ISSN 0915-6364

NATIONAL INSTITUTE FOR FUSION SCIENCE

Dielectronic Recombination Rate Coefficients to the Excited States of CIII from CIV

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(Received - Mar. 25, 1996)

NIFS-DATA-37 July 1996

RESEARCH REPORT
NIFS-DATA Series

NAGOYA, JAPAN

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 $1s^22pnl'$ ($n=2\div6$, $l'\leq(n-1)$) and $1s^23lnl'$ ($n=3\div6$, $l'\leq(n-1)$) states were calculated by using multi-configurational Hartree-Fock (Cowan code) method. Autoionizing levels above the $1s^22s$ and $1s^22p$ 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 exited 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]:

$$\begin{array}{l} X_{z+1}(\alpha_0)+e\rightarrow X_z(\gamma)\rightarrow X_z(\gamma')+h\nu \\ \qquad\qquad\qquad\quad\downarrow \\ \qquad\qquad\qquad\quad X_{z+1}(\alpha')+e' \end{array} \tag{1}$$

Here γ is the autoionizing state of an ion X_z, $\alpha'=\alpha_c$ nlLSJ 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 $\alpha_0=1s^22s^k2p^m$, $\gamma=1s^22s^{k-1}2p^{m+1}nl$, $\gamma'= =1s^22s^k2p^mnl$, $\alpha'=1s^22s^k2p^m[LSJ]$, 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 sates ($n\leq500$, $l\leq10$) 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:

B-like: $1s^22s^2nl$, $1s^22s2pnl$, $1s^22p^2nl$ with $2\leq n\leq6$, $l\leq4$,
C-like: $1s^22s^22pnl$, $1s^22s2p^2nl$, $1s^22p^3nl$ with $2\leq n\leq5$, $l\leq4$,
N-like: $1s^22s^22p^2nl$, $1s^22s2p^3nl$, $1s^22p^4nl$ with $2\leq n\leq7$, $l\leq3$,
O-like: $1s^22s^22p^3nl$, $1s^22s2p^4nl$, $1s^22p^5nl$ with $2\leq n\leq5$, $l\leq4$ (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 $T=10^3$K - $6x10^4$K 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 - $6x10^4$K. 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:

$$1s^22s^2 + e \rightarrow 1s2s^22pnl \rightarrow 1s^22s^2nl,\ 1s^22s^22p + h\nu,$$
$$\downarrow$$
$$1s^22s2p,\ 1s^22lnl' + e \tag{3}$$

2-2 core transitions:

$$1s^22s^2 + e \rightarrow 1s^22s2pnl,\ 1s^22p^2nl \rightarrow 1s^22s^2nl,\ 1s^22s2p3l,\ 1s^22s2p^2,\ 1s^22p^3 + h\nu,$$
$$\downarrow$$
$$1s^22l2l' + e \tag{4}$$

2-3 core transitions:

$$1s^22s^2 + e \rightarrow 1s^22s3lnl \rightarrow 1s^22s^2nl,\ 1s^22s^23l,\ 1s^22s2p3l,\ 1s^22s2pnl + h\nu,$$
$$\downarrow$$
$$1s^22s2p + e. \tag{5}$$

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 .

$$\begin{array}{l} 1s^22s + e \rightarrow 1s^22pnl,\ 1s^23l'nl \rightarrow 1s^22snl,\ 1s^22p^2,\ 1s^22p3l,\ 1s^22p4s,\ 1s^22p4p+h\nu, \\ \qquad\qquad\qquad\quad \downarrow \\ \qquad\qquad\qquad 1s^22s,\ 1s^22p + e. \end{array} \tag{6}$$

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 α_d(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 $1s^22snl$, $1s^22pnl$ (n=2-6, l =0-(n-1)) and $1s^23snl$, $1s^23pnl$ $1s^23dnl$ (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 $1s^22lnl$ (LSJ) states Be-like carbon ion under the first threshold ($I = 386213.9 cm^{-1}$). 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 $1s^22snl$(LSJ) and $1s^22p3l$(LSJ) levels. The agreement is not good for $1s^22p4l$(LSJ) levels. Sometimes (2p4s ^3P_J, for example) all three results disagree in $10000 cm^{-1}$. 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 -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 $1s^22s$ and additional data comparison as in Table Ia are included: autoionization rate (A_a) and branching ratio K,

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

where

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

We can see that K is different from 1 only for some levels: 2p4d ($^3D_1$), 2p4f (^3F_J), 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*l*(LSJ) with n=4 -6) are situated under the second threshold 1s^{2}2p.

Tables IIa and IIb list energy data above the threshold 1s^{2}2p: 1s^{2}3*l*‘n*l* levels of even parity (Table IIa) and 1s^{2}3*l*‘n*l* levels of odd parity (Table IIb). We can see from Table II that the energies of the 1s^{2}3*l*‘n*l* states (n=3-6, *l* =0-(n-1)) are between two thresholds: 1s^{2}2p and 1s^{2}3s. The energy interval among 1s^{2}3*l* states is very small: E$_s$(1s^{2}3s)=37.538eV, E$_s$(1s^{2}3p)=39.673eV, E$_s$(1s^{2}3d) = 40.270eV. Two columns list autoionization rates A$_a$: A$_a$(γ,α_0) and $\sum_{\alpha'}A_a(\gamma,\alpha')$ with α_0=1s^{2}2s and α‘=1s^{2}2s, 1s^{2}2p. We can see from Table II that the decay channel from many 1s^{2}3*l*‘n*l* states to the 1s^{2}2p has larger A$_a$ value than the decay channel to the 1s^{2}2s and therefore the branching ratio K (see eq.(8)) differs from 1. There are direct (allowed in LS coupling scheme) decays for 1s^{2}3sns, 1s^{2}3snd, 1s^{2}3sng, 1s^{2}3dns, 1s^{2}3dnd, 1s^{2}3dng, 1s^{2}3pnp, 1s^{2}3pnf, 1s^{2}3pnh states to 1s^{2}2sk*l*[LS] with LS= ^{1,3}S, ^{1,3}D, ^{1,3}G and to 1s^{2}2pk*l*[LS] with LS= ^{1,3}P, ^{1,3}F, ^{1,3}H. We have completely opposite situation for odd parity states: decays from 1s^{2}3pns, 1s^{2}3pnd, 1s^{2}3png, 1s^{2}3snp, 1s^{2}3snf, 1s^{2}3snh, 1s^{2}3dnp, 1s^{2}3dnf, 1s^{2}3dnh states to 1s^{2}2sk*l*[LS] states with the terms with LS= ^{1,3}S, ^{1,3}D, ^{1,3}G and to 1s^{2}2pk*l*[LS] with the terms LS= ^{1,3}S, ^{1,3}D, ^{1,3}G 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 $1s^22pnl$ states is the only one to the first threshold $1s^22s$. The branching ratio is determined by the radiative decay although the contribution is generally small. There is one additional decay channel ($1s^22p$) for $1s^23snl$ states. It is necessary to add one more decay channel ($1s^23s$) for $1s^23pnl$ states and one else ($1s^23p$) for $1s^23dnl$ states. We included only the $1s^22p$ channel for $1s^23pnl$ and $1s^23dnl$ states since these states with n=3,4 5, 6 are under the $1s^23s$ threshold.

Table II c gives comparison of Cowan and MZ data for $1s^23l'nl$ 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 $1s^22p4d$, $1s^22p4f$, $1s^22pnl$ with n>4 create satellite spectra to the resonance lines $1s^22s$ - $1s^22p$ in the region of 1540 Å. There are other transitions changing the principle quantum numbers such as the $1s^22snl$ - $1s^22pn'l'$, $1s^22p4s$ - $1s^22pnl$ and $1s^22p4p$ - $1s^22pnl$ 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 $gA_r>10^{10}$ 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 $gA_r<10^9$ s^{-1} in these cases. Table IIIa includes transitions to the configurations of even parity (1-$2s^2$, 2-$2p^2$, 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 $2s^2$, 2s3s, 2s3d, 2s4s, 2p4p states (Table IIIa) are smaller than $<10^9$ s^{-1}. Transitions to $2p^2$ states have the largest values of Q_d ($>10^{10}$ 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 ($1s^22s$) (E_S), weighted radiative transition probabilities (gA_r), branching ratios (K), intensity factors of the dielectronic satellite lines from $1s^23l'nl$ states. There are more than several thousands lines created from these states and we chose lines with largest value of radiative transitions probabilities ($gA_r>10^{10}$ 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,

$$\alpha_d\left(\gamma'\middle|\alpha_0\right) = 3.3\times10^{-24}\left(\frac{I_H}{T_e}\right)^{3/2}\sum_{\gamma} e^{-\frac{E_S}{T_e}} Q_d(\gamma,\gamma'|\alpha_0)/g(\alpha_0) \qquad (10)$$

where

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

Here $\gamma'=1s^22snl$, $1s^22p3l$, $1s^22p4s$, $1s^22p4p(^3S, ^3P, ^3D, ^1P)$, $\gamma=1s^22p4p(^1D, ^1S)$, $1s^22p4f$, $1s^22pnl$ (n>4), $1s^23l'nl$, $\alpha'=1s^22s$, $1s^22p$. The values of (sumA$_r$), A$_a$, (sumA$_a$) and E_S are given in Tables I and II for all excited and autoionized states ($1s^22l'nl$ and $1s^2\,3l'nl$). 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 ($1s^22s$ 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, $1s^22snl$, $1s^22p3l$, $1s^22p4s$, $1s^22p4p$ 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) n*l* - 2*l*' 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 $\alpha_d(2snl|2s)$ since these transitions are dominant for n>>6.

$$\alpha_d\left(2sn\ell\ ^{1,3}\ell_J\middle|\,2s\ ^2S\right)=1.65\times10^{-24}\left(\frac{I_H}{T_e}\right)^{3/2}$$
$$\times\sum_{n'=2,3}\sum_{L,J'}e^{-\frac{E_S}{T_e}}Q_d(n'pn\ell\ ^{1,3}L_{J'},2sn\ell\ ^{1,3}\ell_J|\,2s\ ^2S) \qquad (12)$$

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:

$$A_r(n'pn\ell\ ^{1,3}L_{J'} - 2sn\ell\ ^{1,3}\ell_J) = A_r(n'p6\ell\ ^{1,3}L_{J'} - 2s6\ell\ ^{1,3}\ell_J)$$

$$A_r(n'pn\ell\ ^{1,3}L_{J'}) = A_r(n'p6\ell\ ^{1,3}L_{J'}) = \sum_{\gamma''} A_r(n'p6\ell\ ^{1,3}L_{J'} - \gamma'') \tag{13}$$

where n'=2 and 3, sum over γ" includes all autoionizing states with $2pnl'\ ^{1,3}L_{J'}$ and $3pnl'\ ^{1,3}L_{J'}$ levels.

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

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

$$A_a(3pn\ell\ ^{1,3}L_{J'}) = A_a(3p6\ell\ ^{1,3}L_{J'})\left(\frac{6}{n}\right)^3 = \sum_{\alpha'} A_a(3p6\ell\ ^{1,3}L_{J'}|\alpha')\left(\frac{6}{n}\right)^3 \tag{14}$$

Sum over α' includes two thresholds $1s^22s$ and $1s^22p$. There are no sum over α' for 2pnl 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))

$$Q_d(n'pn\ell\ ^{1,3}L_{J'}, 2sn\ell\ ^{1,3}\ell_J|2s\ ^2S) = (2J'+1)\frac{f_{n'}(n=6)}{1+(n/6)^3 f'_{n'}(n=6)} \tag{15}$$

where

$$f_2(n=6) = A_r(2p6\ell\ ^{1,3}L_{J'} - 2s6\ell\ ^{1,3}\ell_J),\ f'_2(n=6) = \frac{A_r(2p6\ell\ ^{1,3}L_{J'})}{A_a(2p6\ell\ ^{1,3}L_{J'})}$$

$$f_3(n=6) = A_r(3p6\ell\ ^{1,3}L_{J'} - 3s6\ell\ ^{1,3}\ell_J)\frac{A_a(3p6\ell\ ^{1,3}L_{J'}|2s\ ^2S)}{A_a(3p6\ell\ ^{1,3}L_{J'})}, \tag{16}$$

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

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

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

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 3*l'*n*l* states as a function of n*l* . We obtain for the energy of our states counted from the threshold [26]

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

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

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

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]:

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

where for b(*l*)=2a(1s,*l*)+a(n'*l'*,*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)

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

that gives -0.1457at.un=-3.965eV for n=6. We obtain E_S =(8.002 -3.965)= 4.037eV 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:

$$E_S(n'\ell' n\ell) = E(1s^2 n'\ell' n\ell) - E(1s^2 2s) = \\ = E(1s^2 n'\ell') - E(1s^2 2s) - \frac{1}{2n^2}(Z-3)^2 \tag{22}$$

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

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

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≤6 but without including n>6. The contribution from 3pn*l* is not included. We can see that the form of curves depends on γ'. The curves of $\alpha_d(\gamma'|2s)$ for $\gamma'=2s^2(^1S)$, $2p^2(^3P, {}^1D, {}^1S)$, $2p3p(^{1,3}S, {}^3P)$, $2p3d(^{1,3}P, {}^{1,3}D, {}^{1,3}F)$ have maximums for very small T_e around 0.2 - 0.3 eV (Fig. 1a,b and Fig.2b). For these γ' transitions with γ=2p4*l* (see Tables IIIa, b) give the largest contribution into $Q_d(\gamma,\gamma'|2s)$. All energies of 2p4*l* 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*l*. $\alpha_d(\gamma'|2s)$ has the largest maximum (>10^{-11} cm^3/s) for $\gamma'=2p^2(^3P)$. Figs.1c, d show two additional maximums for $\alpha_d(\gamma'|2s)$ around 2.5 eV (for γ'=2s5d, 2s5s) and 4.5 eV (for γ'=2s6d, 2s6s). These maximum values of $\alpha_d(\gamma'|2s)$ can be explained by the largest values of $Q_d(\gamma,\gamma'|2s)$ for γ=2pns (^{3}P), 2pnd (^{3}F) 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, 4.7eV (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 γ=2p4f (LS) (Q_d(2p3d LS,2p4f L'S|2s) $>10^{+9}$ 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 $1s^2 3l'nl$ 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 3pnl states to 2snl states are shown in Figs.2a and 2b for $\alpha_d(\gamma'|2s)$ with γ'=2s3p ^{1}P and γ'=2p3d ^{1}D when the $1s^2 3l'nl$ states ($n \le 6$) 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} cm^3/s. In this case the contribution of $1s^2 3l'nl$ states can be important for $\alpha_d(\gamma'|2s)$ which maximum is less than 10^{-14} cm^3/s for $T_e \ge 20$eV. We found such situation for 2s3p ^{1}P level for which $\alpha_d(\gamma'|2s) < 10^{-14}$ cm^3/s and its maximum is around 1eV. The value of α_d(2p3d ^{1}D|2s) is more than 10^{-12} cm^3/s in maximum around 0.3eV. And we can see from Fig.2b that the curve of α_d(2p3d ^{1}D |2s) from 3lnl' do not change the values α_d(2p3d ^{1}D |2s) from 2pnl'.

5. Total dielectronic recombination rate coefficients

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

$$\alpha_d^t = \sum_{n=7}^{\infty} \sum_{\ell SJ} \alpha_d^{(2)}\left(2sn\ell\ {}^{1,3}\ell_J \middle| 2s\ {}^2S\right) + \sum_{n=7}^{\infty} \sum_{\ell SJ} \alpha_d^{(3)}\left(2sn\ell\ {}^{1,3}\ell_J \middle| 2s\ {}^2S\right) +$$

$$+ \sum_{n=2}^{6} \sum_{\ell SJ} \alpha_d\left(2sn\ell\ {}^{1,3}\ell_J \middle| 2s\ {}^2S\right) + \sum_{LSJ} \sum_{\ell} \alpha_d\left(2p3\ell(LSJ) \middle| 2s\ {}^2S\right) +$$

$$\sum_{LSJ}\left[\alpha_d\left(2p^2(LSJ) \middle| 2s\ {}^2S\right) + \alpha_d\left(2p4s(LSJ) \middle| 2s\ {}^2S\right) + \alpha_d\left(2p4p(LSJ) \middle| 2s\ {}^2S\right)\right] \quad (24)$$

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 $\alpha^{(2)}(2snl|2s)$ (Fig.3a) and $\alpha^{(3)}(2snl|2s)$ (Fig.3b)

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

calculated by using eqs.(16), (17) and (25) for T_e=6eV. 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 $\alpha^{(2)}(2snl|2s)$ are almost constant for n=7 - 50 because the term $n^3f'(n=6)/6^3$ 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 $9.463\text{x}10^{-4}$, $4.181\text{x}10^{-4}$, $1.004\text{x}10^{-3}$, $8.019\text{x}10^{-6}$ 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=6eV. The same estimation for the contributions of 3p6s autionizing levels gives 0.164 for the ratio $\alpha^{(3)}(2s100s|2s)/\alpha^{(3)}(2s6s|2s)$ with T_e=20eV. The values of $\alpha^{(3)}(2snl|2s)$ 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 $[\alpha^{(2)}(2snl|2s)+\alpha^{(3)}(2snl|2s)]$ over n from n=7 to n=N_0 for the same value of T_e as in Fig.3a (T_e =6eV). We can see that $\alpha_d^N(2s\ell|2s)$

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

become constant for n≥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

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

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 =0.2eV 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 >10eV.

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 ^{3}P - 2p4f ^{3}D transitions which disagree in two times. It is rather strange since the α_d value for transitions with the same autoionizing level 2p4f ^{3}D

(2p3d ^{3}D - 2p4f ^{3}D transition) agree very well and the transition energy of 2p3d ^{3}P - 2p4f ^{3}D 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 $T_e \leq 1$eV and disagree for $T_e > 1$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 $A_r(2p6\ell\ ^{1,3}L_{J'} - 2s6\ell\ ^{1,3}\ell_J)$, $A_r(2p6\ell\ ^{1,3}L_{J'})$, $A_a(2p6\ell\ ^{1,3}L_{J'})$ 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=6eV. 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)=8.403×10^8 s^{-1}. As a result we obtain $f'_2(n=6)=2.059\times10^{-5}$ 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 8.820×10^{-15} cm^3/s with E_S =4.4eV and T_e=6eV. 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 $[1+2.059\times10^{-5}(100/6)^3]^{-1}$. As a result we obtain $\alpha^{(2)}(2s100s|2s)=4.418\times10^{-15}$ cm^3/s instead of 2.069×10^{-15} cm^3/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,

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

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-3*l* and 3s-4*l* excitation in Fe^{15+}, the 2s-2p and 2s-3*l* excitation in Fe^{23+} and the 1s-2*l* 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

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

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 ($n\leq6$) 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 $n\leq6$ give only 10% to the total dielectronic recombination rate coefficient at T_e=8eV and including the contribution from higher levels (n≤500) provides another 90% that confirm conclusion that it is very important to take into account these transitions.

Acknowledgments

U.I.Safronova would like to thank the members of the Data and Planning Center, the National Institute for Fusion Science; Director of Center, Prof.H.Momota and Director of NIFS, Prof. A. Iiyoshi for their warm hospitality, friendly support and many interesting discussions. She is grateful for the financial support provided by Japan Society for Promotion of Science for her visit to the National Institute for Fusion Science.

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TableIa. 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)

2lnl'	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}
		a	b	c	a
2s4d	$^3D_1$	323.842	323.300	321.411	6.903+09
2s4d	$^3D_2$	323.847	323.300	321.427	1.137+10
2s4d	$^3D_3$	323.857	323.302	321.450	1.563+10
2s4f	$^1F_3$	324.134	323.2003	324.134	1.497+10
2s4p	$^1P_1$	324.919	320.600	322.702	5.876+09
2p3p	$^3S_1$	325.600	335.695	327.278	4.572+09
2s4d	$^1D_2$	325.877	322.257	324.212	2.130+10
2p3p	$^3P_0$	330.935	329.693	329.685	1.813+09
2p3p	$^3P_1$	330.955	329.716	329.907	5.439+09
2p3p	$^3P_2$	330.994	329.757	329.744	9.069+09
2p3d	$^1D_2$	332.441	332.649	332.691	2.713+10
2p3d	$^3F_2$	334.269	328.668	333.387	3.301+09
2p3d	$^3F_3$	334.296	328.707	333.342	4.605+09
2p3d	$^3F_4$	334.333	328.760	333.447	5.882+09
2p3p	$^1D_2$	335.498	332.926	333.118	1.111+10
2p3d	$^3D_1$	336.586	338.597	337.656	3.966+10
2p3d	$^3D_2$	336.598	338.612	337.669	6.608+10
2p3d	$^3D_3$	336.617	338.633	337.688	9.248+10
2p3d	$^3P_2$	339.352	344.241	340.102	3.504+10
2p3d	$^3P_1$	339.379	344.220	340.128	2.104+10
2p3d	$^3P_0$	339.393	344.183	340.142	7.016+09
2s5s	$^3S_1$	340.010	340.362	338.514	4.240+08
2s5s	$^1S_0$	341.492	341.030	339.935	2.388+09
2p3d	$^1F_3$	342.587	331.775	341.371	6.269+10
2p3d	$^1P_1$	344.608	348.258	346.712	1.603+10
2s5p	$^3P_0$	345.490	344.613	344.233	5.007+08
2s5p	$^3P_1$	345.490	344.614	344.236	1.496+09
2s5p	P_2	345.491	344.618	344.239	2.474+09
2s5p	$^1P_1$	346.912	346.343	343.258	1.175+10
2s5d	$^3D_1$	347.132	346.961	345.497	6.417+09
2s5d	$^3D_2$	347.132	346.961	345.497	1.069+10
2s5d	$^3D_3$	347.133	346.962	345.497	1.496+10
2p3p	$^1S_0$	347.182	345.622	345.095	1.083+09
2s5g	$^3G_3$	348.314		346.579	2.653+09
2s5g	$^3G_4$	348.314		346.579	3.411+09
2s5g	$^3G_5$	348.315		346.579	4.169+09
2s5g	$^1G_4$	348.315	346.579		3.404+09
2s5d	$^1D_2$	348.525	346.343	346.658	9.525+09
2s5f	$^3F_2$	348.537	346.925	347.152	4.474+09

Table Ia. (continued)

