6h	1H_5	310.2	1.005+10	0	0	
2s6h	1H_5	3p6h	1H_5	310.2	3.910+10	0	0	
2s6h	3H_4	3p6h	3H_4	310.2	3.850+10	0	0	
2s6h	3H_5	3p6h	3H_5	310.2	3.739+10	0	0	
2s6h	3H_6	3p6h	3H_6	310.2	5.691+10	0	0	
2s6h	3H_6	3p6h	3G_5	309.6	5.014+10	0.1632	8.180+09	36.879
2s6h	3H_5	3p6h	3G_4	309.6	3.170+10	0.3312	1.050+10	36.880
2s6h	3H_4	3p6h	3G_3	309.5	3.321+10	0.1632	5.420+09	36.881
2s6h	3H_4	3p6h	3I_5	309.5	4.631+10	0.5032	2.330+10	36.882
2s6h	3H_5	3p6h	3I_6	309.5	2.896+10	0.4981	1.442+10	36.881
2s6h	1H_5	3p6h	3I_6	309.5	2.611+10	0.4981	1.301+10	36.881
2s6h	3H_6	3p6h	3I_7	309.5	6.505+10	0.5032	3.273+10	36.885
2s6h	1H_5	3p6h	1G_4	309.5	3.256+10	0.4024	1.310+10	36.887
2s6h	3H_5	3p6h	1I_6	309.4	2.625+10	0.4115	1.080+10	36.984
2s6h	1H_5	3p6h	1I_6	309.4	2.947+10	0.4115	1.212+10	36.984

Table IVb. Wavelengths (WL), Ionization Potential (Es), radiative transition probabilities (gAr), branching ratio (K) and intensity factor(Qd) for satellites lines CIII.

Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)	Es(eV)		
2s3s	³ S ₁	3s3p	³ P ₁	334.5	1.013+10	0.4980	5.045+09	18.685
2s3s	³ S ₁	3s3p	³ P ₂	334.5	1.689+10	0.4980	8.411+09	18.687
2s3d	¹ D ₂	3p3d	¹ D ₂	345.4	1.590+10	0	0	22.346
2s3d	¹ D ₂	3p3d	¹ F ₃	327.3	2.138+10	0.5940	1.270+10	24.331
2s3d	¹ D ₂	3p3d	¹ P ₁	317.5	1.071+10	0.0198	2.121+08	25.492
2s3d	³ D ₁	3p3d	³ F ₂	337.8	2.078+10	0.9774	2.031+10	29.487
2s3d	³ D ₂	3p3d	³ F ₃	337.8	3.079+10	0.9774	3.009+10	29.487
2s3d	³ D ₃	3p3d	³ P ₂	327.6	1.386+10	0.1543	2.139+09	23.396
2s3d	³ D ₃	3p3d	³ F ₄	337.8	4.453+10	0.5944	2.647+10	22.259
2s3d	³ D ₃	3p3d	³ D ₃	329.4	1.488+10	0	0	23.190
2s3d	³ D ₃	3d4p	³ F ₄	269.1	1.132+10	0.4004	4.533+09	31.621
2p3p	¹ D ₂	3p3d	¹ D ₂	433.6	1.269+10	0	0	0.2236
2p3p	¹ D ₂	3s4f	¹ F ₃	344.3	2.087+10	0.0241	5.030+08	29.754
2p3p	¹ P ₁	3s3p	¹ P ₁	431.4	1.194+10	0.3321	3.965+09	20.368
2p3p	¹ P ₁	3p3d	¹ D ₂	403.6	5.228+10	0	0	22.346
2p3p	¹ P ₁	3p3d	¹ P ₁	366.1	1.138+10	0.0198	2.253+08	25.492
2p3p	¹ P ₁	3p4d	¹ D ₂	315.0	1.604+10	0	0	30.981
2p3p	³ P ₂	3p3d	³ D ₂	413.0	1.347+10	0	0	23.189
2p3p	³ P ₂	3p3d	³ D ₃	413.0	7.691+10	0	0	23.190
2p3p	³ P ₂	3p3d	³ P ₂	410.2	2.885+10	0.1543	4.452+09	23.396
2p3p	³ P ₂	3p4d	³ D ₃	330.8	1.907+10	0	0	30.644
2p3p	³ P ₁	3p3d	³ D ₁	413.0	1.363+10	0	0	23.188
2p3p	³ P ₁	3p3d	³ D ₂	413.0	4.141+10	0	0	23.189
2p3p	³ P ₁	3p4d	³ D ₂	330.8	1.023+10	0	0	30.644
2p3p	³ P ₀	3p3d	³ D ₁	412.9	1.839+10	0	0	23.188
2p3p	¹ S ₀	3p3d	¹ P ₁	409.5	1.786+10	0.0198	3.536+08	25.492
2p3p	³ D ₃	3p3d	³ F ₄	408.8	9.788+10	0.5944	5.818+10	22.259
2p3p	³ D ₃	3p3d	³ D ₃	396.6	2.224+10	0	0	23.190
2p3p	³ D ₃	3p4d	³ F ₄	314.8	6.216+10	0.3398	2.112+10	31.311
2p3p	³ D ₃	3p5d	³ F ₄	289.2	1.959+10	0.4914	9.626+09	34.796
2p3p	³ D ₃	3p6d	³ F ₄	277.8	1.081+10	0.0652	7.048+08	36.556
2p3p	³ D ₂	3p3d	³ F ₃	408.7	6.806+10	0.5944	4.045+10	22.258
2p3p	³ D ₂	3p3d	³ D ₂	396.5	1.254+10	0	0	23.189
2p3p	³ D ₂	3p4d	³ F ₃	314.7	4.276+10	0.3397	1.453+10	31.309
2p3p	³ D ₂	3p5d	³ F ₃	289.1	1.359+10	0.4914	6.678+09	34.795
2p3p	³ D ₁	3p3d	³ F ₂	408.7	4.606+10	0.5944	2.738+10	22.256
2p3p	³ D ₁	3p4d	³ F ₂	314.7	2.876+10	0.3397	9.770+09	31.308
2p3p	³ S ₁	3p3d	³ P ₂	401.1	3.495+10	0.1543	5.393+09	23.396
2p3p	³ S ₁	3p3d	³ P ₁	401.1	2.122+10	0.1542	3.272+09	23.396
2p3p	³ S ₁	3p4d	³ P ₂	317.9	1.104+10	0.0288	3.180+08	31.485
2s4s	³ S ₁	3p4s	³ P ₁	317.3	1.211+10	0.3501	4.240+09	29.745
2s4s	³ S ₁	3p4s	³ P ₂	317.2	2.018+10	0.3502	7.067+09	29.747
2s4d	¹ D ₂	3p4d	¹ F ₃	323.9	1.462+10	0.0429	6.272+08	30.805
2s4d	¹ D ₂	3p4d	¹ D ₂	322.4	1.229+10	0	0	30.981
2s4d	³ D ₂	3p4d	³ D ₂	323.0	1.116+10	0	0	30.644
2s4d	³ D ₃	3p4d	³ D ₃	323.0	2.001+10	0	0	30.644

Table IVb. (continued)

Lower level	Upper level	WL(A)	gAr(s ⁻¹)	K	Qd(s ⁻¹)	Es(eV)		
2s4d	³ D ₃	3p4d	³ F ₄	317.5	1.094+10	0.5944	6.503+09	22.259
2s4d	³ D ₃	3d4p	³ D ₃	311.9	1.036+10	0	0	32.009
2s5s	³ S ₁	3p5s	³ P ₁	313.0	1.213+10	0.3900	4.731+09	34.605
2s5s	³ S ₁	3p5s	³ P ₂	313.0	2.029+10	0.3907	7.927+09	34.067
2s5d	¹ D ₂	3p5d	¹ D ₂	315.0	2.125+10	0	0	34.699
2s5d	¹ D ₂	3p5d	¹ F ₃	314.8	1.263+10	0.5967	7.536+09	34.713
2s5d	³ D ₁	3p5d	³ F ₂	312.8	1.739+10	0.4886	8.497+09	34.793
2s5d	³ D ₂	3p5d	³ D ₂	314.2	1.243+10	0	0	34.617
2s5d	³ D ₂	3p5d	³ F ₃	312.8	2.575+10	0.4914	1.265+10	34.795
2s5d	³ D ₃	3p5d	³ P ₂	311.1	1.546+10	0.0972	1.503+09	35.004
2s5d	³ D ₃	3p5d	³ D ₃	314.2	2.231+10	0	0	34.618
2s5d	³ D ₃	3p5d	³ F ₄	312.8	3.712+10	0.4914	1.824+10	34.796
2s5g	¹ G ₄	3p5g	¹ G ₄	312.1	3.807+10	0	0	35.030
2s5g	¹ G ₄	3p5g	¹ F ₃	309.3	2.799+10	0.0103	2.883+08	35.383
2s5g	¹ G ₄	3p5g	¹ H ₅	308.5	4.019+10	0.5298	2.129+10	35.491
2s5g	³ G ₃	3p5g	³ G ₃	311.8	2.838+10	0	0	35.071
2s5g	³ G ₃	3p5g	³ H ₄	310.3	2.595+10	0.2034	5.289+09	35.600
2s5g	³ G ₃	3p5g	³ F ₂	309.8	1.859+10	0.5405	1.005+10	33.326
2s5g	³ G ₄	3p5g	³ G ₄	311.8	3.472+10	0	0	35.071
2s5g	³ G ₄	3p5g	³ H ₅	310.3	3.168+10	0.2038	6.456+09	35.601
2s5g	³ G ₄	3p5g	³ F ₃	309.8	2.378+10	0.5380	1.279+10	35.326
2s5g	³ G ₅	3p5g	³ G ₅	311.8	4.588+10	0	0	35.071
2s5g	³ G ₅	3p5g	³ H ₆	310.3	3.932+10	0.2035	8.002+09	35.601
2s5g	³ G ₅	3p5g	³ F ₄	309.8	3.119+10	0.5383	1.679+10	35.325
2s5g	³ G ₅	3d5f	³ H ₆	307.7	1.201+10	0.2035	2.444+09	35.601
2s6s	³ S ₁	3p6s	³ P ₁	311.1	1.258+10	0.4540	5.711+09	36.176
2s6s	³ S ₁	3p6s	³ P ₂	311.1	2.098+10	0.4528	9.500+09	36.179
2s6d	¹ D ₂	3p6d	¹ D ₂	312.5	2.180+10	0	0	36.504
2s6d	¹ D ₂	3p6d	¹ F ₃	312.1	2.000+10	0.0368	7.360+08	36.551
2s6d	³ D ₁	3p6d	³ F ₂	311.3	1.954+10	0.0638	1.247+09	36.553
2s6d	³ D ₂	3p6d	³ D ₂	311.7	1.432+10	0	0	36.498
2s6d	³ D ₂	3p6d	³ F ₃	311.3	2.543+10	0.0381	9.689+08	36.555
2s6d	³ D ₃	3p6d	³ D ₃	311.7	2.600+10	0	0	36.499
2s6d	³ D ₃	3p6d	³ F ₄	311.3	4.135+10	0.0652	2.696+09	36.556
2s6d	³ D ₃	3p6d	³ P ₂	310.5	1.777+10	0.0063	1.120+08	36.662
2s6g	¹ G ₄	3p6g	¹ G ₄	310.8	3.901+10	0	0	36.692
2s6g	¹ G ₄	3p6g	¹ H ₅	308.8	3.953+10	0.4133	1.634+10	36.950
2s6g	¹ G ₄	3p6g	¹ F ₃	308.8	2.525+10	0.0303	7.651+08	36.960
2s6g	³ G ₃	3p6g	³ G ₃	310.7	2.904+10	0	0	36.714
2s6g	³ G ₃	3p6g	³ H ₄	310.3	3.756+10	0.5954	2.236+10	36.766
2s6g	³ G ₃	3p6g	³ F ₂	309.7	2.335+10	0.8120	1.896+10	36.843
2s6g	³ G ₄	3p6g	³ G ₄	310.7	3.510+10	0	0	36.714
2s6g	³ G ₄	3p6g	³ H ₅	310.2	4.515+10	0.5946	2.685+10	36.767
2s6g	³ G ₄	3p6g	³ F ₃	309.7	2.957+10	0.8120	2.416+10	36.843
2s6g	³ G ₅	3p6g	³ G ₅	310.7	4.736+10	0	0	36.715
2s6g	³ G ₅	3p6g	³ H ₆	310.2	5.658+10	0.5959	3.372+10	36.769
2s6g	³ G ₅	3p6g	³ F ₄	309.7	3.976+10	0.8121	3.229+10	36.841

Table V. Energy excitation (E_S), radiative transition probabilities (gAr), autoionization rate (Aa) and intensity factor(Qd)

