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CHARACTERISTICS OF X-RAY TRANSITIONS IN MULTIPLY CHARGED IONS OF ARGON, CHLORINE AND POTASSIUM

USSR State Committee on the Utilization of Atomic Energy
Central Scientific Research Institute on Information and
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IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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Key words: wavelengths, electron transition probability, auto-ionization
probability

Theoretical methods for calculating the energy spectra and determining the wave functions in intermediate coupling are reviewed, and numerical values for the wavelengths and the probabilities of radiative transition and auto-ionization for two-, three- and four-electron ions of chlorine, argon and potassium are given. The characteristics of the transition from the 2p- to the 1s-shell are examined. The calculations are carried out in a one-configuration Hartree-Fock-Pauli approximation using numerical solutions to the Hartree-Fock equations. The auto-ionization probabilities are determined with the help of analytical radial orbitals. Existing experimental and calculated values from other authors are reviewed in detail, and a comparison is made with the authors' own data; this makes it possible to assess the accuracy of the numerical results given and of the calculation method used.

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CONTENTS

1. INTRODUCTION

Calculations of the atomic characteristics of highly-ionized ions of argon and its neighbouring elements chlorine and potassium are of great interest for research into the dynamics of impurity ions in the thermonuclear plasma in tokamaks. An "argon programme" [1, 2] was carried out on the T-10 machine; the programme was based on spectroscopic research into transfer processes in the plasma undergone by ions formed when argon atoms are admitted into the peripheral part of the column. Observing the dynamics of the potassium and chlorine ions formed when KCl pellets are injected into the plasma column is also a promising research method. In all cases, the atoms of argon, chlorine and potassium ionize down to the state of He-like ions, the resonance lines and satellites of which form the basis for observing their dynamics in the plasma.

The quantity of calculated and experimental data available on the excited configurations of these ions is comparatively small. Also, when numerical data are given, they must, in accordance with IAEA recommendations, be accompanied by an estimated value for the accuracy of calculation. It is therefore very important to compare the calculations one is making with other theoretical and experimental data, and this review devotes substantial attention to these matters.

The purpose of this work is to determine the wavelengths and the probabilities of radiative transitions and auto-ionization decay of the states of chlorine, argon and potassium forming dielectron satellites of the resonance lines of H-, He- and Li-like ions. The original results are given alongside a review of existing calculated and experimental data, with which they are compared; it is thus possible to assess the accuracy of the numerical values obtained.

Below the states of two-, three- and four-electron ions of chlorine, argon and potassium with a vacancy in the K-shell are examined, and the wavelengths and probabilities of transition of an electron from the 2p- to the 1s-shell calculated. The characteristics of the electron transitions between discrete levels are calculated in a one-configuration approximation with relativistic corrections and numerical solutions to the Hartree-Fock equations (HFC). The auto-ionization probabilities are determined using analytical radial orbitals for electrons in a discrete spectrum, and Coulomb orbitals with an effective nuclear charge for an electron in a continuum. The results obtained were compared with existing data found by the 1/z perturbation theory method [3-5] and in a Hartree-Fock approximation with relativistic corrections in simplified form [6] (simplified when compared with HFC and the experimental data of Ref. [7]).

It should be noted that these states of chlorine, argon and potassium ions have been little studied, either experimentally or theoretically. They have been most fully studied using the 1/z-parameter perturbation method [3-5]. The characteristics of some transitions in Ar XVI were calculated using a Hartree-Fock approximation with relativistic corrections and are given in Ref.[6]. Experimental research has largely been devoted to the decay of the singly excited states of He-like ions [8]. Experimental values for the wavelengths of the transitions between several multiplets in Ar XV and Ar XVI and of the $1s2p\,^1P_1$ and $^3P_1$ - $1s^2\,^1S_0$ transitions are published in Ref.[7]. We examined the following configurations: $1s^2$, 1s2p, $2s^2$, 2s2p, $2p^2$; $1s^22l$, $1s^23l$, $1s^24l$, $1s2l^2$, 1s2lnl' (n = 2, 3, 4; l' = 0, 1, 2, 3); $1s2l^2$, $1s^22snl$ and 1s2s2pnl (n = 2, 3, 4; l = 0, 1, 2, 3).

Section 2 describes the method used to calculate the energy spectra and electron transition probabilities; these are compared with existing theoretical and experimental data in Section 3. The numerical data needed to determine the intensities of the dielectron satellite lines are given in Annexes 1-4. These give the wavelengths and probabilities for electric dipole and some magnetic quadrupole transitions, and also auto-ionization probabilities summed for all decay paths (Annexes 1-3) or for the ground configuration states alone (Annex 4). The following notations are used in the Annexes: λ = wavelength, Å; A = radiative transition probability, s^{-1}; Γ = auto-ionization probability, s^{-1}; and SLJ = (2s + 1)L(2g + 1). For the transition probabilities, the symbol a, bc + d signifies a, $bc \cdot 10^d \cdot 10^{13}$.

2. METHOD OF CALCULATING ENERGY SPECTRA AND ELECTRON TRANSITION PROBABILITIES

The energy spectrum of the ion was calculated using a one-configuration intermediate-coupling approximation with relativistic corrections [9]. An operator for the kinetic energy of the electron was used as the zero-order approximation along with an operator for the energy of electrostatic interaction of the electron with the nucleus and with other electrons (in the atomic system of units)

$$H_0 = \sum_i \vec{p}_i^{\,2}/2 - \sum_i z/r_i + \sum_{i>j} 1/r_{ij} . \tag{1}$$

For atoms with a nuclear charge $z < 30$ the relativistic effects are comparatively small. They can be allowed for in the form of corrections relating to non-relativistic wave functions within a Breit operator. We used the following operators to take into account all relativistic terms of order α^2 ($\alpha = e^2/\hbar c = 1/137$): a relativistic correction determined by the dependence of the electron's mass on velocity

$$H_1 = -\frac{\alpha^2}{8} \sum_i \vec{p}_i^{\,4} ; \tag{2}$$

a correction for the lag in the magnetic field due to the electron, the so-called orbit-orbit interaction;

$$H_2 = -\frac{\alpha^2}{2} \sum_{i>j} \frac{1}{r_{ij}} \left\{ (\vec{p}_i \cdot \vec{p}_j) + \frac{(\vec{r}_{ij}(\vec{r}_{ij} \cdot \vec{p}_i)\vec{p}_j)}{r_{ij}^2} \right\} ; \tag{3}$$

and corrections for contact and spin-contact interactions

$$H_3 = \frac{z\pi\alpha^2}{2} \sum_i \delta(\vec{r}_i) - \pi\alpha^2 \sum_{i>j} \delta(\vec{r}_{ij}) - \frac{8\pi\alpha^2}{3} \sum_{i>j} (\vec{s}_i \cdot \vec{s}_j) \delta(\vec{r}_{ij}) . \tag{4}$$

The operator used for the spin-orbital interaction has the form

$$H_4 = \frac{\alpha^2}{2} \left(\left\{ \frac{z}{r_i^3} [\vec{r}_i \times \vec{p}_i] - \sum_{i>j} \frac{1}{r_{ij}^3} [\vec{r}_{ij} \times \vec{p}_i] + \sum_{i>j} \frac{2}{r_{ij}^3} [\vec{r}_{ij} \times \vec{p}_j] \right\} \vec{s}_i \right) + \frac{z\alpha^2}{4} \sum_i \frac{1}{r_i^3} (\vec{l}_i \cdot \vec{s}_i) . \tag{5}$$

The spin-orbital interaction within an open shell is calculated using a simplified "spin-orbit" operator (the final term in equation (5)) with the addition of terms for the two-electron spin-orbital interaction operator which are reduced to single-electron terms. The spin-orbit interaction between open shells is not taken into account, but the interaction between open and full shells is determined in full using operator (5).

The program from Ref.[10] is used to find numerical solutions for the Hartree-Fock equations, and the energy spectra are calculated using the program from Ref.[11]. Once the energy matrix has been diagonalized, the eigenvectors obtained characterize the intermediate-coupling energy levels, and the wave function of the γJ state is then written in the form

$$|\gamma J\rangle = \sum_i a(\gamma\alpha_i L_i S_i) |\gamma\alpha_i L_i S_i J\rangle, \tag{7}$$

where γ indicates the configuration and $a(\gamma\alpha_i L_i S_i)$ are coefficients of a polynomial function.

In Ref.[12], using multiply charged ions of chromium as an example, it is demonstrated that the analytical radial orbitals of Ref.[13] can be used to determine auto-ionization probabilities. The accuracy of the auto-ionization probability value is almost as good as can be obtained using numerical solutions for the Hartree-Fock equations, which take a great deal of computer time to find for an electron in a continuous spectrum. To save computing time, analytical radial orbitals of the form given in Ref.[13] are used to define the auto-ionization characteristics:

$$P(nl|r) = A_{nl} \sum_{i=1}^{\max(2,n-l)} C_i^{nl} r^{\min(l+i,n)} e^{-\alpha_i^{nl} r}, \quad C_1^{nl} = 1, \tag{8}$$

the parameters α_i^{nl} and C_i^{nl} for $n - l = 1$ being determined from the minimum non-relativistic energy, and for $n - l > 1$ from the conditions of orthogonality of the single-electron wave functions. Here the energy spectrum and eigenvectors of the wave functions in intermediate coupling were found using the program from Ref.[14], which supplies the programs from Refs.[15] and [16] with radial integral values.

The auto-ionization probability of the level $\Gamma(\beta J)$, s^{-1}, was calculated using the formula

$$\Gamma(\beta J) = 2{,}596 \cdot 10^{17} \sum_l \Bigg| \sum_{\alpha LS, \alpha' L' S', i, j} (\beta J|\alpha LS) \times$$
$$\times (\alpha LS|1/r_{ij}|\alpha' L' S' \epsilon l LSJ) \Bigg|^2 . \tag{9}$$

Coulomb functions with an effective nuclear charge were used as radial wave functions for an electron in a continuous spectrum. The value of the effective charge was taken to be the difference between the charge of the ion's nucleus and the number of electrons remaining after auto-ionization.

The radiative transition probabilities were determined using a transition operator of "length" form, since in the case of electron transition from the 2p- to the 1s-shell the oscillator strengths obtained using operators in the "length" and "velocity" forms are the same to two significant figures, i.e. the oscillator strengths are weakly dependent on the calibration of the electromagnetic field potential [9].

In determining the intensities of the spectral lines of states occupied through dielectron recombination, the following coefficients are needed:

$$q(\beta J - \beta'J') = A(\beta J - \beta'J')K(\beta J) \tag{10}$$

where

$$K(\beta J) = \frac{\sum_{\alpha}\Gamma(\beta J - \alpha)}{\sum_{\beta''J''} A(\beta J - \beta''J'') + \sum_{\alpha'}\Gamma(\beta J - \alpha')} \tag{11}$$

Here $A(\beta J - \beta'J')$ is the probability of radiative transition from a higher state βJ to a lower one $\beta'J'$; $\sum_{\beta''J''} A(\beta J - \beta''J'')$ is the total probability of radiative decay from state βJ to all possible lower states $\beta''J''$; $\sum\Gamma(\beta J - \alpha')$ is the total auto-ionization probability summed for all possible auto-ionization paths, and $\sum_{\alpha}\Gamma(\beta J - \alpha)$ is the probability summed for all ground configuration states formed after auto-ionization. For two- and three-electron ions, the sums of the auto-ionization probabilities in the numerator and denominator are the same, but they differ for four-electron ions because, after auto-ionization, ions are formed in states $1s^2 2s\,^2S_{1/2}$ or $1s^2 2p\,^2P_{1/2,\,3/2}$. Annex 4 gives the values for the sums $\sum_{\alpha}\Gamma(\beta J - \alpha)$ needed to determine the coefficients $K(\beta J)$ or $q(\beta J - \beta'J')$.

3. DISCUSSION OF RESULTS

3.1. Electron transition wavelengths

A criterion for the accuracy of theoretically determined wavelengths can be how far they agree with experimental data. Reference [7] gives wavelengths for the following electric dipole transitions in Ar XVI and Ar XVII ions: $1s2p\,^1P_1$, $^3P_1$ $-1s^2\,^1S_0$, $1s2s2p\,^4P_{3/2}$ $-1s^22s\,^2S_{1/2}$ and $1s2p^2\,^2P$ $-1s^22p\,^2P$, equal to 3.9501, 3.9697, 4.0167 and 3.998 - 3.981 Å, respectively. We obtain calculated wavelengths for these transitions of 3.9483, 3.9695, 4.0142 and 3.9928 - 3.9803 Å. We can conclude from comparing these values that the accuracy of the calculated wavelengths $\Delta\lambda/\lambda = 5 \times 10^{-4}$. In Ref.[7], the wavelengths of the following transitions between states of configurations: $1s2p$ $-1s^2$, $1s2s2p$ $-1s^22s$, and $1s2p^2$ $-1s^22p$ are calculated in a Hartree-Fock approximation with relativistic corrections, as in Ref.[6]. A comparison of these results with our own shows very good agreement; there are a few differences, but only in the third decimal place.

In Table 1, the wavelengths for chlorine, argon, potassium and chromium which we calculated using numerical solutions to the Hartree-Fock equations with relativistic corrections are compared with those which were determined in Ref.[7], and also with those obtained by the 1/z perturbation theory method (ET) [3]. The wavelengths for the transitions in argon and chromium ions are also compared with those obtained using analytical radial orbitals (Eq. (8)). From Table 1 we can see that the wavelengths calculated using the three methods are in good agreement with each other, with differences only in the fourth significant digit. The systematic displacement by 0.03% towards the low side in the wavelengths obtained using analytical radial orbitals, as compared with those determined using numerical solutions to the Hartree-Fock equations in Ref.[12], was successfully eliminated by accurately taking the single-electron contact interaction operator (the first term in formula (4)) into account.

A detailed comparison of the wavelengths we obtained for other transitions and degrees of ionization with those calculated using perturbation theory is given in Table 2, from which we can conclude that all the calculated data for two- and three-electron ions, and also for the transition $1s2s^22p$ LSJ$-1s^22s^2\,^1S_0$, are in good agreement with each other and almost achieve the spectroscopic accuracy of $\Delta\lambda/\lambda \sim 1 \times 10^{-4}$ needed for thermonuclear plasma diagnostics.

The situation is somewhat different where the wavelengths of the transition $1s2s2p^2$ LSJ$-1s^22s2p$ L'S'J' is concerned. For comparison,

Table 1

Comparison of wavelengths λ (Å) of transitions
$1s2s(L_1S_1)2pLSJ$ - $1s^22s^2S_{1/2}$ in ions
of chlorine, argon, potassium and chromium

L_1S_1	LSJ	Cl XV		Ar XVI				K XVII		Cr XXII		
		HFC	ET [3]	HFC	HF [7]	ET [3]	ARO	HFC	ET [3]	HFC	ET [3]	ARO
^3S	$^2P_{1/2}$	4,4848	4,4842	3,9815	3,9825	3,9827	3,9843	3,5596	3,5605	2,1977	2,1972	2,1981
^1S	$^2P_{1/2}$	4,4653	4,4667	3,9662	3,9669	3,9677	3,9671	3,5464	3,5476	2,1896	2,1898	2,1899
	$^4P_{1/2}$	4,5240	4,5227	4,0163		4,0152	4,0174	3,5892	3,5884	2,2121	2,2114	2,2126
^3S	$^2P_{3/2}$	4,4823	4,4822	3,9793	3,9808	3,9806	3,9817	3,5451	3,5468	2,1948	2,1948	2,1953
^1S	$^2P_{3/2}$	4,4643	4,4659	3,9649	3,9657	3,9669	3,9661	3,5573	3,5584	2,1888	2,1889	2,1892
	$^4P_{3/2}$	4,5223	4,5216	4,0146		4,0141	4,0157	3,5876	3,5872	2,2106	2,2103	2,2111

Notes: HFC values obtained using numerical solutions to the Hartree-Fock equations with relativistic corrections; ET using the $1/z$ perturbation theory method; ARO using analytical radial orbitals (equation (8)).

wavelengths of transitions from $1s2s(L_1S_1)2p^2\ ^3P_J$ to $1s^22s2p$ LSJ' were selected and placed in Table 3, from which we can see that the wavelengths we calculated and those given in Ref.[5] differ significantly more for several transitions than in the case of the two- and three-electron ions. For some of the wavelengths, the differences are seen in the third decimal place. These differences are not due to the differing orders of composition of the electron moments used by us and in Ref.[5], since when intermediate coupling is used the wavelengths do not depend on the initial electron moment coupling order. Calculations were made for the Ar XV ion using analytical radial orbitals (Eq. (8)), both for sequential coupling of the moments $1s2s(L_1S_1)2p^2(L_2S_2)LSJ$ and for the primary order of composition of moments of electrons having identical principal quantum numbers $1s(2s2p^2(L_1S_1)L_2S_2)LSJ$, which is the more natural case for multiply charged ions. The wavelength values obtained were identical and are also given in Table 3.