2*lnl*'	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}
		a	b	c	a
2s5f	$^3F_3$	348.538	346.925	347.153	6.266+09
2s5f	$^3F_4$	348.539	346.925	347.155	8.061+09
2s5f	$^1F_3$	350.034	346.825	348.860	2.537+10
2s6s	$^3S_1$	356.592	355.856	354.858	1.578+09
2s6s	$^1S_0$	357.637	356.258	357.637	8.077+08
2s6p	$^3P_0$	358.736	358.264	357.050	1.010+08
2s6p	$^3P_1$	358.737	358.265	357.050	3.029+08
2s6p	$^3P_2$	358.738	358.267	357.050	5.046+08
2s6p	$^1P_1$	358.928	358.941	357.110	6.015+09
2s6d	$^3D_1$	359.797	359.616	358.098	3.569+09
2s6d	$^3D_2$	359.797	359.616	358.098	5.947+09
2s6d	$^3D_3$	359.798	359.616	358.098	8.322+09
2s6g	$^3G_3$	360.433		358.692	1.472+09
2s6g	$^3G_4$	360.433		358.692	1.892+09
2s6g	$^3G_5$	360.433		358.692	2.313+09
2s6g	$^1G_4$	360.433		358.692	1.880+09
2s6f	$^3F_2$	360.442	359.580	358.850	2.417+09
2s6f	$^3F_3$	360.443	359.580	358.850	3.384+09
2s6f	$^3F_4$	360.443	358.581	358.851	4.353+09
2s6h	$^1H_5$	360.549		360.549	1.501+09
2s6h	$^3H_4$	360.549		358.776	1.228+09
2s6h	$^3H_5$	360.549		358.776	1.501+09
2s6h	$^3H_6$	360.549		358.776	1.774+09
2s6d	$^1D_2$	360.617	359.238	358.733	8.356+09
2s6f	$^1F_3$	360.702	359.516	359.121	6.535+09
2p4s	$^3P_0$	377.607	377.572	367.404?	1.613+09
2p4s	$^3P_1$	377.640	377.604	367.404?	4.845+09
2p4s	$^3P_2$	377.707	377.686	367.404?	8.097+09
2p4s	$^1P_1$	380.735	378.180	380.735	6.315+09
2p4p	$^1P_1$	382.416	382.423	381.105	6.681+09
2p4p	$^3D_1$	383.160	383.081	381.950	3.251+09
2p4p	$^3D_2$	383.195	383.119	381.971	5.412+09
2p4p	$^3D_3$	383.250	383.182	382.010	7.585+09
2p4p	$^3S_1$	384.571	386.694	384.571	4.962+09
2p4p	$^3P_0$	386.182	384.536	384.345?	1.148+09
2p4p	$^3P_1$	386.201	384.557	384.365	3.446+09
2p4p	$^3P_2$	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]

2*lnl'*	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)

2*lnl'*	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}	Aa,10^{13} s^{-1}	K
		a	b	c	a	a	a
2p5p	$^3P_0$	410.736	410.856	408.925?	6.966+08	0.0064	0.9892
2p5p	$^3P_1$	410.757	410.876	408.925?	2.097+09	0.0100	0.9931
2p5p	$^3P_2$	410.790	410.915	408.925?	3.488+09	0.0010	0.9348
2p5d	$^1D_2$	411.327	412.534	409.683	6.227+09	1.1771	0.9999
2p5d	$^3F_2$	411.402	411.649		4.223+09	3.4878	1.0000
2p5d	$^3F_3$	411.416	411.692		4.483+09	4.6631	1.0000
2p5d	$^3F_4$	411.464	411.742		5.701+09	4.6703	1.0000
2p5p	$^1D_2$	411.803	411.113	409.506	5.527+09	1.8417	0.9999
2p5d	$^3D_1$	412.049	413.773	410.585?	9.687+09	0.0189	0.9832
2p5d	$^3D_2$	412.061	413.764	410.585?	1.608+10	0.0436	0.9927
2p5d	$^3D_3$	412.083	413.822	410.585?	2.260+10	0.0161	0.9803
2p5f	$^1F_3$	412.328	412.302		7.199+09	0.0377	0.9973
2p5f	$^3F_2$	412.356	412.392	410.863	4.961+09	0.0001	0.5020
2p5f	$^3F_3$	412.365	412.411	410.863	6.952+09	0.0953	0.9990
2p5f	$^3F_4$	412.374	412.421	410.863	8.910+09	0.1097	0.9991
2p5d	$^3P_2$	412.404	413.854	410.892?	1.129+10	2.9123	0.9999
2p5d	$^3P_1$	412.433	413.867	410.892?	6.768+09	2.9344	0.9999
2p5d	$^3P0$	412.448	413.872	410.892?	2.252+09	2.9520	0.9999
2p5f	$^3G_3$	412.656	410.946	410.819?	6.512+09	5.8525	1.0000
2p5f	$^3G_4$	412.681	410.983	410.819?	8.315+09	5.9117	1.0000
2p5f	$^3G_5$	412.726		410.819?	1.022+10	5.9853	1.0000
2p5g	$^3G_4$	412.806		411.104?	6.079+09	0.0002	0.7475
2p5g	$^3G_3$	412.806		411.104?	4.726+09	0.0002	0.7476
2p5g	$^1G_4$	412.819			6.050+09	0.0886	0.9992
2p5g	$^3G_5$	412.819		411.104?	7.390+09	0.0877	0.9992
2p5f	$^1G_4$	412.875	411.521		6.854+09	6.5698	1.0000
2p5f	$^3D_3$	412.975	411.859	413.003	7.171+09	0.0358	0.9972
2p5f	$^3D_2$	413.003	411.901	413.003	5.126+09	0.0367	0.9972
2p5f	$^3D_1$	413.028	411.929	413.028	3.077+09	0.0361	0.9972
2p5g	$^3H_4$	413.015		411.060?	5.503+09	1.4566	1.0000
2p5g	$^3H_5$	413.016		411.060?	6.709+09	1.4617	1.0000
2p5g	$^3H_6$	413.079		411.060?	7.905+09	1.5452	1.0000
2p5g	$^1H_5$	413.081			6.666+09	1.5508	1.0000
2p5g	$^3F_4$	413.118			5.930+09	0.0063	0.9896
2p5g	$^1F_3$	413.120			4.614+09	0.0033	0.9804
2p5g	$^3F_2$	413.170		411.433?	3.295+09	0.0070	0.9907
2p5g	$^3F_3$	413.171		411.433?	4.621+09	0.0040	0.9838
2p5f	$^1D_2$	413.203	412.577	411.433?	5.132+09	0.1135	0.9991
2p5d	$^1F_3$	413.711	410.912		3.129+10	18.288	1.0000
2p5d	$^1P_1$	414.045	415.847		9.241+09	2.2298	0.9999
2p5p	$^1S_0$	414.556	414.548		5.173+08	32.897	1.0000

Table Ib. (continued)

2*lnl'*	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}	Aa,10^{13} s^{-1}	K
		a	b	c	a	a	a
2p6s	$^3P_0$	421.468	422.707		6.870+08	0.0726	0.9990
2p6s	$^3P_1$	421.499	422.700		2.077+09	0.1656	0.9996
2p6s	$^3P_2$	421.570	422.822		3.465+09	0.0690	0.9990
2p6s	$^1P_1$	422.131	422.811		3.855+09	16.019	1.0000
2p6p	$^1P_1$	422.932	424.148		6.796+09	0.0158	0.9859
2p6p	$^3D_1$	423.056	424.267	421.432?	2.084+09	0.0659	0.9989
2p6p	$^3D_2$	423.081	424.291	421.432?	2.871+09	0.0691	0.9992
2p6p	$^3D_3$	423.135	424.354	421.432?	4.027+09	0.0688	0.9992
2p6p	$^3S_1$	423.391	425.318		4.685+09	2.9149	1.0000
2p6p	$^3P_0$	423.819	424.731	422.019?	4.053+08	0.0117	0.9965
2p6p	$^3P_1$	423.841	424.752	422.019?	1.246+09	0.0210	0.9980
2p6p	$^3P_2$	423.872	424.789	422.019?	2.036+09	0.0010	0.9609
2p6d	$^3F_2$	424.159	425.173		3.295+09	1.1312	0.9999
2p6d	$^3F_3$	424.220	425.219		3.095+09	2.0510	1.0000
2p6d	$^1D_2$	424.223	425.718		3.608+09	0.9224	0.9999
2p6d	$^3F_4$	424.269	425.268		3.841+09	2.0579	1.0000
2p6p	$^1D_2$	424.540	424.897		5.236+09	0.8463	0.9998
2p6d	$^3D_1$	424.564	426.411	422.932?	6.398+09	0.0389	0.9845
2p6d	$^3D_2$	424.575	426.486	422.932?	1.054+10	0.0982	0.9979
2p6d	$^3D_3$	424.600	426.467	422.932?	1.488+10	0.0228	0.9908
2p6f	$^1F_3$	424.725	425.585		4.796+09	0.0758	0.9991
2p6f	$^3F_2$	424.744	425.625		3.478+09	0.0013	0.9492
2p6f	$^3F_3$	424.748	425.647		4.760+09	0.2565	0.9997
2p6f	$^3F_4$	424.757	425.656		6.109+09	0.2644	0.9997
2p6d	$^3P_2$	424.765	426.398	423.109?	8.812+09	1.9912	0.9999
2p6d	$^3P_1$	424.791	426.492	423.109?	5.276+09	2.0467	0.9999
2p6d	$^3P_0$	424.804	426.492	423.109?	1.753+09	2.0835	0.9999
2p6f	$^3G_3$	424.898	424.773		4.161+09	3.3362	1.0000
2p6f	$^3G_4$	424.918	424.807		5.316+09	3.4604	1.0000
2p6f	$^3G_5$	424.961			6.444+09	3.6683	1.0000
2p6g	$^3G_4$	424.968		423.253?	4.585+09	0.0007	0.9322
2p6g	$^3G_3$	424.968		423.253?	3.564+09	0.0010	0.9515
2p6g	$^1G_4$	424.975			4.390+09	0.2810	0.9998
2p6g	$^3G_5$	424.976		423.253?	5.365+09	0.2796	0.9999
2p6f	$^1G_4$	425.056		425.132	5.076+09	4.1679	1.0000
2p6h	$^3H_5$	425.076			4.731+09	0.0005	0.9207
2p6h	$^3H_4$	425.076			3.871+09	0.0047	0.9909
2p6h	$^3I_5$	425.078			4.275+09	0.0954	0.9996
2p6h	$^3H_6$	425.078			5.052+09	0.0954	0.9997

Table Ib. (continued)

2*lnl'*	LSJ	E(10^3 cm^{-1})			Sum(gAr), s^{-1}	Aa,10^{13} s^{-1}	K
		a	b	c	a	a	a
2p6g	$^3H_4$	425.091			3.871+09	1.1914	1.0000
2p6g	$^3H_5$	425.092			4.717+09	1.2010	1.0000
2p6g	$^3H_6$	425.144			5.359+09	1.4757	1.0000
2p6f	$^3D_3$	425.097	425.304		6.007+09	0.0184	0.9954
2p6f	$^3D_2$	425.123	425.347		4.351+09	0.0188	0.9954
2p6f	$^3D_1$	425.146	425.377		2.588+09	0.0189	0.9955
2p6g	$^1H_5$	425.146			4.518+09	1.4821	1.0000
2p6g	$^3F_4$	425.161			4.970+09	0.0086	0.9936
2p6g	$^1F_3$	425.162			3.859+09	0.0084	0.9935
2p6g	$^3F_2$	425.206			2.782+09	0.0103	0.9946
2p6g	$^3F_3$	425.207			3.892+09	0.0076	0.9927
2p6h	$^3I_5$	425.173			4.076+09	0.1522	0.9998
2p6h	$^3H_6$	425.173			4.817+09	0.1523	0.9999
2p6h	$^3G_5$	425.200			5.037+09	0.0022	0.9796
2p6h	$^1G_4$	425.200			4.121+09	0.0036	0.9874
2p6h	$^3I_7$	425.211			5.082+09	0.2476	0.9999
2p6h	$^1I_6$	425.211			4.404+09	0.2477	0.9999
2p6h	$^3G_3$	425.235			3.276+09	0.0028	0.9836
2p6h	$^3G_4$	425.235			4.211+09	0.0038	0.9878
2p6f	$^1D_2$	425.289	425.749		6.380+09	0.0655	0.9981
2p6d	$^1F_3$	425.668	424.776		2.814+10	13.171	1.0000
2p6d	$^1P_1$	425.932	427.631		1.090+10	1.5444	0.9998
2p6p	$^1S_0$	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 $1s^23lnl'$[LSJ] even levels. E_S = (E - 386.1597), E($1s^22p_{1/2}$) - E($1s^22s^2$) = 450.6439, E($1s^22p_{3/2}$) - E($1s^22s^2$) = 450.7510, E($1s^23s$) - E($1s^22s^2$) = 689.0076 in 10^3 cm^{-1} . E($1s^22p_{1/2}$) - E($1s^22s$)= 7.9929eV, E($1s^22p_{3/2}$) - E($1s^22s$)= 8.0061eV, E($1s^23s$) - E($1s^22s$) =37.538eV

N	$3lnl'$	LSJ	E(10^3cm^{-1})	E_S(eV)	Sum(gAr),s^{-1}	Aa,10^{13}s^{-1} $1s^22s$	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	3*lnl'*	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
28	3p4f	$^3G_3$	638.375	31.262	6.606+10	0.0070	0.0578	0.1092
28	3p4f	$^3G_4$	638.383	31.263	8.498+10	0.0070	0.0577	0.1094
28	3p4f	$^3G_5$	638.393	31.264	1.039+11	0.0070	0.0576	0.1096
28	3p4f	$^1F_3$	638.698	31.302	6.337+10	0	0.0561	0
28	3p4f	$^3F_2$	640.827	31.566	2.962+10	0	0.0841	0
28	3p4f	$^3F_3$	640.829	31.566	4.147+10	0	0.0840	0
28	3p4f	$^3F_4$	640.833	31.567	5.330+10	0	0.0840	0
27	3p4p	$^1S_0$	640.958	31.582	9.794+09	1.7250	23.444	0.0736
30	3d4d	$^1F_3$	641.628	31.665	1.554+11	0	0.1321	0
27	3p4p	$^1D_2$	642.145	31.729	6.257+10	2.5923	9.7831	0.2649
30	3d4d	$^3D_3$	642.315	31.751	9.892+10	0.0004	0.0277	0.0137
30	3d4d	$^3D_2$	642.316	31.751	7.082+10	0.0006	0.0284	0.0201
30	3d4d	$^3D_1$	642.316	31.751	4.256+10	0.0004	0.0273	0.0139
31	3s5s	$^3S_1$	643.152	31.854	1.670+10	0.0583	0.0633	0.9130
30	3d4d	$^3G_3$	643.572	31.906	1.211+11	0.0178	0.3200	0.0553
30	3d4d	$^3G_4$	643.577	31.907	1.557+11	0.0178	0.3201	0.0553
30	3d4d	$^3G_5$	643.584	31.908	1.901+11	0.0178	0.3201	0.0553
30	3d4d	$^1P_1$	643.991	31.958	6.507+10	0	0.0061	0
28	3p4f	$^1G_4$	644.487	32.020	7.395+10	3.2274	6.7703	0.4766
31	3s5s	$^1S_0$	645.110	32.097	6.492+09	5.8468	11.9436	0.4895
28	3p4f	$^3D_3$	646.290	32.243	8.440+10	0.1470	0.4091	0.3583
28	3p4f	$^3D_2$	646.291	32.243	6.017+10	0.1471	0.4095	0.3582
28	3p4f	$^3D_1$	646.291	32.243	3.606+10	0.1471	0.4098	0.3579
30	3d4d	$^3F_2$	648.324	32.495	1.023+11	0.0005	3.3448	0.0001
30	3d4d	$^3F_3$	648.327	32.496	1.431+11	0	3.3447	0
30	3d4d	$^3F_4$	648.332	32.496	1.840+11	0	3.3448	0
32	3s5d	$^1D_2$	648.504	32.518	4.306+10	3.5221	3.7507	0.9388
30	3d4d	$^3S_1$	649.076	32.589	6.167+10	0	0.0111	0
32	3s5d	$^3D_1$	649.867	32.687	2.158+10	0.4371	0.4540	0.9613
32	3s5d	$^3D_2$	649.868	32.687	3.597+10	0.4373	0.4543	0.9611
32	3s5d	$^3D_3$	649.869	32.687	5.037+10	0.4375	0.4544	0.9613
28	3p4f	$^1D_2$	650.204	32.728	5.722+10	0.5604	2.6302	0.2130
30	3d4d	$^1G_4$	650.668	32.786	1.587+11	2.5151	16.9191	0.1486
30	3d4d	$^3P_0$	652.113	32.965	2.298+10	0	0.1825	0
30	3d4d	$^3P_1$	652.115	32.965	6.893+10	0	0.1821	0
30	3d4d	$^3P_2$	652.118	32.966	1.149+11	0	0.1815	0
33	3s5g	$^3G_3$	653.749	33.168	3.489+10	0	0.0762	0
33	3s5g	$^3G_4$	653.750	33.168	4.486+10	0	0.0763	0
33	3s5g	$^3G_5$	653.751	33.168	5.484+10	0	0.0764	0
30	3d4d	$^1D_2$	653.920	33.189	8.056+10	0.0059	3.2701	0.0018
33	3s5g	$^1G_4$	656.606	33.522	6.743+10	0.0079	1.1616	0.0068
30	3d4d	$^1S_0$	659.350	33.862	1.977+10	0.5912	2.3668	0.2496

Table IIa (continued)

N	3*lnl'*	LSJ	E(10^3cm^{-1})	E$_S$(eV)	Sum(gAr),s^{-1}	Aa,10^{13}s^{-1} $1s^22s$	Aa,10^{13}s^{-1} sum	K
39	3s6s	$^3S_1$	660.243	33.973	1.411+10	0.0236	0.0246	0.9414
39	3s6s	$^1S_0$	660.767	34.038	5.670+09	0.7186	1.0252	0.7005
34	3p5p	$^3D_1$	662.702	34.278	2.021+10	0.0144	0.0552	0.2577
40	3s6d	$^3D_2$	662.707	34.278	3.367+10	0.0148	0.0554	0.2639
40	3s6d	$^3D_3$	662.714	34.279	4.709+10	0.0153	0.0553	0.2733
34	3p5p	$^1P_1$	663.190	34.338	1.793+10	0	0.0627	0
40	3s6d	$^1D_2$	663.519	34.379	3.026+10	0.8730	1.3972	0.6246
40	3s6d	$^3D_1$	664.501	34.501	2.160+10	0.3899	0.5618	0.6931
34	3p5p	$^3D_2$	664.502	34.501	4.359+10	0.3874	0.8582	0.4510
34	3p5p	$^3D_3$	664.513	34.502	5.055+10	0.3894	0.5624	0.6915
34	3p5p	$^1D_2$	664.515	34.502	5.454+10	0.3490	4.9597	0.0704
34	3p5p	$^3P_0$	664.987	34.561	6.471+09	0	4.7153	0
34	3p5p	$^3P_1$	664.992	34.561	1.943+10	0.0001	4.7070	0
34	3p5p	$^3P_2$	665.003	34.563	3.237+10	0.0001	4.7160	0
34	3p5p	$^3S_1$	665.176	34.584	2.542+10	0.0240	0.1414	0.1687
41	3s6g	$^3G_3$	665.411	34.613	3.184+10	0.0070	0.0076	0.8690
41	3s6g	$^3G_4$	665.412	34.613	4.093+10	0.0070	0.0076	0.8690
41	3s6g	$^3G_5$	665.413	34.614	5.002+10	0.0070	0.0076	0.8691
41	3s6g	$^1G_4$	665.601	34.637	4.310+10	0.0456	0.1029	0.4411
35	3p5f	$^1F_3$	667.401	34.860	3.740+10	0	0.0806	0
35	3p5f	$^3F_2$	667.944	34.927	2.696+10	0.0014	0.0120	0.1116
35	3p5f	$^3F_3$	667.946	34.928	3.780+10	0.0015	0.0122	0.1177
35	3p5f	$^3F_4$	667.950	34.928	4.815+10	0	0.0106	0
36	3d5s	$^3D_1$	667.969	34.930	5.062+10	0.1606	0.1967	0.8195
36	3d5s	$^3D_2$	667.973	34.931	8.407+10	0.1590	0.1946	0.8101
36	3d5s	$^3D_3$	667.978	34.932	1.175+11	0.1585	0.1939	0.8101
35	3p5f	$^3G_3$	668.109	34.948	5.011+10	0.0048	0.0748	0.0636
35	3p5f	$^3G_4$	668.118	34.949	6.447+10	0.0049	0.0747	0.0650
35	3p5f	$^3G_5$	668.128	34.950	7.892+10	0.0048	0.0747	0.0636
34	3p5p	$^1S_0$	669.352	35.102	1.151+10	3.3611	19.2544	0.1746
35	3p5f	$^3D_3$	669.689	35.144	5.117+10	0.0030	0.1095	0.0272
35	3p5f	$^3D_2$	669.696	35.144	3.657+10	0.0030	0.1093	0.0273
35	3p5f	$^3D_1$	669.701	35.145	2.195+10	0.0029	0.1090	0.0264
36	3d5s	$^1D_2$	669.881	35.167	6.966+10	2.6473	4.3577	0.6072
37	3d5d	$^1F_3$	671.085	35.317	1.307+11	0	0.0474	0
35	3p5f	$^1G_4$	671.145	35.324	8.245+10	2.1811	7.3015	0.2987
37	3d5d	$^1P_1$	672.165	35.450	5.890+10	0	0.0085	0
37	3d5d	$^3G_3$	672.192	35.454	1.279+11	0.0137	0.2341	0.0581
37	3d5d	$^3G_4$	672.197	35.454	1.643+11	0.0137	0.2344	0.0580
37	3d5d	$^3G_5$	672.203	35.455	2.007+11	0.0137	0.2344	0.0580
37	3d5d	$^3D_1$	672.250	35.461	5.314+10	0.0157	0.0995	0.1550
37	3d5d	$^3D_2$	672.252	35.461	8.856+10	0.0158	0.0997	0.1557

Table IIa. (continued)

N	3*lnl'*	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
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	3*lnl'*	LSJ	E(10^3cm^{-1})	E$_S$(eV)	Sum(gAr),s^{-1}	Aa,10^{13}s^{-1} $1s^22s$	Aa,10^{13}s^{-1} sum	K
43	3p6f	$^1F_3$	681.453	36.602	3.413+10	0	0.0551	0
43	3p6f	$^3F_2$	681.658	36.627	2.460+10	0	0.0016	0
43	3p6f	$^3F_3$	681.660	36.627	3.446+10	0.0001	0.0020	0.0401
43	3p6f	$^3F_4$	681.663	36.628	4.431+10	0.0001	0.0022	0.0371
43	3p6f	$^3G_3$	681.778	36.642	3.817+10	0.0091	0.0778	0.1162
43	3p6f	$^3G_4$	681.788	36.643	4.909+10	0.0092	0.0778	0.1174
43	3p6f	$^3G_5$	681.799	36.645	6.005+10	0.0092	0.0781	0.1170
43	3p6f	$^3D_3$	682.526	36.735	4.069+10	0.0015	0.0868	0.0172
43	3p6f	$^3D_2$	682.535	36.736	2.915+10	0.0014	0.0863	0.0161
43	3p6f	$^3D_1$	682.541	36.737	1.752+10	0.0014	0.0859	0.0162
44	3p6h	$^1H_5$	682.987	36.792	5.313+10	0	0.0001	0
44	3p6h	$^3H_4$	682.996	36.793	4.359+10	0	0.0002	0
44	3p6h	$^3H_5$	682.998	36.793	5.327+10	0	0.0002	0
44	3p6h	$^3H_6$	683.000	36.793	6.297+10	0	0.0002	0
43	3p6f	$^1G_4$	683.370	36.839	5.799+10	2.3694	3.3413	0.7090
45	3d6s	$^3D_1$	683.652	36.874	5.305+10	0.1035	0.1858	0.5518
45	3d6s	$^3D_2$	683.655	36.875	8.842+10	0.1034	0.1854	0.5524
45	3d6s	$^3D_3$	683.660	36.875	1.239+11	0.1032	0.1846	0.5537
44	3p6h	$^3G_5$	683.687	36.879	5.642+10	0.0001	0.0001	0.1632
44	3p6h	$^3G_4$	683.695	36.880	4.620+10	0.0007	0.0016	0.3312
44	3p6h	$^3G_3$	683.704	36.881	3.590+10	0.0001	0.0001	0.1632
44	3p6h	$^3I_5$	683.716	36.882	5.917+10	0.0049	0.0092	0.5032
44	3p6h	$^3I_6$	683.725	36.883	6.995+10	0.0049	0.0093	0.4981
44	3p6h	$^3I_7$	683.737	36.885	8.066+10	0.0049	0.0092	0.5053
44	3p6h	$^1G_4$	683.753	36.887	4.789+10	0.0244	0.0601	0.4024
45	3d6s	$^1D_2$	683.768	36.889	5.533+10	0.1967	0.3602	0.5444
44	3p6h	$^1I_6$	683.813	36.894	7.207+10	0.0064	0.0150	0.4115
46	3d6d	$^1S_0$	683.890	36.904	1.554+10	1.4198	10.9065	0.1302
43	3p6f	$^1D_2$	685.460	37.098	6.580+10	1.9693	2.9053	0.6765
46	3d6d	$^1F_3$	685.497	37.103	1.310+11	0	0.0214	0
46	3d6d	$^3G_3$	685.931	37.157	1.363+11	0.0094	0.1197	0.0773
46	3d6d	$^3G_4$	685.935	37.157	1.752+11	0.0094	0.1198	0.0772
46	3d6d	$^3G_5$	685.940	37.158	2.141+11	0.0094	0.1198	0.0772
46	3d6d	$^3D_1$	685.982	37.163	5.754+10	0.0218	0.0688	0.3083
46	3d6d	$^3D_2$	685.984	37.163	9.587+10	0.0219	0.0690	0.3088
46	3d6d	$^3D_3$	685.988	37.164	1.342+11	0.0219	0.0689	0.3092
46	3d6d	$^1P_1$	686.047	37.171	5.825+10	0.0001	0.0058	0.0129
46	3d6d	$^3F_2$	686.551	37.234	9.550+10	0	1.3573	0
46	3d6d	$^3F_3$	686.554	37.234	1.337+11	0	1.3572	0
46	3d6d	$^3F_4$	686.558	37.235	1.718+11	0	1.3571	0