Lower level	Upper level	Aa s^{-1}	sumAa s^{-1}	sum(gAr) s^{-1}	gAr s^{-1}	$Qd/2$ s^{-1}	E_S eV
2s6s 3S	2p6s 3P_0	0.7260+12	0.7260+12	0.6870+09	0.2648+09	0.1323+09	4.375
2s6s 3S	2p6s 3P_1	0.1656+13	0.1656+13	0.2077+10	0.7908+09	0.3952+09	4.379
2s6s 3S	2p6s 3P_2	0.6900+12	0.6900+12	0.3465+10	0.1330+10	0.6643+09	4.389
2s6s 3S	2p6s 1P_1	0.1602+15	0.1602+15	0.3855+10	0.4750+07	0.2375+07	4.459
2s6s 1S	2p6s 3P_1	0.1656+13	0.1656+13	0.2077+10	0.4950+07	0.2474+07	4.379
2s6s 1S	2p6s 1P_1	0.1602+15	0.1602+15	0.3855+10	0.8653+09	0.4326+09	4.459
2s6p 3P	2p6p 1P_1	0.1580+12	0.1580+12	0.6796+10	0.6280+08	0.3096+08	4.558
2s6p 3P	2p6p 3D_1	0.6590+12	0.6590+12	0.2084+10	0.7891+09	0.3941+09	4.572
2s6p 3P	2p6p 3D_2	0.6910+12	0.6910+12	0.2871+10	0.1411+10	0.7051+09	4.576
2s6p 3P	2p6p 3D_3	0.6880+12	0.6880+12	0.4027+10	0.1982+10	0.9902+09	4.582
2s6p 3P	2p6p 3S_1	0.2915+14	0.2915+14	0.4685+10	0.1040+10	0.5202+09	4.615
2s6p 3P	2p6p 3P_0	0.1170+12	0.1170+12	0.4053+09	0.2677+09	0.1334+09	4.667
2s6p 3P	2p6p 3P_1	0.2100+12	0.2100+12	0.1246+10	0.8054+09	0.4018+09	4.670
2s6p 3P	2p6p 3P_2	0.1000+11	0.1000+11	0.2036+10	0.1340+10	0.6440+09	4.674
2s6p 3P	2p6p 1D_2	0.8463+13	0.8463+13	0.5236+10	0.2608+07	0.1303+07	4.757
2s6p 1P	2p6p 1P_1	0.1580+12	0.1580+12	0.6796+10	9.001+08	4.315+08	4.558
2s6p 1P	2p6p 3D_1	0.6590+12	0.6590+12	0.2084+10	6.633+07	3.306+07	4.572
2s6p 1P	2p6p 3D_2	0.6910+12	0.6910+12	0.2871+10	9.231+05	4.596+05	4.576
2s6p 1P	2p6p 3S_1	0.2915+14	0.2915+14	0.4685+10	5.027+06	2.513+06	4.615
2s6p 1P	2p6p 3P_1	0.2100+12	0.2100+12	0.1246+10	4.899+05	2.436+05	4.670
2s6p 1P	2p6p 3P_2	0.1000+11	0.1000+11	0.2036+10	7.567+05	3.142+05	4.674
2s6p 1P	2p6p 1D_2	0.8463+13	0.8463+13	0.5236+10	8.023+08	4.009+08	4.757
2s6p 1P	2p6p 1S_0	0.5219+15	0.5219+15	0.1252+10	5.516+08	2.758+08	5.094
2s6d 3D	2p6d 3F_2	0.1131+14	0.1131+14	0.3295+10	0.6448+09	0.3224+09	4.709
2s6d 3D	2p6d 3F_3	0.2051+14	0.2051+14	0.3095+10	0.1643+10	0.8217+09	4.718
2s6d 3D	2p6d 3F_4	0.2058+14	0.2058+14	0.3841+10	0.2116+10	0.1058+10	4.723
2s6d 3D	2p6d 1D_2	0.9224+13	0.9224+13	0.3608+10	0.5377+09	0.2689+09	4.718
2s6d 3D	2p6d 3D_1	0.3890+12	0.3890+12	0.6398+10	0.8845+09	0.4399+09	4.760
2s6d 3D	2p6d 3D_2	0.9820+12	0.9820+12	0.1054+11	0.1477+10	0.7370+09	4.761
2s6d 3D	2p6d 3D_3	0.2280+12	0.2280+12	0.1488+11	0.2058+10	0.1020+10	4.765
2s6d 3D	2p6d 3P_2	0.1991+14	0.1991+14	0.8812+10	0.1775+10	0.8876+09	4.784
2s6d 3D	2p6d 3P_1	0.2047+14	0.2047+14	0.5276+10	0.1074+10	0.5370+09	4.788
2s6d 3D	2p6d 3P_0	0.2084+14	0.2084+14	0.1753+10	0.3595+09	0.1797+09	4.789
2s6d 3D	2p6d 1F_3	0.1317+15	0.1317+15	0.2814+11	0.2591+07	0.1295+07	4.896
2s6d 3D	2p6d 1P_1	0.1544+14	0.1544+14	0.1090+11	0.1298+07	0.6487+06	4.930

Table V. (continued)

Lower level	Upper level	Aa s ⁻¹	sumAa s ⁻¹	sum(gAr) s ⁻¹	gAr s ⁻¹	Qd/2 s ⁻¹	E _S eV
2s6d ¹ D	2p6d ³ F ₂	0.1131+14	0.1131+14	0.3295+10	0.6162+09	0.3081+09	4.709
2s6d ¹ D	2p6d ³ F ₃	0.2051+14	0.2051+14	0.3095+10	0.1130+07	0.5650+06	4.718
2s6d ¹ D	2p6d ¹ D ₂	0.9224+13	0.9224+13	0.3608+10	0.7488+09	0.3744+09	4.718
2s6d ¹ D	2p6d ³ D ₁	0.3890+12	0.3890+12	0.6398+10	0.1214+07	0.6037+06	4.760
2s6d ¹ D	2p6d ³ D ₂	0.9820+12	0.9820+12	0.1054+11	0.4914+07	0.2452+07	4.761
2s6d ¹ D	2p6d ³ D ₃	0.2280+12	0.2280+12	0.1488+11	0.7305+06	0.3619+06	4.765
2s6d ¹ D	2p6d ³ P ₂	0.1991+14	0.1991+14	0.8812+10	0.3551+07	0.1775+07	4.784
2s6d ¹ D	2p6d ³ P ₁	0.2047+14	0.2047+14	0.5276+10	0.3152+06	0.1576+06	4.788
2s6d ¹ D	2p6d ¹ F ₃	0.1317+15	0.1317+15	0.2814+11	0.1501+10	0.7505+09	4.896
2s6d ¹ D	2p6d ¹ P ₁	0.1544+14	0.1544+14	0.1090+11	0.1237+10	0.6184+09	4.930
2s6f ³ F	2p6f ¹ F ₃	0.7580+12	0.7580+12	0.4796+10	0.2391+09	0.1195+09	4.779
2s6f ³ F	2p6f ³ F ₂	0.1300+11	0.1300+11	0.3478+10	0.1380+10	0.6549+09	4.782
2s6f ³ F	2p6f ³ F ₃	0.2565+13	0.2565+13	0.4760+10	0.1786+10	0.8930+09	4.782
2s6f ³ F	2p6f ³ F ₄	0.2644+13	0.2644+13	0.6109+10	0.2437+10	0.1218+10	4.783
2s6f ³ F	2p6f ³ G ₃	0.3336+14	0.3336+14	0.4161+10	0.1542+10	0.7709+09	4.800
2s6f ³ F	2p6f ³ G ₄	0.3460+14	0.3460+14	0.5316+10	0.1984+10	0.9919+09	4.803
2s6f ³ F	2p6f ³ G ₅	0.3668+14	0.3668+14	0.6444+10	0.2521+10	0.1260+10	4.809
2s6f ³ F	2p6f ¹ G ₄	0.4168+14	0.4168+14	0.5076+10	0.1415+09	0.7075+08	4.820
2s6f ³ F	2p6f ³ D ₃	0.1840+12	0.1840+12	0.6007+10	0.2318+10	0.1154+10	4.825
2s6f ³ F	2p6f ³ D ₂	0.1880+12	0.1880+12	0.4351+10	0.1638+10	0.8150+09	4.829
2s6f ³ F	2p6f ³ D ₁	0.1890+12	0.1890+12	0.2588+10	0.1006+10	0.5007+09	4.831
2s6f ³ F	2p6f ¹ D ₂	0.6550+12	0.6550+12	0.6380+10	0.4214+08	0.2103+08	4.850
2s6f ¹ F	2p6f ¹ F ₃	0.7580+12	0.7580+12	0.4796+10	0.1623+10	0.8108+09	4.779
2s6f ¹ F	2p6f ³ F ₂	0.1300+11	0.1300+11	0.3478+10	0.3769+07	0.1789+07	4.782
2s6f ¹ F	2p6f ³ F ₃	0.2565+13	0.2565+13	0.4760+10	0.1312+09	0.6558+08	4.782
2s6f ¹ F	2p6f ³ F ₄	0.2644+13	0.2644+13	0.6109+10	0.3582+08	0.1791+08	4.783
2s6f ¹ F	2p6f ³ G ₃	0.3336+14	0.3336+14	0.4161+10	0.8552+08	0.4276+08	4.800
2s6f ¹ F	2p6f ³ G ₄	0.3460+14	0.3460+14	0.5316+10	0.1071+09	0.5355+08	4.803
2s6f ¹ F	2p6f ¹ G ₄	0.4168+14	0.4168+14	0.5076+10	0.2007+10	0.1003+10	4.820
2s6f ¹ F	2p6f ³ D ₃	0.1840+12	0.1840+12	0.6007+10	0.1456+08	0.7246+07	4.825
2s6f ¹ F	2p6f ³ D ₂	0.1880+12	0.1880+12	0.4351+10	0.2618+08	0.1303+08	4.829
2s6f ¹ F	2p6f ¹ D ₂	0.6550+12	0.6550+12	0.6380+10	0.1393+10	0.6951+09	4.850
2s6g ³ G	2p6g ³ G ₅	0.2796+13	0.2796+13	0.5365+10	0.2822+10	0.1411+10	4.811
2s6g ³ G	2p6g ³ G ₄	0.7000+10	0.7000+10	0.4585+10	0.1827+10	0.8516+09	4.809
2s6g ³ G	2p6g ³ G ₃	0.1000+11	0.1000+11	0.3564+10	0.1880+10	0.8946+09	4.809
2s6g ³ G	2p6g ¹ G ₄	0.2810+13	0.2810+13	0.4390+10	0.9599+09	0.4798+09	4.811
2s6g ³ G	2p6g ³ H ₄	0.1191+14	0.1191+14	0.3871+10	0.1580+10	0.7898+09	4.825

Table V. (continued)

Lower level	Upper level	Aa s ⁻¹	sumAa s ⁻¹	sum(gAr) s ⁻¹	gAr s ⁻¹	Qd/2 s ⁻¹	E _S eV
2s6g ³ G	2p6g ³ H ₅	0.1201+14	0.1201+14	0.4717+10	0.1881+10	0.9404+09	4.825
2s6g ³ G	2p6g ³ H ₆	0.1476+14	0.1476+14	0.5359+10	0.2478+10	0.1239+10	4.832
2s6g ³ G	2p6g ¹ H ₅	0.1482+14	0.1482+14	0.4518+10	0.5718+09	0.2859+09	4.832
2s6g ³ G	2p6g ¹ F ₃	0.8400+11	0.8400+11	0.3859+10	0.8214+09	0.4080+09	4.834
2s6g ³ G	2p6g ³ F ₂	0.1030+12	0.1030+12	0.2782+10	0.1627+10	0.8091+09	4.839
2s6g ³ G	2p6g ³ F ₃	0.7600+11	0.7600+11	0.3892+10	0.1600+10	0.7942+09	4.839
2s6g ³ G	2p6g ³ F ₄	0.8600+11	0.8600+11	0.4970+10	0.2867+10	0.1425+10	4.834
2s6g ¹ G	2p6g ³ G ₄	0.7000+10	0.7000+10	0.4585+10	0.7975+09	0.3717+09	4.809
2s6g ¹ G	2p6g ³ G ₃	0.1000+11	0.1000+11	0.3564+10	0.1608+09	0.7650+08	4.809
2s6g ¹ G	2p6g ¹ G ₄	0.2810+13	0.2810+13	0.4390+10	0.1470+10	0.7349+09	4.811
2s6g ¹ G	2p6g ³ G ₅	0.2796+13	0.2796+13	0.5365+10	0.1511+09	0.7554+08	4.811
2s6g ¹ G	2p6g ³ H ₄	0.1191+14	0.1191+14	0.3871+10	0.3053+09	0.1526+09	4.825
2s6g ¹ G	2p6g ³ H ₅	0.1201+14	0.1201+14	0.4717+10	0.4183+09	0.2091+09	4.825
2s6g ¹ G	2p6g ¹ H ₅	0.1482+14	0.1482+14	0.4518+10	0.1524+10	0.7620+09	4.832
2s6g ¹ G	2p6g ³ F ₄	0.8600+11	0.8600+11	0.4970+10	0.3208+08	0.1594+08	4.834
2s6g ¹ G	2p6g ¹ F ₃	0.8400+11	0.8400+11	0.3859+10	0.1433+10	0.7118+09	4.834
2s6g ¹ G	2p6g ³ F ₃	0.7600+11	0.7600+11	0.3892+10	0.6755+09	0.3353+09	4.839
2s6h ³ H	2p6h ³ H ₆	0.9540+12	0.9540+12	0.5052+10	0.3767+10	0.1882+10	4.823
2s6h ³ H	2p6h ³ H ₅	0.5000+10	0.5000+10	0.4731+10	0.1199+10	0.5521+09	4.823
2s6h ³ H	2p6h ³ H ₄	0.4700+11	0.4700+11	0.3871+10	0.2632+10	0.1304+10	4.823
2s6h ³ H	2p6h ³ I ₅	0.9540+12	0.9540+12	0.4275+10	0.5174+10	0.2587+10	4.835
2s6h ³ H	2p6h ³ I ₇	0.2476+13	0.2476+13	0.5082+10	0.3035+10	0.1517+10	4.840
2s6h ³ H	2p6h ¹ I ₆	0.2477+13	0.2477+13	0.4404+10	0.2533+10	0.1266+10	4.840
2s6h ³ H	2p6h ³ G ₅	0.2200+11	0.2200+11	0.5037+10	0.2602+10	0.1274+10	4.839
2s6h ³ H	2p6h ³ G ₄	0.3800+11	0.3800+11	0.4211+10	0.1749+09	0.8641+08	4.843
2s6h ³ H	2p6h ³ G ₃	0.2800+11	0.2800+11	0.3276+10	0.2323+10	0.1142+10	4.843
2s6h ³ H	2p6h ¹ G ₄	0.3600+11	0.3600+11	0.4121+10	0.2724+10	0.1345+10	4.839
2s6h ¹ H	2p6h ³ H ₆	0.9540+12	0.9540+12	0.5052+10	0.2535+10	0.1267+10	4.835
2s6h ¹ H	2p6h ³ H ₅	0.5000+10	0.5000+10	0.4731+10	0.2019+10	0.9295+09	4.823
2s6h ¹ H	2p6h ³ I ₅	0.9540+12	0.9540+12	0.4275+10	0.1584+09	0.7915+08	4.835
2s6h ¹ H	2p6h ¹ I ₆	0.2477+13	0.2477+13	0.4404+10	0.9722+08	0.4860+08	4.840
2s6h ¹ H	2p6h ³ G ₅	0.2200+11	0.2200+11	0.5037+10	0.9341+09	0.4575+09	4.839
2s6h ¹ H	2p6h ³ G ₄	0.3800+11	0.3800+11	0.4211+10	0.2811+10	0.1388+10	4.843
2s6h ¹ H	2p6h ¹ G ₄	0.3600+11	0.3600+11	0.4121+10	0.1686+09	0.8324+08	4.839