The $1s2s2p^2$ configuration is a clear example of a very pronounced mixing of terms when the electron moments are coupled sequentially. Table 4 gives the coefficients of the polynomial wave functions for the ^3P_J-level terms with the greatest degrees of mixing. Here the problem arises of identifying the level correctly. However, such ambiguities do not occur when the moments of the 2s- and $2p^2$-electrons are coupled first, as can be seen from the coefficients of the polynomial functions shown in Table 4. This bears witness to the constant increase in hydrogen degeneracy as higher degrees of ionization are reached.

Table 2

Comparison of wavelengths λ (Å) of transitions
in chlorine, argon and potassium ions

Transition	Ar		Cl		K	
	λ	λ [3 – 5]	λ	λ [3 – 5]	λ	λ [3 – 5]
1	2	3	4	5	6	7
$2s^2\,{}^1S - 1s2p\,{}^1P_1$	3,8109	3,8110	4,2786	4,2787	3,4156	3,4159
${}^3P_1$	3,7913	3,7924	4,2559	4,2571	3,3985	3,3996
$2s2p\,{}^1P_1 - 1s2s\,{}^1S_0$	3,7514	3,7544	4,2092	4,2128	3,3641	3,3667
${}^3S_1$	3,7290	3,7313	4,1827	4,1855	3,3450	3,3469
${}^3P_0 - {}^3S_1$	3,7648	3,7654	4,2245	4,2252	3,3760	3,3766
${}^3P_1 - {}^3S_1$	3,7632	3,7639	4,2229	4,2237	3,3745	3,3751
${}^3P_2 - {}^3S_1$	3,7596	3,7603	4,2192	4,2201	3,3708	3,3714
${}^3P_1 - {}^1S_0$	3,7861	3,7875	4,2499	4,2515	3,3939	3,3953
$1s2s^2\,{}^2S_{1/2} - 1s^22p\,{}^2P_{1/2}$	4,0679	4,0681	4,5859	4,5856	3,6329	3,6332
${}^2P_{3/2}$	4,0721	4,0723	4,5901	4,5897	3,6372	3,6375
$1s2p({}^1P)3s\,{}^2P_{1/2} - 1s^23s\,{}^2S_{1/2}$	3,9539	3,9535	4,4514	4,4497	3,5358	3,5355
${}^2P_{3/2} -$	3,9535	3,9541	4,4510	4,4504	3,5355	3,5360
$1s2p({}^3P)3s\,{}^2P_{1/2} - 1s^23s\,{}^2S_{1/2}$	3,9706	3,9648	4,4706	4,4626	3,5505	3,5457
${}^2P_{3/2} -$	3,9672	3,9613	4,4672	4,4591	3,5469	3,5422
${}^4P_{1/2} -$	3,9787	3,9783	4,4802	4,4786	3,5574	3,5571
${}^4P_{3/2} -$	3,9772	3,9773	4,4786	4,4777	3,5560	3,5561
$1s2p({}^1P)3p\,{}^2S_{1/2} - 1s^23p\,{}^2P_{1/2}$	3,9498	3,9461	4,4467	4,4411	3,5321	3,5292
${}^2P_{3/2}$	3,9510	3,9473	4,4479	4,4422	3,5333	3,5304
${}^2P_{1/2} - {}^2P_{1/2}$	3,9543	3,9544	4,4518	4,4509	3,5361	3,5364
${}^2P_{3/2} - {}^2P_{3/2}$	3,9538	3,9540	4,4513	4,4504	3,5357	3,5359
${}^2D_{3/2} - {}^2P_{1/2}$	3,9555	3,9543	4,4534	4,4508	3,5371	3,5362
${}^2D_{5/2} - {}^2P_{3/2}$	3,9564	3,9553	4,4543	4,4518	3,5379	3,5372
$1s2p({}^1P)3d\,{}^2P_{1/2} - 1s^23d\,{}^2D_{3/2}$	3,9472	3,9455	4,4434	4,4401	3,5302	3,5289
${}^2D_{3/2} -$	3,9517	3,9520	4,4488	4,4479	3,5340	3,5343
$1s2p({}^1P)3d\,{}^2P_{3/2} - 1s^23d\,{}^2D_{5/2}$	3,9467	3,9449	4,4429	4,4395	3,5297	3,5283
${}^2F_{5/2} -$	3,9484	3,9483	4,4450	4,4437	3,5310	3,5310
${}^2D_{5/2} - {}^2D_{5/2}$	3,9517	3,9519	4,4488	4,4479	3,5340	3,5343
${}^2F_{5/2} -$	3,9487	3,9487	4,4453	4,4441	3,5314	3,5314
${}^2F_{7/2} -$	3,9497	3,9498	4,4463	4,4452	3,5323	3,5325
$1s2s^22p\,{}^1P_1 - 1s^22s^2\,{}^1S_0$	4,0092	4,0096	4,5162	4,5167	3,5828	3,5831
${}^3P_1 -$	4,0298	4,0292	4,5401	4,5395	3,6006	3,6001

3.2. Radiative transition probabilities

In Table 5, the probabilities of the electric dipole transitions $1s2p^2$ LSJ-$1s^22p$ L'S'J' and 1s2s2p LSJ-$1s^22s\,{}^2S_{1/2}$, calculated using an operator of "length" form, are compared with existing theoretical data. In Ref.[6], the calculations were made in a Hartree-Fock approximation with simplified relativistic corrections, and in Ref.[3] using the 1/z ET method. For strong transitions with probabilities of the order of 10^{13}- 10^{14} s^{-1}, there is very good agreement between all three sources. Agreement is poorer where probabilities are of the order of 10^{11}- 10^{12} s^{-1}; there are differences

Table 3

Comparison of wavelengths (Å) for transition
$1s2s(L_1S_1)2p^2\ {}^3P_J$ to $1s^22s2pLSJ'$

$L_1S_1{}^3P_J-LSJ'$	Cl XIV		Ar XV			K XVI	
		[5]		[5]			[5]
$^1S\ {}^3P_0-{}^1P_1$	4,5722	4,5692	4,0566	4,0543	4,0542	3,6234	3,6216
$^3P_0-{}^3P_1$	4,5280	4,5280	4,0194	4,0194	4,0171	3,5916	3.5917
$^3P_1-{}^3P_0$	4,5260	4,5251	4,0174	4,0164	4,0150	3,5896	3,5886
$^3P_1-{}^1P_1$	4,5714	4,5675	4,0558	4,0524	4,0532	3,6226	3.6197
$^3P_1-{}^3P_1$	4,5272	4,5263	4,0186	4,0176	4,0161	3,5908	3,5897
$^3P_1-{}^3P_2$	4,5299	4,5289	4,0213	4,0203	4,0188	3,5935	3,5925
$^3P_2-{}^1P_1$	4,5674	4,5652	4,0518	4,0502	4,0489	3,6185	3,6173
$^3P_2-{}^3P_1$	4,5233	4,5240	4,0146	4,0153	4,0119	3,5867	3,5875
$^3P_2-{}^3P_2$	4,5259	4,5267	4,0172	4,0180	4,0145	3,5895	3,5903
$^3S\ {}^3P_0-{}^1P_1$	4,5407	4,5407	4,0302	4,0304	4,0296	3,6013	3,6013
$^3P_0-{}^3P_1$	4,4967	4,5000	3,9934	3,9959	3,9930	3,5698	3,5717
$^3P_1-{}^3P_0$	4,4935	4,4969	3,9901	3,9927	3,9891	3,5663	3,5684
$^3P_1-{}^1P_1$	4,5383	4,5388	4,0280	4,0283	4,0269	3,5989	3,5990
$^3P_1-{}^3P_1$	4,4947	4,4981	3,9913	3,9939	3,9903	3,5675	3,5695
$^3P_1-{}^3P_2$	4,4973	4,5007	3,9939	3,9965	3,9929	3,5702	3,5723
$^3P_2-{}^1P_1$	4,5652	4,5370	4,0254	4,0265	4,0245	3,5963	3,5972
$^3P_2-{}^3P_1$	4,4922	4,4963	3,9887	3,9921	3,9880	3,5649	3,5972
$^3P_2-{}^3P_2$	4,4948	4,4989	3,9914	3,9947	3,9906	3,5677	3,5705

Table 4

Coefficients of polynomial wave functions
$1s2s(L_1S_1)2p^2(^3P)^3P_J$
and $1s(2s2p^2(^3P)L_2S_2)^3P_J$

$(L_1S_1)2p^2(L_2S_2)LS$			$(^1S)2p^2(^3P)^3P_1$			$(^1S)2p^2(^3P)^3P_2$			$(^3S)2p^2(^3P)^3P_2$		
			Cl	Ar	K	Cl	Ar	K	Cl	Ar	K
(^1S)	(^3P)	^3P	0,63	0,61	0,59	0,65	0,66	0,66	−0,65	−0,65	−0,64
(^3S)	(^3P)	^3P	0,58	0,57	0,57	0,66	0,57	0,57	0,68	0,67	0,65
(^3S)	(^1D)	^3D	−0,51	−0,51	−0,54	−0,56	−0,51	−0,49	−0,04	−0,05	−0,05
(^1S)	(^1D)	^1D	−	−	−	−0,06	−0,07	−0,09	−0,32	−0,37	−0,41

$1s(2s2p^2(L_1S_1)L_2S_2)LS$			$(2s2p^2(^3P)^4P)^3P_1$		$(2s2p^2(^3P)^4P)^3P_2$		$(2s2p^2\ (^3P)^2P)^3P_2$	
(^3P)	(^4P)	^3P	0,91	0,93	0,89	0,04	−0,12	−0,14
(^1P)	(^2P)	^3P	0,05	0,07	0,05	0,06	0,90	0,92
(^1D)	(^2D)	^1D	−	−	−0,09	−0,09	−0,41	−0,36
(^1D)	(^2D)	^3D	−0,04	−0,05	−0,45	−0,54	−0,06	−0,06
(^1S)	(^2S)	^3S	−0,42	−0,35	−	−	−	−

Table 5

Comparison of radiative decay probabilities A (10^8 s^{-1}) of states $1s2p^2LSJ$ and $1s2s2pLSJ$ in the argon ion

Transition			A	A [6]	A [3]
$1s2p^2$	$^4P_{5/2} - 1s^22p$	$^2P_{3/2}$	7,54 + 3	–	8,16 + 3
	$^4P_{3/2}$ –	$^2P_{3/2}$	3.28 + 3	–	3,83 + 3
	$^4P_{3/2}$ –	$^2P_{1/2}$	3,49 + 1	–	1,01 + 1
	$^4P_{1/2}$ –	$^2P_{3/2}$	7,88 + 2	–	1,01 + 2
	$^2P_{1/2}$ –	$^2P_{1/2}$	5,94 + 3	–	3,90 + 3
	$^2P_{3/2}$ –	$^2P_{3/2}$	1,44 + 6	1,48 + 6	1,40 + 6
	$^2P_{3/2}$ –	$^2P_{1/2}$	1,05 + 5	9,54 + 4	1,00 + 5
	$^2P_{1/2}$ –	$^2P_{3/2}$	3,91 + 5	4,60 + 5	4,47 + 5
	$^2P_{1/2}$ –	$^2P_{1/2}$	1,20 + 6	1,19 + 6	1,12 + 6
	$^2D_{3/2}$ –	$^2P_{3/2}$	5,32 + 5	3,51 + 3	5,19 + 5
	$^2D_{5/2}$ –	$^2P_{3/2}$	8,95 + 2	5,29 + 5	4,95 + 2
	$^2D_{3/2}$ –	$^2P_{1/2}$	6.21 + 5	6,33 + 5	6,04 + 5
	$^2S_{1/2}$ –	$^2P_{3/2}$	5.17 + 5	4,45 + 5	4,00 + 5
	$^2S_{1/2}$ –	$^2P_{1/2}$	5,86 + 4	8,63 + 4	8,66 + 4
$1s2s2p$	$^4P_{3/2} - 1s^22s\,^2S_{1/2}$		3.89 + 3	–	4,32 + 3
	$^4P_{1/2}$ –		1,36 + 3	–	1,56 + 3
$1s2s(^1S)2p$	$^2P_{3/2}$		1,04 + 6	1,05 + 6	1,01 + 6
	$^2P_{1/2}$ –		8,99 + 5	8,88 + 5	8,70 + 5
$1s2s(^3S)2p$	$^2P_{3/2}$		4,57 + 4	6,29 + 4	4,18 + 4
	$^2P_{1/2}$		1,93 + 5	2,30 + 5	1,86 + 5

of up to 50%, and the weaker transitions differ even more. The probability values for the transitions $1s2p^2\ ^2D_{3/2}$ and $^2D_{5/2}-1s^22p^2P_{3/2}$ in Ref.[6] would appear to be misprints.

Table 6 compares the probabilities of a large number of transitions in chlorine, argon and potassium ions, calculated both by us and according to perturbation theory in Refs.[3-5]. The transition probabilities in two-electron ions obtained using each of the two methods are in very good agreement; the probabilities of a 2p-electron making the transition to a 1s-vacancy and for the configurations 1s2s2p, 1s2p3s, 1s2p3p and 1s2p3d are also in good agreement. We found that the probability of the transition $1s2p(^3P)3s^2P_{1/2}-1s^23s^2S_{1/2}$ was more strongly dependent on the nuclear charge than was found in Ref.[4]. For Cl XV, it differed by two orders of magnitude from the probability given in Ref.[4]; for the Cr XII ion [12], however, the probability we found for this transition (1.54×10^{13} s^{-1}) was in fact of the same order of magnitude as in Ref.[4] (6.04×10^{13} s^{-1}).

We have taken the transition probabilities in Be-like ions from Ref.[5] for comparison. It should be noted that the probabilities of $1s2s^22p$ LSJ

Table 6

Comparison of radiative transition probabilities A (10^{13} s^{-1})
in chlorine, argon and potassium ions