Table IIa. (continued)

N	3*lnl'*	LSJ	$E(10^3cm^{-1})$	E_S(eV)	Sum(gAr),s^{-1}	Aa,$10^{13}s^{-1}$ $1s^22s$	Aa,$10^{13}s^{-1}$ sum	K
47	3d6g	$^1H_5$	687.195	37.313	1.951+11	0	0.0149	0
47	3d6g	$^3H_4$	687.305	37.327	1.598+11	0.0002	0.0214	0.0086
47	3d6g	$^3H_5$	687.308	37.327	1.953+11	0	0.0203	0
47	3d6g	$^3H_6$	687.311	37.328	2.307+11	0	0.0203	0
46	3d6d	$^3S_1$	687.056	37.296	6.020+10	0.0054	0.0241	0.2068
47	3d6g	$^3G_3$	687.425	37.342	1.261+11	0.0032	0.0228	0.1301
47	3d6g	$^3G_4$	687.427	37.342	1.622+11	0.0053	0.0380	0.1332
47	3d6g	$^3G_5$	687.428	37.342	1.982+11	0.0032	0.0228	0.1301
47	3d6g	$^1G_4$	687.448	37.345	1.660+11	0.5841	4.2850	0.1363
47	3d6g	$^3I_5$	687.565	37.359	1.960+11	0.0324	0.0965	0.3297
47	3d6g	$^3I_6$	687.568	37.360	2.316+11	0.0324	0.0965	0.3297
47	3d6g	$^3I_7$	687.573	37.360	2.671+11	0.0324	0.0965	0.3299
47	3d6g	$^1F_3$	687.618	37.366	1.287+11	0	0.0005	0
47	3d6g	$^3F_4$	687.722	37.379	1.657+11	0.0001	0.0254	0.0037
47	3d6g	$^3F_3$	687.722	37.379	1.289+11	0	0.0248	0
47	3d6g	$^3F_2$	687.722	37.379	9.207+10	0	0.0247	0
46	3d6d	$^3P_0$	687.910	37.402	2.165+10	0	0.1151	0
46	3d6d	$^3P_1$	687.911	37.402	6.494+10	0	0.1149	0
46	3d6d	$^3P_2$	687.913	37.402	1.082+11	0	0.1146	0
47	3d6g	$^1I_6$	687.982	37.411	2.320+11	0.0549	0.2056	0.2647
47	3d6g	$^3D_3$	688.468	37.471	1.338+11	0.0016	0.0087	0.1508
47	3d6g	$^3D_2$	688.471	37.472	9.559+10	0.0016	0.0091	0.1463
47	3d6g	$^3D_1$	688.474	37.472	5.734+10	0.0016	0.0087	0.1508
46	3d6d	$^1D_2$	688.634	37.492	1.080+11	0.0212	2.8334	0.0075
46	3d6d	$^1G_4$	688.782	37.510	1.565+11	0.3120	7.4246	0.0420
47	3d6g	$^1D_2$	689.869	37.645	9.676+10	0.1306	2.1359	0.0611
37	3d5d	$^1S_0$	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 $1s^23lnl$ '[LSJ] odd levels.

N	3*lnl'*	LSJ	E(10^3cm^{-1})	E_S(eV)	Sum(gAr),s^{-1}	Aa,10^{13}s^{-1} $1s^22s$	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	3*lnl'*	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	$^1D_2$	640.459	31.521	8.513+10	0	0.2709	0
26	3d4p	$^3F_2$	641.255	31.619	9.646+10	0.0991	0.2455	0.4005
26	3d4p	$^3F_3$	641.261	31.620	1.350+11	0.0991	0.2455	0.4005
26	3d4p	$^3F_4$	641.269	31.621	1.735+11	0.0991	0.2456	0.4004
26	3d4p	$^3D_1$	644.392	32.008	4.525+10	0	4.4879	0
26	3d4p	$^3D_2$	644.396	32.009	7.540+10	0	4.4878	0
26	3d4p	$^3D_3$	644.402	32.009	1.090+11	0	4.4879	0
27	3d4f	$^1G_4$	644.488	32.020	1.487+11	0	0.1899	0
27	3d4f	$^3H_4$	644.726	32.049	1.556+11	0.3210	0.9463	0.3386
27	3d4f	$^3H_5$	644.730	32.050	1.901+11	0.3210	0.9464	0.3386
27	3d4f	$^3H_6$	644.735	32.051	2.246+11	0.3211	0.9464	0.3387
26	3d4p	$^3P_0$	645.211	32.110	1.795+10	0.0734	1.3335	0.0550
26	3d4p	$^3P_1$	645.212	32.110	5.385+10	0.0737	1.3326	0.0552
26	3d4p	$^3P_2$	645.214	32.110	8.973+10	0.0741	1.3306	0.0556
28	3s5p	$^1P_1$	646.332	32.248	2.264+10	1.7926	5.7697	0.3107
28	3s5p	$^3P_0$	647.497	32.393	6.094+09	1.2484	1.4768	0.8450
28	3s5p	$^3P_1$	647.498	32.393	1.828+10	1.2482	1.4767	0.8449
28	3s5p	$^3P_2$	647.500	32.393	3.045+10	1.2480	1.4766	0.8448
27	3d4f	$^3F_2$	647.626	32.409	8.784+10	0.0016	0.1409	0.0112
27	3d4f	$^3F_3$	647.629	32.409	1.229+11	0.0016	0.1409	0.0112
27	3d4f	$^3F_4$	647.633	32.410	1.580+11	0.0016	0.1408	0.0112
26	3d4p	$^1F_3$	648.099	32.467	8.111+10	1.1142	5.9620	0.1868
27	3d4f	$^1D_2$	648.955	32.574	9.025+10	0	0.0047	0
27	3d4f	$^3G_3$	649.605	32.654	1.210+11	0	0.4456	0
27	3d4f	$^3G_4$	649.608	32.655	1.575+11	0	0.4456	0
27	3d4f	$^3G_5$	649.611	32.655	1.925+11	0	0.4456	0
29	3s5f	$^3F_3$	651.267	32.860	3.322+10	0.1891	0.1927	0.9789
29	3s5f	$^3F_2$	651.267	32.860	2.373+10	0.1891	0.1927	0.9789
29	3s5f	$^3F_4$	651.268	32.860	4.271+10	0.1892	0.1927	0.9794
27	3d4f	$^3D_1$	651.917	32.941	5.574+10	0	0	0
27	3d4f	$^3D_2$	651.917	32.941	9.289+10	0	0	0
27	3d4f	$^3D_3$	651.918	32.941	1.301+11	0	0.0017	0
27	3d4f	$^1F_3$	652.061	32.959	9.772+10	0.0110	4.9751	0.0022
27	3d4f	$^1H_5$	653.277	33.109	2.005+11	0.6444	2.9218	0.2204
26	3d4p	$^1P_1$	653.538	33.142	4.013+10	0.1017	3.5615	0.0285
27	3d4f	$^3P_2$	654.313	33.238	9.627+10	0.0051	0.0392	0.1240
27	3d4f	$^3P_1$	654.317	33.238	5.774+10	0.0052	0.0392	0.1264
27	3d4f	$^3P_0$	654.318	33.238	1.924+10	0.0052	0.0392	0.1264
29	3s5f	$^1F_3$	655.254	33.354	9.047+10	0.2156	4.3623	0.0494
27	3d4f	$^1P_1$	658.780	33.791	6.440+10	0.0016	0.3121	0.0051

Table IIb. (continued)

N	3*lnl'*	LSJ	E(10^3cm^{-1})	E_S(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	3*lnl'*	LSJ	E(10^3cm^{-1})	E_S (eV)	Sum(gAr),s^{-1}	Aa,10^{13}s^{-1} $1s^22s$	Aa,10^{13}s^{-1} sum	K
32	3p5g	$^3F_4$	671.153	35.325	7.689+10	0.0200	0.0363	0.5383
32	3p5g	$^3F_3$	671.159	35.326	5.907+10	0.0195	0.0354	0.5380
32	3p5g	$^3F_2$	671.164	35.326	4.181+10	0.0191	0.0345	0.5405
32	3p5g	$^1F_3$	671.618	35.383	5.150+10	0.0048	0.4633	0.0103
33	3d5p	$^3P_0$	671.859	35.413	1.896+10	0.1245	0.5965	0.2081
33	3d5p	$^3P_1$	671.861	35.413	5.687+10	0.1246	0.5957	0.2085
33	3d5p	$^3P_2$	671.866	35.413	9.473+10	0.1246	0.5941	0.2091
32	3p5g	$^1H_5$	672.493	35.491	7.172+10	0.0369	0.0690	0.5298
34	3d5f	$^1G_4$	672.561	35.500	1.556+11	0	0.1187	0
34	3d5f	$^3H_4$	673.371	35.600	1.392+11	0.0669	0.3267	0.2038
34	3d5f	$^3H_5$	673.376	35.601	1.700+11	0.0668	0.3263	0.2038
34	3d5f	$^3H_6$	673.381	35.601	2.007+11	0.0666	0.3258	0.2035
34	3d5f	$^3F_2$	673.417	35.606	8.862+10	0.0008	0.1055	0.0075
34	3d5f	$^3F_3$	673.419	35.606	1.240+11	0.0008	0.1055	0.0075
34	3d5f	$^3F_4$	673.422	35.606	1.594+11	0.0008	0.1054	0.0075
34	3d5f	$^1D_2$	674.038	35.683	9.115+10	0	0.0090	0
33	3d5p	$^1F_3$	674.267	35.711	1.012+11	0.5626	7.7006	0.0730
34	3d5f	$^3G_3$	674.349	35.721	1.250+11	0	0.3743	0
34	3d5f	$^3G_4$	674.352	35.722	1.607+11	0	0.3741	0
34	3d5f	$^3G_5$	674.355	35.722	1.964+11	0	0.3741	0
33	3d5p	$^1P_1$	675.032	35.806	3.698+10	0.0323	2.7908	0.0116
34	3d5f	$^3D_1$	675.298	35.839	5.592+10	0	0.0322	0
34	3d5f	$^3D_2$	675.298	35.839	9.321+10	0	0.0330	0
34	3d5f	$^3D_3$	675.299	35.839	1.305+11	0	0.0330	0
34	3d5f	$^3P_2$	675.966	35.922	9.168+10	0	0.1056	0
34	3d5f	$^3P_1$	675.969	35.922	5.496+10	0	0.1056	0
34	3d5f	$^3P_0$	675.971	35.922	1.831+10	0	0.1056	0
34	3d5f	$^1H_5$	676.506	35.989	1.894+11	0.5917	2.9081	0.2033
34	3d5f	$^1F_3$	676.535	35.992	1.263+11	0.5967	3.8203	0.1561
38	3p6s	$^3P_0$	678.013	36.175	6.241+09	0.2186	0.4807	0.4542
38	3p6s	$^3P_1$	678.021	36.176	1.872+10	0.2191	0.4820	0.4540
38	3p6s	$^3P_2$	678.039	36.179	3.114+10	0.2185	0.4819	0.4528
38	3p6s	$^1P_1$	678.397	36.223	3.073+10	0.9260	2.7263	0.3395
34	3d5f	$^1P_1$	679.573	36.369	5.324+10	0.5397	1.3389	0.4026
39	3p6d	$^3D_1$	680.617	36.498	1.985+10	0	0.6405	0
39	3p6d	$^3D_2$	680.620	36.498	3.306+10	0	0.6375	0
39	3p6d	$^3D_3$	680.625	36.499	4.631+10	0	0.6405	0
39	3p6d	$^1D_2$	680.668	36.504	2.994+10	0	0.1525	0
39	3p6d	$^1F_3$	681.044	36.551	5.690+10	0.0316	0.8590	0.0368
39	3p6d	$^3F_2$	681.060	36.553	3.535+10	0.0009	0.0134	0.0638
39	3p6d	$^3F_3$	681.073	36.555	5.050+10	0.0072	0.1885	0.0381
39	3p6d	$^3F_4$	681.082	36.556	6.366+10	0.0009	0.0131	0.0652

Table IIb. (continued)

N	3*lnl'*	LSJ	E(10^3cm^{-1})	E_S(eV)	Sum(gAr),s^{-1}	Aa,$10^{13}s^{-1}$ $1s^22s$	Aa,$10^{13}s^{-1}$ sum	K
39	3p6d	$^3P_2$	681.938	36.662	4.071+10	0.0045	0.7109	0.0063
39	3p6d	$^3P_1$	681.946	36.663	2.442+10	0.0045	0.7103	0.0063
39	3p6d	$^3P_0$	681.950	36.663	8.141+09	0.0045	0.7099	0.0063
39	3p6d	$^1P_1$	682.327	36.710	3.581+10	0.0008	0.9214	0.0009
40	3p6g	$^1G_4$	682.180	36.692	4.244+10	0	0.0001	0
40	3p6g	$^3G_3$	682.358	36.714	3.348+10	0	0.0031	0
40	3p6g	$^3G_4$	682.360	36.714	4.305+10	0	0.0031	0
40	3p6g	$^3G_5$	682.363	36.715	5.262+10	0	0.0031	0
40	3p6g	$^3H_4$	682.781	36.766	4.591+10	0.0446	0.0744	0.5954
40	3p6g	$^3H_5$	682.790	36.767	5.613+10	0.0446	0.0745	0.5946
40	3p6g	$^3H_6$	682.802	36.769	6.636+10	0.0447	0.0745	0.5959
40	3p6g	$^3F_4$	683.386	36.841	4.723+10	0.0027	0.0028	0.8121
40	3p6g	$^3F_3$	683.396	36.843	3.675+10	0.0027	0.0028	0.8120
40	3p6g	$^3F_2$	683.403	36.843	2.626+10	0.0027	0.0028	0.8120
40	3p6g	$^1H_5$	684.266	36.950	7.913+10	0.1491	0.3600	0.4133
40	3p6g	$^1F_3$	684.347	36.960	5.649+10	0.0064	0.2106	0.0303
41	3d6p	$^1D_2$	684.626	36.995	9.257+10	0	0.0207	0
41	3d6p	$^3F_2$	685.107	37.055	9.590+10	0.0340	0.0676	0.4891
41	3d6p	$^3F_3$	685.112	37.055	1.342+11	0.0340	0.0681	0.4856
41	3d6p	$^3F_4$	685.117	37.056	1.725+11	0.0341	0.0664	0.4991
41	3d6p	$^3D_1$	685.127	37.057	5.281+10	0	1.1952	0
41	3d6p	$^3D_2$	685.131	37.058	8.801+10	0	1.1938	0
41	3d6p	$^3D_3$	685.136	37.058	1.232+11	0	1.1935	0
41	3d6p	$^3P_0$	685.818	37.143	1.997+10	0.1110	0.3804	0.2903
41	3d6p	$^3P_1$	685.821	37.143	5.990+10	0.1110	0.3801	0.2905
41	3d6p	$^3P_2$	685.825	37.144	9.977+10	0.1111	0.3794	0.2913
42	3d6f	$^1G_4$	686.289	37.201	1.602+11	0	0.0689	0
42	3d6f	$^3H_4$	686.533	37.231	1.606+11	0.0585	0.2674	0.2173
42	3d6f	$^3H_5$	686.537	37.232	1.962+11	0.0585	0.2673	0.2174
42	3d6f	$^3H_6$	686.542	37.233	2.317+11	0.0584	0.2673	0.2170
42	3d6f	$^3F_2$	686.640	37.245	9.127+10	0.0017	0.0703	0.0236
42	3d6f	$^3F_3$	686.642	37.245	1.278+11	0.0017	0.0703	0.0236
42	3d6f	$^3F_4$	686.644	37.245	1.642+11	0.0017	0.0702	0.0236
42	3d6f	$^1D_2$	686.974	37.286	9.245+10	0	0.0055	0
42	3d6f	$^3G_3$	687.195	37.313	1.259+11	0	0.2783	0
42	3d6f	$^3G_4$	687.197	37.314	1.618+11	0	0.2783	0
42	3d6f	$^3G_5$	687.201	37.314	1.977+11	0	0.2783	0
41	3d6p	$^1F_3$	687.421	37.341	1.166+11	0.8825	8.9663	0.0984
43	3d6h	$^1I_6$	687.656	37.371	2.312+11	0	0.0007	0

Table IIb. (continued)

N	3*lnl'*	LSJ	E(10^3cm^{-1})	E_S(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

$1s^2 3l3l'$[LSJ] levels. Comparison of results obtained by Cowan (a) and MZ (b) codes