Table VI. Energy excitation (E_s), radiative transition probabilities (gAr), autoionization rate (Aa) and intensity factor(Qd) for $2s6l - 3p6l$ transitions

Lower level	Upper level	Aa s^{-1}	sumAa s^{-1}	sum(gAr) s^{-1}	gAr s^{-1}	$Qd/2$ s^{-1}	E_s eV
2s6s 3S	3p6s 3P_0	0.2186+13	0.4807+13	0.6241+10	0.4193+10	0.9412+09	36.17
2s6s 3S	3p6s 3P_1	0.2191+13	0.4820+13	0.1872+11	0.1258+11	0.2856+10	36.18
2s6s 3S	3p6s 3P_2	0.2185+13	0.4819+13	0.3114+11	0.2098+11	0.4750+10	36.18
2s6s 3S	3p6s 1P_1	0.9260+13	0.2726+14	0.3073+11	0.6689+07	0.1136+07	36.22
2s6s 1S	3p6s 3P_1	0.2191+13	0.4820+13	0.1872+11	0.3160+07	0.7173+06	36.18
2s6s 1S	3p6s 1P_1	0.9260+13	0.2726+14	0.3073+11	0.5210+10	0.8845+09	36.22
2s6p 3P	3p6p 1S_0	0.6078+13	0.4788+14	0.1418+11	0.2995+06	0.1901+05	36.21
2s6p 3P	3p6p 1P_1	0.1000+07	0.3200+12	0.1634+11	0.1658+08	0.2547+02	36.33
2s6p 3P	3p6p 1D_2	0.3210+12	0.3139+14	0.5626+11	0.4702+07	0.2403+05	36.50
2s6p 3P	3p6p 3S_1	0.4000+11	0.5360+12	0.2397+11	0.1229+11	0.4519+09	36.48
2s6p 3P	3p6p 3D_1	0.2070+12	0.8410+12	0.2008+11	0.1225+11	0.1496+10	36.37
2s6p 3P	3p6p 3D_2	0.2080+12	0.8470+12	0.3349+11	0.2044+11	0.2490+10	36.37
2s6p 3P	3p6p 3D_3	0.2090+12	0.8430+12	0.4690+11	0.2861+11	0.3519+10	36.37
2s6p 3P	3p6p 3P_0	0.1000+07	0.2268+14	0.6307+10	0.4124+10	0.9087+02	36.44
2s6p 3P	3p6p 3P_1	0.1000+07	0.2267+14	0.1892+11	0.1237+11	0.2728+03	36.44
2s6p 3P	3p6p 3P_2	0.1000+07	0.2270+14	0.3153+11	0.2062+11	0.4542+03	36.44
2s6p 1P	3p6p 1S_0	0.6078+13	0.4788+14	0.1418+11	0.2102+10	0.1334+09	36.21
2s6p 1P	3p6p 1P_1	0.1000+07	0.3200+12	0.1634+11	0.1264+11	0.1942+05	36.33
2s6p 1P	3p6p 1D_2	0.3210+12	0.3139+14	0.5626+11	0.1447+11	0.7397+08	36.50
2s6p 1P	3p6p 3S_1	0.4000+11	0.5360+12	0.2397+11	0.1104+07	0.4059+05	36.48
2s6p 1P	3p6p 3D_1	0.2070+12	0.8410+12	0.2008+11	0.1549+08	0.1891+07	36.37
2s6p 1P	3p6p 3D_2	0.2080+12	0.8470+12	0.3349+11	0.2538+07	0.3092+06	36.37
2s6p 1P	3p6p 3P_0	0.1000+07	0.2268+14	0.6307+10	0.2397+06	0.5282E-02	36.44
2s6p 1P	3p6p 3P_1	0.1000+07	0.2267+14	0.1892+11	0.3253+06	0.7171E-02	36.44
2s6p 1P	3p6p 3P_2	0.1000+07	0.2270+14	0.3153+11	0.9722+06	0.2141E-01	36.44
2s6d 3D	3p6d 3D_1	0.1000+07	0.6405+13	0.1985+11	0.1236+11	0.9635+03	36.50
2s6d 3D	3p6d 3D_2	0.1000+07	0.6375+13	0.3306+11	0.2048+11	0.1605+04	36.50
2s6d 3D	3p6d 3D_3	0.1000+07	0.6405+13	0.4631+11	0.2883+11	0.2249+04	36.50
2s6d 3D	3p6d 1D_2	0.1000+07	0.1525+13	0.2994+11	0.1301+09	0.4249+02	36.50
2s6d 3D	3p6d 1F_3	0.3160+12	0.8590+13	0.5690+11	0.3813+10	0.7006+08	36.55
2s6d 3D	3p6d 3F_2	0.9000+10	0.1340+12	0.3535+11	0.2296+11	0.7324+09	36.55
2s6d 3D	3p6d 3F_3	0.7200+11	0.1885+13	0.5050+11	0.2835+11	0.5394+09	36.55
2s6d 3D	3p6d 3F_4	0.9000+10	0.1310+12	0.6366+11	0.4135+11	0.1348+10	36.56
2s6d 3D	3p6d 1P_1	0.8000+10	0.9214+13	0.3581+11	0.2503+07	0.1085+04	36.71
2s6d 3D	3p6d 3P_0	0.4500+11	0.7099+13	0.8141+10	0.4261+10	0.1349+08	36.66
2s6d 3D	3p6d 3P_1	0.4500+11	0.7103+13	0.2442+11	0.1278+11	0.4043+08	36.66
2s6d 3D	3p6d 3P_2	0.4500+11	0.7109+13	0.4071+11	0.2129+11	0.6730+08	36.66

Table VI. (continued)

Lower level	Upper level	Aa s ⁻¹	sumAa s ⁻¹	sum(gAr) s ⁻¹	gAr s ⁻¹	Qd/2 s ⁻¹	E _s eV
2s6d ¹ D	3p6d ³ D ₁	0.1000+07	0.6405+13	0.1985+11	0.1406+06	0.1096E-01	36.50
2s6d ¹ D	3p6d ³ D ₂	0.1000+07	0.6375+13	0.3306+11	0.1231+09	0.9645+01	36.50
2s6d ¹ D	3p6d ³ D ₃	0.1000+07	0.6405+13	0.4631+11	0.6570+07	0.5124+00	36.50
2s6d ¹ D	3p6d ¹ D ₂	0.1000+07	0.1525+13	0.2994+11	0.2180+11	0.7120+04	36.50
2s6d ¹ D	3p6d ¹ F ₃	0.3160+12	0.8590+13	0.5690+11	0.2000+11	0.3675+09	36.55
2s6d ¹ D	3p6d ³ F ₂	0.9000+10	0.1340+12	0.3535+11	0.1280+08	0.4083+06	36.55
2s6d ¹ D	3p6d ³ F ₃	0.7200+11	0.1885+13	0.5050+11	0.2681+10	0.5101+08	36.55
2s6d ¹ D	3p6d ¹ P ₁	0.8000+10	0.9214+13	0.3581+11	0.8120+10	0.3521+07	36.71
2s6d ¹ D	3p6d ³ P ₁	0.4500+11	0.7103+13	0.2442+11	0.1275+07	0.4034+04	36.66
2s6d ¹ D	3p6d ³ P ₂	0.4500+11	0.7109+13	0.4071+11	0.1098+07	0.3471+04	36.66
2s6f ³ F	3p6f ¹ D ₂	0.1969+14	0.2905+14	0.6580+11	0.3065+06	0.1038+06	37.10
2s6f ³ F	3p6f ¹ F ₃	0.1000+07	0.5510+12	0.3413+11	0.3438+08	0.3092+02	36.60
2s6f ³ F	3p6f ¹ G ₄	0.2369+14	0.3341+14	0.5799+11	0.2002+07	0.7096+06	36.84
2s6f ³ F	3p6f ³ D ₁	0.1400+11	0.8590+12	0.1752+11	0.1337+11	0.1082+09	36.74
2s6f ³ F	3p6f ³ D ₂	0.1400+11	0.8630+12	0.2915+11	0.2231+11	0.1798+09	36.74
2s6f ³ F	3p6f ³ D ₃	0.1500+11	0.8680+12	0.4069+11	0.3127+11	0.2684+09	36.73
2s6f ³ F	3p6f ³ F ₂	0.1000+07	0.1600+11	0.2460+11	0.2257+11	0.5396+06	36.63
2s6f ³ F	3p6f ³ F ₃	0.1000+10	0.2000+11	0.3446+11	0.3160+11	0.6339+09	36.63
2s6f ³ F	3p6f ³ F ₄	0.1000+10	0.2200+11	0.4431+11	0.4062+11	0.7544+09	36.63
2s6f ³ F	3p6f ³ G ₃	0.9100+11	0.7780+12	0.3817+11	0.3017+11	0.1751+10	36.64
2s6f ³ F	3p6f ³ G ₄	0.9200+11	0.7780+12	0.4909+11	0.3882+11	0.2279+10	36.64
2s6f ³ F	3p6f ³ G ₅	0.9200+11	0.7810+12	0.6005+11	0.4742+11	0.2774+10	36.65
2s6f ¹ F	3p6f ¹ D ₂	0.1969+14	0.2905+14	0.6580+11	0.1216+11	0.4119+10	37.10
2s6f ¹ F	3p6f ¹ F ₃	0.1000+07	0.5510+12	0.3413+11	0.2940+11	0.2644+05	36.60
2s6f ¹ F	3p6f ¹ G ₄	0.2369+14	0.3341+14	0.5799+11	0.4146+11	0.1470+11	36.84
2s6f ¹ F	3p6f ³ D ₂	0.1400+11	0.8630+12	0.2915+11	0.9244+06	0.7448+04	36.74
2s6f ¹ F	3p6f ³ D ₃	0.1500+11	0.8680+12	0.4069+11	0.1948+07	0.1672+05	36.73
2s6f ¹ F	3p6f ³ F ₂	0.1000+07	0.1600+11	0.2460+11	0.5118+06	0.1223+02	36.63
2s6f ¹ F	3p6f ³ F ₃	0.1000+10	0.2000+11	0.3446+11	0.4977+07	0.9985+05	36.63
2s6f ¹ F	3p6f ³ F ₄	0.1000+10	0.2200+11	0.4431+11	0.1297+07	0.2409+05	36.63
2s6f ¹ F	3p6f ³ G ₃	0.9100+11	0.7780+12	0.3817+11	0.2612+08	0.1517+07	36.64
2s6f ¹ F	3p6f ³ G ₄	0.9200+11	0.7780+12	0.4909+11	0.8274+06	0.4858+05	36.64
2s6g ³ G	3p6g ¹ F ₃	0.6400+11	0.2106+13	0.5649+11	0.8163+09	0.1235+08	36.96
2s6g ³ G	3p6g ³ F ₂	0.2700+11	0.2800+11	0.2626+11	0.2335+11	0.9480+10	36.84
2s6g ³ G	3p6g ³ F ₃	0.2700+11	0.2800+11	0.3675+11	0.3176+11	0.1290+11	36.84
2s6g ³ G	3p6g ³ F ₄	0.2700+11	0.2800+11	0.4723+11	0.4199+11	0.1704+11	36.84
2s6g ³ G	3p6g ¹ G ₄	0.1000+07	0.1000+10	0.4244+11	0.1228+10	0.1074+06	36.69
2s6g ³ G	3p6g ³ G ₃	0.1000+07	0.3100+11	0.3348+11	0.3106+11	0.4340+06	36.71

Table VI. (continued)