Transition			Cl		Ar		K	
			A	A [3 – 5]	A	A [3 – 5]	A	A [3 – 5]
1			2	3	4	5	6	7
$2s^2$	$^1S_0 - 1s2p$	$^1P_1$	1,89 + 0	1,86 + 0	2,30 + 0	2,25 + 0	2,85 + 0	2,68 + 0
		$^3P_1$	1.43 – 1	1,45 – 1	2,41 – 1	2,44 – 1	5.48 – 2	3,94 – 1
$2s2p$	$^1P_1 - 1s2s$	$^1S_0$	5,06 + 0	5,12 + 0	6,37 + 0	6,44 + 1	7,93 + 0	8,01 + 0
		$^3S_1$	1,92 – 2	2,16 – 2	3,36 – 2	3,73 – 2	5,64 – 2	8,24 – 2
	$^3P_1 -$	$^1S_0$	1,83 – 2	2,09 – 2	3,21 – 2	3,62 – 2	5,40 – 2	6,06 – 2
	$^3P_0 -$	$^3S_1$	5,02 + 0	5,02 + 0	6,34 + 0	6,33 + 0	7,00 + 0	7,89 + 0
	$^3P_1 -$	$^3S_1$	5,01 + 0	5,00 + 0	6,31 + 0	6,30 + 0	7,86 + 0	7,84 + 0
	$^3P_2 -$	$^3S_1$	5,04 + 0	5,04 + 0	6,37 + 0	6,36 + 0	7,94 + 0	7,93 + 0
$1s2s^2$	$^2S_{1/2} - 1s^22p$	$^2P_{1/2}$	1,45 – 1	1,34 – 1	1,82 – 1	1,72 – 1	1,89 – 1	2,18 – 1
		$^2P_{3/2}$	2,35 – 1	2,18 – 1	2,84 – 1	2,69 – 1	3,77 – 1	3,27 – 1
$1s2p(^1P)3s$	$^2P_{1/2} - 1s^23s$	$^2S_{1/2}$	9.00 + 0	3.77 + 0	1,13 + 0	7,14 + 0	1,41 + 1	1.01 + 1
	$^2P_{3/2} -$	$^2S_{1/2}$	8,83 + 0	6,90 + 0	1,11 + 1	8,70 + 0	1,38 + 1	1,06 + 1
$1s2p(^3P)3s$	$^2P_{1/2} -$	$^2S_{1/2}$	1,98 – 2	1,35 + 0	6,16 – 2	1,73 + 0	1,10 – 1	2,19 + 0
	$^2P_{3/2} -$	$^2S_{1/2}$	1,33 – 1	5,71 – 1	1,73 – 1	6,00 – 1	2,43 – 1	5,90 – 1
	$^4P_{1/2} -$	$^2S_{1/2}$	2,05 – 2	2,15 – 2	3,26 – 2	3,68 – 2	5,17 – 2	6,05 – 2
	$^4P_{3/2} -$	$^2S_{1/2}$	7,94 – 2	6,39 – 2	1,34 – 1	1,12 – 1	2,26 – 1	1,91 – 1
$1s2p(^1P)3p$	$^2S_{1/2} - 1s^23p$	$^2P_{1/2}$	1,17 + 0	1,38 + 0	1,33 + 0	1,62 + 0	1,43 + 0	1,86 + 0
		$^2P_{3/2}$	6,35 + 0	4,73 + 0	8,19 + 0	6,14 + 0	1,04 + 1	7,86 + 0
	$^2P_{1/2} -$	$^2P_{1/2}$	7,39 + 0	6,68 + 0	9,53 + 0	8,69 + 0	1,22 + 1	1,11 + 1
		$^2P_{3/2}$	7,82 + 0	7,72 + 0	9,95 + 0	9,74 + 0	1,25 + 1	1,21 + 1
	$^2D_{3/2} -$	$^2P_{3/2}$	7,80 + 0	6,96 + 0	9,94 + 0	8,88 + 0	1,25 + 1	1,12 + 1
	$^2D_{5/2} -$	$^2P_{3/2}$	8,63 + 0	7,04 + 0	1,09 + 1	9,05 + 0	1,34 + 1	1,16 + 1
$1s2p(^1P)3d$	$^2P_{3/2} - 1s^23d$	$^2D_{5/2}$	8,69 + 0	8,15 + 0	1,09 + 1	1,04 + 1	1,37 + 1	1,30 + 1
$1s2p(^1P)3d$	$^2D_{5/2} - 1s^23d$	$^2D_{5/2}$	8,30 + 0	7,97 + 0	1,06 + 1	1,01 + 1	1,31 + 1	1,27 + 1
	$^2P_{3/2} -$	$^2D_{3/2}$	7,94 + 0	7,39 + 0	1,00 + 1	9,41 + 0	1,26 + 1	1,18 + 1
	$^2F_{5/2} -$	$^2D_{3/2}$	6,98 + 0	6,69 + 0	7,20 + 0	6,88 + 0	8,81 + 0	8,32 + 0
	$^2D_{3/2} -$	$^2D_{3/2}$	7,26 + 0	7,10 + 0	8,91 + 0	8,77 + 0	1,08 + 1	1,06 + 1
	$^2F_{5/2} -$		1,34 + 0	1,25 + 0	1,88 + 0	1,77 + 0	2.63 + 0	2.48 + 0
	$^2F_{7/2} -$		7,51 + 0	7,06 + 0	9.43 + 0	8,96 + 0	1,18 + 1	1,12 + 1
$1s2s^22p$	$^1P_1 - 1s^22s^2$	$^1S_0$	8,03 + 0	6,37 + 0	1,02 + 1	8,16 + 0	1,28 + 1	1,03 + 1
	$^3P_1 -$		7,85 – 2	6,48 – 2	1,37 – 1	1,14 – 1	2,29 – 1	1,93 – 1

to $1s^22s^2$ $^1S_0$ transitions which we calculated are in good agreement with those calculated using perturbation theory [5]. Table 7 gives a comparison of the probabilities of electric dipole transitions $1s2s2p^2$ LSJ-$1s^22s2p$ L'S'J'. The probabilities of a number of transitions differ substantially from those obtained using perturbation theory [5]. These discrepancies are systematically

Table 7

Comparison of probabilities (10^{13} s^{-1}) of transitions
$1s2s(L_1S_1)2p^2(^3P)^3P_J-1s^22s2pLSJ'$

$(L_1S_1)^3P_J - LSJ'$	Cl XIV		Ar XV			K XVI		
	HFC	ET [5]	HFC	ET [5]	ARO	HFC	ET [5]	ARO
(^1S) $^3P_0-{}^1P_1$	3,19 − 5	7,89 − 5	9,52 − 5	1,02 − 4	3,79 − 4	2,27 − 4	1,25 − 4	6,35 − 5
$^3P_0-{}^3P_1$	1,12 + 1	9,17 + 0	1,42 + 1	1,17 + 1	1,46 + 1	1,79 + 1	1,46 + 1	1,78 + 1
$^3P_1-{}^3P_0$	6,15 + 0	8,69 − 1	7,97 + 0	8,05 − 1	8,39 + 0	1,01 + 1	6,68 − 1	9,86 + 0
$^3P_1-{}^1P_1$	1,97 − 4	1,16 − 3	4,66 − 4	2,48 − 3	7,34 − 4	8,59 − 4	5,08 − 3	3,97 − 4
$^3P_1-{}^3P_1$	7,57 − 1	3,94 + 0	8,34 − 1	5,20 + 0	6,94 − 1	9,79 − 1	6,70 + 0	1,63 + 0
$^3P_1-{}^3P_2$	2,58 + 0	3,31 + 0	3,03 + 0	3,95 + 0	2,93 + 0	3,59 + 0	4,59 + 0	4,38 + 0
$^3P_2-{}^1P_1$	7,80 − 3	7,53 − 3	1,47 − 2	1,45 − 2	2,57 − 2	2,72 − 2	2,72 − 2	3,25 − 2
$^3P_2-{}^3P_1$	3,23 − 1	1,16 + 0	5,02 − 1	1,39 + 0	6,71 − 1	6,92 − 1	1,62, + 0	3,74 − 1
$^3P_2-{}^3P_2$	9,05 + 0	7,95 + 0	1,17 + 1	1,02 + 1	1,22 + 1	1,47 + 1	1,29 + 1	1,42 + 1
(^3S) $^3P_0-{}^1P_1$	9,31 − 2	6,44 − 2	1,56 − 1	9,53 − 2	1,56 − 1	2,63 − 1	1,60 − 1	2,59 − 1
$^3P_0-{}^3P_1$	7,83 − 1	2,55 + 0	1,60 + 0	3,32 + 0	1,58 + 0	1,44 + 0	4,29 + 0	1,63 + 0
$^3P_1-{}^3P_0$	7,66 − 2	3,74 − 1	7,44 − 2	3,99 − 1	6,94 − 2	6,71 − 2	4,09 − 1	7,63 − 2
$^3P_1-{}^1P_1$	3,81 − 2	4,71 − 2	6,97 − 2	7,47 − 2	3,63 − 2	8,83 − 2	1,13 − 1	8,17 − 2
$^3P_1-{}^3P_1$	4,04 − 2	2,32 − 1	3,23 − 2	2,32 − 1	4,51 − 3	2,09 − 2	2,20 − 1	2,04 − 2
(^3S) $^3P_1-{}^3P_2$	7,76 − 1	1,97 + 0	1,20 + 0	2,78 + 0	2,22 + 0	1,82 + 0	3,84 + 0	2,09 + 0
$^3P_2-{}^1P_1$	3,99 − 1	7,27 − 1	6,64 − 1	1,14 + 0	8,70 − 1	1,03 + 0	1,65 + 0	7,94 − 1
$^3P_2-{}^3P_1$	7,32 − 2	3,11 − 1	7,83 − 2	3,41 − 1	1,06 − 1	8,11 − 2	3,68 − 1	1,06 − 1
$^3P_2-{}^3P_2$	3,46 − 1	1,19 + 0	3,97 − 1	1,34 + 0	6,52 − 1	4,41 − 1	1,50 + 0	6,86 − 1

conserved over the isoelectronic sequence in the transition from Cl XIV to K XVI and in some cases reach an order of magnitude. To verify that our calculations were correct we obtained the probabilities of the same transitions in Ar XV and K XVI ions using analytical radial orbitals. We also used the two electron moment coupling schemes, both $1s2s(L_1S_1)2p^2(L_2S_2)LSJ$ and $1s(2s2p^2(L_2S_2)L_1S_1)LSJ$. The transition probabilities calculated with each of the two electron moment coupling schemes, as might be expected, were identical, and therefore only one set is included in Table 7 (ARO). They are close to the values obtained from the Hartree-Fock functions.

The probability of the magnetic quadrupole transition $1s2p\,^3P_2-1s^2\,^1S_0$ was calculated using analytical radial orbitals (Eq. (8)). The values obtained were 1.97×10^8 s^{-1} for Cl XVI, 3.18×10^8 s^{-1} for Ar XVII and 4.97×10^8 s^{-1} for K XVIII. These are in good agreement with the values obtained using the more accurate relativistic version of the random phase method with replacement [17]: 1.96×10^8 s^{-1} for Cl XVI and 3.16×10^8 s^{-1} for Ar XVII, and also with experimental measurements $(2.7 \pm 0.3) \times 10^8$ s^{-1} [18] and $(2.3 \pm 1) \times 10^8$ s^{-1} [19] for chlorine and argon, respectively.

3.3. Auto-ionization probabilities

For practical applications, the total probability of auto-ionization decay of the state under investigation is of great importance. Some doubly excited states can decay with the emission of an electron having either of the two possible values of the momentum ℓ. In Be-like ions, states are encountered which, when they decay, result in ions in states with various configurations, for example $1s2s^22p$-$1s^22s\varepsilon p$ and $1s^22p\varepsilon s$, $1s2s2p^2$-$1s^22s\varepsilon s$, εd and $1s^22p\varepsilon p$. The auto-ionization probability values summed for all possible decay paths are shown in the tables; they were calculated using the analytical radial orbitals of Eq. (8), in accordance with the programs in Refs.[20, 21]. The Coulomb functions of an electron in a continuous spectrum were orthogonalized to the radial orbitals of the core using the Gram-Schmidt procedure. The calculations showed that the contribution from the orthogonality of the continuous spectrum function was insignificant for the multiply charged ions under investigation. The probabilities were, however, highly dependent on the values of the auto-ionization energy. When the energies were uncorrected for relativistic effects, the auto-ionization probabilities of states of the form $2s^2\ {}^1S_0$, $1s2s^2\ {}^2S_{1/2}$, $1s2s({}^3S)2p\ {}^2P_{3/2}$ and so on vary severalfold.

A comparison is given in Table 8 of the auto-ionization probabilities for states of the configurations 2l2l' and 1s2l2l' as obtained by us, as found using the 1/z perturbation theory [3] and also as determined using numerical solutions to the Hartree-Fock equations with the relativistic corrections from Ref.[6]. Table 8 shows that, for most states with high auto-ionization probabilities, the results are in good agreement; a similar conclusion is reached in Ref.[22], where the auto-ionization probabilities for states of the two-electron ion of titanium obtained using the perturbation theory and in a Hartree-Fock-Pauli approximation are compared, and in Ref.[12], which gives a detailed comparison of the auto-ionization characteristics of states of the chromium ion determined using numerical solutions to the Hartree-Fock equations, analytical radial orbitals and perturbation theory methods. However, for some states, the auto-ionization probabilities calculated by us and those given in Ref.[3] differ significantly; for example, for levels $J = 0$ the configuration $2p^2$ $J = 1/2$ - $1s2p^2$. In Ref.[6], the auto-ionization probabilities for some states of configurations $1s2s2p$ and $1s2p^2$ are determined using numerical solutions to the Hartree-Fock equations with relativistic corrections. The probabilities taken from Ref.[6] are in six cases out of nine closer to our values than to the ones from perturbation theory [3]. The greatest deviation is for level $J = 1/2$ of the configuration $1s2p^2$.

Table 8

Comparison of auto-ionization decay probabilities $\Gamma(10^{13}\ s^{-1})$ for levels of configurations $2l2l^1$ and $1s2l2l^1$ in ions of chlorine, argon and potassium

State		Cl		Ar			K	
		Γ	Γ [3]	Γ	Γ [3]	Γ [6]	Γ	Γ [3]
$2s^2$	$^1S_0$	3,85 + 1	3,38 + 1	3,56 + 1	3,36 + 1	–	3,79 + 1	3,35 + 1
2s2p	$^1P_1$	1,84 + 1	2,02 + 1	1,79 + 1	2,01 + 1	–	2,07 + 1	2,01 + 1
	$^3 3_0$	1,59 + 0	1,35 + 0	1,54 + 0	1,35 + 0	–	1,95 + 0	1,35 + 0
	$^3P_1$	1,64 + 0	1,43 + 0	1,62 + 0	1,46 + 0	–	2,11 + 0	1,50 + 0
	$^3P_2$	1,58 + 0	1,35 + 0	1,54 + 0	1,35 + 0	–	1,94 + 0	1,35 + 0
$2p^2$	$^1S_0$	1,61 + 1	2,23 + 0	1,43 + 1	2,35 + 0	–	1,54 + 1	2,49 + 0
	$^3P_0$	2,61 – 1	9,26 – 2	3,16 – 1	1,18 – 1	–	4,46 – 1	1,49 – 1
	$^3P_2$	1,30 + 0	1,73 + 0	1,87 + 0	2,41 + 0	–	2,58 + 0	2,35 + 0
	$^1D_2$	3,32 + 1	3,56 + 1	3,25 + 1	3,49 + 1	–	3,19 + 1	3,41 + 1
$1s2s^2$	$^2S_{1/2}$	1,12 + 1	1,52 + 1	1,06 + 1	1,51 + 1	–	1,14 + 1	1,51 + 1
$1s2s(^1S)2p$	$^2P_{1/2}$	1,81 + 0	1,11 + 0	1,67 + 0	1,26 + 0	1,28 + 0	1,94 + 0	1,43 + 0
	$^2P_{3/2}$	8,49 – 1	1,73 – 1	5,19 – 1	1,34 – 1	2,40 – 1	5,25 – 1	9,83 – 2
$1s2s(^3S)2p$	$^2P_{1/2}$	6,85 + 0	1,10 + 1	7,62 + 0	1,08 + 1	8,27 + 0	7,25 + 0	1,07 + 1
	$^2P_{3/2}$	7,79 + 0	1,19 + 1	8,76 + 0	1,20 + 1	7,23 + 0	8,65 + 0	1,20 + 1
	$^4P_{1/2}$	8,53 – 4	2,90 – 3	1,65 – 3	3,97 – 3	–	2,26 – 3	5,31 – 3
	$^4P_{3/2}$	2,65 – 3	1,30 – 2	4,92 – 3	8,08 – 3	–	7,35 – 3	1,15 – 2
$1s2p^2$	$^2S_{1/2}$	7,72 + 0	2,81 + 0	6,25 + 0	2,85 + 0	2,04 + 0	7,55 + 0	2,90 + 0
	$^2P_{1/2}$	1,61 – 1	1,14 – 2	1,68 – 1	1,61 – 2	1,56 – 2	2,72 – 1	2,21 – 2
	$^2P_{3/2}$	9,26 – 1	1,03 + 0	1,17 + 0	1,33 + 0	1,00 + 0	1,40 + 0	1,68 + 0
	$^4P_{1/2}$	4,85 – 2	1,27 – 3	6,40 – 2	1,97 – 3	–	9,33 – 2	3,01 – 3
	$^4P_{3/2}$	1,76 – 2	1,30 – 2	2,37 – 2	1,80 – 2	–	3,28 – 2	2,41 – 2
	$^4P_{5/2}$	1,52 – 1	2,04 – 1	2,16 – 1	2,92 – 1	–	3,19 – 1	4,12 – 1
	$^2D_{3/2}$	1,45 + 1	1,76 + 1	1,43 + 1	1,73 + 1	1,16 + 1	1,43 + 1	1,69 + 1
	$^2D_{5/2}$	1,53 + 1	1,84 + 1	1,53 + 1	1,83 + 1	1,25 + 1	1,54 + 1	1,82 + 1

Auto-ionization of the state $1s2p^2\ ^2P_{1/2}$ in pure LS coupling is forbidden. The non-zero auto-ionization probabilities are obtained through admixture of the wave function of level $1s2p^2\ ^2P_{1/2}$. Hence the differences in the auto-ionization probabilities for states $^2S_{1/2}$ and $^2P_{1/2}$ are due to the different coefficients of the polynomial wave functions found by us and in Refs.[3, 6], i.e. to small differences in allowing for the spin-orbital interaction energy.

Table 9 gives a comparison of the auto-ionization probabilities for states of configurations 1s2p3l determined using analytical radial orbitals and calculated by the perturbation theory method [4]. Agreement between the probabilities can be considered satisfactory, since the differences in most cases do not exceed a factor of two. Greater divergences are observed only for those auto-ionization transitions which are forbidden in pure LS coupling.