N	3*l*3*l*'	LSJ	E(10^3cm^{-1})		Aa,10^{13}s^{-1} $1s^2 2s$		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	$2s^2(^1S_0)$	$2p4d(^1P_1)$	254.8	4.072+08	0.9999	4.072+08
1	$2s^2(^1S_0)$	$2p5d(^1P_1)$	241.5	3.089+08	0.9999	3.089+08
1	$2s^2(^1S_0)$	$2p6d(^1P_1)$	234.7	1.973+08	0.9998	1.973+08
2	$2p^2(^3P_2)$	$2p4d(^3D_3)$	397.3	3.530+10	0.9446	3.334+10
2	$2p^2(^3P_1)$	$2p4d(^3D_2)$	397.2	1.964+10	0.9603	1.886+10
2	$2p^2(^3P_2)$	$2p4d(^3P_2)$	396.0	1.158+10	0.9999	1.158+10
2	$2p^2(^3P_2)$	$2p5d(^3D_3)$	363.6	1.743+10	0.9803	1.709+10
2	$2p^2(^3P_1)$	$2p5d(^3D_2)$	363.5	1.017+10	0.9927	1.010+10
2	$2p^2(^3P_2)$	$2p6d(^3D_3)$	347.8	1.016+10	0.9908	1.007+10
2	$2p^2(^1D_2)$	$2p4d(^1D_2)$	418.1	8.376+09	0.9991	8.368+09
2	$2p^2(^1D_2)$	$2p4d(^1F_3)$	410.1	4.348+10	1.0000	4.348+10
2	$2p^2(^1D_2)$	$2p5d(^1D_2)$	379.8	2.797+09	0.9999	2.797+09
2	$2p^2(^1D_2)$	$2p5d(^1F_3)$	376.4	2.628+10	1.0000	2.628+10
2	$2p^2(^1D_2)$	$2p6d(^1F_3)$	360.2	2.298+10	1.0000	2.298+10
2	$2p^2(^1S_0)$	$2p4d(^1P_1)$	475.3	9.823+09	0.9999	9.822+09
2	$2p^2(^1S_0)$	$2p5d(^1P_1)$	431.0	6.014+09	0.9999	6.011+09
2	$2p^2(^1S_0)$	$2p6d(^1P_1)$	410.0	5.789+09	0.9998	5.788+09
3	$2s3s(^1S_0)$	$2p6d(^1P_1)$	557.4	1.432+08	0.9998	1.431+08
4	$2s3d(^3D_3)$	$2p4d(^3P_2)$	835.0	1.056+08	0.9999	1.056+08
4	$2s3d(^3D_2)$	$2p5d(^3P_2)$	701.4	2.257+08	0.9999	2.257+08
4	$2s3d(^3D_2)$	$2p5d(^3P_1)$	701.2	1.222+08	0.9999	1.222+08
4	$2s3d(^1D_2)$	$2p6d(^1P_1)$	669.5	1.030+09	0.9998	1.030+09
4	$2s3d(^3D_3)$	$2p6d(^3D_2)$	646.2	1.057+08	0.9979	1.055+08
4	$2s3d(^3D_3)$	$2p6d(^3D_3)$	646.1	1.617+08	0.9908	1.602+08
4	$2s3d(^3D_3)$	$2p6d(^3P_2)$	645.4	7.440+08	0.9999	7.439+08
4	$2s3d(^3D_2)$	$2p6d(^3P_2)$	645.4	1.932+08	0.9999	1.932+08
4	$2s3d(^3D_2)$	$2p6d(^3P_1)$	645.3	4.143+08	0.9999	4.143+08
4	$2s3d(^3D_1)$	$2p6d(^3P_1)$	645.3	1.723+08	0.9999	1.723+08
4	$2s3d(^3D_1)$	$2p6d(^3P_0)$	645.2	1.988+08	0.9999	1.988+08
5	$2p3p(^1S_0)$	$2p4d(^1P_1)$	2209.4	5.879+08	0.9999	5.878+08
5	$2p3p(^1D_2)$	$2p4d(^1F_3)$	1772.6	3.858+09	1.0000	3.858+09
5	$2p3p(^3P_2)$	$2p4d(^3D_3)$	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($^3P_1$)	2p4d($^3D_2$)	1729.9	1.735+09	0.9603	1.666+09
5	2p3p($^3S_1$)	2p4d($^3P_2$)	1562.6	1.236+09	0.9999	1.236+09
5	2p3p($^3D_3$)	2p4d($^3F_4$)	1506.6	7.222+09	1.0000	7.222+09
5	2p3p($^3D_2$)	2p4d($^3F_3$)	1506.5	4.986+09	1.0000	4.986+09
5	2p3p($^3D_1$)	2p4d($^3F_2$)	1506.4	3.291+09	1.0000	3.291+09
5	2p3p($^1S_0$)	2p5d($^1P_1$)	1495.5	3.777+08	0.9999	3.777+08
5	2p3p($^1P_1$)	2p4d($^1D_2$)	1462.5	2.089+09	0.9991	2.087+09
5	2p3p($^1S_0$)	2p6s($^1P_1$)	1334.2	1.972+08	1.0000	1.972+08
5	2p3p($^1D_2$)	2p5d($^1F_3$)	1278.5	1.899+09	1.0000	1.899+09
5	2p3p($^1S_0$)	2p6d($^1P_1$)	1269.8	5.451+08	0.9998	5.450+08
5	2p3p($^3P_2$)	2p5d($^3D_3$)	1233.2	1.757+09	0.9446	1.660+09
5	2p3p($^3P_1$)	2p5d($^3D_2$)	1232.9	1.016+09	0.9927	1.009+09
5	2p3p($^1D_2$)	2p6d($^1F_3$)	1109.0	2.363+09	1.0000	2.363+09
5	2p3p($^3D_3$)	2p5d($^3F_4$)	1107.1	2.186+09	1.0000	2.186+09
5	2p3p($^3D_2$)	2p5d($^3F_3$)	1107.1	1.544+09	1.0000	1.544+09
5	2p3p($^3P_2$)	2p6d($^3D_3$)	1068.3	1.300+09	0.9908	1.288+09
6	2s4s($^3S_1$)	2p4d($^3P_2$)	1271.0	1.246+08	0.9999	1.246+08
7	2s4d($^1D_2$)	2p4d($^1D_2$)	1629.9	1.417+09	0.9991	1.416+09
7	2s4d($^3D_2$)	2p4d($^3D_2$)	1540.5	1.380+09	0.9603	1.325+09
7	2s4d($^3D_3$)	2p4d($^3D_3$)	1540.3	2.574+09	0.9446	2.431+09
7	2s4d($^1D_2$)	2p4d($^1F_3$)	1514.3	1.811+09	1.0000	1.811+09
8	2p4p($^1P_1$)	2p5s($^1P_1$)	3939.5	1.072+08	1.0000	1.072+08
8	2p4p($^1P_1$)	2p5d($^1D_2$)	3458.8	2.476+08	0.9999	2.476+08
8	2p4p($^3D_2$)	2p5s($^3P_1$)	4270.7	1.796+08	0.9981	1.793+08
8	2p4p($^3D_3$)	2p5s($^3P_2$)	4268.1	3.308+08	0.9916	3.280+08
8	2p4p($^3D_3$)	2p5d($^3F_4$)	3544.2	7.899+08	1.0000	7.899+08
8	2p4p($^3D_2$)	2p5d($^3F_3$)	3543.3	5.544+08	1.0000	5.544+08
8	2p4p($^3D_1$)	2p5d($^3F_2$)	3540.8	2.945+08	1.0000	2.945+08
8	2p4p($^3D_3$)	2p5d($^3D_3$)	3468.1	1.334+08	0.9803	1.308+08
8	2p4p($^3D_3$)	2p6s($^3P_2$)	2609.5	1.432+08	0.9990	1.431+08
8	2p4p($^3D_3$)	2p6d($^3F_4$)	2437.8	4.153+08	1.0000	4.153+08
8	2p4p($^3D_2$)	2p6d($^3F_3$)	2437.4	2.955+08	1.0000	2.955+08
8	2p4p($^3D_3$)	2p6d($^3D_3$)	2418.3	1.015+08	0.9908	1.006+08
8	2p4p($^3S_1$)	2p5d($^3P_2$)	3592.8	2.196+08	0.9999	2.196+08
8	2p4p($^3S_1$)	2p5d($^3P_1$)	3589.0	1.275+08	0.9999	1.275+08
8	2p4p($^3S_1$)	2p6d($^3P_2$)	2487.9	1.555+08	0.9999	1.555+08
8	2p4p($^3P_2$)	2p5s($^3P_2$)	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($^3P_2$)	2p5d($^3D_3$)	3869.0	5.763+08	0.9803	5.649+08
8	2p4p($^3P_1$)	2p5d($^3D_2$)	3866.9	3.305+08	0.9927	3.281+08
8	2p4p($^3P_0$)	2p5d($^3D_1$)	3865.7	1.482+08	0.9832	1.457+08
8	2p4p($^3P_2$)	2p5d($^3P_2$)	3821.5	1.645+08	0.9999	1.645+08
8	2p4p($^3P_2$)	2p6s($^3P_2$)	2830.1	1.396+08	0.9990	1.395+08
8	2p4p($^3P_2$)	2p6d($^3D_3$)	2606.6	4.334+08	0.9908	4.294+08
8	2p4p($^3P_1$)	2p6d($^3D_2$)	2605.9	2.578+08	0.9979	2.573+08
8	2p4p($^3P_0$)	2p6d($^3D_1$)	2605.3	1.172+08	0.9845	1.154+08
8	2p4p($^3P_2$)	2p6d($^3P_2$)	2595.4	1.427+08	0.9999	1.427+08
10	2s5s($^1S_0$)	2p5s($^1P_1$)	1475.1	1.195+09	1.0000	1.195+09
10	2s5s($^3S_1$)	2p5s($^3P_2$)	1534.0	1.272+09	0.9916	1.261+09
11	2s5d($^3D_2$)	2p5d($^3F_3$)	1555.5	1.402+09	1.0000	1.402+09
11	2s5d($^3D_3$)	2p5d($^3F_4$)	1554.4	2.118+09	1.0000	2.118+09
11	2s5d($^3D_3$)	2p5d($^3F_3$)	1539.6	1.782+09	1.0000	1.782+09
11	2s5d($^3D_3$)	2p5d($^3P_2$)	1532.0	1.270+09	0.9999	1.270+09
11	2s5d($^1D_2$)	2p5d($^1F_3$)	1534.0	2.074+09	1.0000	2.074+09
11	2s5d($^1D_2$)	2p5d($^1P_1$)	1526.2	1.054+09	0.9999	1.054+09
12	2s5g($^3G_4$)	2p5g($^3G_4$)	1550.5	1.340+09	0.7475	1.002+09
12	2s5g($^3G_3$)	2p5g($^3G_3$)	1550.5	1.735+09	0.7476	1.297+09
12	2s5g($^3G_5$)	2p5g($^3G_5$)	1550.2	3.053+09	0.9992	3.051+09
12	2s5g($^3G_3$)	2p5g($^3H_4$)	1545.5	1.894+09	1.0000	1.893+09
12	2s5g($^3G_4$)	2p5g($^3H_5$)	1545.5	1.680+09	1.0000	1.679+09
12	2s5g($^3G_5$)	2p5g($^3H_6$)	1544.0	2.815+09	1.0000	2.814+09
12	2s5g($^3G_5$)	2p5g($^3F_4$)	1543.1	2.226+09	0.9896	2.203+09
12	2s5g($^3G_3$)	2p5g($^3F_2$)	1541.8	1.421+09	0.9907	1.408+09
12	2s5g($^3G_4$)	2p5g($^3F_3$)	1541.8	1.240+09	0.9838	1.220+09
12	2s5g($^1G_4$)	2p5g($^1G_4$)	1550.2	1.577+09	0.9992	1.576+09
12	2s5g($^1G_4$)	2p5g($^1H_5$)	1544.0	1.611+09	1.0000	1.611+09
12	2s5g($^1G_4$)	2p5g($^1F_3$)	1543.0	1.250+09	0.9804	1.226+09
15	2s6s($^3S_1$)	2p6s($^3P_2$)	1538.9	1.330+09	0.9990	1.329+09
15	2s6s($^1S_0$)	2p6s($^1P_1$)	1550.5	8.653+08	1.0000	8.653+08
16	2s6d($^3D_2$)	2p6d($^3F_3$)	1552.2	1.350+09	1.0000	1.350+09
16	2s6d($^3D_3$)	2p6d($^3F_4$)	1551.0	2.116+09	1.0000	2.116+09
16	2s6d($^3D_3$)	2p6d($^3D_3$)	1543.1	1.718+09	0.9803	1.684+09
16	2s6d($^3D_3$)	2p6d($^3P_2$)	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($^1D_2$)	2p6d($^1F_3$)	1537.2	1.501+09	1.0000	1.501+09
16	2s6d($^1D_2$)	2p6d($^1P_1$)	1531.0	1.237+09	0.9998	1.237+09
17	2s6g($^3G_4$)	2p6g($^3G_4$)	1549.5	1.272+09	0.9322	1.186+09
17	2s6g($^3G_3$)	2p6g($^3G_3$)	1549.5	1.585+09	0.9515	1.508+09
17	2s6g($^3G_5$)	2p6g($^3G_5$)	1549.3	2.781+09	1.0000	2.781+09
17	2s6g($^3G_3$)	2p6g($^3H_4$)	1546.6	1.563+09	1.0000	1.563+09
17	2s6g($^3G_4$)	2p6g($^3H_5$)	1546.5	1.564+09	1.0000	1.564+09
17	2s6g($^3G_5$)	2p6g($^3H_6$)	1545.3	2.478+09	1.0000	2.478+09
17	2s6g($^3G_5$)	2p6g($^3F_4$)	1544.9	2.342+09	0.9936	2.327+09
17	2s6g($^3G_3$)	2p6g($^3F_2$)	1543.8	1.627+09	0.9946	1.618+09
17	2s6g($^3G_4$)	2p6g($^3F_3$)	1543.8	1.526+09	0.9927	1.515+09
17	2s6g($^1G_4$)	2p6g($^1G_4$)	1549.3	1.470+09	0.9998	1.470+09
17	2s6g($^1G_4$)	2p6g($^1H_5$)	1545.2	1.524+09	1.0000	1.524+09
17	2s6g($^1G_4$)	2p6g($^1F_3$)	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($^3P_2$)	2p5p($^3D_3$)	279.5	2.137+09	0.9973	2.131+09
1	2s2p($^3P_1$)	2p5p($^3D_2$)	279.5	1.170+09	0.9974	1.167+09
1	2s2p($^3P_2$)	2p5p($^3S_1$)	279.1	1.425+09	1.0000	1.425+09
1	2s2p($^3P_2$)	2p5p($^3P_2$)	278.4	1.138+09	0.9348	1.064+09
1	2s2p($^3P_2$)	2p6p($^3D_3$)	269.2	1.127+09	0.9992	1.126+09
1	2s2p($^3P_2$)	2p6p($^3S_1$)	269.0	1.556+09	1.0000	1.556+09
1	2s2p($^3P_1$)	2p6p($^3S_1$)	268.9	1.009+09	1.0000	1.009+09
1	2s2p($^1P_1$)	2p4p($^1D_2$)	347.7	5.479+09	1.0000	5.478+09
1	2s2p($^1P_1$)	2p5p($^1P_1$)	324.1	3.691+09	0.9616	3.549+09
1	2s2p($^1P_1$)	2p5p($^1D_2$)	321.2	3.223+09	0.999	3.223+09
1	2s2p($^1P_1$)	2p6p($^1P_1$)	310.1	4.598+09	0.9859	4.533+09
1	2s2p($^1P_1$)	2p6p($^1D_2$)	308.6	2.229+09	0.9998	2.229+09
1	2s2p($^1P_1$)	2p6f($^1D_2$)	307.9	2.332+09	0.9981	2.328+09
2	2s3p($^1P_1$)	2p6p($^1P_1$)	611.8	2.164+08	0.9859	2.133+08
2	2s3p($^1P_1$)	2p6p($^1D_2$)	605.9	1.633+08	0.9998	1.633+08
3	2p3s($^3P_2$)	2p4f($^3D_3$)	1209.9	1.285+08	0.9976	1.282+08
3	2p3s($^3P_2$)	2p5p($^3D_2$)	986.3	1.114+08	0.9974	1.111+08
3	2p3s($^3P_1$)	2p5p($^3D_1$)	985.9	1.124+08	0.9973	1.121+08
3	2p3s($^3P_2$)	2p5p($^3D_3$)	985.8	6.589+08	0.9973	6.571+08
3	2p3s($^3P_1$)	2p5p($^3D_2$)	985.6	3.595+08	0.9974	3.586+08
3	2p3s($^3P_0$)	2p5p($^3D_1$)	985.6	1.589+08	0.9973	1.585+08
3	2p3s($^3P_2$)	2p5p($^3S_1$)	980.5	1.121+08	1.0000	1.121+08
3	2p3s($^3P_2$)	2p5p($^3P_2$)	972.8	2.037+08	0.9348	1.904+08
3	2p3s($^3P_2$)	2p6p($^3D_3$)	868.5	3.162+08	0.9992	3.160+08
3	2p3s($^3P_1$)	2p6p($^3D_2$)	868.4	1.750+08	0.9992	1.749+08
3	2p3s($^1P_1$)	2p4p($^1D_2$)	1294.8	1.261+09	1.0000	1.261+09
3	2p3s($^1P_1$)	2p4p($^1S_0$)	1221.2	1.111+08	1.0000	1.111+08
3	2p3s($^1P_1$)	2p5p($^1P_1$)	1018.8	1.699+08	0.9616	1.634+08
3	2p3s($^1P_1$)	2p5p($^1D_2$)	991.2	3.882+08	0.9999	3.882+08
3	2p3s($^1P_1$)	2p6p($^1P_1$)	892.7	1.346+08	0.9859	1.327+08
3	2p3s($^1P_1$)	2p6p($^1D_2$)	880.1	2.457+08	0.9998	2.457+08
4	2p3d($^1D_2$)	2p4f($^1F_3$)	1757.9	9.008+09	0.9821	8.847+09
4	2p3d($^1D_2$)	2p4f($^1D_2$)	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($^1D_2$)	2p5f($^1F_3$)	1251.7	3.008+09	0.9973	3.000+09
4	2p3d($^1D_2$)	2p6f($^1F_3$)	1083.6	1.207+09	0.9991	1.206+09
4	2p3d($^3F_2$)	2p4f($^3G_3$)	1789.1	1.024+10	1.0000	1.024+10
4	2p3d($^3F_3$)	2p4f($^3G_4$)	1789.1	1.317+10	1.0000	1.317+10
4	2p3d($^3F_4$)	2p4f($^3G_5$)	1788.8	1.763+10	1.0000	1.763+10
4	2p3d($^3F_3$)	2p5f($^3G_4$)	1275.7	2.262+09	1.0000	2.262+09
4	2p3d($^3F_2$)	2p5f($^3G_3$)	1275.7	1.785+09	1.0000	1.785+09
4	2p3d($^3F_4$)	2p5f($^3G_5$)	1275.6	3.239+09	1.0000	3.239+09
4	2p3d($^3F_3$)	2p6f($^3G_4$)	1103.4	1.027+09	1.0000	1.027+09
4	2p3d($^3F_4$)	2p6f($^3G_5$)	1103.4	1.628+09	1.0000	1.628+09
4	2p3d($^3D_3$)	2p4f($^3F_4$)	1894.9	1.099+10	0.9930	1.091+10
4	2p3d($^3D_2$)	2p4f($^3F_3$)	1894.6	7.423+09	0.9903	7.351+09
4	2p3d($^3D_1$)	2p4f($^3F_2$)	1894.5	5.201+09	0.3666	1.907+09
4	2p3d($^3D_3$)	2p4f($^3D_3$)	1850.9	1.512+09	0.9976	1.508+09
4	2p3d($^3D_3$)	2p5f($^3F_4$)	1320.0	3.504+09	0.9991	3.501+09
4	2p3d($^3D_2$)	2p5f($^3F_3$)	1319.8	2.334+09	0.9990	2.332+09
4	2p3d($^3D_1$)	2p5f($^3F_2$)	1319.7	1.703+09	0.5020	8.549+08
4	2p3d($^3D_3$)	2p6f($^3F_4$)	1134.5	1.564+09	0.9997	1.564+09
4	2p3d($^3D_2$)	2p6f($^3F_3$)	1134.4	1.026+09	0.9997	1.026+09
4	2p3d($^3P_2$)	2p4f($^3D_3$)	1949.5	7.109+09	0.9976	7.092+09
4	2p3d($^3P_1$)	2p4f($^3D_2$)	1949.5	3.769+09	0.9976	3.760+09
4	2p3d($^3P_0$)	2p4f($^3D_1$)	1949.0	1.700+09	0.9752	1.658+09
4	2p3d($^3P_1$)	2p4f($^3D_1$)	1948.5	1.291+09	0.9752	1.259+09
4	2p3d($^3P_2$)	2p4f($^3D_2$)	1948.4	1.286+09	0.9976	1.283+09
4	2p3d($^3P_2$)	2p5f($^3D_3$)	1358.2	2.500+09	0.9972	2.493+09
4	2p3d($^3P_1$)	2p5f($^3D_2$)	1358.2	1.322+09	0.9972	1.318+09
4	2p3d($^3P_2$)	2p6f($^3D_3$)	1166.2	1.281+09	0.9954	1.275+09
4	2p3d($^1F_3$)	2p4f($^1G_4$)	2089.4	9.035+09	1.0000	9.034+09
4	2p3d($^1F_3$)	2p5f($^1G_4$)	1433.8	1.395+09	1.0000	1.395+09
4	2p3d($^1P_1$)	2p4f($^1D_2$)	2159.0	2.857+09	0.9986	2.853+09
5	2s4p($^1P_1$)	2p4p($^1D_2$)	1581.5	1.621+08	1.0000	1.621+08
5	2s4p($^1P_1$)	2p4p($^1S_0$)	1473.1	1.345+08	1.0000	1.345+08
5	2s4p($^1P_1$)	2p5p($^1P_1$)	1188.3	1.212+08	0.9616	1.165+08
5	2s4p($^1P_1$)	2p5p($^1D_2$)	1150.9	2.748+08	0.9999	2.748+08
5	2s4p($^1P_1$)	2p6p($^1P_1$)	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($^1P_1$)	2p6p($^1D_2$)	1003.8	4.544+08	0.9998	4.543+08
5	2s4p($^1P_1$)	2p6f($^1D_2$)	996.3	1.368+08	0.9981	1.365+08
6	2s4f($^3F_2$)	2p4f($^3F_2$)	1519.4	2.030+09	0.3666	7.443+08
6	2s4f($^3F_3$)	2p4f($^3F_3$)	1519.3	2.589+09	0.9903	2.564+09
6	2s4f($^3F_4$)	2p4f($^3F_4$)	1519.3	3.892+09	0.9930	3.865+09
6	2s4f($^3F_4$)	2p4f($^3D_3$)	1490.8	1.300+09	0.9976	1.297+09
6	2s4f($^3F_3$)	2p4f($^3F_2$)	1519.6	2.807+08	0.3666	1.029+08
6	2s4f($^3F_4$)	2p4f($^3F_3$)	1519.5	2.799+08	0.9903	2.772+08
6	2s4f($^3F_2$)	2p4f($^3F_3$)	1519.2	2.509+08	0.9903	2.485+08
6	2s4f($^3F_3$)	2p4f($^3F_4$)	1519.1	2.640+08	0.9930	2.622+08
6	2s4f($^3F_3$)	2p4f($^3D_3$)	1490.7	1.517+08	0.9976	1.513+08
6	2s4f($^3F_3$)	2p4f($^3D_2$)	1490.0	8.855+08	0.9976	8.834+08
6	2s4f($^3F_2$)	2p4f($^3D_2$)	1489.9	1.424+08	0.9976	1.404+08
6	2s4f($^3F_2$)	2p4f($^3D_1$)	1489.3	6.245+08	0.9752	6.090+08
6	2s4f($^3F_3$)	2p5f($^3F_3$)	1126.1	1.028+08	0.9990	1.027+08
6	2s4f($^3F_4$)	2p5f($^3F_4$)	1126.0	1.654+08	0.9991	1.653+08
6	2s4f($^3F_2$)	2p5f($^3G_3$)	1122.3	4.829+08	1.0000	4.829+08
6	2s4f($^3F_3$)	2p5f($^3G_4$)	1122.1	6.136+08	1.0000	6.136+08
6	2s4f($^3F_4$)	2p5f($^3G_5$)	1121.6	8.645+08	1.0000	8.645+08
6	2s4f($^3F_4$)	2p6f($^3F_4$)	988.2	1.023+08	0.9997	1.023+08
6	2s4f($^3F_2$)	2p6f($^3G_3$)	986.7	1.984+08	1.0000	1.984+08
6	2s4f($^3F_3$)	2p6f($^3G_4$)	986.6	2.513+08	1.0000	2.513+08
6	2s4f($^3F_4$)	2p6f($^3G_5$)	986.2	4.036+08	1.0000	4.035+08
6	2s4f($^3F_4$)	2p6f($^3D_3$)	984.9	1.564+08	0.9954	1.557+08
6	2s4f($^3F_3$)	2p6f($^3D_2$)	984.6	1.063+08	0.9954	1.058+08
7	2p4s($^3P_2$)	2p5p($^3D_3$)	3151.7	2.163+08	0.9973	2.157+08
7	2p4s($^3P_1$)	2p5p($^3D_2$)	3150.4	1.175+08	0.9974	1.172+08
7	2p4s($^3P_2$)	2p6p($^3D_3$)	2201.2	1.327+08	0.9992	1.326+08
7	2p4s($^1P_1$)	2p5p($^1P_1$)	3529.5	2.251+08	0.9616	2.165+08
7	2p4s($^1P_1$)	2p6p($^1P_1$)	2369.8	2.051+08	0.9859	2.022+08
9	2s5p($^1P_1$)	2p4f($^1D_2$)	2272.0	1.774+09	0.9986	1.772+09
9	2s5p($^1P_1$)	2p4p($^1D_2$)	2425.0	2.141+08	1.0000	2.141+08
9	2s5p($^1P_1$)	2p5p($^1P_1$)	1608.8	3.467+08	0.9616	3.334+08
9	2s5p($^1P_1$)	2p5p($^1D_2$)	1541.0	2.880+08	0.9999	2.880+08
9	2s5p($^1P_1$)	2p5f($^1D_2$)	1508.5	8.046+08	0.9991	8.039+08
9	2s5p($^1P_1$)	2p6p($^1D_2$)	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($^3P_1$)	2p6p($^3P_1$)	1536.0	2.301+08	0.9980	2.296+08
14	2s6p($^3P_0$)	2p6p($^3P_1$)	1535.9	3.181+08	0.9980	3.175+08
14	2s6p($^3P_2$)	2p6p($^3P_2$)	1535.3	9.577+08	0.9609	9.203+08
14	2s6p($^3P_1$)	2p6p($^3P_2$)	1535.2	3.827+08	0.9609	3.677+08
15	2s6f($^3F_2$)	2p6f($^3F_2$)	1555.1	1.134+09	0.9492	1.076+08
15	2s6f($^3F_3$)	2p6f($^3F_3$)	1555.0	1.543+09	0.9997	1.543+09
15	2s6f($^3F_4$)	2p6f($^3F_4$)	1554.8	2.433+09	0.9997	2.432+09
15	2s6f($^3F_2$)	2p6f($^3G_3$)	1551.4	1.534+09	1.0000	1.534+09
15	2s6f($^3F_3$)	2p6f($^3G_4$)	1550.9	1.981+09	1.0000	1.981+09
15	2s6f($^3F_4$)	2p6f($^3G_5$)	1549.9	2.521+09	1.0000	2.520+09
15	2s6f($^3F_4$)	2p6f($^3D_3$)	1546.7	1.982+09	0.9954	1.973+09
15	2s6f($^3F_3$)	2p6f($^3D_2$)	1546.0	1.351+09	0.9954	1.345+09
15	2s6f($^3F_2$)	2p6f($^3D_1$)	1545.5	1.006+09	0.9955	1.001+09
15	2s6f($^1F_3$)	2p6f($^1F_3$)	1561.9	1.623+09	0.9991	1.622+09
15	2s6f($^1F_3$)	2p6f($^1G_4$)	1553.9	2.007+09	1.0000	2.007+09
15	2s6f($^1F_3$)	2p6f($^1D_2$)	1548.3	1.393+09	0.9981	1.390+09
16	2s6h($^1H_5$)	2p6h($^3H_5$)	1549.7	2.019+09	0.9207	1.859+09
16	2s6h($^1H_5$)	2p6h($^3H_6$)	1547.4	1.845+09	0.9996	1.844+09
16	2s6h($^1H_5$)	2p6h($^3G_4$)	1545.9	2.811+09	0.9878	2.777+09
16	2s6h($^3H_6$)	2p6h($^3H_5$)	1549.7	1.141+09	0.9207	1.051+09
16	2s6h($^3H_4$)	2p6h($^3H_4$)	1549.7	1.647+09	0.9909	1.632+09
16	2s6h($^3H_5$)	2p6h($^3I_5$)	1549.6	2.150+09	0.9998	2.150+09
16	2s6h($^3H_6$)	2p6h($^3H_6$)	1549.6	2.576+09	0.9998	2.575+09
16	2s6h($^3H_6$)	2p6h($^3H_6$)	1547.4	1.041+09	0.9998	1.041+09
16	2s6h($^3H_4$)	2p6h($^3I_5$)	1547.4	1.646+09	0.9998	1.646+09
16	2s6h($^3H_6$)	2p6h($^3G_5$)	1546.7	2.432+09	0.9796	2.382+09
16	2s6h($^3H_5$)	2p6h($^1G_4$)	1546.7	1.871+09	0.9874	1.847+09
16	2s6h($^3H_6$)	2p6h($^3I_7$)	1546.5	3.035+09	0.9999	3.035+09
16	2s6h($^3H_5$)	2p6h($^1I_6$)	1546.5	2.499+09	0.9999	2.499+09
16	2s6h($^3H_4$)	2p6h($^3G_3$)	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	$^{3}P1$	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	$^{1}F_{3}3$	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	$^1P_1$	3d4s	$^1D_2$	325.9	1.180+10	0.2370	2.797+09	30.465
2s4p	$^3P_2$	3p4p	$^3D_3$	320.4	1.617+10	0.5816	9.404+09	30.408
2s4p	$^3P_2$	3p4p	$^3P_2$	316.3	1.488+10	0	0	
2s4f	$^3F_2$	3p4f	$^3G_3$	317.5	2.698+10	0.1092	2.946+09	31.262
2s4f	$^3F_2$	3p4f	$^3F_2$	315.1	1.036+10	0	0	
2s4f	$^3F_4$	$3d^2$	$^3F_4$	389.7	1.581+10	0	0	
2s4f	$^3F_3$	$3d^2$	$^3F_3$	389.6	1.112+10	0	0	
2s4f	$^1F_3$	$3d^2$	$^1G_4$	382.6	2.565+10	0.2151	5.517+09	24.705
2s4f	$^1F_3$	3p4f	$^1F_3$	317.9	2.337+10	0	0	