Lower level	Upper level	Aa s ⁻¹	sumAa s ⁻¹	sum(gAr) s ⁻¹	gAr s ⁻¹	Qd/2 s ⁻¹	E _s eV
2s6g ³ G	3p6g ³ G ₄	0.1000+07	0.3100+11	0.4305+11	0.3885+11	0.5430+06	36.71
2s6g ³ G	3p6g ³ G ₅	0.1000+07	0.3100+11	0.5262+11	0.4886+11	0.6827+06	36.72
2s6g ³ G	3p6g ³ H ₄	0.4460+12	0.7440+12	0.4591+11	0.3916+11	0.1229+11	36.77
2s6g ³ G	3p6g ³ H ₅	0.4460+12	0.7450+12	0.5613+11	0.4666+11	0.1387+11	36.77
2s6g ³ G	3p6g ³ H ₆	0.4470+12	0.7450+12	0.6636+11	0.5658+11	0.1686+11	36.77
2s6g ³ G	3p6g ¹ H ₅	0.1491+13	0.3600+13	0.7913+11	0.1063+10	0.2198+09	36.95
2s6g ¹ G	3p6g ³ F ₃	0.6400+11	0.2106+13	0.5649+11	0.2525+11	0.3822+09	36.96
2s6g ¹ G	3p6g ³ F ₃	0.2700+11	0.2800+11	0.3675+11	0.9260+09	0.3760+09	36.84
2s6g ¹ G	3p6g ³ F ₄	0.2700+11	0.2800+11	0.4723+11	0.4004+08	0.1626+08	36.84
2s6g ¹ G	3p6g ¹ G ₄	0.1000+07	0.1000+10	0.4244+11	0.3901+11	0.3413+07	36.69
2s6g ¹ G	3p6g ³ G ₃	0.1000+07	0.3100+11	0.3348+11	0.6967+08	0.9735+03	36.71
2s6g ¹ G	3p6g ³ G ₄	0.1000+07	0.3100+11	0.4305+11	0.1172+10	0.1638+05	36.71
2s6g ¹ G	3p6g ³ G ₅	0.1000+07	0.3100+11	0.5262+11	0.5521+08	0.7714+03	36.72
2s6g ¹ G	3p6g ³ H ₄	0.4460+12	0.7440+12	0.4591+11	0.1205+08	0.3587+07	36.77
2s6g ¹ G	3p6g ³ H ₅	0.4460+12	0.7450+12	0.5613+11	0.1214+10	0.3609+09	36.77
2s6g ¹ G	3p6g ¹ H ₅	0.1491+13	0.3600+13	0.7913+11	0.3953+11	0.8170+10	36.95
2s6h ³ H	3p6h ¹ H ₅	0.1000+07	0.1000+10	0.5313+11	0.1026+11	0.8800+06	36.79
2s6h ³ H	3p6h ³ H ₄	0.1000+07	0.2000+10	0.4359+11	0.3981+11	0.2909+07	36.79
2s6h ³ H	3p6h ³ H ₅	0.1000+07	0.2000+10	0.5327+11	0.4051+11	0.2960+07	36.79
2s6h ³ H	3p6h ³ H ₆	0.1000+07	0.2000+10	0.6297+11	0.5789+11	0.4230+07	36.79
2s6h ³ H	3p6h ³ G ₅	0.1000+10	0.1000+10	0.5642+11	0.5131+11	0.4186+10	36.88
2s6h ³ H	3p6h ³ G ₄	0.7000+10	0.1600+11	0.4620+11	0.3364+11	0.5571+10	36.88
2s6h ³ H	3p6h ³ G ₃	0.1000+10	0.1000+10	0.3590+11	0.3321+11	0.2709+10	36.88
2s6h ³ H	3p6h ¹ G ₄	0.2440+12	0.6010+12	0.4789+11	0.9333+10	0.1878+10	36.89
2s6h ³ H	3p6h ³ I ₅	0.4900+11	0.9200+11	0.5917+11	0.4709+11	0.1185+11	36.88
2s6h ³ H	3p6h ³ I ₆	0.4900+11	0.9300+11	0.6995+11	0.3024+11	0.7531+10	36.88
2s6h ³ H	3p6h ³ I ₇	0.4900+11	0.9200+11	0.8066+11	0.6505+11	0.1637+11	36.88
2s6h ³ H	3p6h ¹ I ₆	0.6400+11	0.1500+12	0.7207+11	0.2630+11	0.5410+10	36.89
2s6h ¹ H	3p6h ¹ H ₅	0.1000+07	0.1000+10	0.5313+11	0.3910+11	0.3353+07	36.79
2s6h ¹ H	3p6h ³ H ₄	0.1000+07	0.2000+10	0.4359+11	0.5430+09	0.3967+05	36.79
2s6h ¹ H	3p6h ³ H ₅	0.1000+07	0.2000+10	0.5327+11	0.8816+10	0.6442+06	36.79
2s6h ¹ H	3p6h ³ H ₆	0.1000+07	0.2000+10	0.6297+11	0.4052+09	0.2960+05	36.79
2s6h ¹ H	3p6h ³ G ₅	0.1000+10	0.1000+10	0.5642+11	0.8515+09	0.6946+08	36.88
2s6h ¹ H	3p6h ³ G ₄	0.7000+10	0.1600+11	0.4620+11	0.9034+10	0.1496+10	36.88
2s6h ¹ H	3p6h ³ I ₅	0.4900+11	0.9200+11	0.5917+11	0.5976+09	0.1504+09	36.88
2s6h ¹ H	3p6h ³ I ₆	0.4900+11	0.9300+11	0.6995+11	0.2611+11	0.6502+10	36.88
2s6h ¹ H	3p6h ¹ G ₄	0.2440+12	0.6010+12	0.4789+11	0.3256+11	0.6552+10	36.89
2s6h ¹ H	3p6h ¹ I ₆	0.6400+11	0.1500+12	0.7207+11	0.2947+11	0.6063+10	36.89

Table VII. Dielectronic recombination rate coefficients ($T_e=10^4\text{K}$) for lines.
a-present result, b-[4]

Transition		α_d in cm^3/s	
		a	b
$2p^2(^3P)$	$2p4d(^3P)$	1.922-12	1.899-12
$2p^2(^1D)$	$2p4d(^1F)$	3.084-12	2.991-12
$2p3d(^3F)$	$2p4f(^3G)$	3.972-12	2.903-12
$2p3d(^3D)$	$2p4f(^3D)$	2.115-13	1.93-13
$2p3d(^3P)$	$2p4f(^3D)$	9.258-13	4.95-13
$2p3p(^1D)$	$2p4d(^1F)$	2.736-13	2.00-13
$2s4d(^1D)$	$2p4d(^1F)$	1.285-13	1.93-13

Table VIII. Fitting parameters for $\alpha_d(\gamma')$ in eq.(28)

Excited st. (γ')	$A_1(\text{cm}^3\text{s}^{-1})$	$E_1(\text{eV})$	$A_2(\text{cm}^3\text{s}^{-1})$	$E_2(\text{eV})$
$2s^2$ 1S	4.661E-14	3.841E+00	3.394E-14	7.794E-01
$2p^2$ 3P	7.000E-12	3.557E+00	7.930E-12	3.405E-01
$2p^2$ 1D	6.890E-12	1.867E+00	1.761E-12	2.349E-01
$2p^2$ 1S	1.073E-12	3.986E+00	8.165E-13	7.783E-01
$2s2p$ 3P	4.569E-15	5.390E-01	1.302E-12	3.247E+00
$2s2p$ 1P	4.874E-13	2.541E-01	1.447E-12	3.718E+00
$2s3s$ 3S	4.758E-15	3.774E+00	2.923E-15	4.284E-01
$2s3s$ 1S	1.567E-14	4.460E+00	5.720E-15	7.797E-01
$2p3p$ 3S	2.203E-13	3.571E+00	1.846E-13	4.275E-01
$2p3p$ 1S	9.750E-14	4.148E+00	4.912E-14	7.798E-01
$2p3p$ 1P	1.901E-13	3.153E+00	1.846E-13	1.379E-01
$2p3p$ 3P	8.335E-13	3.595E+00	6.725E-13	3.380E-01
$2p3p$ 1D	1.596E-13	2.426E-01	6.820E-13	2.014E+00
$2p3p$ 3D	7.855E-13	3.290E+00	1.459E-12	1.682E-01
$2s3d$ 3D	2.376E-13	4.126E+00	2.825E-14	2.416E-01
$2s3d$ 1D	1.780E-13	2.667E+00	3.128E-14	2.715E-01
$2s3p$ 1P	2.459E-15	5.821E-01	4.630E-14	4.307E+00
$2s3p$ 3P	1.322E-14	5.593E-01	3.157E-14	3.994E+00
$2p3s$ 3P	2.323E-14	5.617E-01	2.717E-13	3.319E+00
$2p3s$ 1P	1.097E-13	2.515E-01	9.425E-14	3.393E+00
$2p3d$ 1D	8.425E-13	4.016E-01	4.650E-13	3.432E+00
$2p3d$ 3F	3.708E-12	4.988E-01	1.238E-12	3.639E+00
$2p3d$ 3D	1.863E-12	4.106E-01	1.176E-12	3.529E+00
$2p3d$ 3P	1.261E-12	5.582E-01	8.205E-13	3.656E+00
$2p3d$ 1F	7.570E-13	4.820E-01	3.778E-13	2.789E+00
$2p3d$ 1P	2.401E-13	5.898E-01	2.639E-13	3.501E+00
$2s4s$ 3S	1.853E-14	4.269E-01	8.860E-15	3.259E+00
$2s4s$ 1S	6.430E-15	3.021E+00	7.445E-16	7.832E-01
$2s4s$ 1D	1.357E-13	1.450E-01	2.368E-13	8.748E-01
$2s4d$ 3D	2.845E-13	2.891E+00	6.820E-13	3.060E-01
$2p4p$ 1P	2.410E-15	2.079E-01	5.775E-14	2.995E+00
$2p4p$ 3D	7.390E-15	1.972E-01	3.527E-13	3.292E+00
$2p4p$ 3S	2.457E-15	4.336E-01	6.580E-14	3.538E+00
$2s4p$ 3P	1.367E-14	5.538E-01	1.972E-14	3.628E+00
$2s4f$ 3F	8.325E-13	4.236E-01	3.882E-13	3.342E+00
$2s4p$ 1P	1.884E-14	2.862E-01	1.157E-13	3.554E+00
$2p4s$ 3P	1.075E-15	5.677E-01	8.540E-14	3.295E+00
$2p4s$ 1P	7.460E-15	2.844E-01	5.220E-14	3.231E+00

Table VIII.(continued)

Excited st.(γ')	$A_1(\text{cm}^3\text{s}^{-1})$	$E_1(\text{eV})$	$A_2(\text{cm}^3\text{s}^{-1})$	$E_2(\text{eV})$
2s5s ^1S	2.556E-14	7.821E-01	1.403E-13	3.000E+00
2s5s ^3S	1.747E-15	4.273E-01	1.894E-13	2.543E+00
2s5d ^3D	3.321E-15	1.772E-01	1.039E-12	3.190E+00
2s5g ^3G	1.062E-16	1.639E-01	1.662E-12	3.331E+00
2s5g ^1G	1.180E-17	7.134E-01	5.575E-13	3.330E+00
2s5d ^1D	5.725E-16	7.331E-01	3.713E-13	3.335E+00
2s5p ^3P	6.030E-14	5.581E-01	5.840E-13	2.976E+00
2s5p ^1P	1.213E-13	4.261E-01	2.064E-13	2.329E+00
2s5f ^3F	7.445E-14	4.940E-01	1.504E-12	3.294E+00
2s5f ^1F	1.937E-13	4.601E-01	5.540E-13	3.090E+00
2s6s ^3S	2.575E-17	2.539E+00	1.984E-13	4.385E+00
2s6s ^1S	2.618E-15	7.801E-01	7.875E-14	4.413E+00
2s6d ^3D	1.029E-14	1.811E-01	1.042E-12	4.716E+00
2s6g ^3G	2.652E-16	1.705E-01	1.730E-12	4.727E+00
2s6g ^1G	1.213E-14	3.334E+00	5.705E-13	4.824E+00
2s6d ^1D	5.110E-15	7.248E-01	3.577E-13	4.686E+00
2s6p ^3P	2.050E-15	4.100E-15	6.365E-13	4.582E+00
2s6f ^3F	1.269E-15	4.583E-01	1.407E-12	4.776E+00
2s6h ^1H	3.563E-16	5.134E-01	7.040E-13	4.834E+00
2s6h ^3H	1.071E-15	5.046E-01	2.145E-12	4.833E+00
2s6f ^1F	3.015E-15	3.425E-01	4.661E-13	4.747E+00
Total(n=7-500)	5.864E-11	4.448E+07	7.140E-10	4.797E+00

Figure Captions

Fig.1 Dielectronic Recombination Rate Coefficient $\alpha_d(\gamma^1l2s)$ for even states as function of T_e

- a) $\gamma^i=2s^2(^1S), 2p^2(^3P), 2p^2(^1D), 2p^2(^1S)$
- b) $\gamma^i=2p3p(^3S), 2p3p(^1S), 2p3p(^3P), 2p3p(^1P), 2p3p(^3D), 2p3p(^1D)$
- c) $\gamma^i=2s3d(^3D), 2s3d(^1D), 2s4d(^3D), 2s4d(^1D), 2s5d(^3D), 2s5d(^1D), 2s6d(^3D), 2s6d(^1D), 2s6g(^3G), 2s6g(^1G)$
- d) $\gamma^i=2s3s(^3S), 2s3s(^1S), 2s4s(^3S), 2s4s(^1S), 2s5s(^3S), 2s5s(^1S), 2s6s(^3S), 2s6s(^1S)$

Fig.2 Dielectronic Recombination Rate Coefficient $\alpha_d(\gamma^1l2s)$ for odd states as function of T_e

- a) $\gamma^i=2s2p(^3P), 2s2p(^1P), 2s3p(^3P), 2s3p(^1P), 2s4p(^3P), 2s4p(^1P), 2s5p(^3P), 2s5p(^1P), 2s6p(^3P)$.
- b) $\gamma^i=2p3d(^1D), 2p3d(^3F), 2p3d(^3D), 2p3d(^3P), 2p3d(^1F), 2p3d(^1P)$.
- c) $\gamma^i=2s4f(^3F), 2s4f(^1F), 2s5f(^3F), 2s5f(^1F), 2s6f(^3F), 2s6f(^1F), 2s6h(^1H)$.
- d) $\gamma^i=2p3s(^3P), 2p3s(^1P), 2p4s(^3P), 2p4s(^1P)$

Fig.3. Dielectronic Recombination Rate Coefficient $\alpha_d(2snl/2s)$ as function of n for $T_e = 6$ eV.