Table 9

Comparison of auto-ionization decay probabilities Γ(10^{13} s^{-1}) of configurations $1s2l3l^1$ in three-electron ions of chlorine, argon and potassium

State		Cl XV		Ar XVI		K XVII	
		Γ	Γ [4]	Γ	Γ [4]	Γ	Γ [4]
$1s2p(^3P)3s$	$^2P_{1/2}$	1,57 + 0	4,08 + 0	1,76 + 0	4,05 + 0	1,84 + 0	4,05 + 0
	$^2P_{3/2}$	1,60 + 0	4,66 + 0	1,78 + 0	4,73 + 0	1,88 + 0	4,79 + 0
	$^4P_{1/2}$	1,28 − 2	2,71 − 3	2,07 − 2	3,76 − 3	2,49 − 2	5,03 − 3
	$^4P_{3/2}$	3,26 − 2	1,95 − 2	5,17 − 2	2,70 − 2	6.38 − 2	3,64 − 2
$1s2p(^1P)3p$	$^2S_{1/2}$	2,95 + 0	1,31 + 0	2,81 + 0	1,33 + 0	2,89 + 0	1,36 + 0
	$^2P_{1/2}$	3,56 − 2	1,96 − 6	3,86 − 2	3,48 − 6	4,94 − 2	4,58 − 6
	$^2P_{3/2}$	2,78 − 1	1.39 + 0	3,31 − 1	1,51 + 0	4,39 − 1	1,63 + 0
	$^2D_{3/2}$	7,80 + 0	4,45 + 0	3,99 + 0	4,40 + 0	4,13 + 0	4,36 + 0
	$^2D_{5/2}$	8,63 + 0	4,90 + 0	3,39 + 0	4,83 + 0	3,47 + 0	4,74 + 0
$1s2p(^3P)3p$	$^2S_{1/2}$	7,71 − 1	2,29 − 1	7,15 − 1	2,30 − 1	8,58 − 1	2,31 − 1
	$^2P_{1/2}$	2.03 − 3	1,75 − 3	1,58 − 3	2,29 − 3	2,34 − 3	2,88 − 3
	$^2P_{3/2}$	2,33 − 2	1,31 − 2	3,74 − 2	1,90 − 2	4,61 − 2	–
	$^2D_{3/2}$	2,30 + 0	1,81 + 0	2,41 + 0	1,71 + 0	2,25 + 0	1,65 + 0
	$^2D_{5/2}$	3,00 + 0	3,12 + 0	3,28 + 0	3,19 + 0	3,28 + 0	3,27 + 0
$1s2p(^1P)3d$	$^2P_{1/2}$	5,81 − 2	3,36 − 1	6,18 − 2	3,29 − 1	6,29 − 2	3,23 − 1
	$^2P_{3/2}$	5,66 − 2	3,20 − 1	5,97 − 2	3,12 − 1	6.06 − 2	3,04 − 1
	$^2D_{3/2}$	4,26 − 4	9,14 − 4	5,32 − 4	1.21 − 3	7,40 − 4	1,55 − 3
	$^2D_{5/2}$	3,24 − 2	5,52 − 2	5,13 − 2	7,31 − 2	6.66 − 2	9,46 − 2
	$^2F_{5/2}$	1,34 + 0	2,01 + 0	1,39 + 0	1,99 + 0	1,40 + 0	1,97 + 0
	$^2F_{7/2}$	1,37 + 0	2,07 + 0	1,44 + 0	2,07 + 0	1,46 + 0	2,08 + 0

Table 10

Comparison of auto-ionization probabilities Γ(10^{13} s^{-1}) for levels of configurations $1s2s^22p$ and $1s2s2p^2$ in ions of chlorine, argon and potassium

State		Cl XIV		Ar XV		K XVI	
		Γ	Γ [5]	Γ	Γ [5]	Γ	Γ [5]
$1s2s^22p$	$^1P_1$	5,05 + 0	7,91 + 0	6,50 + 0	7,96 + 0	6,71 + 0	8,01 + 0
	$^3P_1$	9,80 + 0	1,52 + 1	1,20 + 1	1,52 + 1	1,23 + 1	1,52 + 1
$1s(2s2p^2(^3P)\,^4P)$	$^3P_0$	2,24 + 0	6,24 + 0	2,84 + 0	6,37 + 0	2.44 + 0	6,53 + 0
	$^3P_1$	3,32 + 0	9,24 + 0	8,22 + 0	1,02 + 1	5,26 + 0	1,12 + 1
	$^3P_2$	7,28 + 0	8,65 + 0	7,14 + 0	6,88 + 0	6,47 + 0	7,12 + 0
$1s(2s2p^2(^3P)\,^2P)$	$^3P_0$	1,16 + 1	1,53 + 1	1,31 + 1	1,52 + 1	1,26 + 1	1,51 + 1
	$^3P_1$	1,49 + 1	1,51 + 1	1,18 + 1	1,49 + 1	1,61 + 1	1,46 + 1
	$^3P_1$	1,27 + 1	2,04 + 1	3,91 + 1	2,14 + 1	1,39 + 1	2,23 + 1
	$^1P_1$	3.15 + 0	8,35 + 0	6,50 + 0	8.37 + 0	3,59 + 0	8,39 + 0
$1s(2s2p^2(^1S)\,^2S)$	$^1S_0$	1,76 + 1	2,38 + 1	2.03 + 1	2,37 + 1	1,83 + 1	2,37 + 1
	$^3S_1$	8,79 + 0	1,12 + 1	1,06 + 1	1,15 + 1	9.32 + 0	1,18 + 1
$1s(2s2p^2(^1D)\,^2D)$	$^3D_1$	1,50 + 1	1,79 + 1	1,35 + 1	1,69 + 1	1,39 + 1	1,58 + 1
	$^3D_2$	1,06 + 1	2,03 + 1	1,47 + 1	2,00 + 1	1,25 + 1	1,98 + 1
	$^3D_3$	1,59 + 1	2,14 + 1	1,91 + 1	2,14 + 1	1,67 + 1	2,13 + 1
	$^1D_2$	2,42 + 1	3,03 + 1	3,35 + 1	2,93 + 1	2,48 + 1	2,84 + 1

The auto-ionization probabilities for states with configurations $1s2s^2 2p$, $1s2s2p^2$ and $1s2p^3$ for Be-like ions were determined in Ref.[5] using the 1/z perturbation theory method. Here, the energy used for an electron in a continuum was $(z - 2)^2/4$ for all ions with a nuclear charge $z > 10$. Table 10 gives a comparison of the auto-ionization probabilities of states $1s2s^2 2p$ LSJ and $1s2s2p^2$ LSJ calculated by us with those taken from Ref.[5]. As can be seen from the numerical data in Table 10, the auto-ionization probabilities given by the two methods are in excellent agreement for most states, the differences remaining within 50%. The auto-ionization probability values strongly on the quality of the radial wave functions, as they are calculated in a zero-order approximation with respect to electrostatic interelectron interaction (Eq. (9)). The differences in the auto-ionization probabilities obtained (see Tables 9 and 10) are due to the use of different radial orbitals. In the present work, we used variational analytical radial orbitals which approximated well to the numerical solutions of the Hartree-Fock equations, while in Ref.[5] hydrogen wave functions were used. The intermediate coupling wave functions must be similar, since both methods allow for relativistic corrections of order α^2 (there may be differences when the small terms are taken into account). The good agreement between the wavelengths and the radiative transition probabilities is a further indication that this is so, particularly for the two- and three-electron ions. To elucidate the reasons for the divergences observed, we need calculated data obtained using other methods.

From the expression for the coefficient $q(\beta J - \beta' J')$ (Eq.(10)) it follows that the accuracy of the auto-ionization probability plays an important role in determining emission spectra. The probabilities of radiative and auto-ionization transitions for the strong lines in the cases considered are of approximately the same order, and the coefficient $K(\beta J)$ differs from unity.

4. CONCLUSIONS

Analysis of the results obtained leads to the following conclusions:

1. The wavelengths of the electron transitions when a vacancy in the 1s-shell of multiply charged argon, chlorine and potassium ions is filled can be determined to an accuracy of $\Delta\lambda/\lambda \sim 10^{-4}$ even using a one-configuration Hartree-Fock approximation with relativistic corrections of order α^2. This degree of accuracy is adequate for the needs of spectroscopic diagnosis of multiply-charged impurity ions of intermediate and heavy elements in tokamak plasmas. Any of the methods examined can be used for this purpose when corrected for relativistic effects: Hartree-Fock approximation on the basis of numerical or analytical radial wave functions, and perturbation theory as well;
2. Electron transition probabilities of the order of 10^{12}-10^{14} s^{-1} can be determined with the same degree of accuracy both by the perturbation theory method and by using numerical solutions to the Hartree-Fock equations or analytical radial orbitals, with relativistic corrections of order α^2 in all three cases. The worst agreement between the radiative transition probabilities is obtained for weak intercombination and other forbidden transitions, which become allowed transitions through the appearance of intermediate coupling of electron moments. The inaccuracy in the determination of weak radiative transition probabilities has no effect on the shape of the integral spectrum, and little on its component parts;
3. The quality of the radial wave functions used in determining the auto-ionization probabilities in a zero-order approximation for the electrostatic interelectron interaction is extremely important for multiply-charged ions such as chlorine, argon and potassium. The auto-ionization probabilities determined using numerical solutions to the Hartree-Fock equations, variational analytical and hydrogen radial orbitals differ by factors of 1.5-2 or even more. The reason for the divergence would appear to be the differing accuracies of the radial wave functions used, since the energies are determined roughly in the same approximation, and the wavelengths and radiative transition probabilities are in fairly good agreement. Further calculations of the auto-ionization probabilities using other methods are thus desirable. Accuracy in the auto-ionization probabilities is essential, as they are mostly of the same order of magnitude as the radiative transition probabilities.

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Annex 1

WAVELENGTHS (A), RADIATIVE TRANSITION PROBABILITIES A AND AUTO-IONIZATION PROBABILITIES Γ(10^{13} s^{-1}) FOR Cl XVI, Cl XV AND Cl XIV

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2p - 1s^2$									
113	101	4,4438	8,88+0		315	101	4,4646	1,97-5	
313	101	4,4684	9,12-2						
$2s^2 - 1s2p$									
101	113	4,2786	1,89+0	3,85+1	101	313	4,2559	1,43-1	3,85+1
$2s2p - 1s2s$									
311	303	4,2245	5,02+0	1,59+0	113	303	4,1827	1,92-2	1,84+1
113	101	4,2092	5,06+0	1,84+1	313	303	4,2229	5,01+0	7,34-2
313	101	4,2499	1,83-2	1,64+0	315	303	4,2192	5,04+0	1,58+0
$2p^2 - 1s2p$									
311	113	4,2493	5,96-3	2,61-1	313	315	4,2281	4,21+0	0
101	113	4,2104	1,02+1	1,61+1	315	113	4,2440	2,01-1	1,30+0
311	313	4,2270	1,01+1	2,07-1	125	113	4,2311	9,79+0	3,32+1
101	313	4,1884	6,22-3	1,28+1	315	313	4,2217	2,61+0	1,30+0
313	311	4,2233	3,38+0	0	125	313	4,2089	1,57-4	3,32+1
313	113	4,2470	2,57-2	0	315	315	4,2251	7,30+0	1,30+0
313	313	4,2247	2,50+0	0	125	315	4,2123	2,84-1	3,32+1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s^2 - 1s^2 2p$									
202	212	4,5859	1,45-1	1,12+1	202	214	4,5901	2,35-1	1,12+1
$1s2s(^1S)2p - 1s^2 2s$									
212	202	4,4848	6,82+0	1,81+0	214	202	4,4823	7,85+0	8,49-1
$1s2s(^3S)2p - 1s^2 2s$									
212	202	4,4653	1,75+0	6,85+0	214	202	4,4643	7,11-1	7,79+0
412	202	4,5240	7,92-3	8,53-4	414	202	4,5223	2,22-2	2,65-3
$1s2p^2 - 1s^2 2p$									
212	212	4,4871	9,31+0	1,61-1	414	212	4,5183	1,94-4	1,76-2
412	212	4,5203	3,21-2	4,85-2	224	212	4,4921	4,73+0	1,45+1
202	212	4,4689	5,53-1	7,72+0	214	214	4,4867	1,13+1	9,26-1
212	214	4,4910	3,19+0	1,61-1	414	214	4,5223	1,89-2	1,76-2
412	214	4,5243	4,73-3	4,85-2	224	214	4,4960	2,87-4	1,45+1
202	214	4,4728	3,89+0	7,72+0	416	214	4,5196	4,08-2	1,52-1
214	212	4,4827	9,09-1	9,26-1	226	214	4,4953	4,17+0	1,53+1
$1s2p(^3P)3s - 1s^2 3s$									
212	202	4,4514	9,00+0	5,31-2	214	202	4,4510	8,83+0	2,70-7
$1s2p(^1P)3s - 1s^2 3s$									
212	202	4,4706	1,98-2	1,57+0	214	202	4,4672	1,33-1	1,60+0
412	202	4,4802	2,05-2	1,26-2	414	202	4,4786	7,94-2	3,26-2
$1s2p(^1P)3p - 1s^2 3p$									
202	212	4,4467	1,17+0	2,95+0	224	212	4,4534	7,80+0	4,13+0
212	212	4,4518	7,39+0	3,56-2	214	214	4,4513	7,82+0	2,78-1
202	214	4,4479	6,35+0	2,95+0	224	214	4,4546	4,47-1	4,13+0
212	214	4,4529	1,20+0	3,56-2	226	214	4,4543	8,63+0	3,64+0
214	212	4,4502	5,09-1	2,78-1					

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2p(^3P)3p - 1s^23p$									
202	212	4,4627	8,28-2	7,71-1	224	212	4,4706	4,16-1	2,30+0
212	212	4,4795	3,12-1	2,03-3	424	212	4,4845	7,66-2	5,35-3
412	212	4,4763	1,49-2	4,67-2	404	214	4,4783	6,91-2	3,26-2
422	212	4,4857	6,17-2	2,11-4	214	214	4,4817	2,41-1	2,33-2
202	214	4,4638	1,46+0	7,71-1	414	214	4,4755	1,94-3	1,27-2
212	214	4,4807	1,53-2	2,03-3	224	214	4,4718	4,20-1	2,30+0
412	214	4,4774	7,12-3	4,67-2	424	214	4,4856	2,45-2	5,35-3
422	214	4,4868	1,57-2	2,11-4	416	214	4,4742	2,91-3	1,22-1
404	212	4,4771	1,05-1	3,26-2	226	214	4,4681	3,29-1	3,00+0
214	212	4,4805	1,13-1	2,33-2	426	214	4,4835	4,28-2	2,59-6
414	212	4,4743	2,28-5	1,27-2					
$1s2p(^1P)3d - 1s^23d$									
212	224	4,4434	8,69+0	5,81-2	226	224	4,4484	1,58+0	3,24-2
214	224	4,4425	5,97-1	5,66-2	236	224	4,4450	5,98+0	1,34+0
224	224	4,4488	8,30+0	4,26-4	226	226	4,4488	7,26+0	3,24-2
214	226	4,4429	7,94+0	5,66-2	236	226	4,4453	1,34+0	1,34+0
224	226	4,4492	5,36-1	4,26-4	238	226	4,4463	7,51+0	1,37+0
$1s2p(^3P)3d - 1s^23d$									
212	224	4,4607	3,45-1	4,47-3	416	224	4,4679	5,27-1	4,53-3
412	224	4,4676	1,96-4	8,15-7	226	224	4,4758	1,37-1	7,01-4
422	224	4,4718	4,36-2	2,72-4	426	224	4,4715	4,01-2	1,40-3
214	224	4,4630	1,59-2	5,38-3	236	224	4,4685	7,25-1	9,16-3
414	224	4,4678	2,51-3	1,67-6	436	224	4,4788	5,97-2	4,83-3
224	224	4,4759	6,61-2	3,65-4	416	226	4,4683	9,80-2	4,53-3
424	224	4,4718	2,33-2	7,45-5	226	226	4,4762	6,28-2	7,01-4
434	224	4,4799	5,03-2	1,31-5	426	226	4,4718	3,95-2	1,40-3
214	226	4,4634	5,77-1	5,38-3	236	226	4,4689	2,34-1	9,16-3
414	226	4,4682	6,19-4	1,67-6	436	226	4,4792	1,56-2	4,83-3
224	226	4,4762	1,96-2	3,65-4	428	226	4,4696	7,75-3	4,02-3
424	226	4,4721	5,01-3	7,45-5	238	226	4,4650	1,50+0	1,13-2
434	226	4,4803	1,06-3	1,31-5	438	226	4,4775	3,60-2	6,85-3