2s4f	$^3F_3$	3p4f	$^3G_4$	317.5	3.541+10	0.1094	3.874+09	31.263
2s4f	$^3F_4$	3p4f	$^3G_5$	317.5	4.618+10	0.1096	5.061+09	31.264
2s4f	$^3F_4$	3p4f	$^3F_4$	315.1	1.980+10	0	0	
2s4f	$^3F_3$	3p4f	$^3F_3$	315.1	1.371+10	0	0	
2s4f	$^3F_4$	3d4d	$^3D_3$	313.6	1.256+10	0.0137	1.721+08	31.751
2s4f	$^1F_3$	3p4f	$^1G_4$	312.1	1.411+10	0.4766	6.725+09	32.020
2p4s	$^1P_1$	3d4s	$^1D_2$	398.3	4.689+10	0.2370	1.111+10	30.465
2p4s	$^3P_2$	3p4p	$^3D_3$	394.2	2.715+10	0.5816	1.579+10	30.408
2p4s	$^3P_1$	3p4p	$^3D_2$	394.1	1.451+10	0.5806	8.425+09	30.407
2p4s	$^3P_2$	3d4s	$^3D_2$	386.9	1.510+10	0.8574	1.295+10	31.000
2p4s	$^3P_2$	3d4s	$^3D_3$	386.9	8.452+10	0.8583	7.254+10	31.007
2p4s	$^3P_1$	3d4s	$^3D_1$	386.8	1.513+10	0.8600	1.301+10	31.005
2p4s	$^3P_1$	3d4s	$^3D_2$	386.8	4.536+10	0.8574	3.889+10	31.000
2p4s	$^3P_0$	3d4s	$^3D_1$	386.7	2.018+10	0.8600	1.735+10	31.005
2p4s	$^1P_1$	3p4p	$^1D_2$	382.8	2.079+10	0.2649	5.507+09	31.729
2p4d	$^3F_2$	3p4f	$^3G_3$	398.7	3.007+10	0.1092	3.284+09	31.262
2p4d	$^1D_2$	3p4f	$^1F_3$	397.8	2.254+10	0	0	
2p4d	$^1D_2$	3d4d	$^1F_3$	393.2	5.738+10	0	0	
2p4d	$^1D_2$	3p4p	$^1D_2$	392.4	1.848+10	0.2649	4.895+09	31.729
2p4d	$^3F_2$	3d4d	$^3G_3$	390.6	8.214+10	0.0553	4.542+09	31.906
2p4d	$^1D_2$	3d4d	$^1P_1$	389.6	1.372+10	0	0	
2p4d	$^3F_2$	3d4d	$^3F_2$	383.5	2.347+10	0.0001	2.347+06	32.495
2p4d	$^1D_2$	3d4d	$^1D_2$	375.1	1.978+10	0.0018	3.560+07	33.189
2p4d	$^3F_4$	3p4f	$^3G_5$	398.8	5.321+10	0.1096	5.832+09	31.264
2p4d	$^3F_3$	3p4f	$^3G_4$	398.7	4.074+10	0.1094	4.457+09	31.263
2p4d	$^3F_4$	3d4d	$^3F_4$	383.6	4.448+10	0	0	
2p4d	$^3F_3$	3d4d	$^3F_3$	383.5	3.182+10	0	0	
2s5p	$^1P_1$	$3d^2$	$^1D_2$	405.1	2.006+10	0.0008	1.605+07	25.491
2s5p	$^1P_1$	$3d^2$	$^1S_0$	370.1	1.371+10	0.1325	1.817+09	28.382
2s5p	$^3P_2$	3s6d	$^3D_3$	315.3	1.266+10	0.2733	3.460+09	34.279
2s5p	$^3P_2$	3p5p	$^3D_3$	313.6	1.113+10	0.6915	7.696+09	34.502
2s5p	$^3P_2$	3p5p	$^3P_2$	313.1	1.431+10	0	0	
2s6p	$^1P_1$	3p6p	$^1P_1$	312.3	1.264+10	0	0	
2s6p	$^3P_1$	3p6p	$^3D_2$	311.8	1.510+10	0.2436	3.678+09	36.366
2s6p	$^3P_2$	3p6p	$^3D_3$	311.8	2.861+10	0.2460	7.036+09	36.368
2s6p	$^3P_2$	3p6p	$^3P_2$	311.2	1.524+10	0	0	
2s6p	$^1P_1$	3p6p	$^1D_2$	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$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	$^3S_1$	3s3p	$^3P_1$	334.5	1.013+10	0.4980	5.045+09	18.685
2s3s	$^3S_1$	3s3p	$^3P_2$	334.5	1.689+10	0.4980	8.411+09	18.687
2s3d	$^1D_2$	3p3d	$^1D_2$	345.4	1.590+10	0	0	22.346
2s3d	$^1D_2$	3p3d	$^1F_3$	327.3	2.138+10	0.5940	1.270+10	24.331
2s3d	$^1D_2$	3p3d	$^1P_1$	317.5	1.071+10	0.0198	2.121+08	25.492
2s3d	$^3D_1$	3p3d	$^3F_2$	337.8	2.078+10	0.9774	2.031+10	29.487
2s3d	$^3D_2$	3p3d	$^3F_3$	337.8	3.079+10	0.9774	3.009+10	29.487
2s3d	$^3D_3$	3p3d	$^3P_2$	327.6	1.386+10	0.1543	2.139+09	23.396
2s3d	$^3D_3$	3p3d	$^3F_4$	337.8	4.453+10	0.5944	2.647+10	22.259
2s3d	$^3D_3$	3p3d	$^3D_3$	329.4	1.488+10	0	0	23.190
2s3d	$^3D_3$	3d4p	$^3F_4$	269.1	1.132+10	0.4004	4.533+09	31.621
2p3p	$^1D_2$	3p3d	$^1D_2$	433.6	1.269+10	0	0	0.2236
2p3p	$^1D_2$	3s4f	$^1F_3$	344.3	2.087+10	0.0241	5.030+08	29.754
2p3p	$^1P_1$	3s3p	$^1P_1$	431.4	1.194+10	0.3321	3.965+09	20.368
2p3p	$^1P_1$	3p3d	$^1D_2$	403.6	5.228+10	0	0	22.346
2p3p	$^1P_1$	3p3d	$^1P_1$	366.1	1.138+10	0.0198	2.253+08	25.492
2p3p	$^1P_1$	3p4d	$^1D_2$	315.0	1.604+10	0	0	30.981
2p3p	$^3P_2$	3p3d	$^3D_2$	413.0	1.347+10	0	0	23.189
2p3p	$^3P_2$	3p3d	3D$_3$	413.0	7.691+10	0	0	23.190
2p3p	$^3P_2$	3p3d	$^3P_2$	410.2	2.885+10	0.1543	4.452+09	23.396
2p3p	$^3P_2$	3p4d	$^3D_3$	330.8	1.907+10	0	0	30.644
2p3p	$^3P_1$	3p3d	$^3D_1$	413.0	1.363+10	0	0	23.188
2p3p	$^3P_1$	3p3d	$^3D_2$	413.0	4.141+10	0	0	23.189
2p3p	$^3P_1$	3p4d	$^3D_2$	330.8	1.023+10	0	0	30.644
2p3p	$^3P_0$	3p3d	$^3D_1$	412.9	1.839+10	0	0	23.188
2p3p	$^1S_0$	3p3d	$^1P_1$	409.5	1.786+10	0.0198	3.536+08	25.492
2p3p	$^3D_3$	3p3d	$^3F_4$	408.8	9.788+10	0.5944	5.818+10	22.259
2p3p	$^3D_3$	3p3d	$^3D_3$	396.6	2.224+10	0	0	23.190
2p3p	$^3D_3$	3p4d	$^3F_4$	314.8	6.216+10	0.3398	2.112+10	31.311
2p3p	$^3D_3$	3p5d	$^3F_4$	289.2	1.959+10	0.4914	9.626+09	34.796
2p3p	$^3D_3$	3p6d	$^3F_4$	277.8	1.081+10	0.0652	7.048+08	36.556
2p3p	$^3D_2$	3p3d	$^3F_3$	408.7	6.806+10	0.5944	4.045+10	22.258
2p3p	$^3D_2$	3p3d	$^3D_2$	396.5	1.254+10	0	0	23.189
2p3p	$^3D_2$	3p4d	$^3F_3$	314.7	4.276+10	0.3397	1.453+10	31.309
2p3p	$^3D_2$	3p5d	$^3F_3$	289.1	1.359+10	0.4914	6.678+09	34.795
2p3p	$^3D_1$	3p3d	$^3F_2$	408.7	4.606+10	0.5944	2.738+10	22.256
2p3p	$^3D_1$	3p4d	$^3F_2$	314.7	2.876+10	0.3397	9.770+09	31.308
2p3p	$^3S_1$	3p3d	$^3P_2$	401.1	3.495+10	0.1543	5.393+09	23.396
2p3p	$^3S_1$	3p3d	$^3P_1$	401.1	2.122+10	0.1542	3.272+09	23.396
2p3p	$^3S_1$	3p4d	$^3P_2$	317.9	1.104+10	0.0288	3.180+08	31.485
2s4s	$^3S_1$	3p4s	$^3P_1$	317.3	1.211+10	0.3501	4.240+09	29.745
2s4s	$^3S_1$	3p4s	$^3P_2$	317.2	2.018+10	0.3502	7.067+09	29.747
2s4d	$^1D_2$	3p4d	$^1F_3$	323.9	1.462+10	0.0429	6.272+08	30.805
2s4d	$^1D_2$	3p4d	$^1D_2$	322.4	1.229+10	0	0	30.981
2s4d	$^3D_2$	3p4d	$^3D_2$	323.0	1.116+10	0	0	30.644
2s4d	$^3D_3$	3p4d	$^3D_3$	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	$^3D_3$	3p4d	$^3F_4$	317.5	1.094+10	0.5944	6.503+09	22.259
2s4d	$^3D_3$	3d4p	$^3D_3$	311.9	1.036+10	0	0	32.009
2s5s	$^3S_1$	3p5s	$^3P_1$	313.0	1.213+10	0.3900	4.731+09	34.605
2s5s	$^3S_1$	3p5s	$^3P_2$	313.0	2.029+10	0.3907	7.927+09	34.067
2s5d	$^1D_2$	3p5d	$^1D_2$	315.0	2.125+10	0	0	34.699
2s5d	$^1D_2$	3p5d	$^1F_3$	314.8	1.263+10	0.5967	7.536+09	34.713
2s5d	$^3D_1$	3p5d	$^3F_2$	312.8	1.739+10	0.4886	8.497+09	34.793
2s5d	$^3D_2$	3p5d	$^3D_2$	314.2	1.243+10	0	0	34.617
2s5d	$^3D_2$	3p5d	$^3F_3$	312.8	2.575+10	0.4914	1.265+10	34.795
2s5d	$^3D_3$	3p5d	$^3P_2$	311.1	1.546+10	0.0972	1.503+09	35.004
2s5d	$^3D_3$	3p5d	$^3D_3$	314.2	2.231+10	0	0	34.618
2s5d	$^3D_3$	3p5d	$^3F_4$	312.8	3.712+10	0.4914	1.824+10	34.796
2s5g	$^1G_4$	3p5g	$^1G_4$	312.1	3.807+10	0	0	35.030
2s5g	$^1G_4$	3p5g	$^1F_3$	309.3	2.799+10	0.0103	2.883+08	35.383
2s5g	$^1G_4$	3p5g	$^1H_5$	308.5	4.019+10	0.5298	2.129+10	35.491
2s5g	$^3G_3$	3p5g	$^3G_3$	311.8	2.838+10	0	0	35.071
2s5g	$^3G_3$	3p5g	$^3H_4$	310.3	2.595+10	0.2034	5.289+09	35.600
2s5g	$^3G_3$	3p5g	$^3F_2$	309.8	1.859+10	0.5405	1.005+10	33.326
2s5g	$^3G_4$	3p5g	$^3G_4$	311.8	3.472+10	0	0	35.071
2s5g	$^3G_4$	3p5g	$^3H_5$	310.3	3.168+10	0.2038	6.456+09	35.601
2s5g	$^3G_4$	3p5g	$^3F_3$	309.8	2.378+10	0.5380	1.279+10	35.326
2s5g	$^3G_5$	3p5g	$^3G_5$	311.8	4.588+10	0	0	35.071
2s5g	$^3G_5$	3p5g	$^3H_6$	310.3	3.932+10	0.2035	8.002+09	35.601
2s5g	$^3G_5$	3p5g	$^3F_4$	309.8	3.119+10	0.5383	1.679+10	35.325
2s5g	$^3G_5$	3d5f	$^3H_6$	307.7	1.201+10	0.2035	2.444+09	35.601
2s6s	$^3S_1$	3p6s	$^3P_1$	311.1	1.258+10	0.4540	5.711+09	36.176
2s6s	$^3S_1$	3p6s	$^3P_2$	311.1	2.098+10	0.4528	9.500+09	36.179
2s6d	$^1D_2$	3p6d	$^1D_2$	312.5	2.180+10	0	0	36.504
2s6d	$^1D_2$	3p6d	$^1F_3$	312.1	2.000+10	0.0368	7.360+08	36.551
2s6d	$^3D_1$	3p6d	$^3F_2$	311.3	1.954+10	0.0638	1.247+09	36.553
2s6d	$^3D_2$	3p6d	$^3D_2$	311.7	1.432+10	0	0	36.498
2s6d	$^3D_2$	3p6d	$^3F_3$	311.3	2.543+10	0.0381	9.689+08	36.555
2s6d	$^3D_3$	3p6d	$^3D_3$	311.7	2.600+10	0	0	36.499
2s6d	$^3D_3$	3p6d	$^3F_4$	311.3	4.135+10	0.0652	2.696+09	36.556
2s6d	$^3D_3$	3p6d	$^3P_2$	310.5	1.777+10	0.0063	1.120+08	36.662
2s6g	$^1G_4$	3p6g	$^1G_4$	310.8	3.901+10	0	0	36.692
2s6g	$^1G_4$	3p6g	$^1H_5$	308.8	3.953+10	0.4133	1.634+10	36.950
2s6g	$^1G_4$	3p6g	$^1F_3$	308.8	2.525+10	0.0303	7.651+08	36.960
2s6g	$^3G_3$	3p6g	$^3G_3$	310.7	2.904+10	0	0	36.714
2s6g	$^3G_3$	3p6g	$^3H_4$	310.3	3.756+10	0.5954	2.236+10	36.766
2s6g	$^3G_3$	3p6g	$^3F_2$	309.7	2.335+10	0.8120	1.896+10	36.843
2s6g	$^3G_4$	3p6g	$^3G_4$	310.7	3.510+10	0	0	36.714
2s6g	$^3G_4$	3p6g	$^3H_5$	310.2	4.515+10	0.5946	2.685+10	36.767
2s6g	$^3G_4$	3p6g	$^3F_3$	309.7	2.957+10	0.8120	2.416+10	36.843
2s6g	$^3G_5$	3p6g	$^3G_5$	310.7	4.736+10	0	0	36.715
2s6g	$^3G_5$	3p6g	$^3H_6$	310.2	5.658+10	0.5959	3.372+10	36.769
2s6g	$^3G_5$	3p6g	$^3F_4$	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 ^3G	2p6g $^3H_5$	0.1201+14	0.1201+14	0.4717+10	0.1881+10	0.9404+09	4.825
2s6g ^3G	2p6g $^3H_6$	0.1476+14	0.1476+14	0.5359+10	0.2478+10	0.1239+10	4.832
2s6g ^3G	2p6g $^1H_5$	0.1482+14	0.1482+14	0.4518+10	0.5718+09	0.2859+09	4.832
2s6g ^3G	2p6g $^1F_3$	0.8400+11	0.8400+11	0.3859+10	0.8214+09	0.4080+09	4.834
2s6g ^3G	2p6g $^3F_2$	0.1030+12	0.1030+12	0.2782+10	0.1627+10	0.8091+09	4.839
2s6g ^3G	2p6g $^3F_3$	0.7600+11	0.7600+11	0.3892+10	0.1600+10	0.7942+09	4.839
2s6g ^3G	2p6g $^3F_4$	0.8600+11	0.8600+11	0.4970+10	0.2867+10	0.1425+10	4.834
2s6g ^1G	2p6g $^3G_4$	0.7000+10	0.7000+10	0.4585+10	0.7975+09	0.3717+09	4.809
2s6g ^1G	2p6g $^3G_3$	0.1000+11	0.1000+11	0.3564+10	0.1608+09	0.7650+08	4.809
2s6g ^1G	2p6g $^1G_4$	0.2810+13	0.2810+13	0.4390+10	0.1470+10	0.7349+09	4.811
2s6g ^1G	2p6g $^3G_5$	0.2796+13	0.2796+13	0.5365+10	0.1511+09	0.7554+08	4.811
2s6g ^1G	2p6g $^3H_4$	0.1191+14	0.1191+14	0.3871+10	0.3053+09	0.1526+09	4.825
2s6g ^1G	2p6g $^3H_5$	0.1201+14	0.1201+14	0.4717+10	0.4183+09	0.2091+09	4.825
2s6g ^1G	2p6g $^1H_5$	0.1482+14	0.1482+14	0.4518+10	0.1524+10	0.7620+09	4.832
2s6g ^1G	2p6g $^3F_4$	0.8600+11	0.8600+11	0.4970+10	0.3208+08	0.1594+08	4.834
2s6g ^1G	2p6g $^1F_3$	0.8400+11	0.8400+11	0.3859+10	0.1433+10	0.7118+09	4.834
2s6g ^1G	2p6g $^3F_3$	0.7600+11	0.7600+11	0.3892+10	0.6755+09	0.3353+09	4.839
2s6h ^3H	2p6h $^3H_6$	0.9540+12	0.9540+12	0.5052+10	0.3767+10	0.1882+10	4.823
2s6h ^3H	2p6h $^3H_5$	0.5000+10	0.5000+10	0.4731+10	0.1199+10	0.5521+09	4.823
2s6h ^3H	2p6h $^3H_4$	0.4700+11	0.4700+11	0.3871+10	0.2632+10	0.1304+10	4.823
2s6h ^3H	2p6h $^3I_5$	0.9540+12	0.9540+12	0.4275+10	0.5174+10	0.2587+10	4.835
2s6h ^3H	2p6h $^3I_7$	0.2476+13	0.2476+13	0.5082+10	0.3035+10	0.1517+10	4.840
2s6h ^3H	2p6h $^1I_6$	0.2477+13	0.2477+13	0.4404+10	0.2533+10	0.1266+10	4.840
2s6h ^3H	2p6h $^3G_5$	0.2200+11	0.2200+11	0.5037+10	0.2602+10	0.1274+10	4.839
2s6h ^3H	2p6h $^3G_4$	0.3800+11	0.3800+11	0.4211+10	0.1749+09	0.8641+08	4.843
2s6h ^3H	2p6h $^3G_3$	0.2800+11	0.2800+11	0.3276+10	0.2323+10	0.1142+10	4.843
2s6h ^3H	2p6h $^1G_4$	0.3600+11	0.3600+11	0.4121+10	0.2724+10	0.1345+10	4.839
2s6h ^1H	2p6h $^3H_6$	0.9540+12	0.9540+12	0.5052+10	0.2535+10	0.1267+10	4.835
2s6h ^1H	2p6h $^3H_5$	0.5000+10	0.5000+10	0.4731+10	0.2019+10	0.9295+09	4.823
2s6h ^1H	2p6h $^3I_5$	0.9540+12	0.9540+12	0.4275+10	0.1584+09	0.7915+08	4.835
2s6h ^1H	2p6h $^1I_6$	0.2477+13	0.2477+13	0.4404+10	0.9722+08	0.4860+08	4.840
2s6h ^1H	2p6h $^3G_5$	0.2200+11	0.2200+11	0.5037+10	0.9341+09	0.4575+09	4.839
2s6h ^1H	2p6h $^3G_4$	0.3800+11	0.3800+11	0.4211+10	0.2811+10	0.1388+10	4.843
2s6h ^1H	2p6h $^1G_4$	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 2s6*l* - 3p6*l* 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 ^1D	3p6d $^3D_1$	0.1000+07	0.6405+13	0.1985+11	0.1406+06	0.1096E-01	36.50
2s6d ^1D	3p6d $^3D_2$	0.1000+07	0.6375+13	0.3306+11	0.1231+09	0.9645+01	36.50
2s6d ^1D	3p6d $^3D_3$	0.1000+07	0.6405+13	0.4631+11	0.6570+07	0.5124+00	36.50
2s6d ^1D	3p6d $^1D_2$	0.1000+07	0.1525+13	0.2994+11	0.2180+11	0.7120+04	36.50
2s6d ^1D	3p6d $^1F_3$	0.3160+12	0.8590+13	0.5690+11	0.2000+11	0.3675+09	36.55
2s6d ^1D	3p6d $^3F_2$	0.9000+10	0.1340+12	0.3535+11	0.1280+08	0.4083+06	36.55
2s6d ^1D	3p6d $^3F_3$	0.7200+11	0.1885+13	0.5050+11	0.2681+10	0.5101+08	36.55
2s6d ^1D	3p6d $^1P_1$	0.8000+10	0.9214+13	0.3581+11	0.8120+10	0.3521+07	36.71
2s6d ^1D	3p6d $^3P_1$	0.4500+11	0.7103+13	0.2442+11	0.1275+07	0.4034+04	36.66
2s6d ^1D	3p6d $^3P_2$	0.4500+11	0.7109+13	0.4071+11	0.1098+07	0.3471+04	36.66
2s6f ^3F	3p6f $^1D_2$	0.1969+14	0.2905+14	0.6580+11	0.3065+06	0.1038+06	37.10
2s6f ^3F	3p6f $^1F_3$	0.1000+07	0.5510+12	0.3413+11	0.3438+08	0.3092+02	36.60
2s6f ^3F	3p6f $^1G_4$	0.2369+14	0.3341+14	0.5799+11	0.2002+07	0.7096+06	36.84
2s6f ^3F	3p6f $^3D_1$	0.1400+11	0.8590+12	0.1752+11	0.1337+11	0.1082+09	36.74
2s6f ^3F	3p6f $^3D_2$	0.1400+11	0.8630+12	0.2915+11	0.2231+11	0.1798+09	36.74
2s6f ^3F	3p6f $^3D_3$	0.1500+11	0.8680+12	0.4069+11	0.3127+11	0.2684+09	36.73
2s6f ^3F	3p6f $^3F_2$	0.1000+07	0.1600+11	0.2460+11	0.2257+11	0.5396+06	36.63
2s6f ^3F	3p6f $^3F_3$	0.1000+10	0.2000+11	0.3446+11	0.3160+11	0.6339+09	36.63
2s6f ^3F	3p6f $^3F_4$	0.1000+10	0.2200+11	0.4431+11	0.4062+11	0.7544+09	36.63
2s6f ^3F	3p6f $^3G_3$	0.9100+11	0.7780+12	0.3817+11	0.3017+11	0.1751+10	36.64
2s6f ^3F	3p6f $^3G_4$	0.9200+11	0.7780+12	0.4909+11	0.3882+11	0.2279+10	36.64
2s6f ^3F	3p6f $^3G_5$	0.9200+11	0.7810+12	0.6005+11	0.4742+11	0.2774+10	36.65
2s6f ^1F	3p6f $^1D_2$	0.1969+14	0.2905+14	0.6580+11	0.1216+11	0.4119+10	37.10
2s6f ^1F	3p6f $^1F_3$	0.1000+07	0.5510+12	0.3413+11	0.2940+11	0.2644+05	36.60
2s6f ^1F	3p6f $^1G_4$	0.2369+14	0.3341+14	0.5799+11	0.4146+11	0.1470+11	36.84
2s6f ^1F	3p6f $^3D_2$	0.1400+11	0.8630+12	0.2915+11	0.9244+06	0.7448+04	36.74
2s6f ^1F	3p6f $^3D_3$	0.1500+11	0.8680+12	0.4069+11	0.1948+07	0.1672+05	36.73
2s6f ^1F	3p6f $^3F_2$	0.1000+07	0.1600+11	0.2460+11	0.5118+06	0.1223+02	36.63
2s6f ^1F	3p6f $^3F_3$	0.1000+10	0.2000+11	0.3446+11	0.4977+07	0.9985+05	36.63
2s6f ^1F	3p6f $^3F_4$	0.1000+10	0.2200+11	0.4431+11	0.1297+07	0.2409+05	36.63
2s6f ^1F	3p6f $^3G_3$	0.9100+11	0.7780+12	0.3817+11	0.2612+08	0.1517+07	36.64
2s6f ^1F	3p6f $^3G_4$	0.9200+11	0.7780+12	0.4909+11	0.8274+06	0.4858+05	36.64
2s6g ^3G	3p6g $^1F_3$	0.6400+11	0.2106+13	0.5649+11	0.8163+09	0.1235+08	36.96
2s6g ^3G	3p6g $^3F_2$	0.2700+11	0.2800+11	0.2626+11	0.2335+11	0.9480+10	36.84
2s6g ^3G	3p6g $^3F_3$	0.2700+11	0.2800+11	0.3675+11	0.3176+11	0.1290+11	36.84
2s6g ^3G	3p6g $^3F_4$	0.2700+11	0.2800+11	0.4723+11	0.4199+11	0.1704+11	36.84
2s6g ^3G	3p6g $^1G_4$	0.1000+07	0.1000+10	0.4244+11	0.1228+10	0.1074+06	36.69
2s6g ^3G	3p6g $^3G_3$	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 ^3G	3p6g $^3G_4$	0.1000+07	0.3100+11	0.4305+11	0.3885+11	0.5430+06	36.71
2s6g ^3G	3p6g $^3G_5$	0.1000+07	0.3100+11	0.5262+11	0.4886+11	0.6827+06	36.72
2s6g ^3G	3p6g $^3H_4$	0.4460+12	0.7440+12	0.4591+11	0.3916+11	0.1229+11	36.77
2s6g ^3G	3p6g $^3H_5$	0.4460+12	0.7450+12	0.5613+11	0.4666+11	0.1387+11	36.77
2s6g ^3G	3p6g $^3H_6$	0.4470+12	0.7450+12	0.6636+11	0.5658+11	0.1686+11	36.77
2s6g ^3G	3p6g $^1H_5$	0.1491+13	0.3600+13	0.7913+11	0.1063+10	0.2198+09	36.95
2s6g ^1G	3p6g $^3F_3$	0.6400+11	0.2106+13	0.5649+11	0.2525+11	0.3822+09	36.96
2s6g ^1G	3p6g $^3F_3$	0.2700+11	0.2800+11	0.3675+11	0.9260+09	0.3760+09	36.84
2s6g ^1G	3p6g $^3F_4$	0.2700+11	0.2800+11	0.4723+11	0.4004+08	0.1626+08	36.84
2s6g ^1G	3p6g $^1G_4$	0.1000+07	0.1000+10	0.4244+11	0.3901+11	0.3413+07	36.69
2s6g ^1G	3p6g $^3G_3$	0.1000+07	0.3100+11	0.3348+11	0.6967+08	0.9735+03	36.71
2s6g ^1G	3p6g $^3G_4$	0.1000+07	0.3100+11	0.4305+11	0.1172+10	0.1638+05	36.71
2s6g ^1G	3p6g $^3G_5$	0.1000+07	0.3100+11	0.5262+11	0.5521+08	0.7714+03	36.72
2s6g ^1G	3p6g $^3H_4$	0.4460+12	0.7440+12	0.4591+11	0.1205+08	0.3587+07	36.77
2s6g ^1G	3p6g $^3H_5$	0.4460+12	0.7450+12	0.5613+11	0.1214+10	0.3609+09	36.77
2s6g ^1G	3p6g $^1H_5$	0.1491+13	0.3600+13	0.7913+11	0.3953+11	0.8170+10	36.95
2s6h ^3H	3p6h $^1H_5$	0.1000+07	0.1000+10	0.5313+11	0.1026+11	0.8800+06	36.79
2s6h ^3H	3p6h $^3H_4$	0.1000+07	0.2000+10	0.4359+11	0.3981+11	0.2909+07	36.79
2s6h ^3H	3p6h $^3H_5$	0.1000+07	0.2000+10	0.5327+11	0.4051+11	0.2960+07	36.79
2s6h ^3H	3p6h $^3H_6$	0.1000+07	0.2000+10	0.6297+11	0.5789+11	0.4230+07	36.79
2s6h ^3H	3p6h $^3G_5$	0.1000+10	0.1000+10	0.5642+11	0.5131+11	0.4186+10	36.88
2s6h ^3H	3p6h $^3G_4$	0.7000+10	0.1600+11	0.4620+11	0.3364+11	0.5571+10	36.88
2s6h ^3H	3p6h $^3G_3$	0.1000+10	0.1000+10	0.3590+11	0.3321+11	0.2709+10	36.88
2s6h ^3H	3p6h $^1G_4$	0.2440+12	0.6010+12	0.4789+11	0.9333+10	0.1878+10	36.89
2s6h ^3H	3p6h $^3I_5$	0.4900+11	0.9200+11	0.5917+11	0.4709+11	0.1185+11	36.88
2s6h ^3H	3p6h $^3I_6$	0.4900+11	0.9300+11	0.6995+11	0.3024+11	0.7531+10	36.88
2s6h ^3H	3p6h $^3I_7$	0.4900+11	0.9200+11	0.8066+11	0.6505+11	0.1637+11	36.88
2s6h ^3H	3p6h $^1I_6$	0.6400+11	0.1500+12	0.7207+11	0.2630+11	0.5410+10	36.89
2s6h ^1H	3p6h $^1H_5$	0.1000+07	0.1000+10	0.5313+11	0.3910+11	0.3353+07	36.79
2s6h ^1H	3p6h $^3H_4$	0.1000+07	0.2000+10	0.4359+11	0.5430+09	0.3967+05	36.79
2s6h ^1H	3p6h $^3H_5$	0.1000+07	0.2000+10	0.5327+11	0.8816+10	0.6442+06	36.79
2s6h ^1H	3p6h $^3H_6$	0.1000+07	0.2000+10	0.6297+11	0.4052+09	0.2960+05	36.79
2s6h ^1H	3p6h $^3G_5$	0.1000+10	0.1000+10	0.5642+11	0.8515+09	0.6946+08	36.88
2s6h ^1H	3p6h $^3G_4$	0.7000+10	0.1600+11	0.4620+11	0.9034+10	0.1496+10	36.88
2s6h ^1H	3p6h $^3I_5$	0.4900+11	0.9200+11	0.5917+11	0.5976+09	0.1504+09	36.88
2s6h ^1H	3p6h $^3I_6$	0.4900+11	0.9300+11	0.6995+11	0.2611+11	0.6502+10	36.88
2s6h ^1H	3p6h $^1G_4$	0.2440+12	0.6010+12	0.4789+11	0.3256+11	0.6552+10	36.89
2s6h ^1H	3p6h $^1I_6$	0.6400+11	0.1500+12	0.7207+11	0.2947+11	0.6063+10	36.89