Fig.4. Total Dielectronic Recombination Rate Coefficient $\alpha_d^N(2s\ell/2s)$ as function of N for $T_e = 6$ eV.

Fig.5. Dielectronic Recombination Rate Coefficient $\alpha_d^N(2s\ell^1\ell/2s)$ -a, $\alpha_d^N(2s\ell^3\ell/2s)$ -b as function of T_e .

Fig.6. Dielectronic Recombination Rate Coefficient $\alpha_d(\gamma^1l2s^2)$ as function of T_e

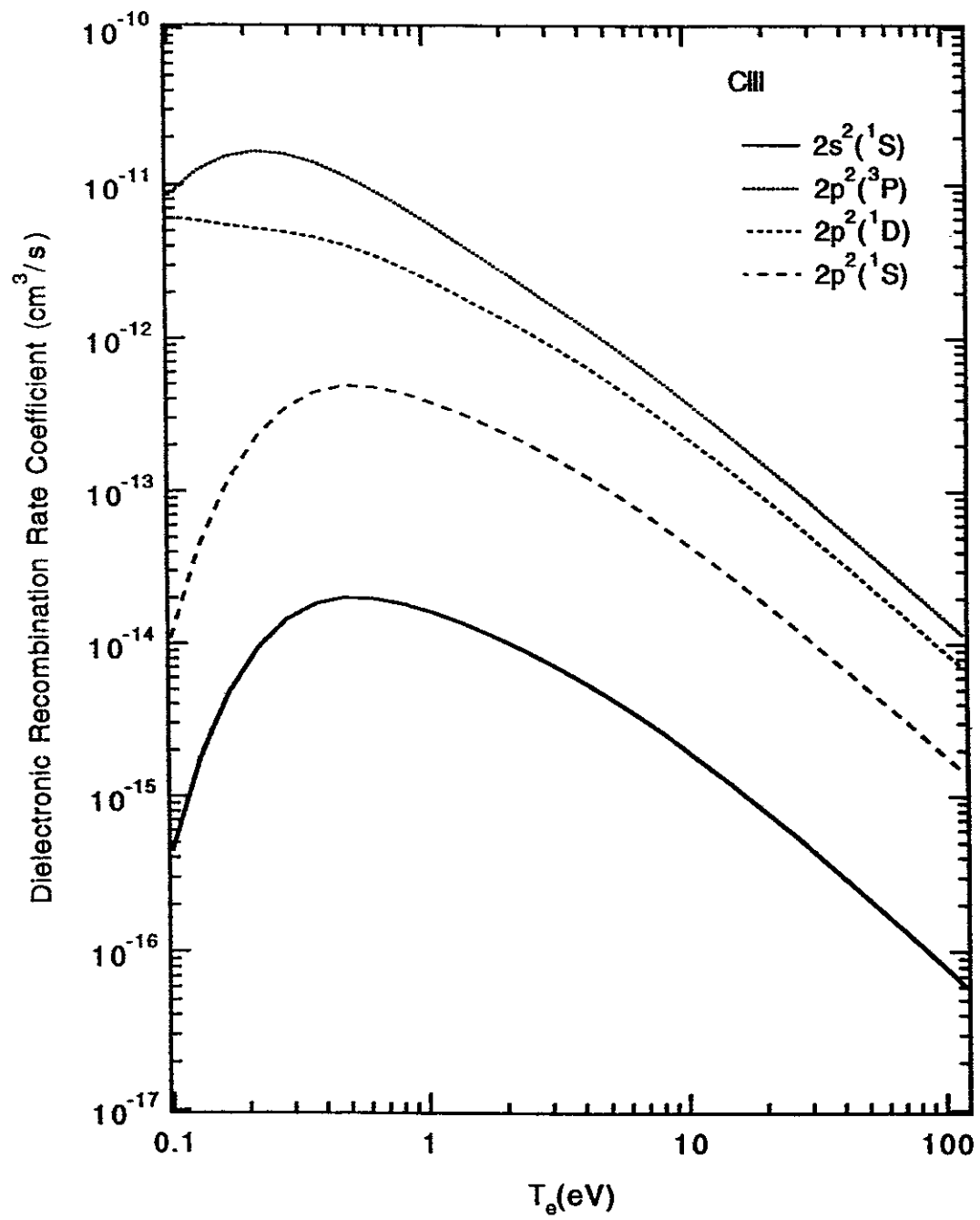


Fig. 1(a)

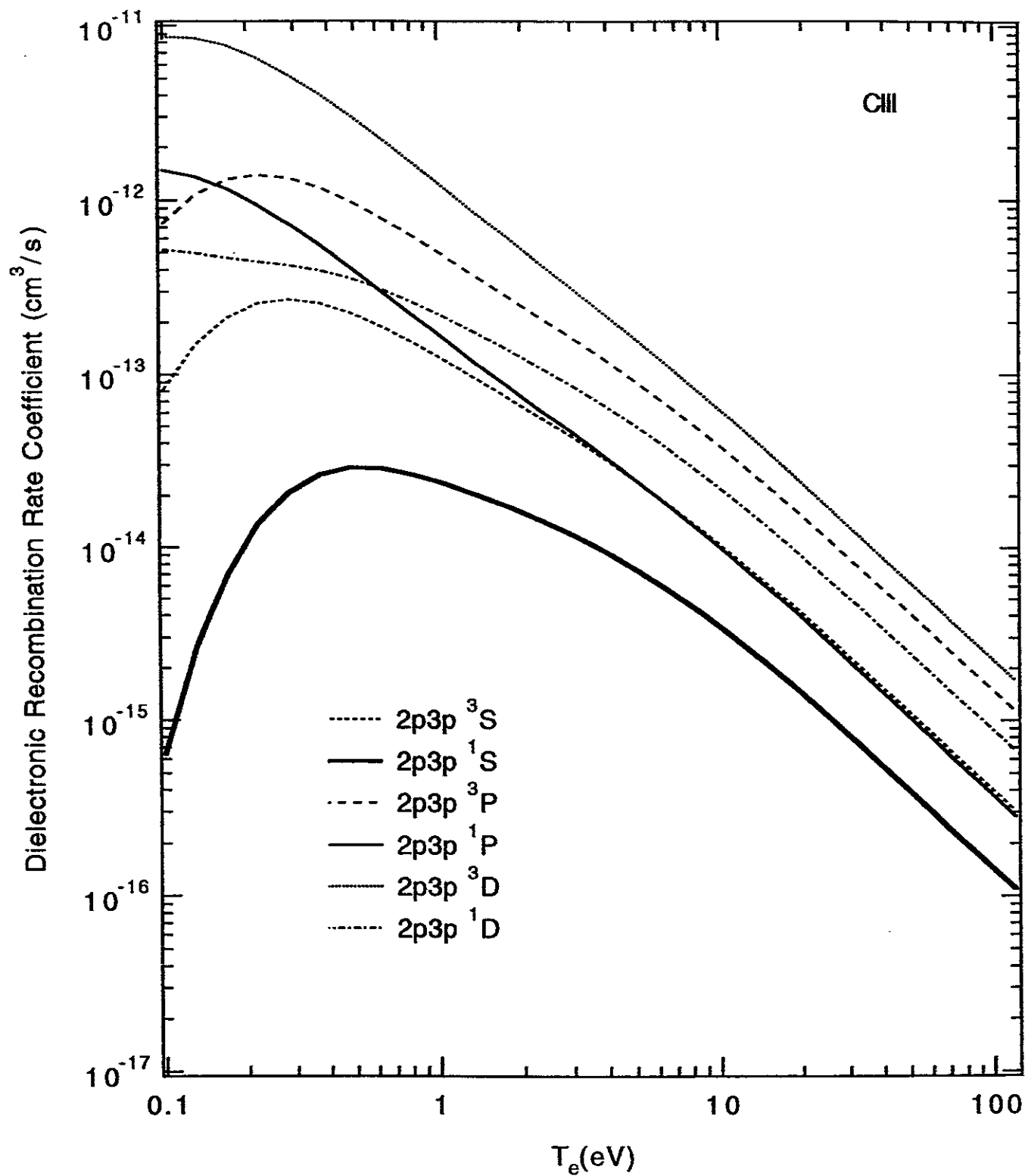


Fig. 1(b)

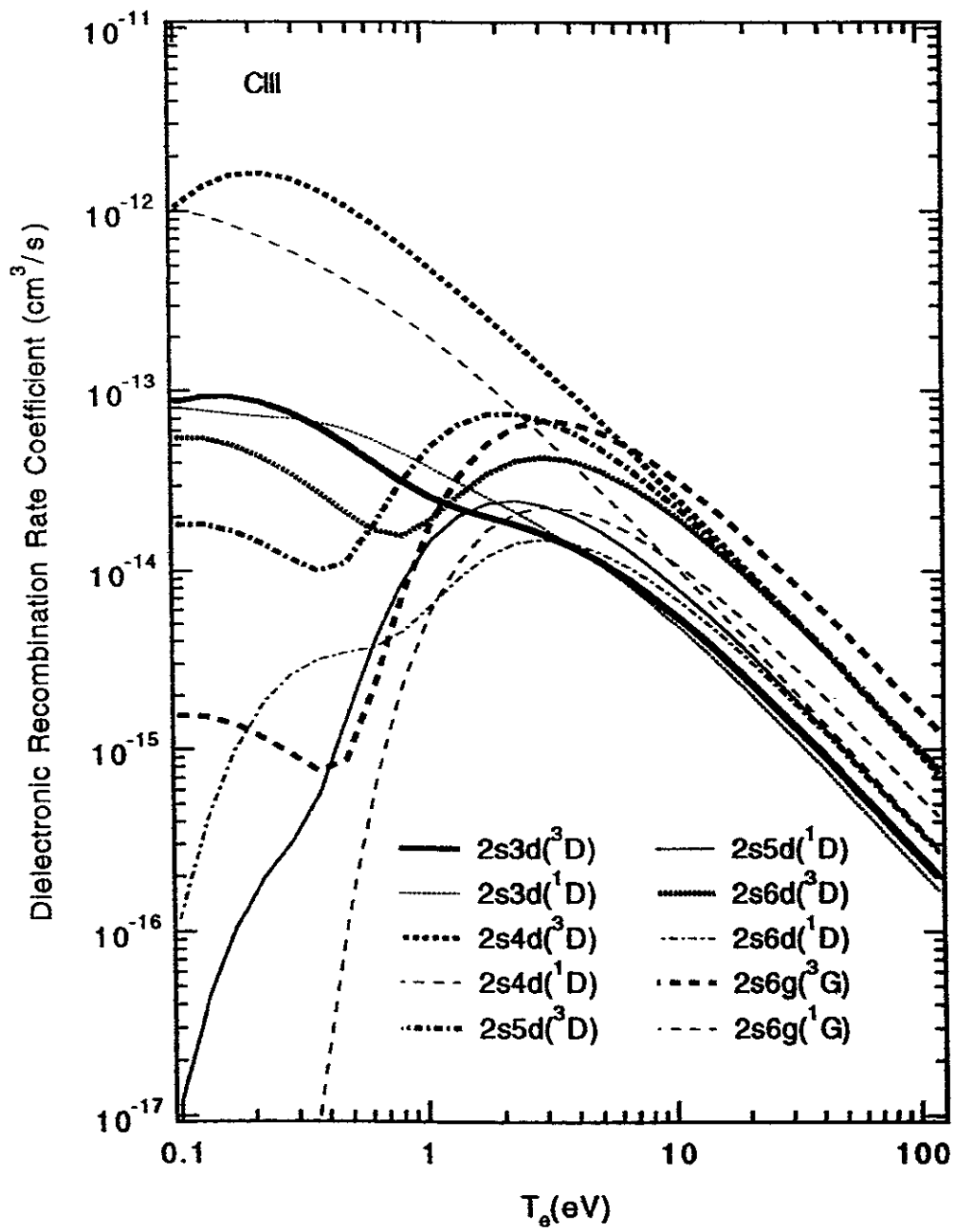


Fig. 1(c)