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2p(^1P)4s - 1s^24s$									
212	202	4,4467	9,00+0	3,42-2	214	202	4,4466	8,95+0	5,29-3
$1s2p(^3P)4s - 1s^24s$									
212	202	4,4696	4,79-2	5,75-1	214	202	4,4659	2,71-2	5,88-1
412	202	4,4738	1,65-2	2,13-2	414	202	4,4724	9,28-2	3,65-2
$1s2p(^1P)4p - 1s^24p$									
202	212	4,4455	1,79+0	7,82-1	224	212	4,4476	8,47+0	1,18+0
212	212	4,4474	7,17+0	2,61-3	214	214	4,4472	8,44+0	9,23-2
202	214	4,4460	7,12+0	7,82-1	224	214	4,4481	4,15-1	1,18+0
212	214	4,4478	1,78+0	2,61-3	226	214	4,4478	8,98+0	9,60-1
214	212	4,4467	4,11-1	9,23-2					
$1s2p(^3P)4p - 1s^24p$									
202	212	4,4640	3,14-3	7,09-1	224	212	4,4679	5,08-3	8,67-1
212	212	4,4715	3,82-3	7,24-2	424	212	4,4746	4,59-2	2,20-2
412	212	4,4721	7,45-2	9,80-4	404	214	4,4736	6,46-2	4,19-2
422	212	4,4755	2,96-2	1,84-3	214	214	4,4710	1,92-2	4,65-1
202	214	4,4645	1,38-1	7,09-1	414	214	4,4693	2,98-3	4,60-2
212	214	4,4720	2,67-3	7,24-2	224	214	4,4684	1,11-1	8,67-1
412	214	4,4726	2,50-2	9,80-4	424	214	4,4751	2,48-3	2,20-2
422	214	4,4760	6,27-3	1,84-3	416	214	4,4691	4,72-2	7,72-2
404	212	4,4731	5,79-2	4,19-2	226	214	4,4662	6,61-3	1,61+0
214	212	4,4705	6,40-2	4,65-1	426	214	4,4736	6,64-2	7,61-2
414	212	4,4688	4,60-5	4,60-2					
$1s2p(^1P)4d - 1s^24d$									
212	224	4,4441	9,00+0	3,37-2	226	224	4,4457	2,89+0	6,55-2
214	224	4,4437	6,64-1	3,32-2	236	224	4,4452	5,89+0	6,39-1
224	224	4,4459	8,31+0	9,62-5	226	226	4,4459	6,07+0	6,55-2
214	226	4,4439	8,27+0	3,32-2	236	226	4,4453	2,83+0	6,39-1
224	226	4,4461	6,53-1	9,62-5	238	226	4,4458	8,91+0	6,74-1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2p(^3P)4d - 1s^24d$									
212	224	4,4635	1,86-2	2,92-4	416	224	4,4693	6,98-2	4,01-3
412	224	4,4660	6,76-5	8,38-8	226	224	4,4713	8,66-2	9,40-4
422	224	4,4699	6,24-2	1,95-4	426	224	4,4662	4,61-2	5,25-3
214	224	4,4649	1,05-2	5,39-4	236	224	4,4668	6,17-2	1,28-2
414	224	4,4662	1,62-3	4,07-6	436	224	4,4725	3,30-2	4,95-3
224	224	4,4709	7,46-3	3,67-4	416	226	4,4695	7,60-2	4,01-3
424	224	4,4699	4,49-2	3,90-6	226	226	4,4715	1,95-2	9.40-4
434	224	4,4735	2,76-2	1,18-5	426	226	4,4663	1,58-2	5,25-3
214	226	4,4650	8,15-2	5,39-4	236	226	4,4669	5,40-2	1,28-2
414	226	4,4663	1,05-3	4,07-6	436	226	4,4727	3,77-3	4,95-3
224	226	4,4710	7,20-2	3,67-4	428	226	4,4671	2,00-3	2,93-3
424	226	4,4701	7,91-6	3,90-6	238	226	4,4644	1,04-1	4,43-2
434	226	4,4736	1,09-4	1,18-5	438	226	4,4714	5,22-2	1,13-2
$1s2p(^1P)4f - 1s^24f$									
224	236	4,4430	9,01+0	8,74-5	238	236	4,4447	4,19-1	1,71-5
226	236	4,4429	3,79-1	6,70-5	248	236	4,4435	8,56+0	4,27-2
236	236	4,4448	8,60+0	1,53-6	238	238	4,4448	8,55+0	1,71-5
226	238	4,4429	8,62+0	6,70-5	248	238	4,4436	4,17-1	4,27-2
236	238	4,4449	3,76-1	1,53-6	2410	238	4,4436	9,00+0	4,17-2
$1s2p(^3P)4f - 1s^24f$									
224	236	4,4638	4,89-6	2,02-4	428	236	4,4650	1,82-3	5,49-5
424	236	4,4644	2,83-3	3,96-5	238	236	4,4653	5,36-3	1,29-4
434	236	4,4692	7,58-2	1,25-5	438	236	4,4681	1,41-4	1,27-4
226	236	4,4650	3,83-3	8,30-5	248	236	4,4702	2,15-7	5,11-5
426	236	4,4644	1,01-5	8,31-5	448	236	4,4691	9,33-2	1,54-4
236	236	4,4704	4,94-4	2,71-5	428	238	4,4651	6,53-4	5,49-5
436	236	4,4692	6,04-3	1,13-5	238	238	4,4654	2,30-3	1,29-4
446	236	4,4683	9,08-2	6,92-5	438	238	4,4682	1,04-1	1,27-4
226	238	4,4651	5,12-4	8,30-5	248	238	4,4703	2,23-4	5,11-5
426	238	4,4645	6,83-3	8,31-5	448	238	4,4692	3,25-8	1,54-4
236	238	4,4705	4,26-5	2,71-5	4310	238	4,4690	7,80-2	7,96-4
436	238	4,4693	7,47-2	1,13-5	2410	238	4,4644	2,85-4	6,58-4
446	238	4,4684	7,58-3	6,92-5	4410	238	4,4654	1,85-3	6,38-5

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s^22p - 1s^22s^2$									
113	101	4,5162	8,03+0	5,06+0	313	101	4,5401	7,85-2	9,80+0
315	101	4,5365	1,72-5	9,85+0	311				9,86+0
$1s2s(^1S)2p^2 - 1s^22s2p$									
311	113	4,5722	3,19-5	2,24+0	313	315	4,5299	2,58+0	3,32+0
101	113	4,5179	3,93+0	1,76+1	315	113	4,5674	7,80-3	7,28+0
311	313	4,5280	1,12+1	2,24+0	125	113	4,5408	3,55+0	2,42+1
101	313	4,4747	4,62-4	1,76+1	315	313	4,5233	3,23-1	7,28+0
313	311	4,5260	6,15+0	3,32+0	125	313	4,4972	1,14-2	2,42+1
313	113	4,5714	1,97-4	3,32+0	315	315	4,5259	9,05+0	7,28+0
313	313	4,5272	7,57-1	3,32+0	125	315	4,4998	1,61-1	2,42+1
$1s2s(^3S)2p^2 - 1s^22s2p$									
311	113	4,5407	9,31-2	1,16+1	113	315	4,4786	7,65-4	3,15+0
311	313	4,4967	7,83-1	1,16+1	313	315	4,4973	7,76-1	1,49+1
113	311	4,4749	3,25-3	3,15+0	513	315	4,5780	8,77-4	2,24-2
313	311	4,4935	7,66-2	1,49+1	303	315	4,5066	2,27+0	8,79+0
513	311	4,5741	3,31-3	2,24-2	323	315	4,5277	1,73+0	1,50+1
303	311	4,5028	3,55-1	8,79+0	315	113	4,5357	3,99-1	1,27+1
323	311	4,5239	7,83-2	1,50+1	515	113	4,6186	2,30-7	8,80-3
113	113	4,5192	1,20+1	3,15+0	325	113	4,5706	1,83-3	1,06+1
313	113	4,5383	3,81-2	1,49+1	315	313	4,4922	7,32-2	1,27+1
513	113	4,6204	9,25-8	2,24-2	515	313	4,5735	1,49-5	8,80-3
303	113	4,5477	2,74-2	8,79+0	325	313	4,5264	5,58+0	1,06+1
323	113	4,5692	4,46-3	1,50+1	315	315	4,4948	3,46-1	1,27+1
113	313	4,4761	8,12-4	3,15+0	515	315	4,5762	7,32-3	8,80-3
313	313	4,4947	4,04-2	1,49+1	325	315	4,5290	4,29-1	1,06+1
513	313	4,5753	9,30-3	2,24-2	517	315	4,5737	1,02-2	4,11-2
303	313	4,5040	1,20+0	8,79+0	327	315	4,5280	3,98+0	1,59+1
323	313	4,5251	4,01+0	1,50+1					
$1s2s(^3S)2p(^4P)3s - 1s^22s3s$									
311	303	4,4916	6,98+0	3,18-1	113	303	4,4826	3,37-1	2,61+0
113	101	4,4925	6,41+0	2,61+0	313	303	4,4910	7,02+0	3,22-1
313	101	4,5009	1,14-1	3,22-1	315	303	4,4701	5,88-1	1,24-1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^2P)3s - 1s^22s3s$									
311	303	4,4714	1,49+0	1,01+0	113	303	4,4651	1,22-2	1,47+0
113	101	4,4748	1,77+0	1,47+0	313	303	4,4709	1,10+0	1,13+0
313	101	4,4807	1,67-1	1,13+0	315	303	4,4893	7,85+0	1,23+0
$1s2s(^3S)2p(^4P)3s - 1s^22s3s$									
311	303	4,5203	2,74-3	2,87+0	513	303	4,5333	9,01-3	6,59-3
313	101	4,5290	1,67-2	2,86+0	315	303	4,5161	1,98-2	2,84+0
513	101	4,5434	1,47-5	6,59-3	515	303	4,5317	1,95-2	1,17-2
313	303	4,5190	1,95-6	2,86+0					
$1s2s(^1S)2p(^2P)3p - 1s^22s3p$									
101	113	4,4655	3,02-3	2,29+0	323	313	4,4977	2,61+0	2,28+0
311	113	4,4955	1,73-3	5,87-1	303	315	4,4908	5,58-1	1,84+0
101	313	3,4616	6,58-3	2,29+0	113	315	4,4955	1,00+0	1,68+0
311	313	4,4915	7,42+0	5,87-1	313	315	4,4917	4,87+0	6,08-1
303	311	4,4897	2,19+0	1,84+0	323	315	4,4985	2,46-2	2,28+0
113	311	4,4944	1,11+0	1,68+0	315	113	4,4760	3,29-2	3,28+0
313	311	4,4906	1,69+0	6,08-1	125	113	4,4720	1,47-1	3,59+0
323	311	4,4974	2,10+0	2,28+0	325	113	4,4794	2,06-1	5,17+0
303	113	4,9440	5,71-1	1,84+0	315	313	4,4721	5,05-2	3,28+0
113	113	4,4986	3,59+0	1,68+0	125	313	4,4681	1,08-3	3,59+0
313	113	4,4948	3,95-1	6,08-1	325	313	4,4954	4,32+0	5,17+0
323	113	4,5017	1,09+0	2,28+0	315	315	4,4728	4,32-1	3,28+0
303	313	4,4900	3,67+0	1,84+0	125	315	4,4689	1,42-3	3,59+0
113	313	4,4947	1,86-1	1,68+0	325	315	4,4962	2,02+0	5,17+0
313	313	4,4909	2,15-1	6,08-1	327	315	4,4940	7,22+0	1,98+0
$1s2s(^3S)2p(^2P)3p - 1s^22s3p$									
101	113	4,4876	8,40+0	2,97+0	303	113	4,4746	1,52-1	1,69+0
311	113	4,4775	7,24-2	1,02+0	113	113	4,4730	2,63+0	2,57-1
101	313	4,4836	3,50-3	2,97+0	313	113	4,4769	3,84-5	1,13+0
311	313	4,4736	9,08-1	1,02+0	323	113	4,4799	9,18-3	2,54+0
303	311	4,4704	9,32-2	1,69+0	303	313	4,4707	4,55-1	1,69+0
113	311	4,4688	1,63-2	2,57-1	113	313	4,4691	4,81-5	2,57-1
313	311	4,4727	1,29-1	1,13+0	313	313	4,4730	1,86-1	1,13+0
323	311	4,4757	1,01+0	2,54+0	323	313	4,4760	1,02+0	2,54+0

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^2P)3p - 1s^22s3p$									
303	315	4,4714	1,40+0	1,69+0	315	313	4,4898	2,95+0	3,71+0
113	315	4,4698	1,32-2	2,57-1	125	313	4,4883	2,26-3	7,29+0
313	315	4,4737	3,10-1	1,13+0	325	313	4,4755	1,01+0	6,92+0
323	315	4,4768	8,91-2	2,54+0	315	315	4,4905	4,19+0	3,71+0
315	113	4,4937	6,63-1	3,71+0	125	315	4,4890	1,04+0	7,29+0
125	113	4,4922	7,25+0	7,29+0	325	315	4,4763	6,23-1	6,92+0
325	113	4,4794	1,51-1	6,92+0	327	315	4,4756	1,17+0	2,30+0
$1s2s(^3S)2p(^4P)3p - 1s^22s3p$									
311	113	4,5351	5,85-3	4,23-1	513	315	4,5311	3,50-3	5,60-1
521	113	4,5433	3,67-7	1,13-2	323	315	4,5250	8,88-3	3,24+0
311	313	4,5311	1,11-1	4,23-1	523	315	4,5395	3,67-3	9,15-3
521	313	4,5392	1,79-2	1,15-2	505	113	4,5374	1,14-4	1,01-1
303	311	4,5157	4,95-3	1,78+0	315	113	4,5335	3,04-3	6,27-1
313	311	4,5308	7,65-2	4,09-1	515	113	4,5326	1,42-5	2,15-2
513	311	4,5300	8,33-5	5,60-1	325	113	4,5267	1,08-2	5,63+0
323	311	4,5239	3,32-2	3,24+0	525	113	4,5416	7,76-5	1,34-2
523	311	4,5384	1,44-2	9,15-3	505	313	5,5334	1,69-2	1,01-1
303	113	4,5200	1,21-2	1,78+0	315	313	4,5295	6,22-2	6,27-1
313	113	4,5351	5,20-3	4,09-1	515	313	4,5286	1,53-6	2,15-2
513	113	4,5343	2,40-4	5,60-1	325	313	4,5227	3,32-2	5,63+0
323	113	4,5282	1,77-2	3,24+0	525	313	4,5376	1,72-2	1,34-2
523	113	4,5427	8,14-5	9,15-3	505	315	4,5340	3,59-2	1,01-1
303	313	4,5160	3,09-2	1,78+0	315	315	4,5303	6,12-2	6,27-1
313	313	4,5311	3,48-2	4,09-1	515	315	4,5394	1,18-3	2,15-2
513	313	4,5303	1,64-3	5,60-1	325	315	4,5235	7,00-2	5,63+0
323	313	4,5242	6,46-2	3,24+0	525	315	4,5384	4,72-4	1,34-2
523	313	4,5387	3,10-4	9,15-3	517	315	4,5283	2,99-3	5,92-2
303	315	4,5168	1,80-1	1,78+0	327	315	4,5215	4,99-2	3,43+0
313	315	4,5318	1,54-2	4,09-1	527	315	4,5367	1,23-2	7,54-3
$1s2s(^1S)2p(^2P)3d - 1s^22s3d$									
311	323	4,4829	7,49+0	1,23-1	323	323	4,4880	4,98+0	6,87-2
113	323	4,4616	2,59-2	8,35-1	113	125	4,4700	1,98-1	8,35-1
313	323	4,4832	2,87+0	6,02-1	313	125	4,4917	2,09-2	6,02-1