Table VII. Dielectronic recombination rate coefficients ($T_e=10^4K$) 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(cm^3s^{-1})	E_1(eV)	A_2(cm^3s^{-1})	E_2(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(cm^3s^{-1})	E_1(eV)	A_2(cm^3s^{-1})	E_2(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 $\alpha_d(\gamma'|2s)$ for even states as function of T_e

a) $\gamma'=2s^2\ (^1S),\ 2p^2\ (^3P),\ 2p^2\ (^1D),\ 2p^2\ (^1S)$

b) $\gamma'=2p3p\ (^3S),\ 2p3p\ (^1S),\ 2p3p\ (^3P),\ 2p3p\ (^1P),\ 2p3p\ (^3D),\ 2p3p\ (^1D)$

c) $\gamma'=2s3d(^3D),\ 2s3d(^1D),\ 2s4d(^3D),\ 2s4d(^1D),\ 2s5d(^3D),\ 2s5d(^1D),\ 2s6d(^3D),\ 2s6d(^1D),\ 2s6g(^3G),\ 2s6g(^1G)$

d) $\gamma'=2s3s(^3S),\ 2s3s(^1S),\ 2s4s(^3S),\ 2s4s(^1S),\ 2s5s(^3S),\ 2s5s(^1S),\ 2s6s(^3S),\ 2s6s(^1S)$

Fig.2 Dielectronic Recombination Rate Coefficient $\alpha_d(\gamma'|2s)$ for odd states as function of T_e

a) $\gamma'=2s2p(^3P),\ 2s2p(^1P),\ 2s3p(^3P),\ 2s3p(^1P),\ 2s4p(^3P),\ 2s4p(^1P),\ 2s5p(^3P),\ 2s5p(^1P),\ 2s6p(^3P)$.

b) $\gamma'=2p3d(^1D),\ 2p3d(^3F),\ 2p3d(^3D),\ 2p3d(^3P),\ 2p3d(^1F),\ 2p3d(^1P)$.

c) $\gamma'=2s4f(^3F),\ 2s4f(^1F),\ 2s5f(^3F),\ 2s5f(^1F),\ 2s6f(^3F),\ 2s6f(^1F),\ 2s6h(^1H)$.

d) $\gamma'=2p3s(^3P),\ 2p3s(^1P),\ 2p4s(^3P),\ 2p4s(^1P)$

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 of T_e.

Fig.6. Dielectronic Recombination Rate Coefficient $\alpha_d(\gamma'|2s^2)$ as function of T_e

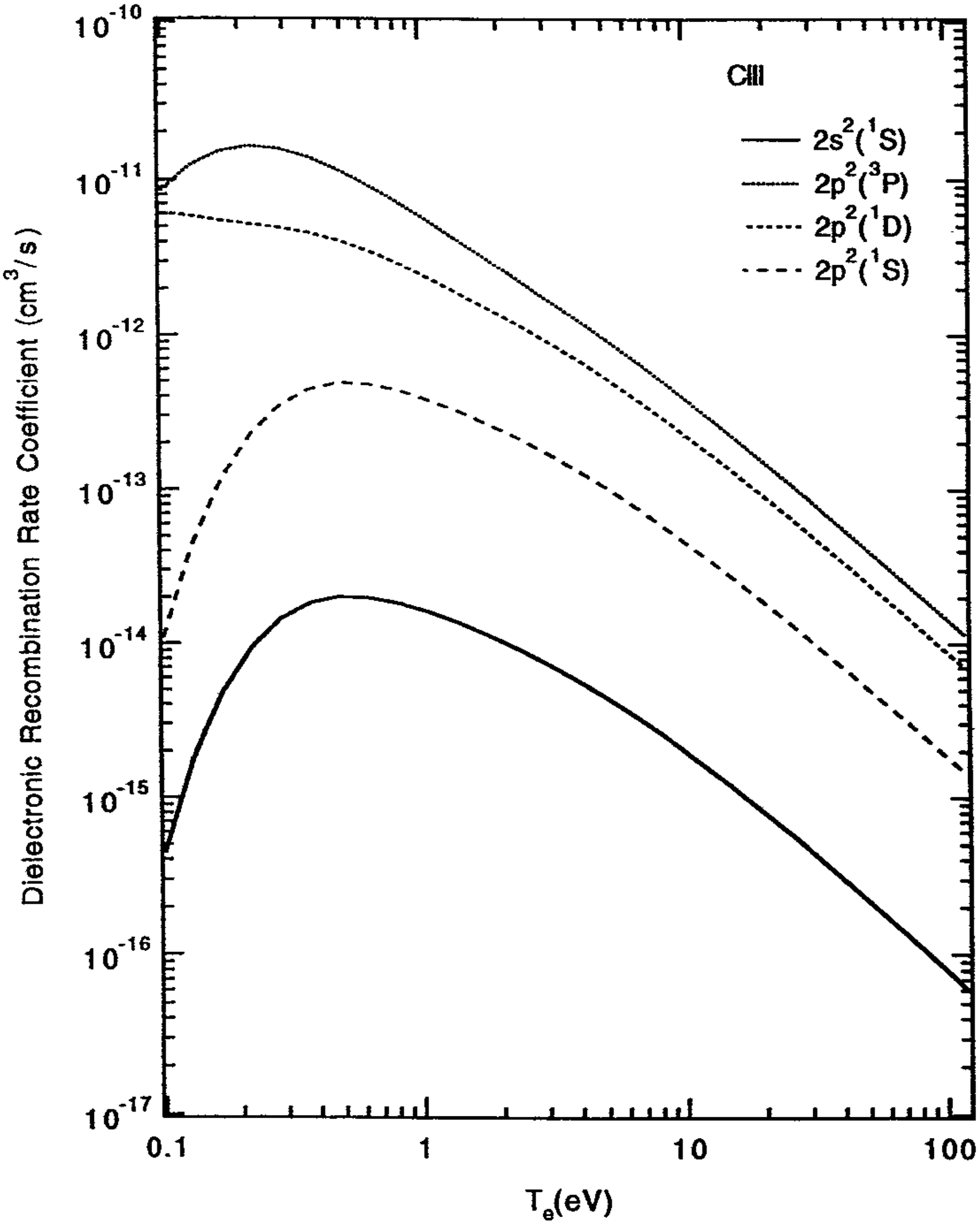

CIII
2s2(1S)
2p2(3P)
2p2(1D)
2p2(1S)
Dielectronic Recombination Rate Coefficient (cm3/s)
10-10
10-11
10-12
10-13
10-14
10-15
10-16
10-17
0.1
1
10
100
Te(eV)

Fig. 1(a)

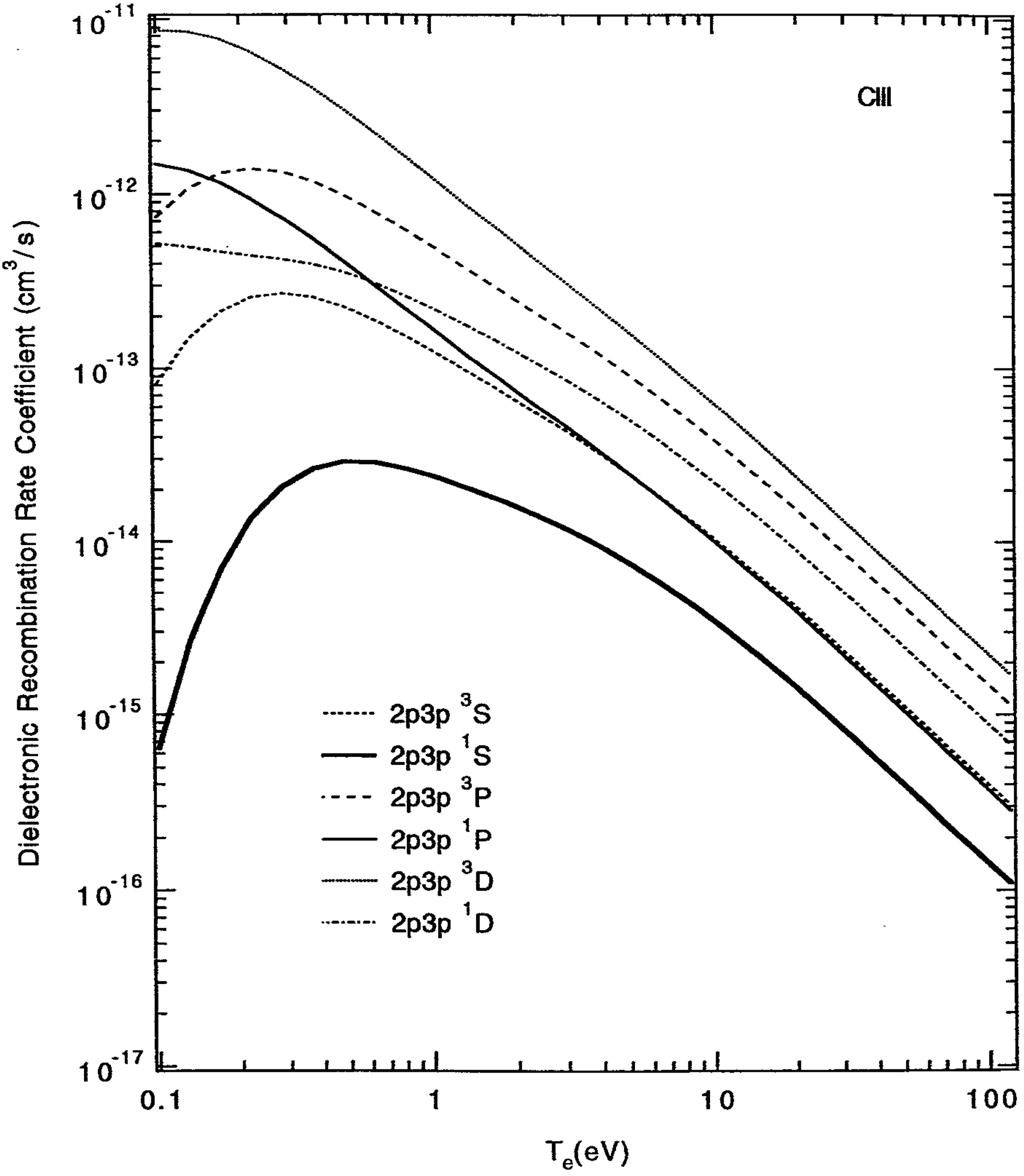

CIII
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
100
T_e(eV)
2p3p ^{3}S
2p3p ^{1}S
2p3p ^{3}P
2p3p ^{1}P
2p3p ^{3}D
2p3p ^{1}D

Fig. 1(b)

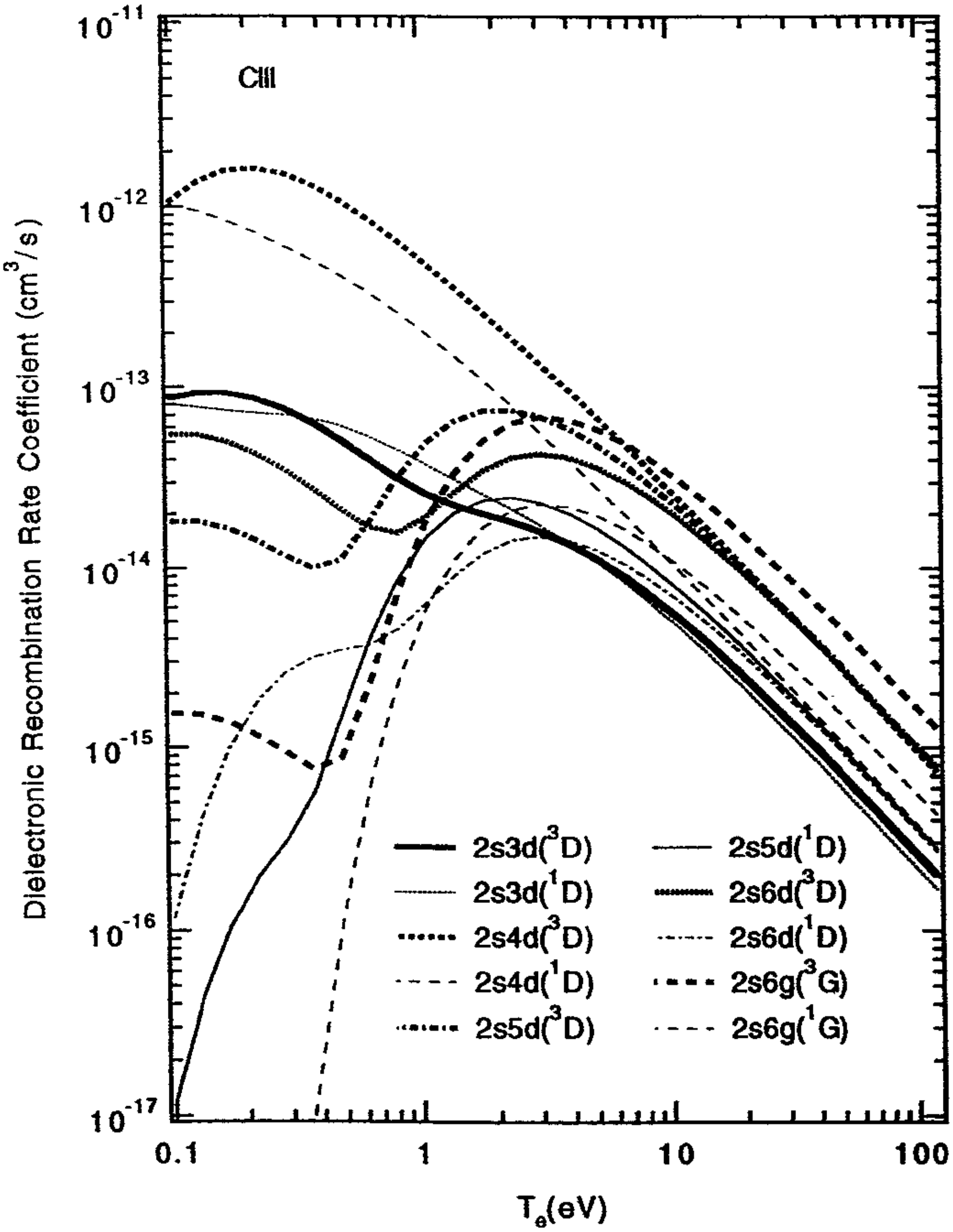

CIII
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
100
T$_e$(eV)
2s3d(^{3}D)
2s3d(^{1}D)
2s4d(^{3}D)
2s4d(^{1}D)
2s5d(^{3}D)
2s5d(^{1}D)
2s6d(^{3}D)
2s6d(^{1}D)
2s6g(^{3}G)
2s6g(^{1}G)