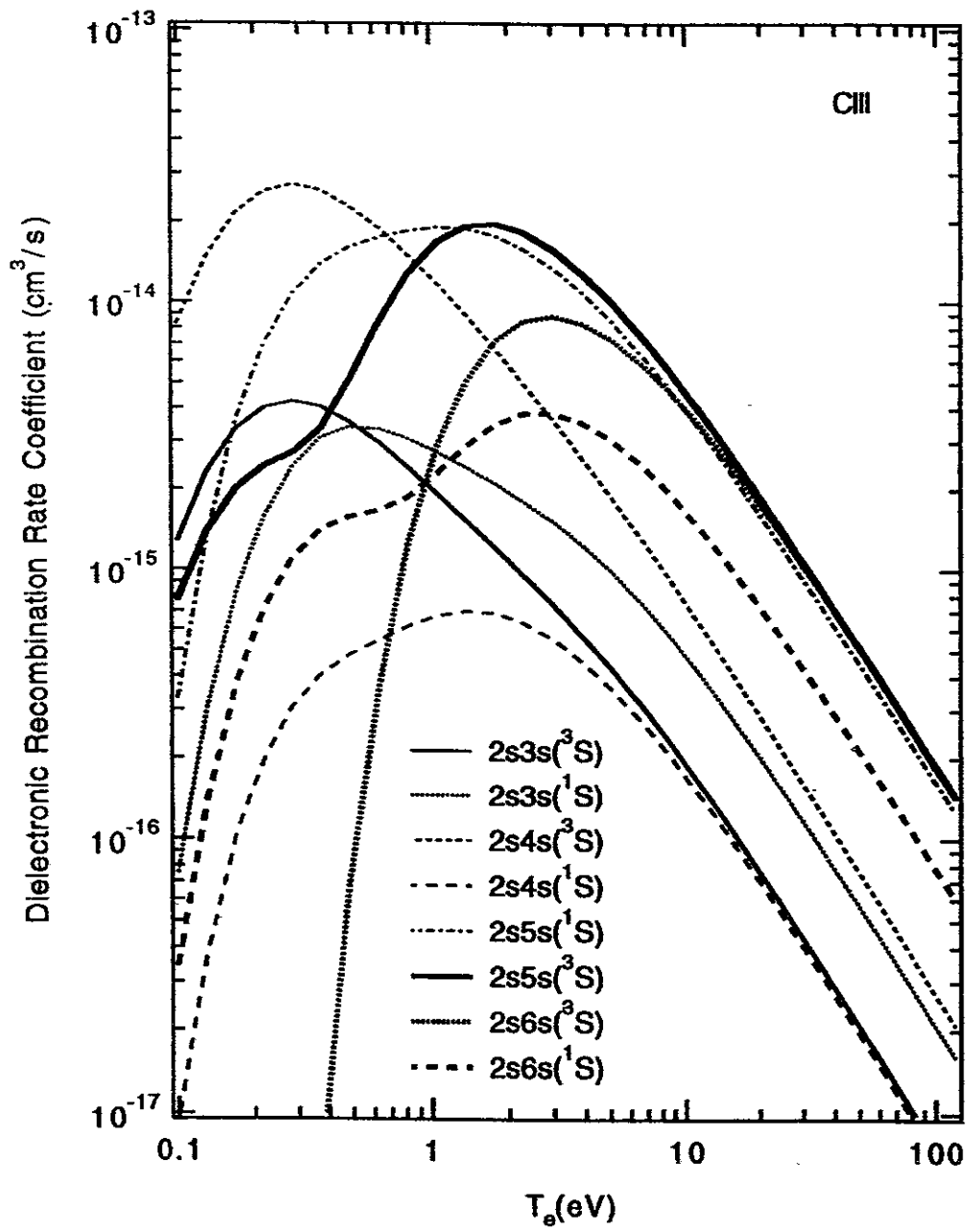


Fig. 1(d)

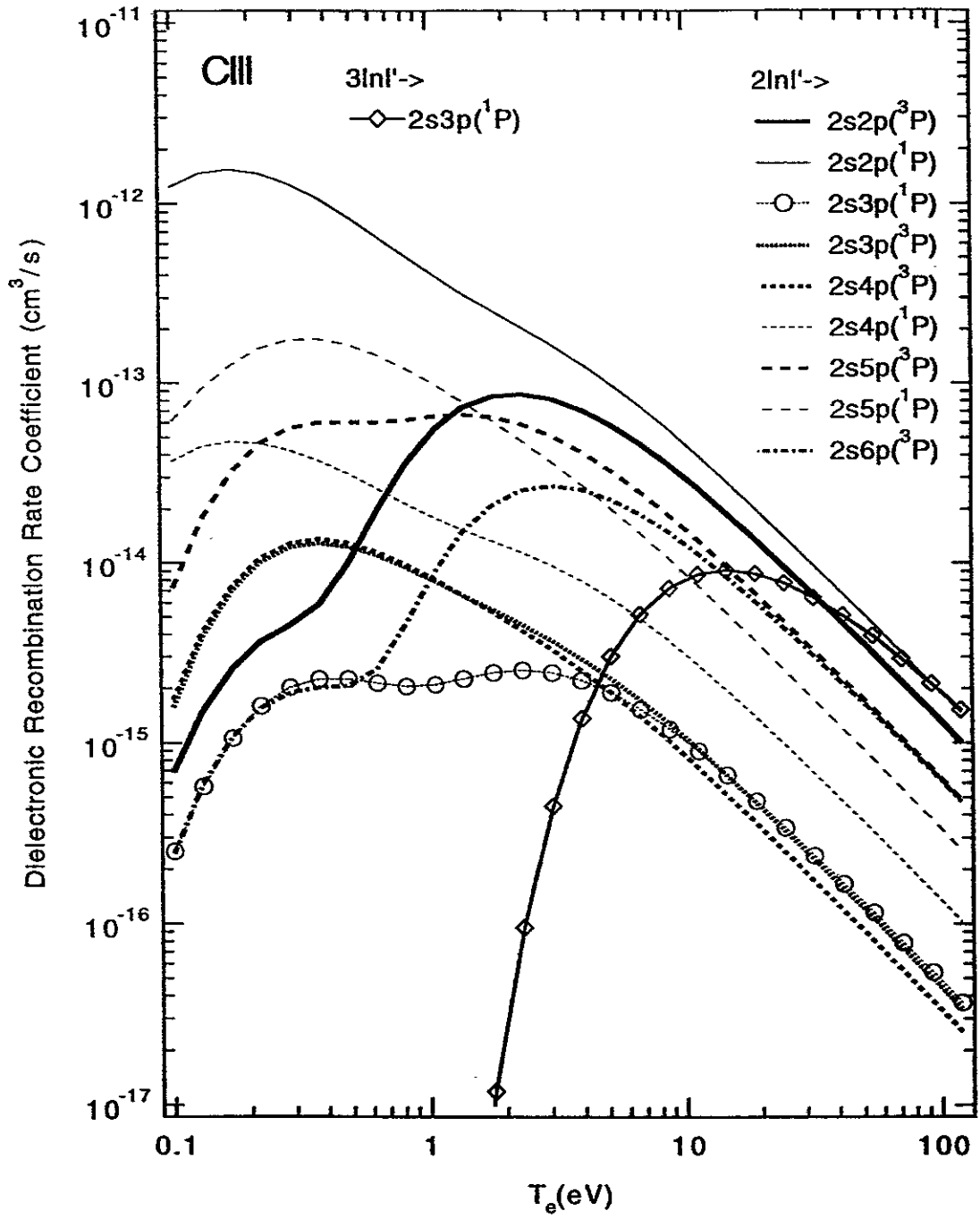


Fig. 2(a)

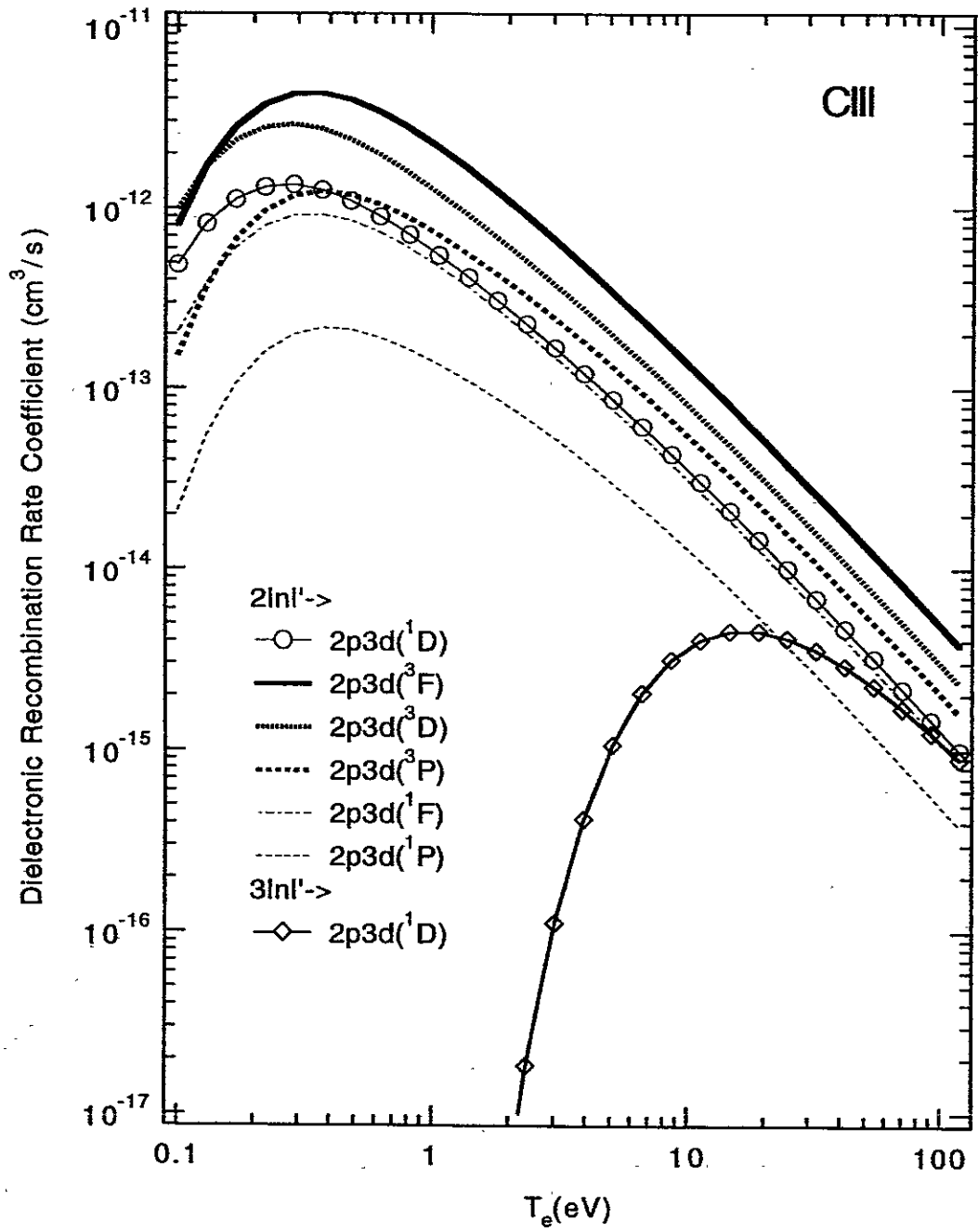


Fig. 2(b)

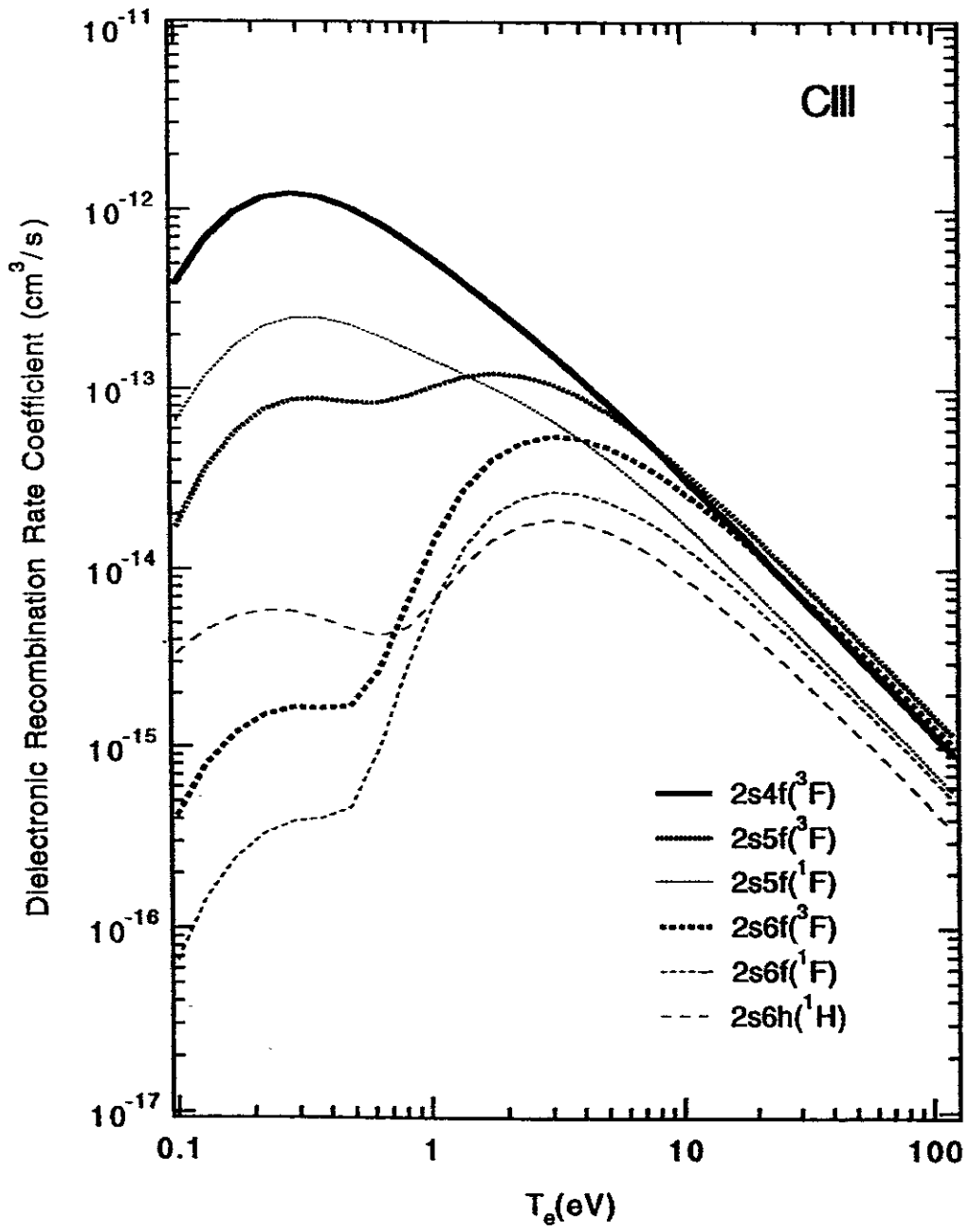


Fig. 2(c)