Annex 1, continued

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^1S)2p(^2P)3d - 1s^22s3d$									
323	125	4,4965	1,04-2	6,87-2	335	325	4,4907	1,48+0	7,37-1
113	325	4,4617	5,20-2	8,35-1	315	327	4,4832	3,93+0	1,07-1
313	325	4,4833	4,46+0	6,02-1	125	327	4,4859	4,41-1	2,85-1
323	325	4,4881	2,61+0	6,87-2	325	327	4,4881	2,39+0	1,33-1
315	323	4,4829	1,25-2	1,07-1	335	327	4,4909	4,96-2	7,37-1
125	323	4,4855	1,40+0	2,85-1	327	125	4,4743	7,17-3	8,61-2
325	323	4,4878	1,14+0	1,33-1	137	125	4,4715	8,16-2	4,63-1
335	323	4,4906	3,76+0	7,37-1	337	125	4,4979	5,81-2	8,35-1
315	125	4,4915	1,29+0	1,07-1	327	325	4,4660	8,28-2	8,61-2
125	125	4,4941	2,95+0	2,85-1	137	325	4,4632	1,51-5	4,63-1
325	125	4,4963	3,81-1	1,33-1	337	325	4,4894	3,93+0	8,35-1
335	125	4,4992	2,82-1	7,37-1	327	327	4,4662	4,19-1	8,61-2
315	325	4,4831	1,52+0	1,07-1	137	327	4,4634	6,22-3	4,63-1
125	325	4,4857	1,05+0	2,85-1	337	327	4,4896	2,06+0	8,35-1
325	325	4,4879	3,34+0	1,33-1	339	327	4,4880	6,66+0	8,76-1
$1s2s(^3S)2p(^2P)3d - 1s^22s3d$									
311	323	4,4627	9,00-1	4,72-2	315	325	4,4628	1,65-1	2,63-2
113	323	4,4735	1,43-2	1,67-1	125	325	4,4675	5,69-3	1,68-1
313	323	4,4628	2,02-1	8,59-2	325	325	4,4663	2,50-1	6,54-2
323	323	4,4665	3,64-1	2,76-2	335	325	4,4682	5,32-1	4,01-1
113	125	4,4820	7,75+0	1,67-1	315	327	4,4630	1,11+0	2,63-2
313	125	4,4713	9,34-2	8,59-2	125	327	4,4677	5,72-6	1,68-1
323	125	4,4750	4,35-1	2,76-2	325	327	4,4664	3,87-1	6,54-2
113	325	4,4737	1,35-1	1,67-1	335	327	4,4684	3,97-2	4,01-1
313	325	4,4630	7,39-1	8,59-2	327	125	4,4953	1,99-4	1,45-1
323	325	4,4666	3,90-1	2,76-2	137	125	4,4866	8,26+0	9,04-1
315	323	4,4627	8,69-3	2,63-2	337	125	4,4765	7,17-2	3,75-1
125	323	4,4673	1,29-2	1,68-1	327	325	4,4869	2,55+0	1,45-1
325	323	4,4662	8,69-2	6,54-2	137	325	4,4782	6,29-2	9,04-1
335	323	4,4681	1,62+0	4,01-1	337	325	4,4681	1,41+0	3,75-1
315	125	4,4711	7,64-3	2,63-2	327	327	4,4871	5,37+0	1,45-1
125	125	4,4758	3,30+0	1,68-1	137	327	4,4784	3,67-2	9,04-1
325	125	4,4747	1,83-1	6,54-2	337	327	4,4683	4,65-1	3,75-1
335	125	4,4765	7,90-2	4,01-1	339	327	4,4680	1,35+0	3,01-1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^4P)3d - 1s^22s3d$									
311	323	4,5102	1,15-1	2,86-2	315	325	4,5127	1,27-3	2,16-2
521	323	4,5255	1,39-2	5,68-5	515	325	4,5221	5,19-4	7,17-4
313	323	4,5110	9,96-3	1,93-1	325	325	4,5242	4,56-3	3,34-2
513	323	4,5217	1,11-4	7,81-5	525	325	4,5258	1,38-2	1,59-3
323	323	4,5242	1,58-2	1,39-2	335	325	4,5171	1,31-1	6,76-2
523	323	4,5255	1,06-2	1,49-4	535	325	4,5327	1,82-3	8,20-4
533	323	4,5331	8,21-3	6,65-5	315	327	4,5129	1,64-1	2,16-2
313	125	4,5196	3,76-3	1,93-1	515	327	4,5223	5,12-5	7,17-4
513	125	4,5304	2,00-5	7,81-5	325	327	4,5244	1,46-3	3,34-2
323	125	4,5328	8,33-3	1,39-2	525	327	5,5260	2,84-3	1,59-3
523	125	4,5342	6,56-5	1,49-4	335	327	4,5173	1,80-3	6,76-2
533	125	4,5418	4,13-5	6,65-5	535	327	4,5329	9,88-4	8,20-4
313	325	4,5111	1,24-1	1,93-1	517	125	4,5309	1,56-3	2,48-3
513	325	4,5219	2,20-5	7,81-5	327	125	4,5321	4,66-3	7,90-3
323	325	4,5243	8,40-5	1,39-2	527	125	4,5346	6,00-4	1,11-3
523	325	4,5257	5,11-3	1,49-4	337	125	4,5240	8,49-3	9,11-2
533	325	4,5332	3,02-3	6,65-5	537	125	4,5404	8,18-7	1,49-3
315	323	4,5125	4,71-4	2,16-2	517	325	4,5223	3,97-3	2,48-3
515	323	4,5219	1,21-4	7,17-4	327	325	4,5235	3,15-2	7,90-3
325	323	4,5241	2,99-2	3,34-2	527	325	4,5260	6,08-3	1,11-3
525	323	4,5257	4,66-3	1,59-3	337	325	4,5154	3,96-1	9,11-2
335	323	4,5170	4,13-1	6,76-2	537	325	4,5318	1,20-2	1,49-3
535	323	4,5326	9,33-3	8,20-4	517	327	4,5225	9,01-5	2,48-3
315	125	4,5212	6,31-3	2,16-2	327	327	4,5237	5,27-3	7,90-3
515	125	4,5306	1,65-5	7,17-4	527	327	4,5262	2,14-2	1,11-3
325	125	4,5328	8,50-4	3,34-2	337	327	4,5156	1,10-1	9,11-2
525	125	4,5344	2,14-5	1,59-3	537	327	4,5320	3,29-4	1,49-3
335	125	4,5256	9,12-3	6,76-2	529	327	4,5237	3,60-3	1,16-3
535	125	4,5413	1,11-5	8,20-4	339	327	4,5137	4,60-1	5,03-2
					539	327	4,5307	1,05-2	1,84-3
$1s2s(^1S)2p(^2P)4s - 1s^22s4s$									
311	303	4,4882	6,83+0	1,51-1	113	303	4,4838	9,77-1	1,04+0
113	101	4,4868	6,50+0	1,04+0	313	303	4,4877	6,20+0	2,39-1
313	101	4,4908	6,57-1	2,39-1	315	303	4,4856	7,79+0	6,61-2

$1s2s(^3S)2p(^2P)4s - 1s^22s4s$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	303	4,4683	1,67+0	4,07-1	113	303	4,4654	9,63-4	5,37-1
113	101	4,4684	1,16+0	5,37-1	313	303	4,4680	1,31+0	4,48-1
313	101	4,4711	1,68-1	4,48-1	315	303	4,4673	6,82-1	4,96-1

$1s2s(^3S)2p(^4P)4s - 1s^22s4s$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	303	4,5234	4,10-3	1,15+0	513	303	4,5279	9,18-3	1,36-2
313	101	4,5250	1,74-2	1,14+0	315	303	4,5189	5,14-3	1,13+0
513	101	4,5310	1,37-4	1,36-2	515	303	4,5262	2,16-2	1,91-2
313	303	4,5219	8,59-4	1,14+0					

$1s2s(^1S)2p(^2P)4p - 1s^22s4p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
101	113	4,4656	3,98-1	5,57-1	323	313	4,4901	3,21+0	9,08-1
311	113	4,4893	6,62-2	3,99-1	303	315	4,4860	1,27+0	7,30-1
101	313	4,4642	1,14-2	5,57-1	113	315	4,4889	4,06+0	5,71-1
311	313	4,4880	7,03+0	3,99-1	313	315	4,4869	1,48+0	4,03-1
303	311	4,4855	1,51+0	7,30-1	323	315	4,4904	2,87-2	9,08-1
113	311	4,4884	5,12-2	5,71-1	315	113	4,4876	6,10-1	2,94+0
313	311	4,4865	3,45+0	4,03-1	125	113	4,4866	6,08+0	3,04+0
323	311	4,4899	2,34+0	9,08-1	325	113	4,4902	9,71-1	1,15+0
303	113	4,4870	1,45+0	7,30-1	315	313	4,4862	5,00+0	2,94+0
113	113	4,4899	2,25+0	5,71-1	125	313	4,4852	1,00-3	3,04+0
313	113	4,4880	2,25+0	4,03-1	325	313	4,4888	2,57+0	1,15+0
323	113	4,4914	8,84-1	9,08-1	315	315	4,4865	2,17+0	2,94+0
303	313	4,4857	3,25+0	7,30-1	125	315	4,4855	1,88+0	3,04+0
113	313	4,4885	2,25-1	5,71-1	325	315	4,4891	3,27+0	1,15+0
313	313	4,4866	3,78-1	4,03-1	327	315	4,4690	8,57-1	7,66-1

$1s2s(^3S)2p(^2P)4p - 1s^22s4p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
101	113	4,4846	7,97+0	1,57+0	303	113	4,4690	3,94-1	5,39-1
311	113	4,4704	5,76-2	3,67-1	113	113	4,4683	1,17+0	2,96-1
101	313	4,4832	1,34-1	1,57+0	313	113	4,4700	5,77-2	3,90-1
311	313	4,4691	1,30+0	3,67-1	323	113	4,4711	2,23-2	9,33-1
303	311	4,4675	1,02-1	5,39-1	303	313	4,4676	3,67-1	5,39-1
113	311	4,4668	2,24-2	2,96-1	113	313	4,4669	2,42-2	2,96-1
313	311	4,4685	2,18-1	3,90-1	313	313	4,4686	7,18-2	3,90-1
323	311	4,4696	7,71-1	9,33-1	323	313	4,4697	9,48-1	9,33-1

$1s2s(^3S)2p(^2P)4p - 1s^22s4p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
303	3I5	4,4679	6,29-I	5,39-I	3I5	3I3	4,468I	2,0I-I	I,74+0I
II3	3I5	4,4672	I,0I-I	2,96-I	I25	3I3	4,4664	5,97-4	9,67-I
3I3	3I5	4,4690	8,0I-I	3.90-I	325	3I3	4,4693	6,9I-I	2,54+0
323	3I5	4,4700	I,03-I	9,33-I	3I5	3I5	4,4684	4,8I-I	I,74+0
3I5	II3	4,4695	3,99-2	I,74+0	I25	3I5	4,4667	2,90-3	9,67-I
I25	II3	4,4678	5,83-I	9,67-I	325	3I5	4,4696	6,62-I	2,54+0
325	II3	4,4707	I,94-I	2,54+0	327	3I5	4,4690	8,57-I	8,77-I

$1s2s(^3S)2p(^4P)4p - 1s^22s4p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
3II	II3	4,527I	I,27-2	I,73-I	5I3	3I5	4,5265	I,23-3	I,75-I
52I	II3	4,53I2	7,02-5	9,08-3	323	3I5	4,5238	5,98-4	I,27+0
3II	3I3	4,5257	7,00-3	I,73-I	523	3I5	4,5297	2,58-3	9,90-3
52I	3I3	4,5297	I,5I+0	9,08-3	505	II3	4,5284	3,II-4	4,I9-2
303	3II	4,5I86	2,29-4	8,3I-I	3I5	II3	4,5258	I,04-2	4,67-I
3I3	3II	4,5257	7,53-4	2,25-I	5I5	II3	4,5249	I,3I-4	3,54-2
5I3	3II	4,526I	I,76-2	I,75-I	325	II3	4,5230	4,I6-3	2,22+0
323	3II	4,5234	I,55-3	I,27+0	525	II3	4,5300	3,67-4	2,40-2
523	3II	4,5292	I,02-2	9,90-3	505	3I3	4,5270	I,4I-2	4,I9-2
303	II3	4,5202	3,57-3	8,3I-I	3I5	3I3	4,5244	I,I9-2	4,67-I
3I3	II3	4,5272	6,55-4	2,25-I	5I5	3I3	4,5235	9,98-6	3,54-2
5I3	II3	4,5276	I,07-3	I,75-I	325	3I3	4,52I6	I,3I-5	2,22+0
323	II3	4,5249	I,83-2	I,27+0	525	3I3	4,5286	I,05-2	2,40-2
523	II3	4,5308	2,0I-4	9,90-3	505	3I5	4,5273	I,70-2	4,I9-2
303	3I3	4,5I87	I,49-4	8,3I-I	3I5	3I5	4,5247	I,0I-4	4,67-I
3I3	3I3	4,5258	2,37-3	2,25-I	5I5	3I5	4,5238	I,7I-6	3,54-2
5I3	3I3	4,5262	7,87-3	I,75-I	325	3I5	4,52I9	I,74-2	2,22+0
323	3I3	4,5235	I,I6-2	I,27+0	525	3I5	4,5289	6,78-4	2,40-2
523	3I3	4,5294	2,I4-5	9,90-3	5I7	3I5	4,5236	I,47-3	3,8I-2
303	3I5	4,5I9I	2,00-2	8,3I-I	327	3I5	4,5206	I,09-3	I,48+0
3I3	3I5	4,526I	3,64-6	2,25-I	527	3I5	4,5275	I,69-2	2,7I-2

$1s2s(^1S)2p(^2P)4d - 1s^22s4d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
3II	323	4,4835	7,69+0	7,02-2	323	323	4,4864	3,I4+0	6,32-2
II3	323	4,4805	3,5I-2	I,54-I	II3	I25	4,483I	7,38+0	I,54-I
3I3	323	4,4837	4,52+0	2,95-I	3I3	I25	4,4864	5,72-2	2,95-I

slj	s'l'j'	λ	A	Γ	slj	s'l'j'	λ	A	Γ
$1s2s(^1S)2p(^2P)4d - 1s^22s4d$									
323	I25	4,4890	I,89-I	6,32-2	335	325	4,4880	2,06+0	3,93-I
II3	325	4,4805	3,86-I	I,54-I	3I5	327	4,4845	2,8I-I	I,38-I
3I3	325	4,4837	3,08+0	2,95-I	I25	327	4,4835	2,27+0	5,93-2
323	325	4,4864	3,78+0	6,32-2	325	327	4,4866	4,29+0	7,57-2
3I5	323	4,4844	2,64+0	I,38-I	335	327	4,488I	I,07-I	3,93-I
I25	323	4,4833	I,37-2	5,93-2	327	I25	4,4875	6,00-3	I,37-I
325	323	4,4865	4,58-I	7,57-2	I37	I25	4,4679	2,40-I	I,24-I
335	323	4,4879	3,93+0	3,93-I	337	I25	4,4898	2,87-I	4,03-I
3I5	I25	4,487I	I,53+0	I,38-I	327	325	4,4849	3,83+0	I,37-I
I25	I25	4,4860	3,77+0	5,93-2	I37	325	4,4653	6,48-4	I,24-I
325	I25	4,4892	I,06+0	7,57-2	337	325	4,487I	3,35+0	4,03-I
335	I25	4,4906	3,89-I	3,93-I	327	327	4,4849	3,97+0	I,37-I
3I5	325	4,4844	3,09+0	I,38-I	I37	327	4,4653	9,69-2	I,24-I
I25	325	4,4834	I,3I+0	5,93-2	337	327	4,4872	3,I6+0	4,03-I
325	325	4,4865	9,50-I	7,57-2	339	327	4,4854	7,53+0	4,64-I
$1s2s(^3S)2p(^2P)4d - 1s^22s4d$									
3II	323	4,4645	8,09-I	2,73-2	3I5	325	4,4647	2,09-I	I,29-2
II3	323	4,464I	3,I0-2	4,46-I	I25	325	4,4667	I,75-I	I,I4-I
3I3	323	4,4647	2,39-I	2,66-2	325	325	4,4662	I,92-I	8,07-2
323	323	4,4665	5,I7-I	I,9I-2	335	325	4,467I	4,87-I	I,40-I
II3	I25	4,4668	4,80-I	4,46-I	3I5	327	4,4648	8,42-I	I,29-2
3I3	I25	4,4673	I,87-I	2,66-2	I25	327	4,4668	2,63-I	I,I4-I
323	I25	4,4692	2,I2-I	I,9I-2	325	327	4,4663	4,27-I	8,07-2
II3	325	4,4642	I,20-I	4,46-I	335	327	4,4672	I,45-2	I,40-I
3I3	325	4,4647	4,96-I	2,66-2	327	I25	4,4686	5,30-2	9,25-2
323	325	4,4665	6,39-I	I,9I-2	I37	I25	4,4842	7,66+0	5,83-I
3I5	323	4,4647	I,76-2	I,29-2	337	I25	4,4695	2,46-I	I,37-I
I25	323	4,4667	I,45-I	I,I4-I	327	325	4,4659	3,44-I	9,25-2
325	323	4,4662	3,I8-I	8,07-2	I37	325	4,48I6	I,56-I	5,83-I
335	323	4,467I	9,20-I	I,40-I	337	325	4,4669	7,78-I	I,37-I
3I5	I25	4,4679	2,I5-4	I,29-2	327	327	4,4660	2,9I-I	9,52-2
I25	I25	4,4693	I,08+0	I,I4-I	I37	327	4,48I7	2,85-I	5,83-I
325	I25	4,4688	I,06-2	8,07-2	337	327	4,4670	6,78-I	I,37-I
335	I25	4,4697	6,52-I	I,40-I	339	327	4,4664	9,32-I	I,27-I