Fig. 1(c)

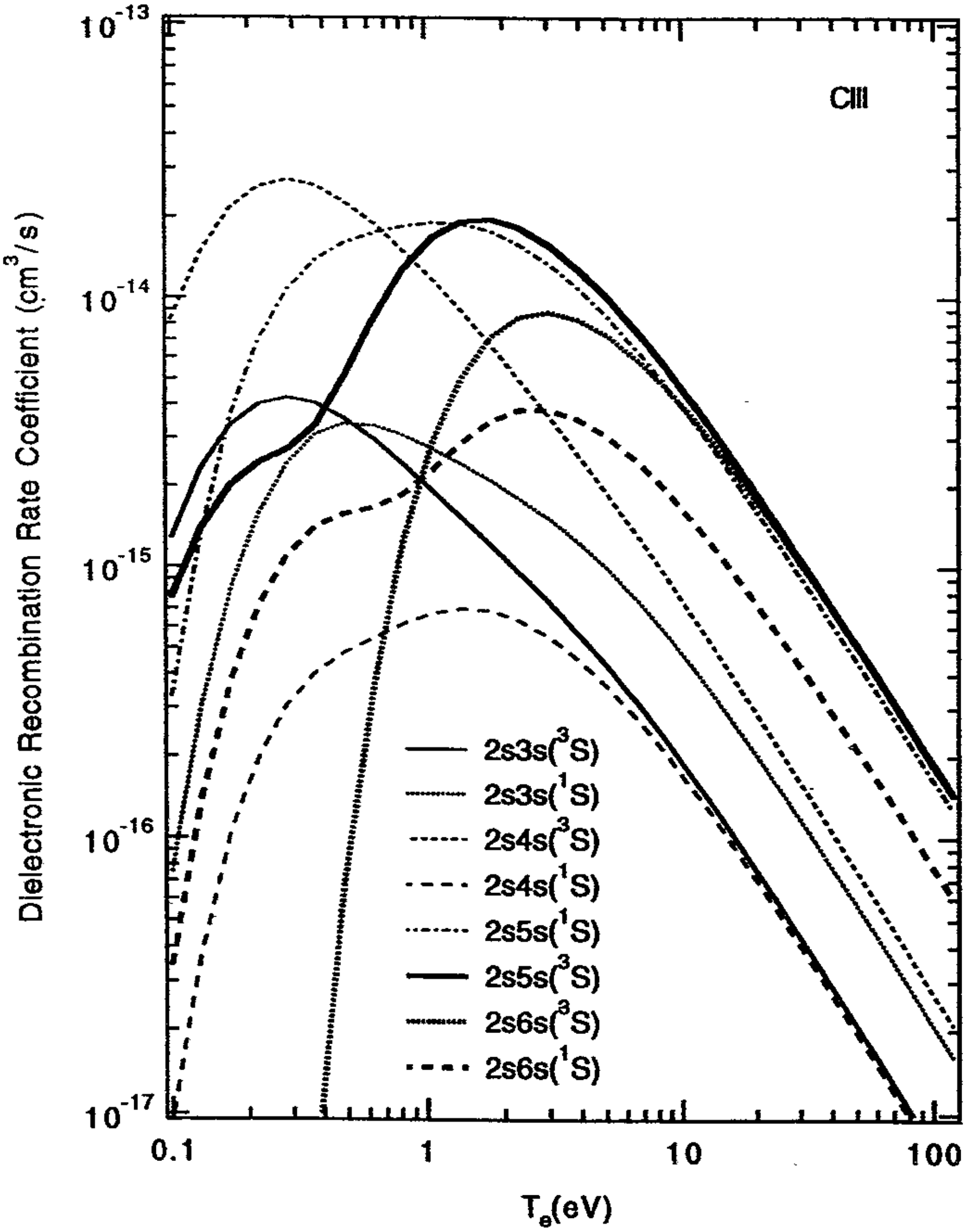

10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
Dielectronic Recombination Rate Coefficient (cm^3/s)
CIII
2s3s(^{3}S)
2s3s(^{1}S)
2s4s(^{3}S)
2s4s(^{1}S)
2s5s(^{1}S)
2s5s(^{3}S)
2s6s(^{3}S)
2s6s(^{1}S)
0.1
1
10
100
T_e(eV)

Fig. 1(d)

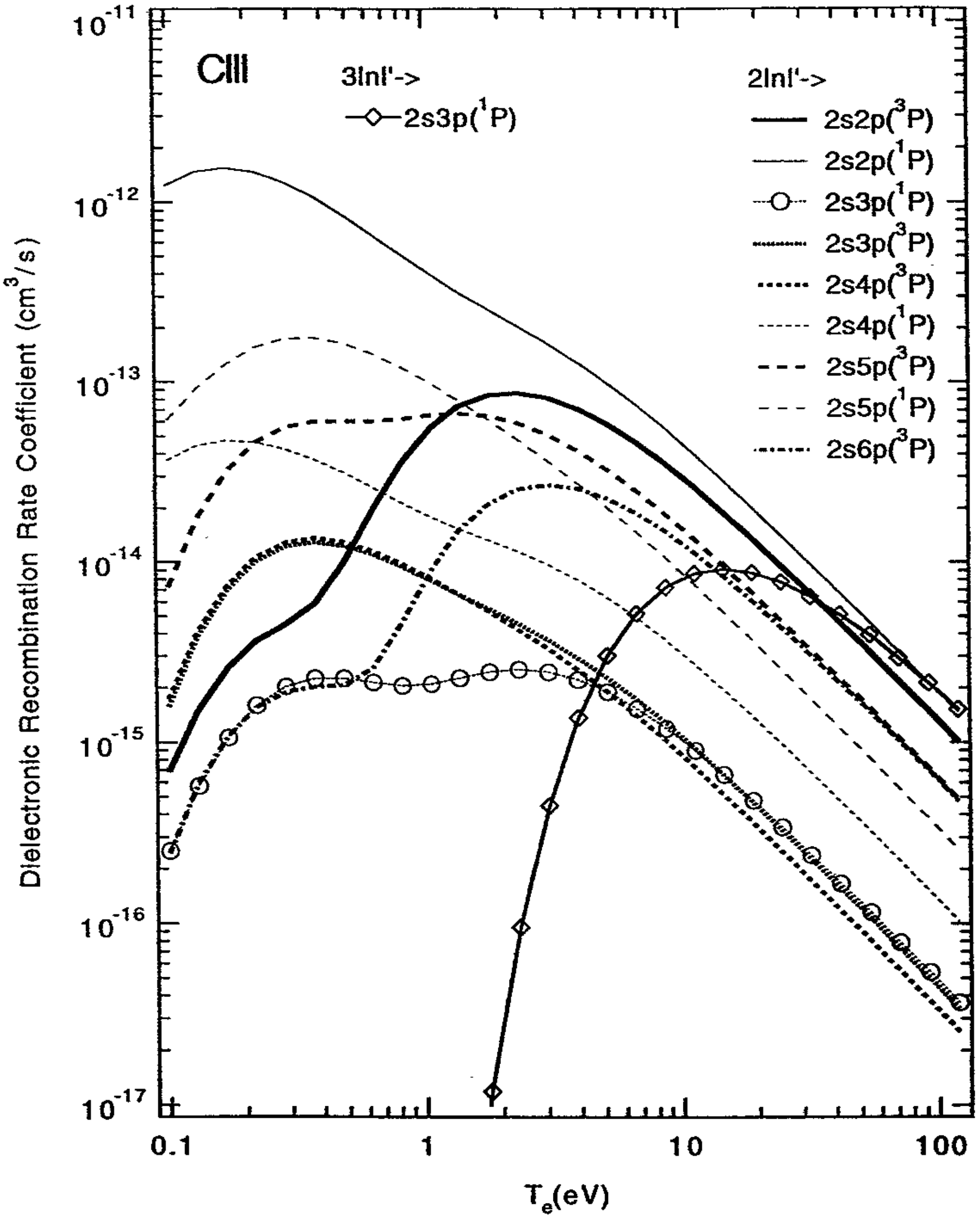
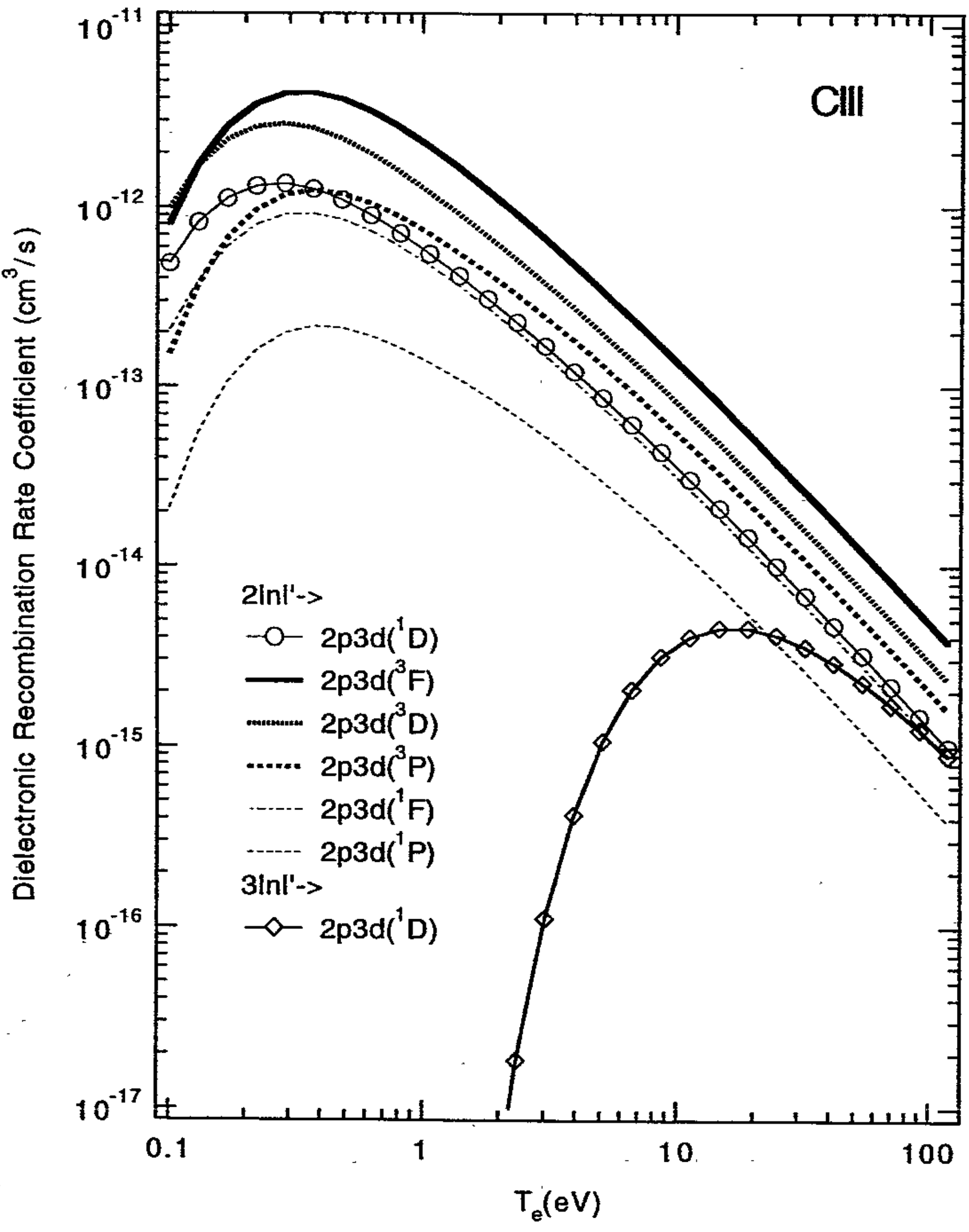

CIII
3lnl'->
2s3p(^{1}P)
2lnl'->
2s2p(^{3}P)
2s2p(^{1}P)
2s3p(^{1}P)
2s3p(^{3}P)
2s4p(^{3}P)
2s4p(^{1}P)
2s5p(^{3}P)
2s5p(^{1}P)
2s6p(^{3}P)
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
100
T$_e$(eV)

Fig. 2(a)



CIII
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
100
T_e(eV)
2lnl'->
2p3d(^{1}D)
2p3d(^{3}F)
2p3d(^{3}D)
2p3d(^{3}P)
2p3d(^{1}F)
2p3d(^{1}P)
3lnl'->
2p3d(^{1}D)

Fig. 2(b)

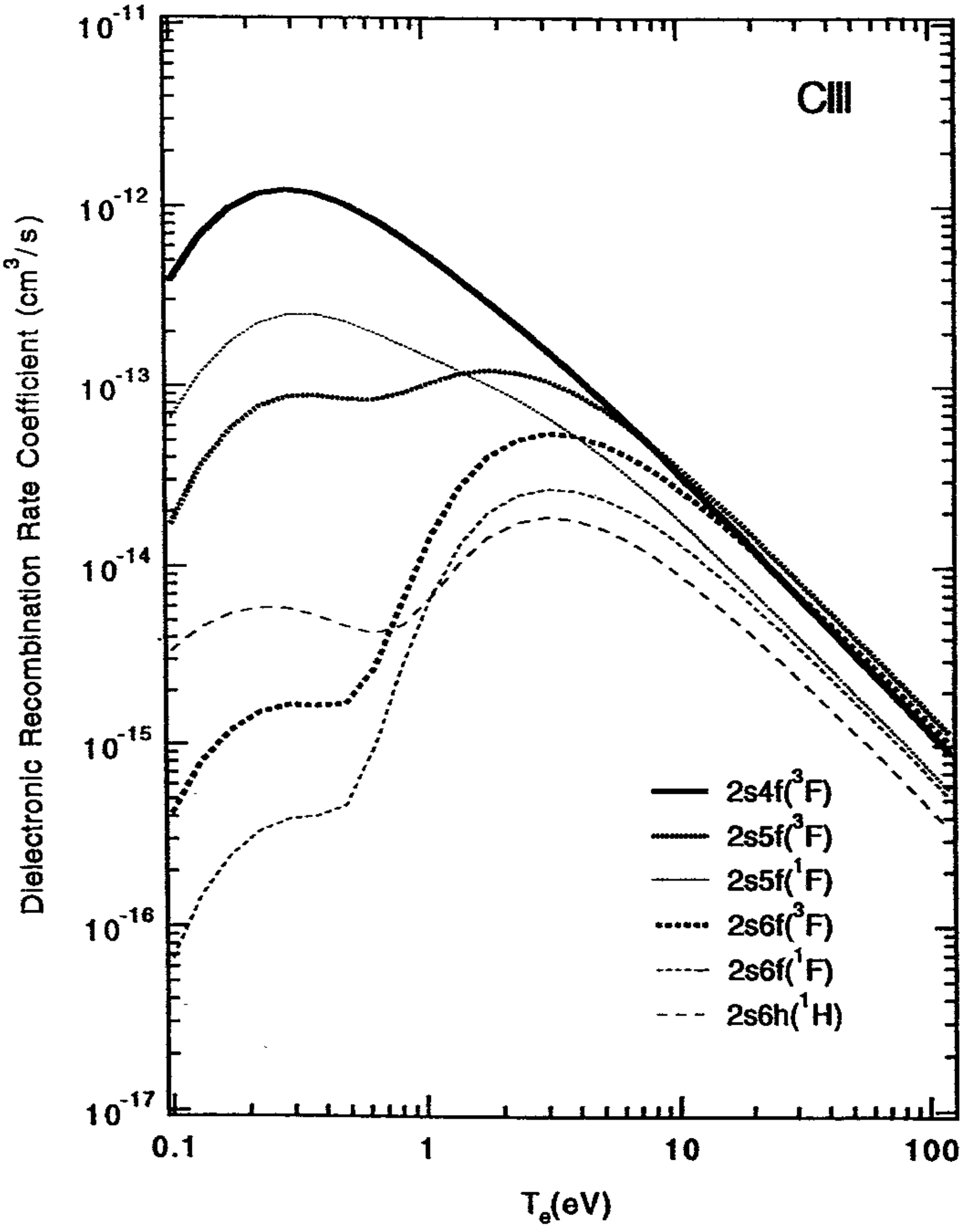

CIII
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
100
T$_e$(eV)
2s4f(^{3}F)
2s5f(^{3}F)
2s5f(^{1}F)
2s6f(^{3}F)
2s6f(^{1}F)
2s6h(^{1}H)

Fig. 2(c)

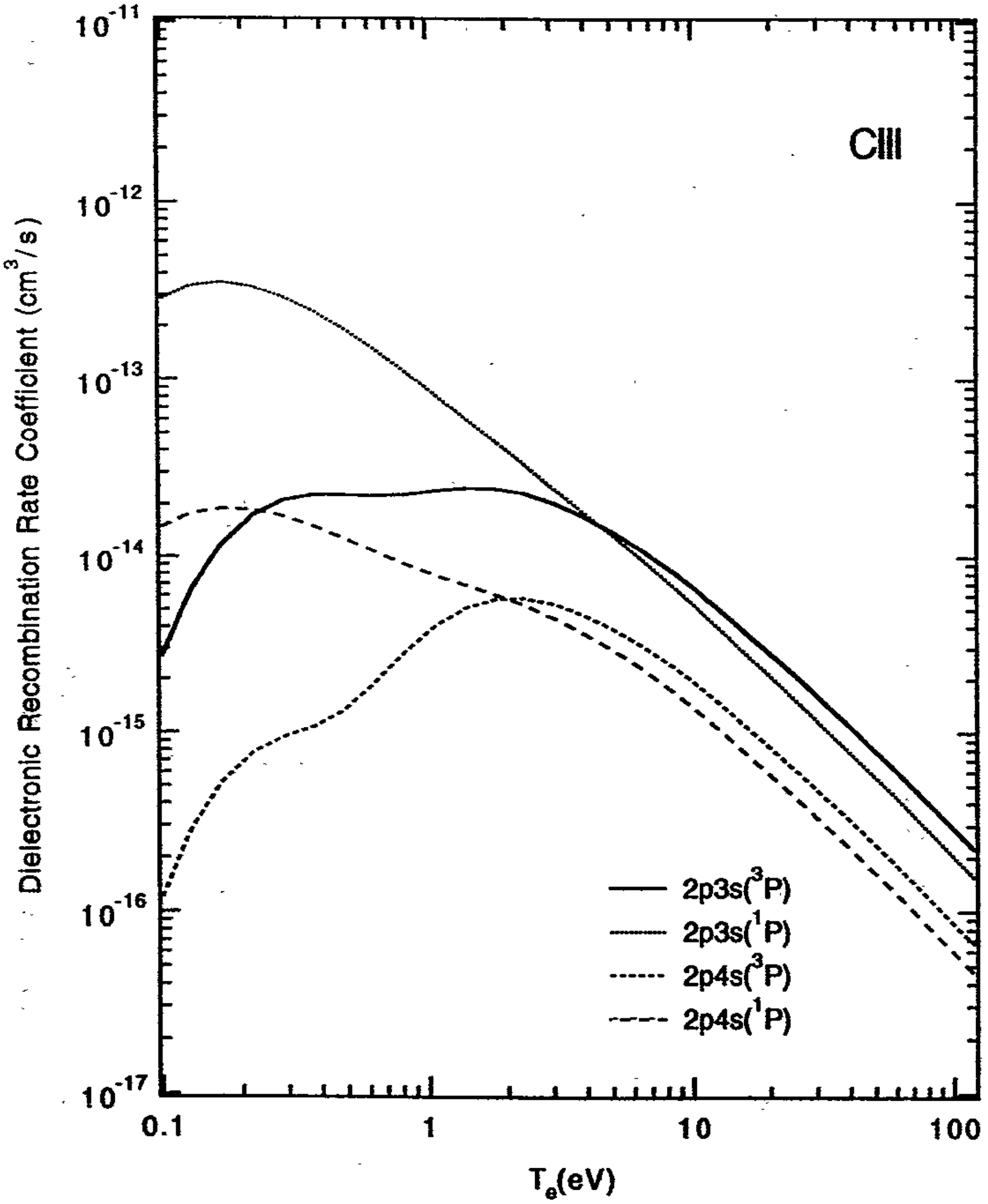

CIII
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
100
T_e(eV)
2p3s(^{3}P)
2p3s(^{1}P)
2p4s(^{3}P)
2p4s(^{1}P)

Fig. 2(d)