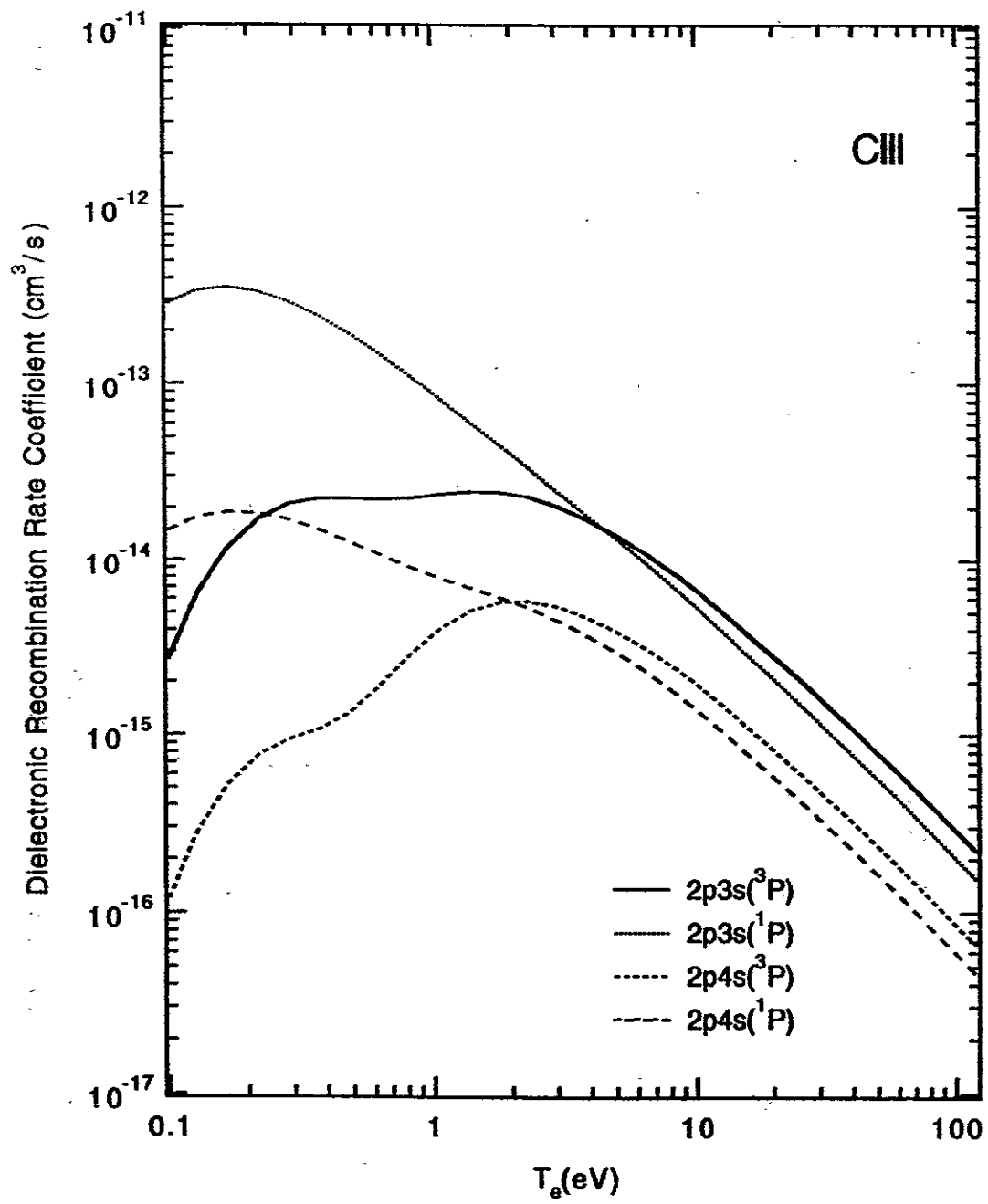


Fig. 2(d)

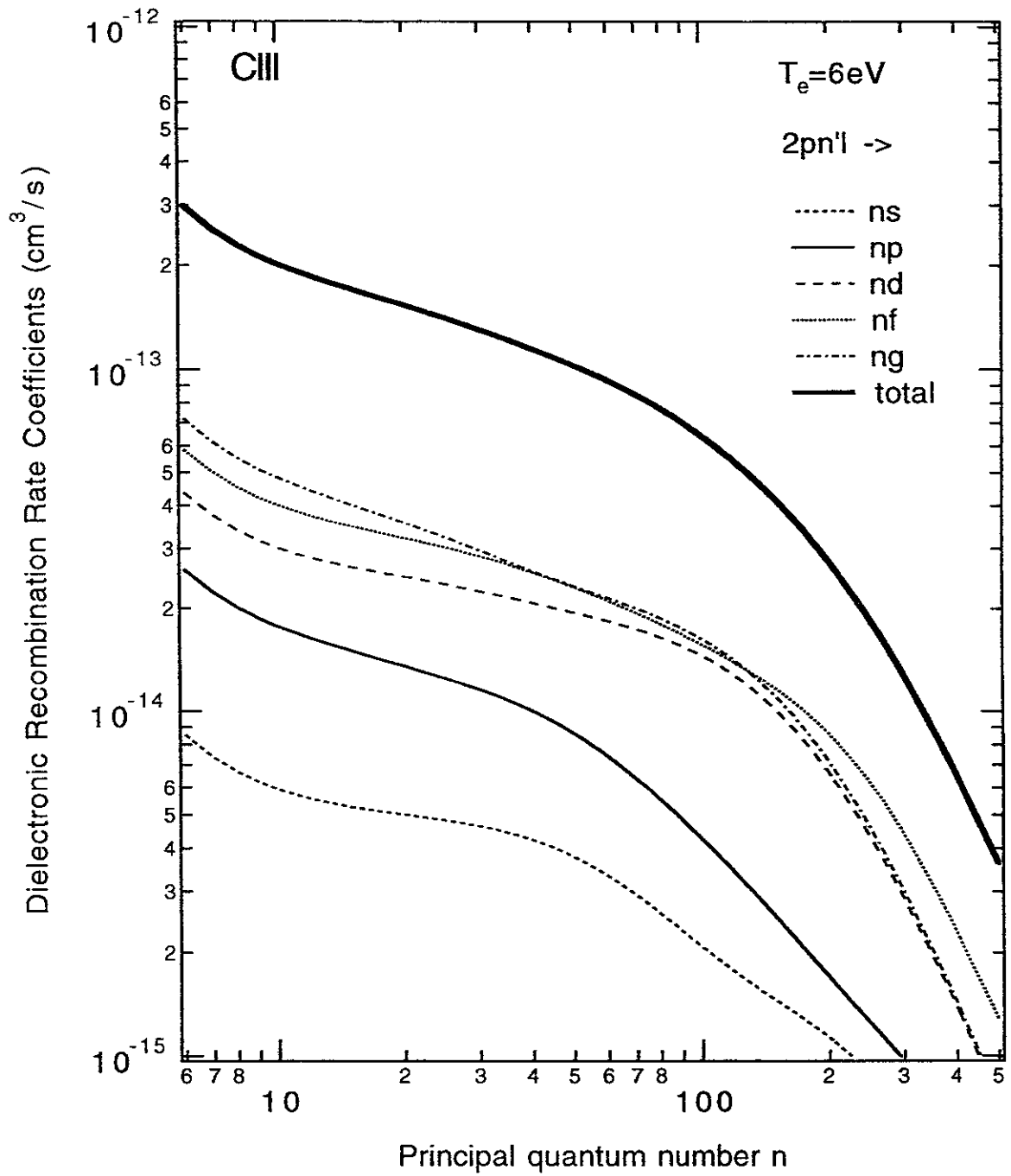


Fig. 3(a)

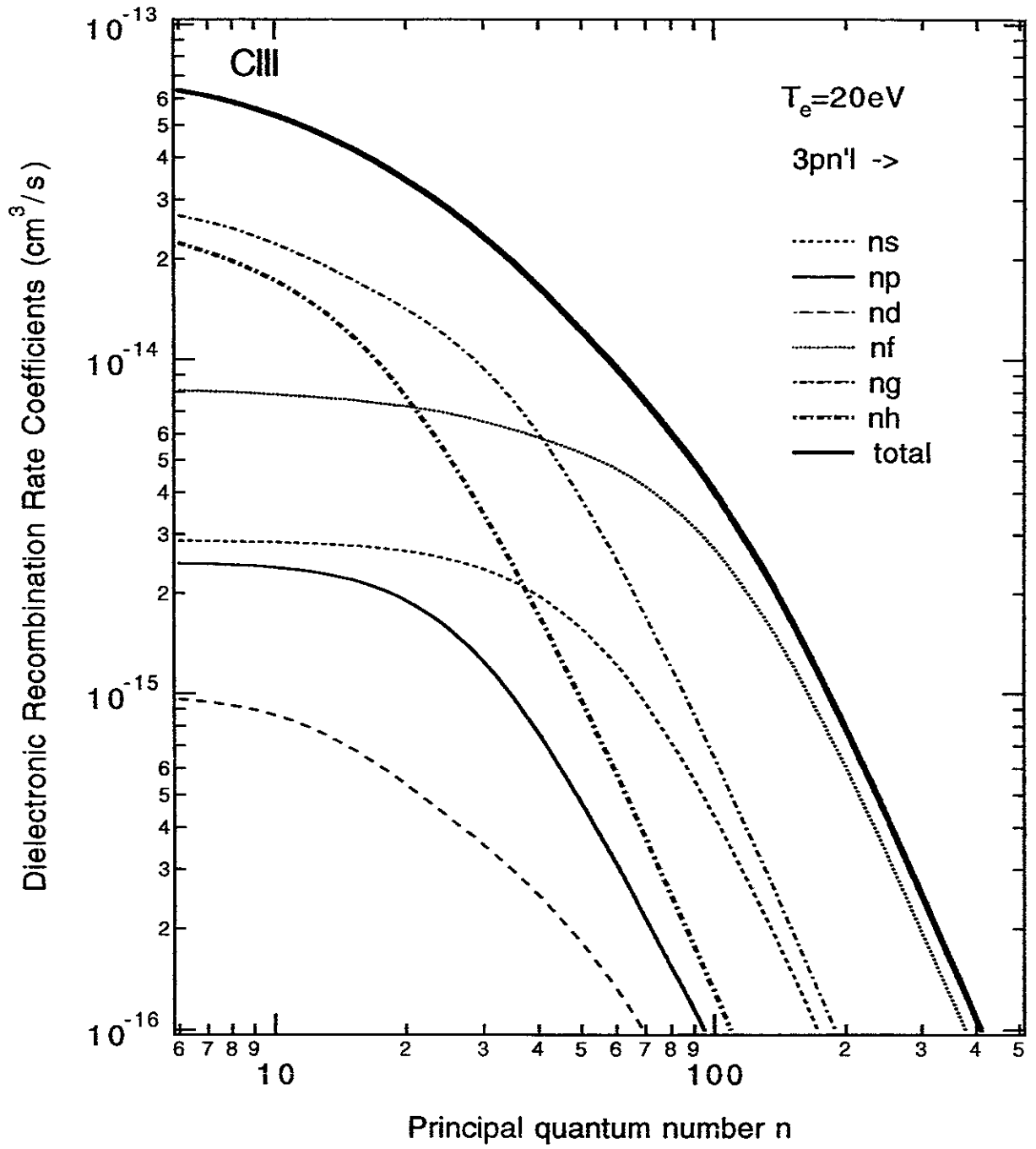


Fig. 3(b)