slj	s'l'j'	λ	A	Γ	slj	s'l'j'	λ	A	Γ
$1s2s(^3S)2p(^4P)4d - 1s^22s4d$									
3II	323	4,5I67	5,7I-3	8,56-3	5I5	325	4,5209	7,23-3	I,I3-2
52I	323	4,5239	I,69-2	6,85-5	325	325	4,5237	4,34-3	I,77-2
3I3	323	4,5I72	7,20-6	5,65-2	525	325	4,5243	8,73-3	3,9I-3
5I3	323	4,5207	6,7I-5	4,24-5	335	325	4,5208	9,77-3	3,45-2
323	323	4,5233	9,33-5	8,87-3	535	325	4,527I	6,I7-4	9,38-4
523	323	4,5240	I,I8-2	2,23-4	3I5	327	4,5I84	I,65-2	7,72-3
533	323	4,5275	6,47-3	I,63-4	5I5	327	4,52I0	I,45-4	I,I3-2
3I3	I25	4,5200	I,92-3	5,65-2	325	327	4,5238	3,50-3	I,77-2
5I3	I25	4,5235	6,43-6	4,25-5	525	327	4,5244	6,00-3	3,9I-3
323	I25	4,5260	I,30-2	8,87-3	335	327	4,5209	8,54-4	3,45-2
523	I25	4,5268	2,59-4	2,23-4	535	327	4,5272	I,35-3	9,38-4
533	I25	4,5302	2,72-4	I,63-4	5I7	I25	4,5273	I,I0-3	7,27-4
3I3	325	4,5I73	9,95-3	5,65-2	327	I25	4,5252	I,II-2	I,26-2
5I3	325	4,5208	I,I6-6	4,25-5	527	I25	4,5238	3,34-4	I,38-3
323	325	4,5234	I,3I-3	8,87-3	337	I25	4,52I7	4,00-3	5,38-2
523	325	4,524I	6,76-3	2,23-4	537	I25	4,5292	7,II-5	2,06-3
533	325	4,5275	3,47-3	I,63-4	5I7	325	4,5246	8,85-3	7,27-4
3I5	323	4,5I83	I,70-4	7,72-3	327	325	4,5225	I,3I-2	I,26-2
5I5	323	4,5209	9,53-3	I,I3-2	527	325	4,52I2	I,97-6	I,38-3
325	323	4,5236	6,4I-3	I,77-2	337	325	4,5I90	2,I7-2	5,38-2
525	323	4,5243	8,93-3	3,9I-3	537	325	4,5265	9,33-3	2,06-3
335	323	4,5208	2,62-2	3,45-2	5I7	327	4,5247	I,30-2	7,27-4
535	323	4,527I	8,I5-3	9,38-4	327	327	4,5226	2,46-3	I,26-2
3I5	I25	4,52I0	2,37-3	7,72-3	527	327	4,52I2	9,9I-4	I,38-3
5I5	I25	4,5236	4,30-3	I,I3-2	337	327	4,5I9I	I,43-2	5,38-2
325	I25	4,5264	5,07-4	I,77-2	537	327	4,5266	I,88-4	2,06-3
525	I25	4,5270	4,09-5	3,9I-3	529	327	4,52I7	I,I6-3	7,70-4
335	I25	4,5235	I,09-2	3,45-2	339	327	4,5I77	2,60-2	5,68-2
535	I25	4,5298	I,I4-4	9,38-4	539	327	4,5253	I,44-2	2,98-3
3I5	325	4,5I83	9,II-4	7,72-3					
$1s2s(^1S)2p(^2P)4f - 1s^22s4f$									
323	335	4,4824	7,76+0	5,44-4	335	335	4,4859	3,66+0	5,34-3
I25	335	4,4820	4,07-2	2,94-2	I25	I37	4,4826	5,54+0	2,94-2
325	335	4,4829	3,86+0	I,0I-I	325	I37	4,4835	I,30+0	I,0I-I

$1s2s(^1S)2p(^2P)4f - 1s^22s4f$

sLJ	$s'L'J'$	λ	A	Γ	sLJ	$s'L'J'$	λ	A	Γ
335	I37	4,4864	6,23-I	5.34-3	347	337	4,4859	4,07+0	8,87-3
I25	337	4,482I	2,I7+0	2,94-2	327	339	4,4830	3,65+0	5,38-4
325	337	4,4829	2,50+0	I,0I-I	I37	339	4,4836	2,68-3	I,07-2
335	337	4,4859	2,60+0	5,34-3	337	339	4,4858	I,83+0	5,06-3
327	335	4,4829	I,75-2	5,38-4	347	339	4,4860	I,5I+0	8,87-3
I37	335	4,4836	4,4I+0	I,07-2	339	I37	4,4862	I,23+0	I,I8-2
337	335	4,4858	I,57+0	5,06-3	I49	I37	4,483I	5,48+0	2,72-2
347	335	4,4859	I,I7+0	8,87-3	349	I37	4,484I	7,22-I	I,33-2
327	I37	4,4835	I,88+0	5,38-4	339	337	4,4857	7,97-I	I,I8-2
I37	I37	4,484I	2,08+0	I,07-2	I49	337	4,4826	I,82+0	2,72-2
337	I37	4,4863	3,36+0	5,06-3	349	337	4,4836	4,90+0	I,33-2
347	I37	4,4864	5,29-2	8,87-3	339	339	4,4858	4,8I+0	I,I8-2
327	337	4,4830	2,I2+0	5,38-4	I49	339	4,4826	4,57-I	2,72-2
I37	337	4,4836	I,20+0	I,07-2	349	339	4,4836	2,08+0	I,33-2
337	337	4,4858	6,I9-3	5,06-3	34II	339	4,4830	7,74+0	2,54-2

$1s2s(^3S)2p(^2P)4f - 1s^22s4f$

sLJ	$s'L'J'$	λ	A	Γ	sLJ	$s'L'J'$	λ	A	Γ
323	335	4,464I	7,46-I	I,8I-4	327	337	4,4644	I.I0-I	I,09-4
I25	335	4,4645	8,47-2	9,99-3	I37	337	4,4662	3,79-4	I,90-3
325	335	4,4640	4,43-2	2,96-2	337	337	4,4662	9,64-I	I,49-3
335	335	4,4662	8,08-I	7,90-3	347	337	4,465I	2,20-2	4,75-3
I25	I37	4,4650	5,3I-I	9,99-3	327	339	4,4645	9,33-I	I,09-4
325	I37	4,4645	3,59-I	2,96-2	I37	339	4,4663	2,5I-I	I,90-3
335	I37	4,4668	I,48-I	7,90-3	337	339	4,4662	3,32-I	I,49-3
I25	337	4,4645	4,I9-I	9,99-3	347	339	4,4652	2,27-4	4,75-3
325	337	4,4640	3,35-I	2,96-2	339	I37	4,4666	2,37-I	I,52-3
335	337	4,4663	4,9I-I	7,90-3	I49	I37	4,465I	4,I2-I	2,32-3
327	335	4.4644	3.92-3	I,09-4	349	I37	4,4656	4,24-I	3,62-3
I37	335	4,4662	I.74-I	I,90-3	339	337	4,466I	5,84-2	I,52-3
337	335	4,466I	8,65-2	I.49-3	I49	337	4,4646	2,84-I	2,32-3
347	335	4,465I	I,06+0	4,75-3	349	337	4,465I	6,38-I	3,62-3
327	I37	4,4649	3,73-3	I,09-4	339	339	4.466I	I,I2+0	I,52-3
I37	I37	4,4668	I,06+0	I,90-3	I49	339	4,4646	2,23-2	2,32-3
337	I37	4.4667	3,00-2	I.49-3	349	339	4,465I	8,00-4	3,62-3
347	I37	4,4657	2,94-2	4,75-3	34II	339	4,4646	7,58-I	3,5I-3

$1s2s(^3S)2p(^4P)4f - 1s^22s4f$

sLJ	$s'L'J'$	λ	A	Γ	sLJ	$s'L'J'$	λ	A	Γ
323	335	4.5I82	2,75-5	4,I5-4	327	337	4,5I94	I.23-5	2,09-4
523	335	4,5I92	3,80-4	I,86-5	527	337	4.5I98	7,57-4	I,03-4
533	335	4,5234	I,94-2	I,32-5	337	337	4,524I	7,83-4	2,27-4
325	335	4,5I89	7,35-5	5,43-2	537	337	4,5246	6,57-4	7,26-5
525	335	4,5I95	5.73-4	9,77-3	347	337	4.52I9	3,24-5	9,07-4
335	335	4,5227	I,34-2	2,03-4	547	337	4,5226	I,57-2	I,39-4
535	335	4,5233	4,I4-3	3,73-3	327	339	4,5I94	8,68-4	2,09-4
545	335	4,5246	I,06-3	7,43-5	527	339	4,5I99	I,83-6	I,03-4
325	I37	4,5I94	8,42-4	5,43-2	337	339	4,5242	5,9I-3	2,27-4
525	I37	4,5200	I,I2-4	9,77-3	537	339	4,5246	2,30-3	7,26-5
335	I37	4,5232	7,05-3	2,03-4	347	339	4,5220	2,00-3	9,07-4
535	I37	4,5238	6,9I-3	3,73-3	547	339	4,5227	I,0I-3	I,39-4
545	I37	4,525I	2,02-3	7,43-5	529	I37	4,5206	I,02-4	I,39-5
325	337	4,5I89	3,04-4	5,43-2	339	I37	4,5235	8,28-3	2,78-4
525	337	4,5I95	2,25-4	9,77-3	539	I37	4,5250	I,97-3	I,22-4
335	337	4,5227	2,24-5	2,03-4	349	I37	4,5202	7,52-4	4,27-4
535	337	4,5233	9,30-3	3,73-3	549	I37	4,5227	5,09-3	2,40-4
545	337	4,5246	4,45-3	7,43-5	529	337	4,5200	I,I0-4	I,39-5
327	335	4,5I94	5,62-5	2,09-4	339	337	4,5230	I,38-2	2,78-4
527	335	4,5I98	7,38-7	I,03-4	539	337	4,5245	2,49-3	I,22-4
337	335	4,524I	3,06-3	2,27-4	349	337	4,5I96	6,I0-4	4,27-4
537	335	4,5245	3,65-3	7,26-5	549	337	4,5222	2,47-3	2,40-4
347	335	4,52I9	6,06-3	9,07-4	529	339	4,520I	5,68-4	I,39-5
547	335	4,5226	3,45-3	I,39-4	339	339	4,5230	5,07-5	2,78-4
327	I37	4,5I99	3,75-4	2,09-4	539	339	4,5245	2,72-3	I,22-4
527	I37	4,5204	5,09-5	I,03-4	349	339	4,5I97	7,32-5	4,27-4
337	I37	4,5247	2,92-7	2,27-4	549	339	4,5I22	I,45-2	2,40-4
537	I37	4,525I	8,25-4	7,26-5	53II	339	4,523I	I,94-2	I,79-4
347	I37	4,5225	I,65-2	9,07-4	34II	339	4,5I9I	4,II-5	6,94-4
547	I37	4,523I	8,85-4	I,39-4	54II	339	4,520I	5,49-4	I,76-5

Annex 2

WAVELENGTHS (A), RADIATIVE TRANSITION PROBABILITIES A AND AUTO-IONIZATION PROBABILITIES Γ(10^{13} s^{-1}) FOR Ar XVII, Ar XVI AND Ar XV

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2p - 1s^2$									
113	101	3,9483	1,12+1		315	101	3,9657	3,18-5	
313	101	3,9695	1,57-1						
$2s^2 - 1s2p$									
101	113	3,8109	2,30+0	3,56+1	101	313	3,7913	2,41-1	3,56+1
$2s2p - 1s2s$									
311	303	3,7648	6,34+0	1,54+0	113	303	3,7290	3,36-2	1,79+1
113	101	3,7514	6,37+0	1,79+1	313	303	3,7632	6,31+0	1,62+0
313	101	3,7861	3,21-2	1,62+0	315	303	3,7596	6,37+0	1,54+0
$2p^2 - 1s2p$									
311	113	3,7861	9,73-3	3,16-1	313	315	3,7678	5,31+0	0
101	113	3,7524	1,29+1	1,43+1	315	113	3,7808	3,66-1	1,87+0
311	313	3,7668	1,27+1	3,16-1	125	113	3,7698	1,22+1	3,25+1
101	313	3,7334	1,01-2	1,43-1	315	313	3,7615	3,33+0	1,87+0
313	311	3,7630	4,26+0	0	125	313	3,7507	1,97-5	3,25+1
313	113	3,7837	4,42-2	0	315	315	3,7650	9,07+0	1,87+0
313	313	3,7644	3,15+0	0	125	315	3,7541	5,09-1	3,25+1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s^2 - 1s^22s$									
202	212	4,0679	1,82-1	1,51+1	202	214	4,0721	2,84-1	1,51+1
$1s2s(^3S)2p - 1s^22s$									
212	202	3,9815	8,99+0	1,67+0	214	202	3,9649	4,57-1	5,19-1
$1s2s(^1S)2p - 1s^22s$									
212	202	3,9662	1,93+0	7,62+0	214	202	3,9793	1,04+1	8,76+0
412	202	4,0163	1,36-2	1,55-3	414	202	4,0146	3,89-2	4,92-3
$1s2p^2 - 1s^22p$									
212	212	3,9838	1,20+1	1,68-1	414	212	4,0103	3,65-4	2,37-2
412	212	4,0123	5,82-2	5,40-2	224	212	3,9880	6,15+0	1,43+1
202	212	3,9682	5,64-1	6,25+0	214	214	3,9834	1,44+1	1,17+0
212	214	3,9878	3,86+0	1,68-1	414	214	4,0144	3,18-2	2,37-2
412	214	4,0164	8,02-3	5,40-2	224	214	3,9921	4,05-3	1,43+1
202	214	3,9722	5,18+0	6,25+0	416	214	4,0117	7,41-2	2,16-1
214	212	3,9793	1,05+0	1,17+0	226	214	3,9912	5,30+0	1,53+1
$1s2p(^1P)3s - 1s^23s$									
212	202	3,9539	1,13+1	6,10-2	214	202	3,9535	1,11+1	6,21-4
$1s2p(^3P)3s - 1s^23s$									
212	202	3,9706	5,15-2	1,76+0	214	202	3,9672	1,73-1	1,78+0
412	202	3,9787	3,26-2	2,07-2	414	202	3,9772	1,34-1	5,17-2
$1s2p(^1P)3p - 1s^23p$									
202	212	3,9498	1,33+0	2,81+0	224	212	3,9555	9,94+0	3,99+0
212	212	3,9543	9,53+0	3,85-2	214	214	3,9538	9,95+0	3,31-1
202	214	3,9510	8,19+0	2,81+0	224	214	3,9567	4,52-1	3,99+0
212	214	3,9554	1,31+0	3,85-2	226	214	3,9564	1,09+1	3,39+0
214	212	3,9527	5,29-1	3,31-1					

Annex 2, continued

$1s2p(^3P)3p - 1s^23p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
202	212	3,9634	5,64-2	9,22-1	224	212	3,9703	4,72-1	2,42+0
212	212	3,9776	3,76-1	2,82-3	424	212	3,9820	1,27-1	8,09-3
412	212	3,9751	2,48-2	7,15-2	404	214	3,9765	5,61-2	8,75-2
422	212	3,9832	9,03-2	4,20-4	214	214	3,9798	2,86-1	3,74-2
202	214	3,9645	1,87+0	9,22-1	414	214	3,9743	2,32-3	2,17-2
212	214	3,9787	5,08-3	2,82-3	224	214	3,9715	6,12-1	2,42+0
412	214	3,9763	9,64-3	7,15-2	424	214	3,9832	3,48-2	8,09-3
422	214	3,9844	2,08-2	4,20-4	416	214	3,9732	1,62-2	1,78-1
404	212	3,9753	1,67-1	8,75-2	226	214	3,9680	3,65-1	3,28+0
214	212	3,9786	1,45-1	3,74-2	426	214	3,9811	7,48-2	4,53-2
414	212	3,9731	6,36-5	2,17-2					

$1s2p(^1P)3d - 1s^23d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
212	224	3,9472	1,09+1	6,16-2	226	224	3,9513	2,21+0	5,13-2
214	224	3,9463	7,03-1	5,97-2	236	224	3,9484	7,29+0	1,39+0
224	224	3,9517	1,05+1	5,32-4	226	226	3,9517	8,91+0	5,13-2
214	226	3,9467	1,00+1	5,97-2	236	226	3,9487	1,88+0	1,39+0
224	226	3,9521	6,14-1	5,32-4	238	226	3,9497	9,43+0	1,44+0