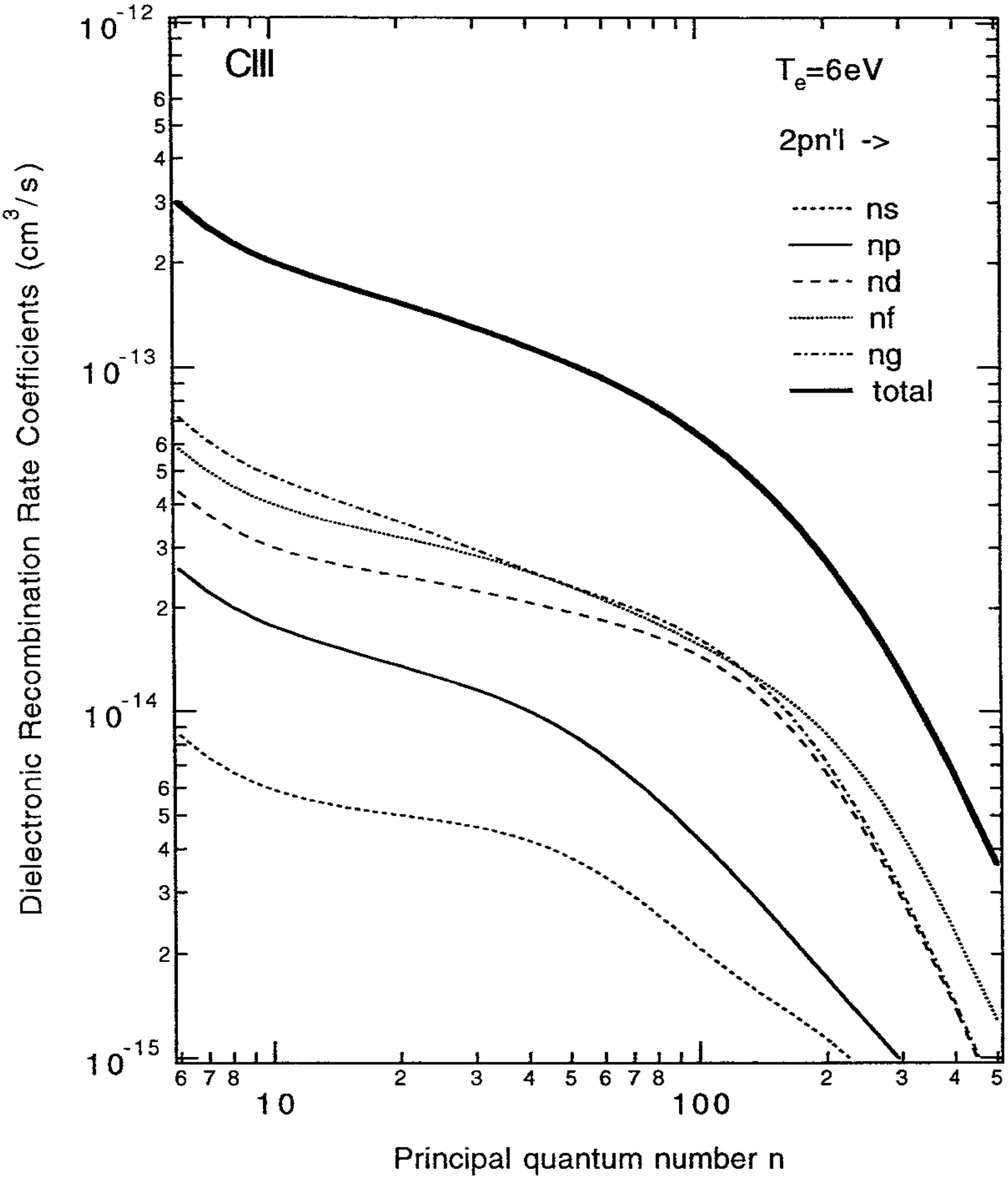

CIII
T_e=6eV
2pn'l ->
ns
np
nd
nf
ng
total
Dielectronic Recombination Rate Coefficients (cm^3/s)
Principal quantum number n
10^{-12}
10^{-13}
10^{-14}
10^{-15}
6
5
4
3
2
10
100
7
8

Fig. 3(a)

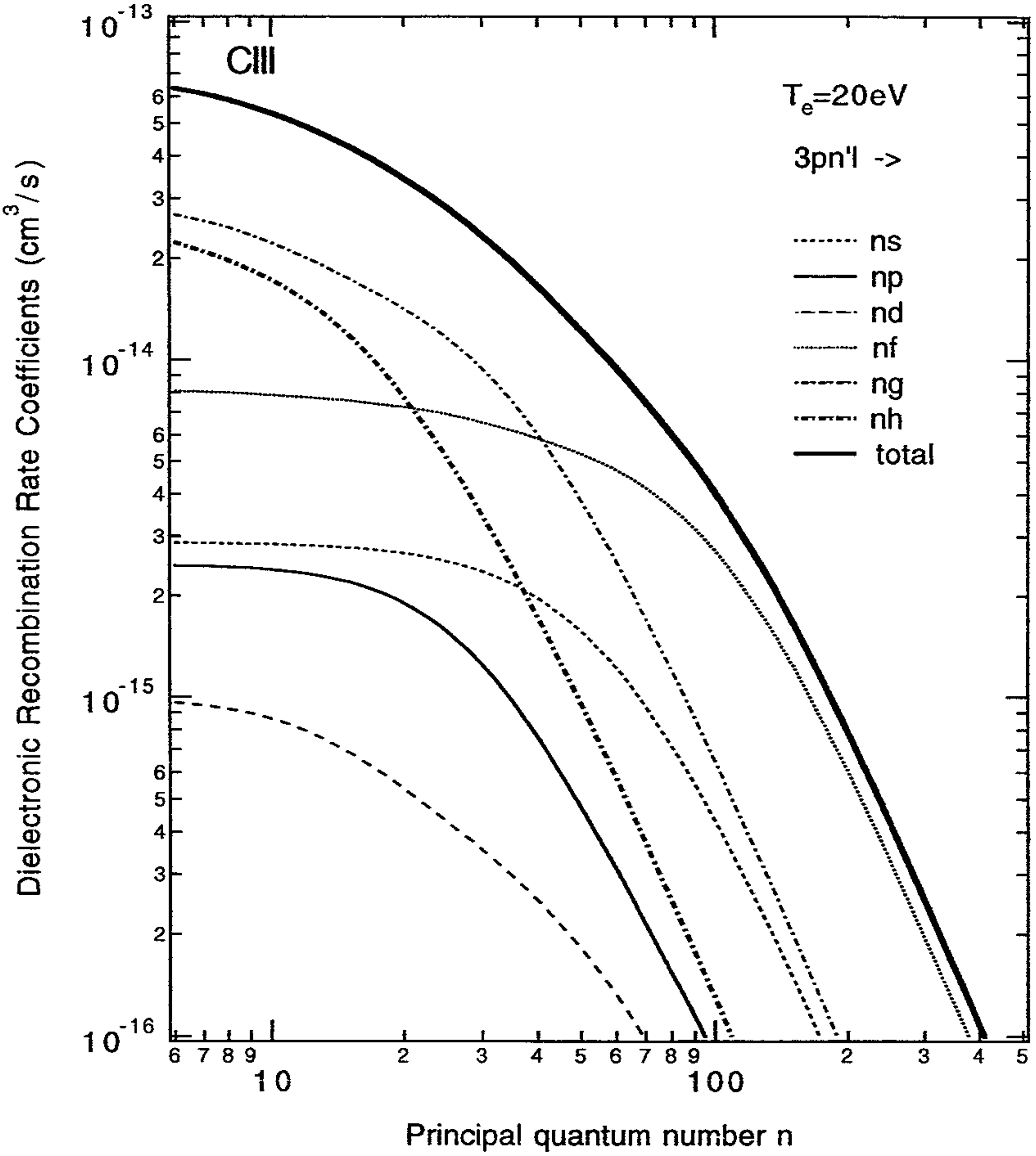

CIII
T_e=20eV
3pn'l ->
ns
np
nd
nf
ng
nh
total
Dielectronic Recombination Rate Coefficients (cm^3/s)
10^{-13}
10^{-14}
10^{-15}
10^{-16}
6
5
4
3
2
10
100
Principal quantum number n

Fig. 3(b)

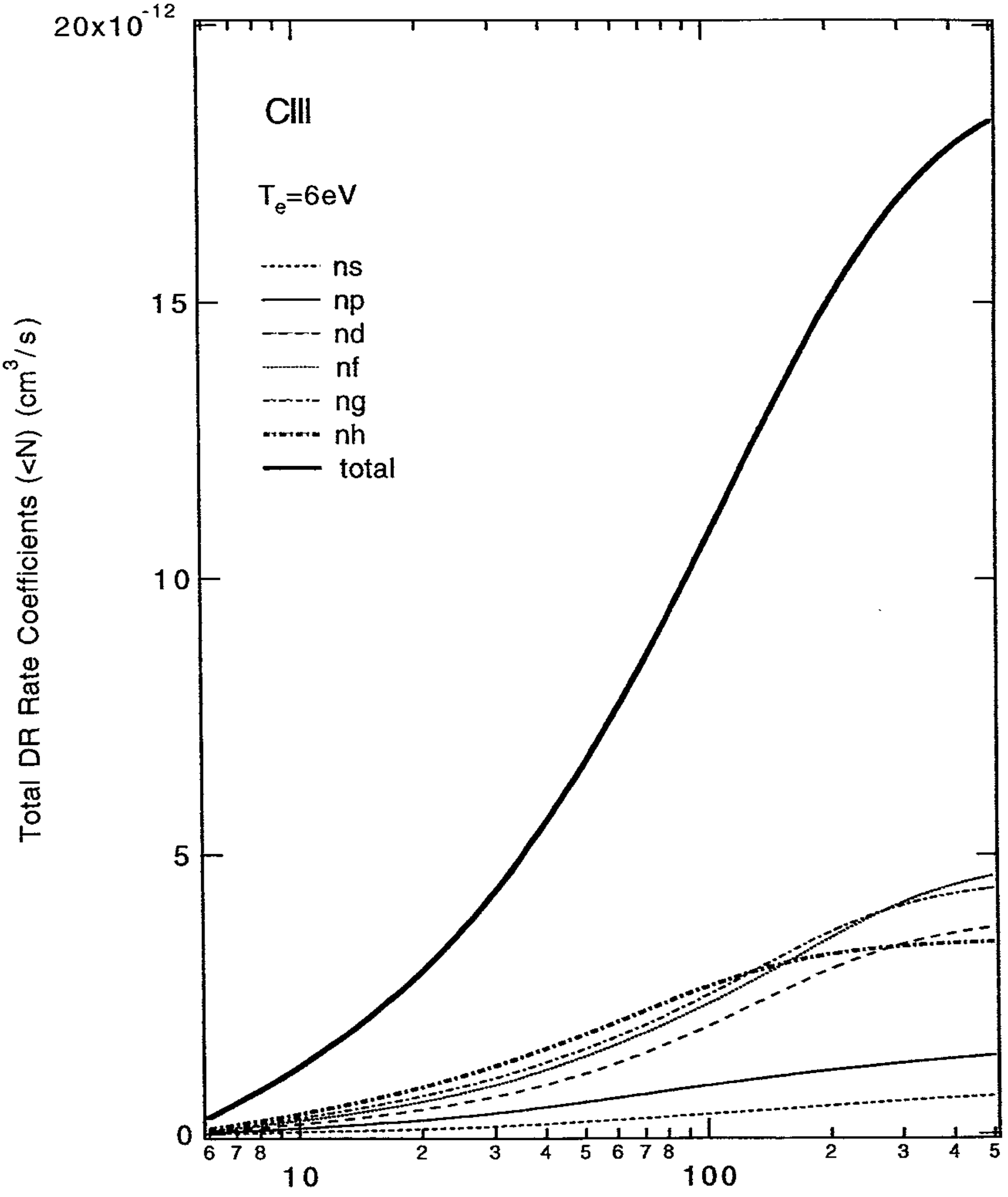

20x10^-12
15
10
5
0
CIII
Te=6eV
ns
np
nd
nf
ng
nh
total
Total DR Rate Coefficients (<N) (cm^3/s)
6 7 8
10
2 3 4 5 6 7 8
100
2 3 4 5
Principal quantum number N

Fig. 4

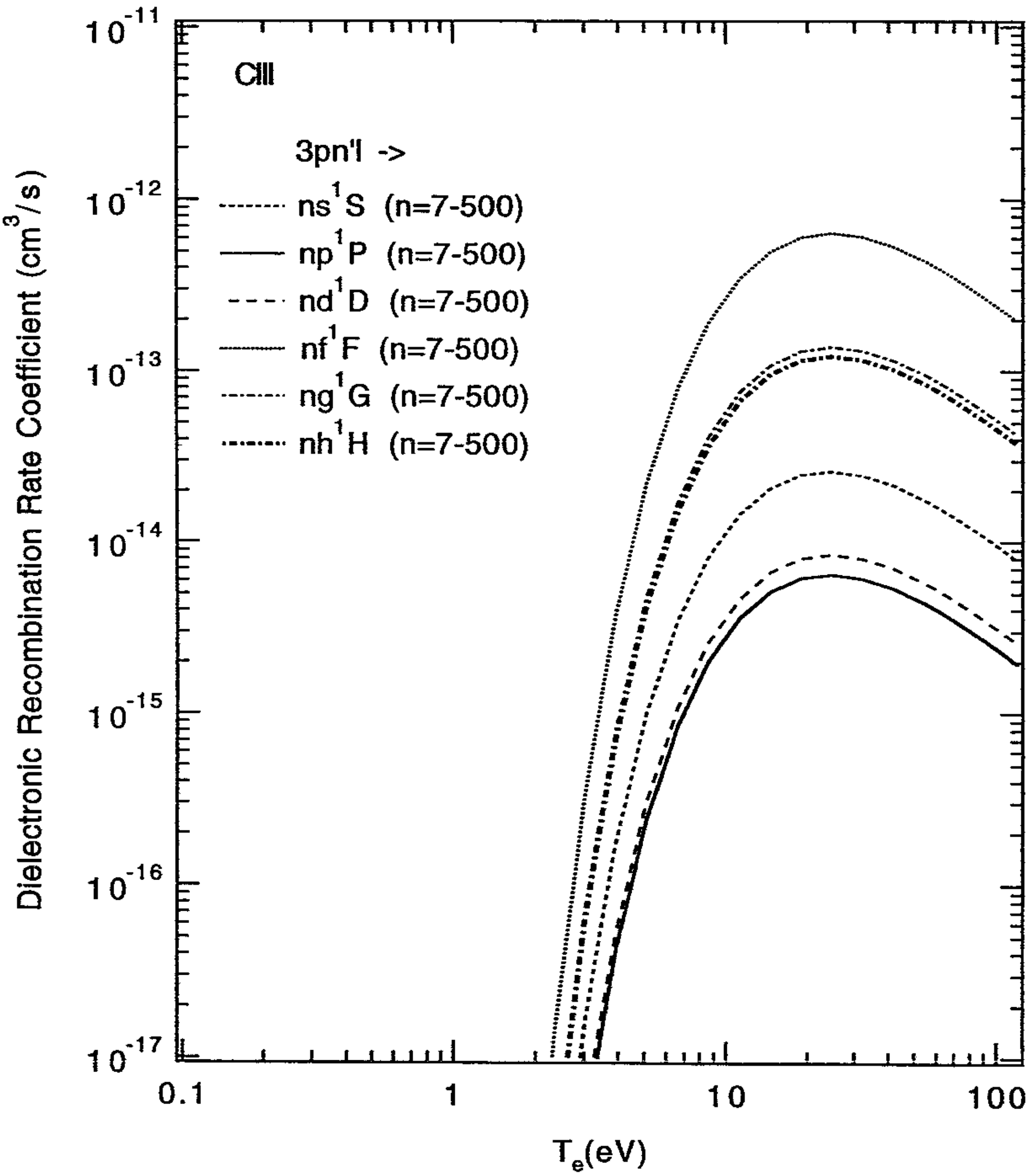

CIII
3pn'l ->
ns^{1}S (n=7-500)
np^{1}P (n=7-500)
nd^{1}D (n=7-500)
nf^{1}F (n=7-500)
ng^{1}G (n=7-500)
nh^{1}H (n=7-500)
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
100
T$_e$(eV)

Fig. 5(a)

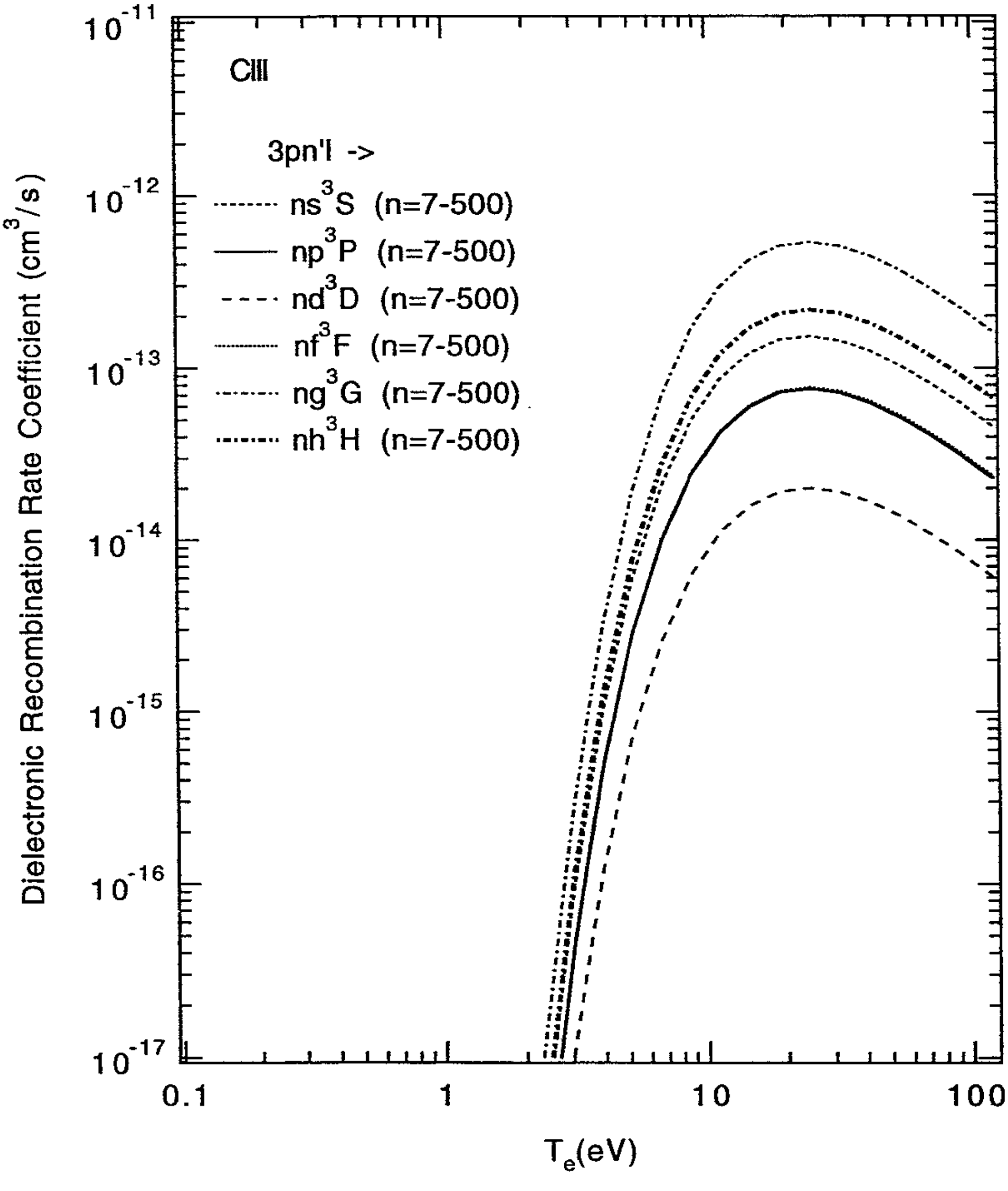
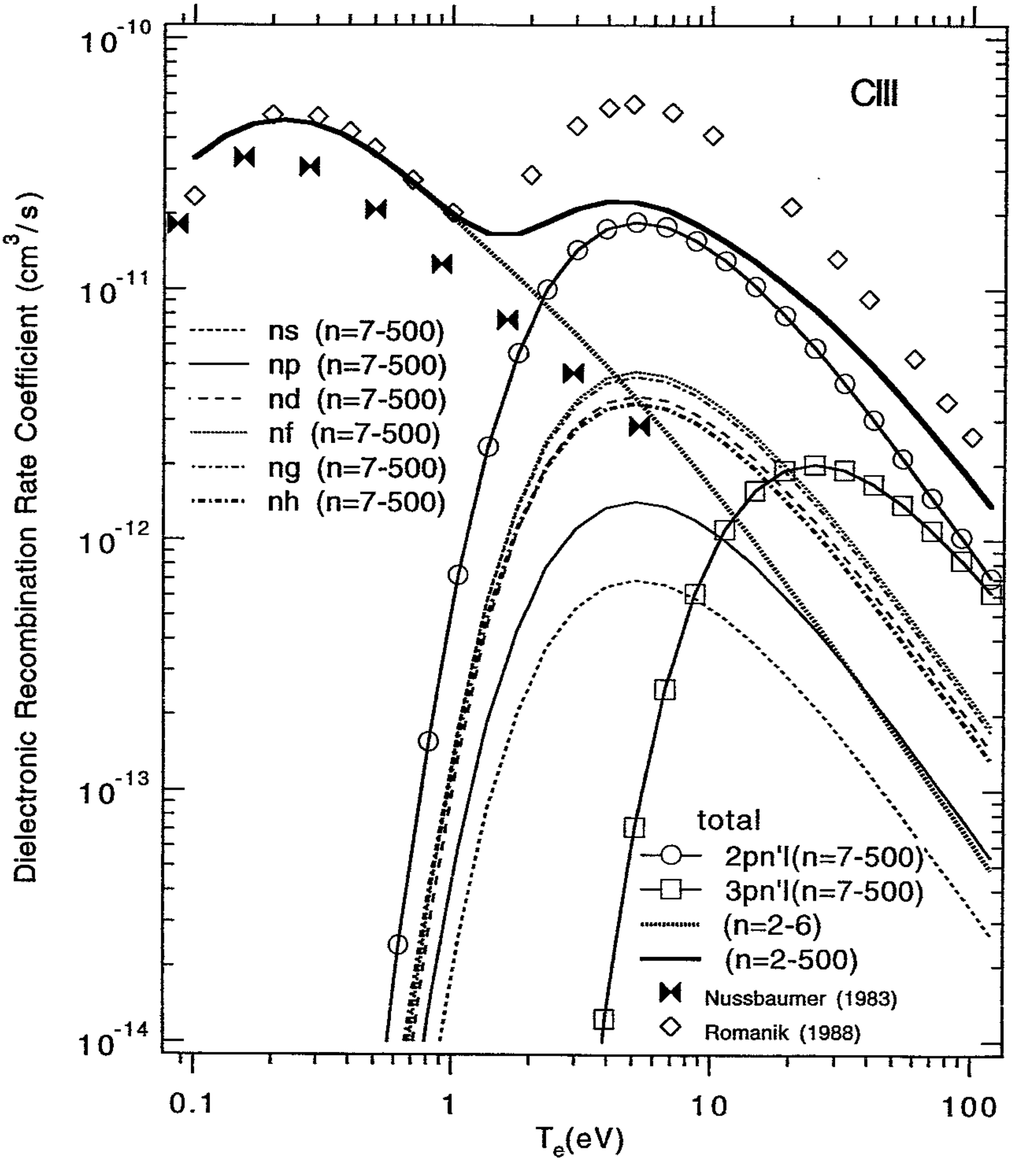

CIII
3pn'l ->
ns³S (n=7-500)
np³P (n=7-500)
nd³D (n=7-500)
nf³F (n=7-500)
ng³G (n=7-500)
nh³H (n=7-500)
Dielectronic Recombination Rate Coefficient (cm³/s)
10⁻¹¹
10⁻¹²
10⁻¹³
10⁻¹⁴
10⁻¹⁵
10⁻¹⁶
10⁻¹⁷
0.1
1
10
100
Tₑ(eV)

Fig. 5(b)



CIII
Dielectronic Recombination Rate Coefficient (cm^3/s)
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}
0.1
1
10
100
T_e(eV)
ns (n=7-500)
np (n=7-500)
nd (n=7-500)
nf (n=7-500)
ng (n=7-500)
nh (n=7-500)
total
2pn'l(n=7-500)
3pn'l(n=7-500)
(n=2-6)
(n=2-500)
Nussbaumer (1983)
Romanik (1988)

Fig. 6

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