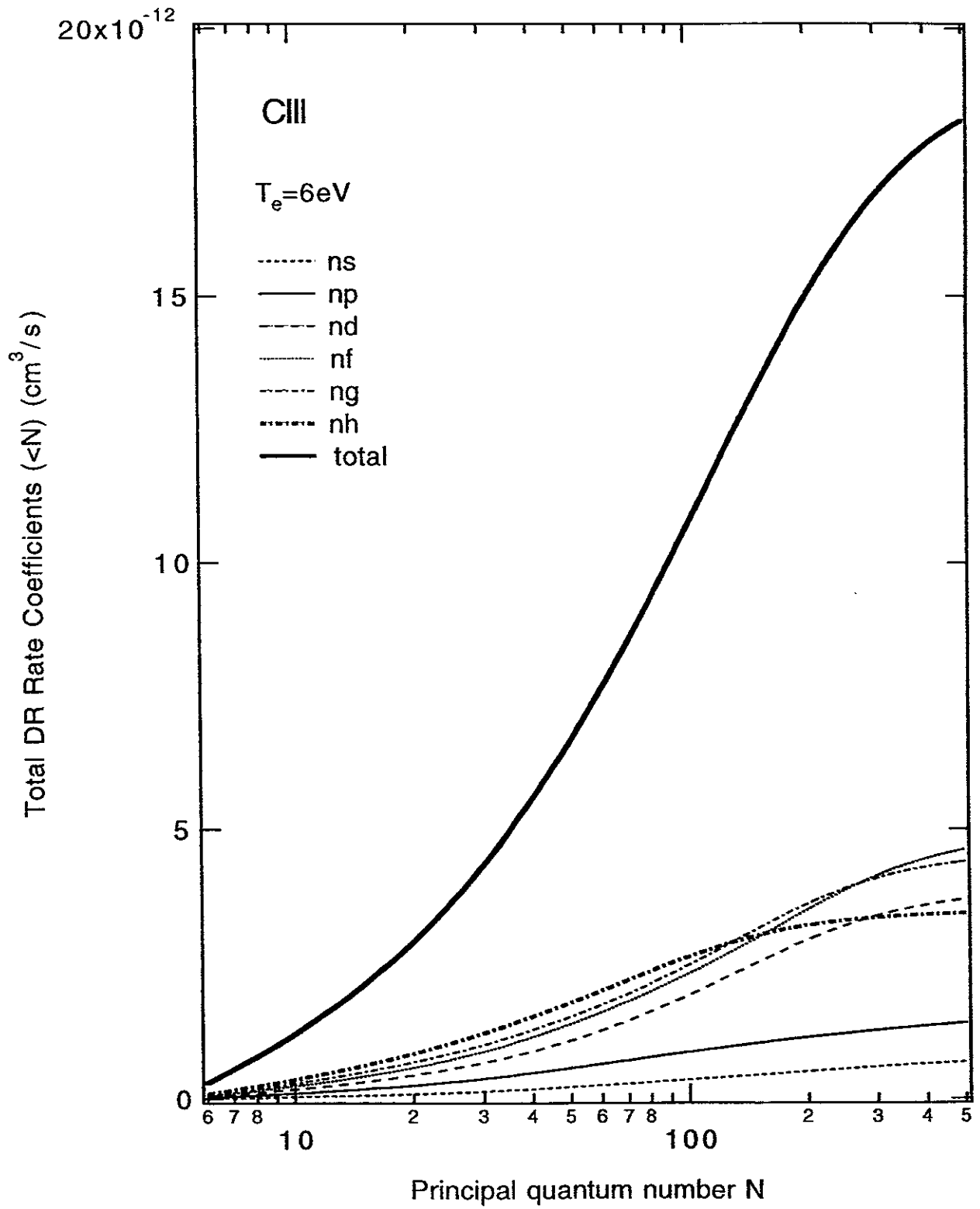


Fig. 4

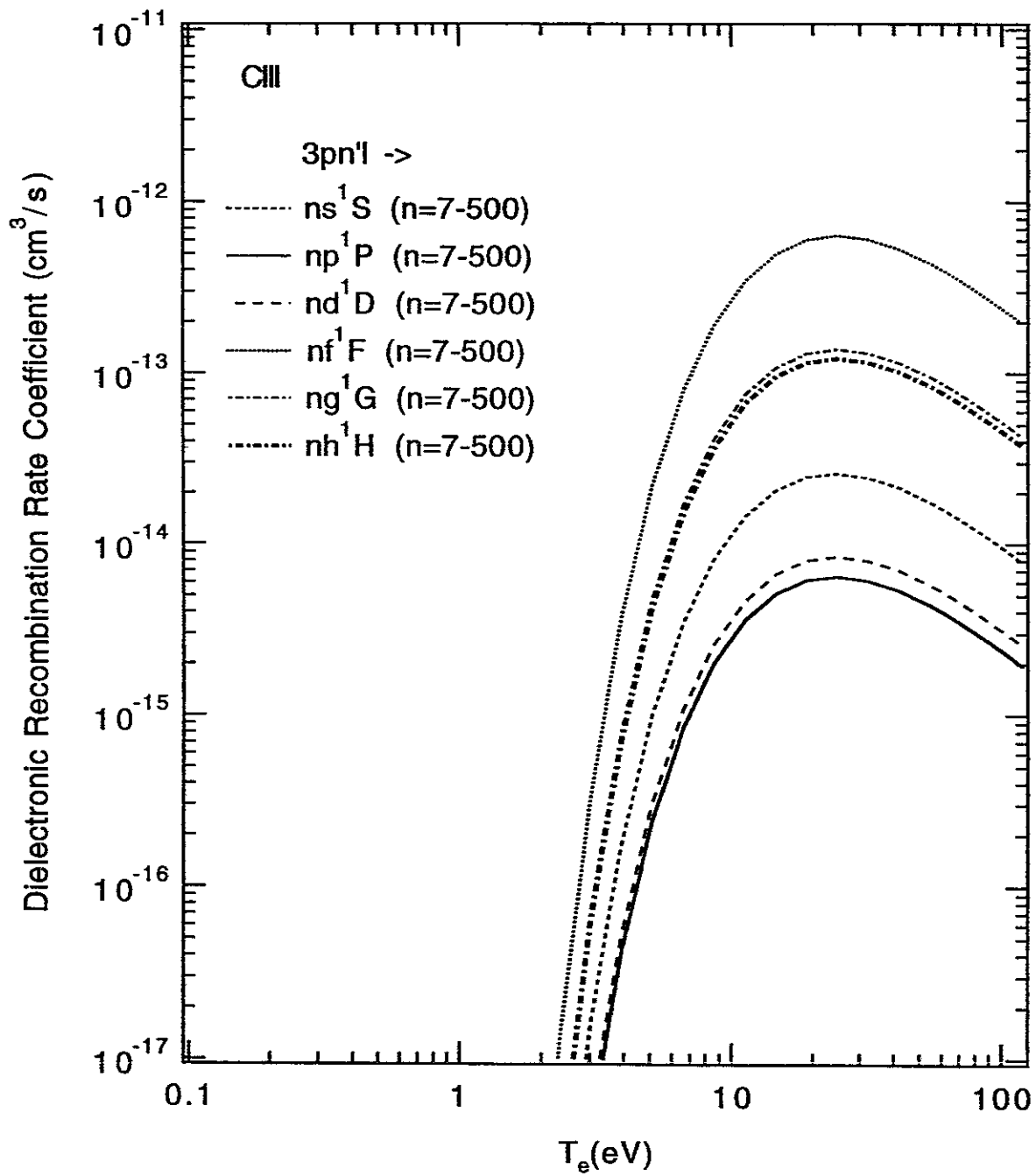


Fig. 5(a)

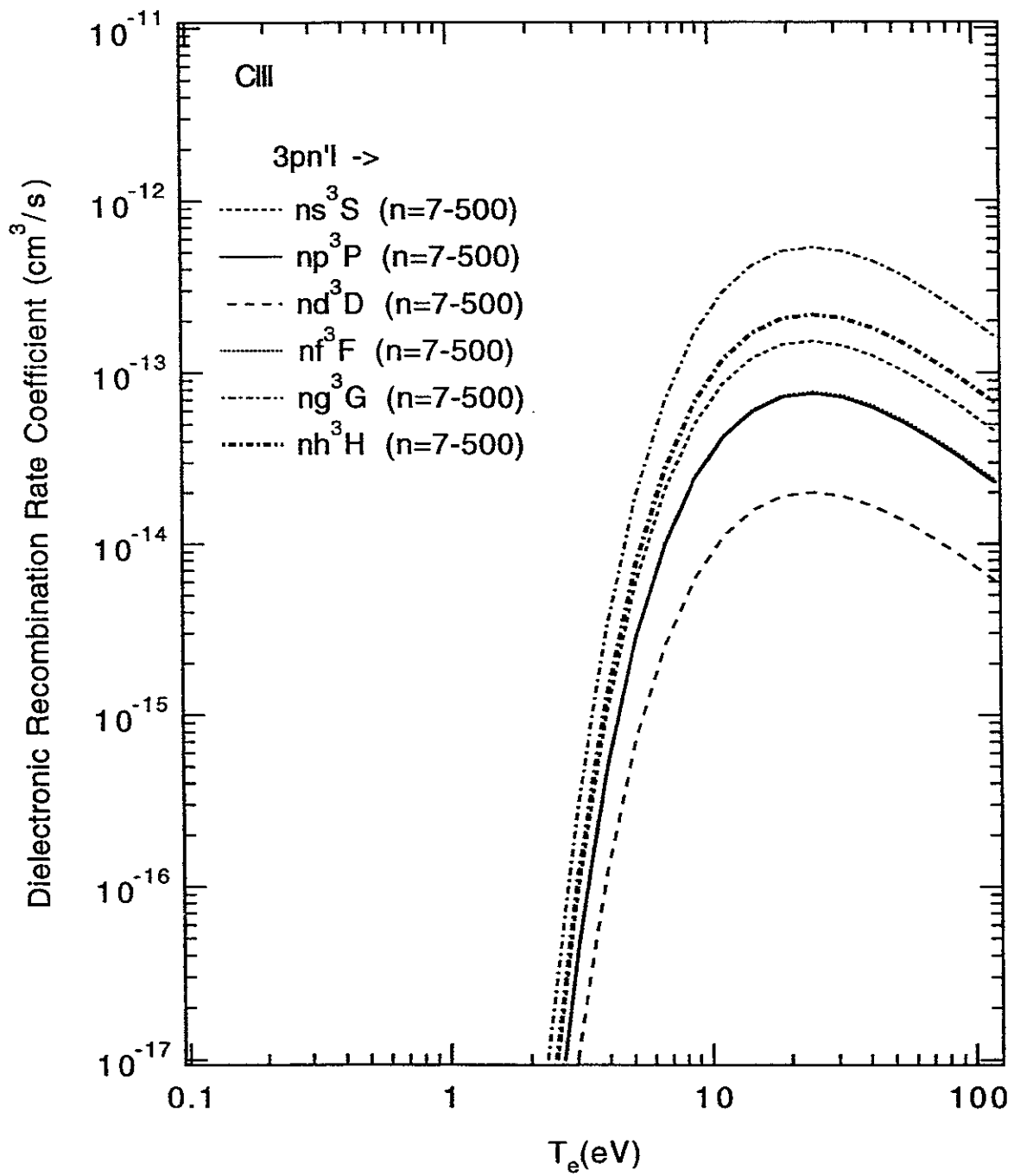


Fig. 5(b)

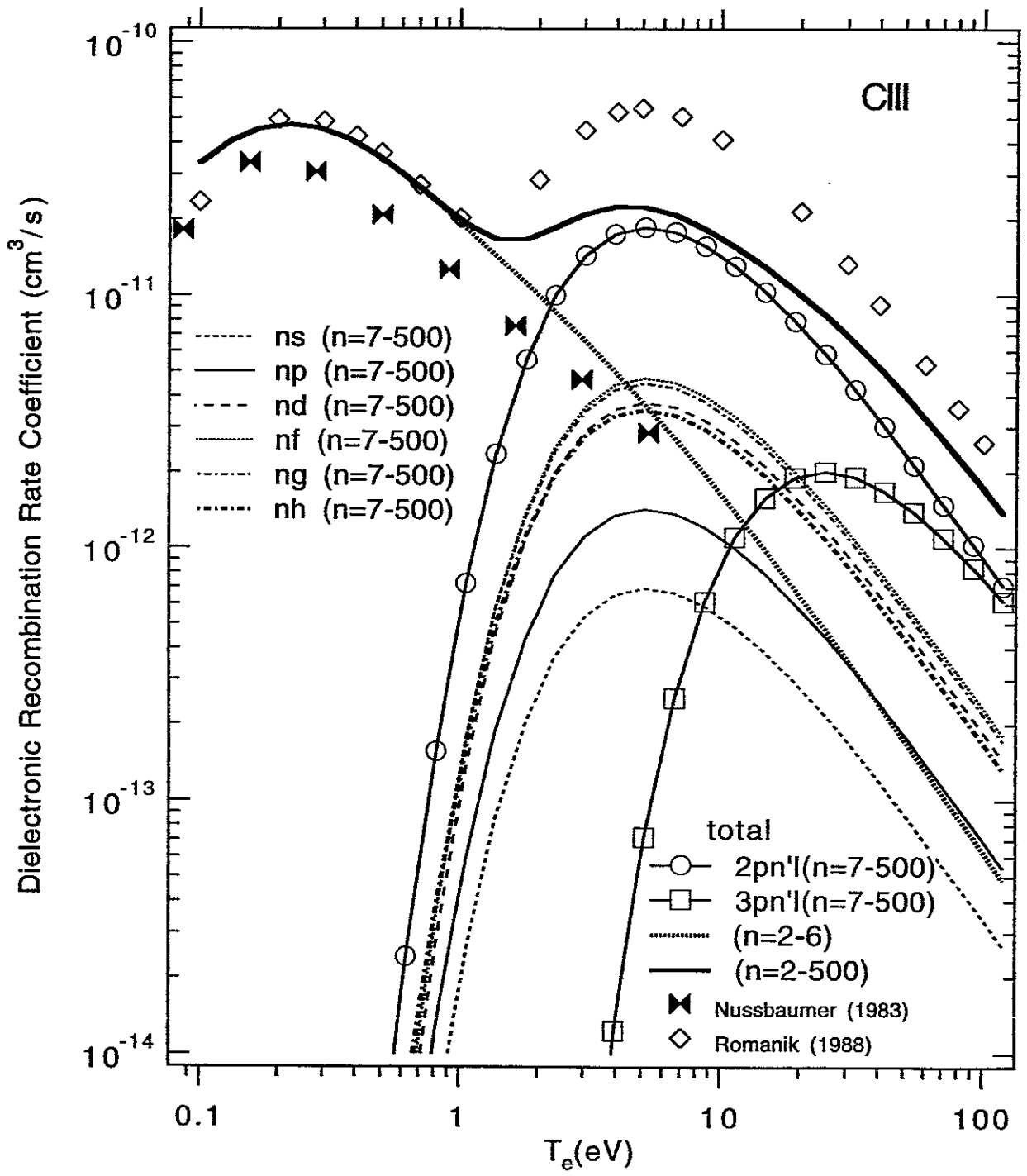


Fig. 6

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