$1s2p(^3P)3d - 1s^23d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
212	224	3,9615	4,37-1	4,13-3	416	224	3,9678	3,24-1	2,53-3
412	224	3,9674	2,31-4	6,68-7	226	224	3,9748	2,15-1	5,02-4
422	224	3,9714	7,59-2	3,88-4	426	224	3,9711	9,85-2	1,55-3
214	224	3,9638	3,64-2	5,26-3	236	224	3,9685	1,17+0	3,93-3
414	224	3,9676	4,11-3	6,91-6	436	224	3,9776	1,01-1	7,08-3
224	224	3,9748	7,85-2	5,89-4	416	226	3,9682	5,24-2	2,53-3
424	224	3,9715	4,25-2	7,92-5	226	226	3,9752	7,31-2	5,02-4
434	224	3,9786	7,51-2	2,16-5	426	226	3,9715	8,35-2	1,55-3
214	226	3,9641	7,72-1	5,26-3	236	226	3,9689	4,04-1	3,93-3
414	226	3,9680	1,72-3	6,91-6	436	226	3,9779	2,23-2	7,08-3
224	226	3,9751	4,27-2	5,89-4	428	226	3,9692	1,22-2	5,42-3
424	226	3,9718	6,48-3	7,52-5	238	226	3,9652	1,91+0	3,29-3
434	226	3,9790	1,34-3	2,16-5	438	226	3,9763	6,32-2	1,10-2

$1s2p(^1P)4s - 1s^24s$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
212	202	3,9499	1,13+1	3,92-2	214	202	3,9498	1,21+1	3,69-3

$1s2p(^3P)4s - 1s^24s$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
212	202	3,9697	9,17-2	6,41-1	214	202	3,9660	3,50-2	6,57-1
412	202	3,9734	2,47-2	3,27-2	414	202	3,9720	1,55-1	5,16-2

$1s2p(^1P)4p - 1s^24p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
202	212	3,9488	2,05+0	7,87-1	224	212	3,9507	1,07+1	1,22+0
212	212	3,9505	9,22+0	3,27-3	214	214	3,9503	1,07+1	1,17-1
202	214	3,9493	9,15+0	7,87-1	224	214	3,9512	4,24-1	1,22+0
212	214	3,9509	2,03+0	3,27-3	226	214	3,9509	1,13+1	9,61-2
214	212	3,9498	4,20-1	1,17-1					

$1s2p(^3P)4p - 1s^24p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
202	212	3,9643	8,14-3	7,12-1	224	212	3,9702	9,19-2	6,69-1
212	212	3,9711	5,38-3	9,68-2	424	212	3,9739	7,33-2	3,44-2
412	212	3,9717	1,14-1	6,29-3	404	214	3,9731	9,07-2	5,26-2
422	212	3,9748	4,34-2	3,01-3	214	214	3,9681	1,43-1	6,55-1
202	214	3,9648	1,88-1	7,12-1	414	214	3,9689	6,95-3	6,05-2
212	214	3,9716	1,39-2	9,68-2	224	214	3,9707	5,66-2	6,69-1
412	214	3,9722	4,46-2	6,29-3	424	214	3,9744	2,94-3	3,44-2
422	214	3,9753	8,57-3	3,01-3	416	214	3,9687	6,91-3	9,92-2
404	212	3,9726	9,40-2	5,26-2	226	214	3,9662	3,43-3	1,63+0
214	212	3,9676	3,09-3	6,55-1	426	214	3,9729	1,15-1	1,12-1
414	212	3,9684	1,40-5	6,05-2					

$1s2p(^1P)4d - 1s^24d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
212	224	3,9477	1,13+1	3,54-2	226	224	3,9491	4,03+0	8,86-2
214	224	3,9474	7,94-1	3,48-2	236	224	3,9486	6,99+0	6,43-1
224	224	3,9493	1,05+1	1,31-4	226	226	3,9493	7,23+0	8,86-2
214	226	3,9475	1,04+1	3,48-2	236	226	3,9488	3,95+0	6,43-1
224	226	3,9494	7,78-1	1,31-4	238	226	3,9492	1,12+1	6,93-1

$1s2p(^3P)4d - 1s^24d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
212	224	3,9639	2,19-2	3,20-4	416	224	3,9693	1,11-1	6,68-3
412	224	3,9661	8,58-5	3,30-8	226	224	3,9712	1,42-1	6,99-4
422	224	3,9699	1,08-1	2,74-4	426	224	3,9662	4,49-2	3,61-3
214	224	3,9652	1,64-2	5,65-4	236	224	3,9668	7,18-2	1,32-2
414	224	3,9662	2,66-3	8,83-6	436	224	3,9722	4,87-2	7,29-3
224	224	3,9707	1,10-2	5,47-4	416	226	3,9695	1,43-1	6,68-3
424	224	3,9699	8,19-2	2,19-9	226	226	3,9714	2,87-2	6,99-4
434	224	3,9731	4,04-2	1,72-5	426	226	3,9664	1,49-2	3,61-3
214	226	3,9653	1,06-1	5,65-4	236	226	3,9669	7,04-2	1,32-2
414	226	3,9663	2,09-3	8,83-6	436	226	3,9724	4,36-3	7,29-3
224	226	3,9708	1,26-1	5,47-4	428	226	3,9670	2,71-3	3,41-3
424	226	3,9701	7,36-4	2,19-9	238	226	3,9647	1,26-1	5,01-2
434	226	3,9732	1,30-4	1,72-5	438	226	3,9711	9,23-2	1,70-2

$1s2p(^1P)4f - 1s^24f$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
224	236	3,9467	1,13+1	9,58-5	238	236	3,9482	5,55-1	2,61-5
226	236	3,9466	4,65-1	7,06-5	248	236	3,9472	1,07+1	4,46-2
236	236	3,9483	1,08+1	2,15-6	238	238	3,9483	1,07+1	2,61-5
226	238	3,9467	1,09+1	7,06-5	248	238	3,9473	5,51-1	4,46-2
236	238	3,9484	4,61-1	2,15-6	2410	238	3,9473	1,13+1	4,34-2

$1s2p(^3P)4f - 1s^24f$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
224	236	3,9641	9,89-6	2,12-4	428	236	3,9652	2,39-3	5,74-5
424	236	3,9647	3,94-3	4,42-5	238	236	3,9703	2,63-8	1,51-4
434	236	3,9693	1,29-1	1,56-5	438	236	3,9655	6,78-3	4,87-5
226	236	3,9652	4,81-3	8,05-5	248	236	3,9684	2,11-4	1,49-4
426	236	3,9647	1,19-5	8,22-5	448	236	3,9692	1,56-1	2,06-4
236	236	3,9705	7,91-4	3,24-5	428	238	3,9653	7,62-4	5,74-5
436	236	3,9693	1,06-2	1,48-5	238	238	3,9704	2,78-4	1,51-4
446	236	3,9686	1,53-1	8,57-5	438	238	3,9655	2,81-3	4,87-5
226	238	3,9653	6,44-4	8,05-5	248	238	3,9685	1,75-1	1,49-4
426	238	3,9648	9,30-3	8,22-5	448	238	3,9693	4,25-7	2,06-4
236	238	3,9706	4,16-5	3,24-5	4310	238	3,9691	1,33-1	1,07-3
436	238	3,9694	1,25-1	1,48-5	2410	238	3,9647	3,48-4	6,88-4
446	238	3,9686	1,33-2	8,57-5	4410	238	3,9655	2,37-3	5,96-5

$1s2s^22p - 1s^22s^2$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
113	101	4,0092	1,02+1	6,50+0	313	101	4,0298	1,37-1	1,20+1
315	101	4,0261	2,77-5	1,21+1	311				1,21+1

$1s2s(^1S)2p^2 - 1s^22s2p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	113	4,0566	9,52-5	2,84+0	313	315	4,0213	3,03+0	8,22+0
101	113	4,0104	5,00+0	2,03+1	315	113	4,0518	1,47-2	7,14+0
311	313	4,0194	1,42+1	2,84+0	125	113	4,0301	4,39+0	3,35+1
101	313	3,9740	9,20-4	2,03+1	315	313	4,0146	5,02-1	7,14+0
313	311	4,0174	7,97+0	8,22+0	125	313	3,9933	1,66-2	3,35+1
313	113	4,0558	4,56-4	8,22+0	315	315	4,0172	1,17+1	7,14+0
313	313	4,0186	8,34-1	8,22+0	125	315	3,9959	2,81-1	3,35+1

$1s2s(^3S)2p^2 - 1s^22s2p$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	113	4,0302	1,56-1	1,31+1	113	315	3,9780	1,45-3	6,50+0
311	313	3,9934	1,06+0	1,31+1	313	315	3,9939	1,20+0	1,18+1
113	311	3,9742	5,45-3	6,50+0	513	315	4,0620	1,54-3	4,37-2
313	311	3,9901	7,44-2	1,18+1	303	315	4,0017	2,83+0	1,06+1
513	311	4,0580	6,17-3	4,37-2	323	315	4,0192	2,36+0	1,35+1
303	311	3,9978	4,27-1	1,06+1	315	113	4,0254	6,64-1	3,91+1
323	311	4,0153	4,34-2	1,35+1	515	113	4,0954	5,94-7	1,61-1
113	113	4,0118	1,53+1	6,50+0	325	113	4,0551	4,06-3	1,47+1
313	113	4,0280	5,97-2	1,18+1	315	313	3,9887	7,83-2	3,91+1
513	113	4,0972	1,49-7	4,37-2	515	313	4,0574	3,02-5	1,61-1
303	113	4,0359	5,23-2	1,06+1	325	313	4,0178	7,06+0	1,47+1
323	113	4,0537	7,90-3	1,35+1	315	315	3,9914	3,97-1	3,91+1
113	313	3,9753	1,13-3	6,50+0	515	315	4,0601	1,30-2	1,61-1
313	313	3,9913	3,23-2	1,18+1	325	315	4,0205	4,40-1	1,47+1
513	313	4,0592	1,70-2	4,37-2	517	315	4,0577	1,90-2	8,40-2
303	313	3,9990	1,50+0	1,06+1	327	315	4,0195	5,08+0	1,91+1
323	313	4,0165	5,33+0	1,35+1					

$1s2s(^1S)2p(^1P)3s - 1s^22s3s$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	303	3,9888	8,75+0	3,37-1	113	303	3,9809	5,98-1	2,73+0
113	101	3,9892	8,05+0	2,73+0	313	303	3,9883	8,75+0	3,48-1
313	101	3,9966	1,96-1	3,48-1	315	303	3,9706	6,73-1	1,33+0

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^2P)3s - 1s^2 2s3s$									
311	303	3,9719	2,06+0	1,06+0	113	303	3,9663	2,25-2	1,51+0
113	101	3,9746	2,23+0	1,51+0	313	303	3,9713	1,43+0	1,22+0
313	101	3,9796	3,07-1	1,22+0	315	303	3,9864	1,01+1	9,18-2
$1s2s(^3S)2p(^4P)3s - 1s^2 2s3s$									
311	303	4,0132	6,57-3	3,02+0	513	303	4,0242	1,58-2	9,37-3
313	101	4,0202	2,99-2	3,01+0	315	303	4,0089	3,04-2	2,99+0
513	101	4,0326	3,45-5	9,37-3	515	303	4,0225	3,51-2	1,67-2
313	303	4,0118	1,55-4	3,01+0					
$1s2s(^1S)2p(^2P)3p - 1s^2 2s3p$									
101	113	3,9666	5,99-4	2,61+0	323	313	3,9941	3,41+0	4,10+1
311	113	3,9921	2,28-3	6,29-1	303	315	3,9878	1,06+0	2,25+0
101	313	3,9632	1,10-2	2,61+0	113	315	3,9919	1,64+0	1,39+1
311	313	3,9886	9,36+0	6,29-1	313	315	3,9887	5,36+0	1,17+1
303	311	3,9867	2,27+0	2,25+0	323	315	3,9949	2,45-2	4,10+1
113	311	3,9908	1,32+0	1,39+1	315	113	3,9756	6,09-2	1,01+1
313	311	3,9876	2,85+0	1,17+1	125	113	3,9721	1,63-1	2,39+2
323	311	3,9938	2,60+0	4,10+1	325	113	3,9953	3,58-1	1,66+2
303	113	3,9904	1,10+0	2,25+0	315	313	3,9721	4,65-2	1,01+1
113	113	3,9946	4,29+0	1,39+1	125	313	3,9687	1,79-2	2,39+2
313	113	3,9913	5,63-1	1,17+1	325	313	3,9918	5,27+0	1,66+2
323	113	3,9976	1,23+0	4,10+1	315	315	3,9229	5,48-1	1,01+1
303	313	3,9870	4,35+0	2,25+0	125	315	3,9695	2,99-3	2,39+2
113	313	3,9211	1,59-1	1,39+1	325	315	3,9926	2,62+0	1,66+2
313	313	3,9879	5,19-1	1,17+1	327	315	3,9904	9,30+0	2,16+0
$1s2s(^3S)2p(^2P)3p - 1s^2 2s3p$									
101	113	3,9852	1,07+1	2,96+0	303	113	3,9744	2,34-1	4,22+0
311	113	3,9771	1,34-1	1,10-1	113	113	3,9730	3,30+0	2,80-1
101	313	3,9817	7,00-3	2,96+0	313	113	3,9765	1,82-4	7,31+0
311	313	3,9737	1,26+0	1,10-1	323	113	3,9791	1,47-2	2,45+1
303	311	3,9707	9,90-2	4,22+0	303	313	3,9710	5,46-1	4,22+0
113	311	3,9693	2,40-2	2,80-1	113	313	3,9696	9,57-5	2,80-1
313	311	3,9728	1,42-1	7,31+0	313	313	3,9730	2,44-1	7,31+0
323	311	3,9753	1,32+0	2,45+1	323	313	3,9756	1,40+0	2,45+1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^2P)3p - 1s^2 2s3p$									
303	315	3,9718	1,91+0	4,22+0	315	313	3,9869	4,06+0	1,45+2
113	315	3,9704	1,77-2	2,80-1	125	313	3,9856	1,27-2	8,42+2
313	315	3,9738	3,91-1	7,31+0	325	313	3,9751	1,22+0	2,61+2
323	315	3,9764	1,24-1	2,45+1	315	315	3,9877	4,71+0	1,45+2
315	113	3,9903	1,18+0	1,45+2	125	315	3,9864	1,82+0	8,42+2
125	113	3,9890	8,73+0	8,42+2	325	315	3,9759	8,60-1	2,61+2
325	113	3,9786	2,67-1	2,61+2	327	315	3,9753	1,40+0	2,45+0
$1s2s(^3S)2p(^4P)3p - 1s^2 2s3p$									
311	113	4,0254	1,09-2	4,58-1	513	315	4,0221	5,61-3	9,91-1
521	113	4,0327	2,73-6	1,46-2	323	315	4,0170	1,23-2	1,82+1
311	313	4,0219	1,36-1	4,58-1	523	315	4,0295	5,88-3	2,05-1
521	313	4,0292	2,98-2	1,46-2	505	113	4,0275	2,30-4	2,86+0
303	311	4,0086	4,14-3	2,13+0	315	113	4,0238	6,15-3	2,25+1
313	311	4,0216	1,04-1	9,65+0	515	113	4,0230	9,67-5	4,65+0
513	311	4,0210	8,10-4	9,91-1	325	113	4,0181	1,83-2	7,90+1
323	311	4,0159	4,04-2	1,82+1	525	113	4,0311	1,95-4	1,22-1
523	311	4,0284	2,50-2	2,05-1	505	313	4,0240	2,79-2	2,86+0
303	113	4,0124	2,01-2	2,13+0	315	313	4,0203	8,60-2	2,25+1
313	113	4,0254	8,37-3	9,65+0	515	313	4,0195	1,27-4	4,65+0
513	113	4,0248	7,58-4	9,91-1	325	313	4,0146	3,79-2	7,90+1
323	113	4,0197	3,35-2	1,82+1	525	313	4,0276	3,06-2	1,22-1
523	113	4,0322	1,73-4	2,05-1	505	315	4,0248	5,70-2	2,86+0
303	313	4,0089	3,23-2	2,13+0	315	315	4,0211	6,31-2	2,25+1
313	313	4,0219	4,47-2	9,65+0	515	315	4,0203	2,56-3	4,65+0
513	313	4,0213	2,18-3	9,91-1	325	315	4,0155	1,08-1	7,90+1
323	313	4,0162	9,05-2	1,82+1	525	315	4,0284	6,82-4	1,22-1
523	313	4,0287	4,13-4	2,05-1	517	311	4,0193	5,17-3	9,16-2
303	315	4,0097	2,48-1	2,13+0	327	315	4,0135	6,06-2	3,67+0
313	315	4,0227	1,17-2	9,65+0	527	315	4,0267	2,25-2	1,15-2
$1s2s(^3S)2p(^2P)3d - 1s^2 2s3d$									
311	323	3,9811	9,63+0	1,30-1	323	323	3,9856	6,13+0	8,23+0
113	323	3,9633	3,51-2	9,85+0	113	125	3,9705	1,82-1	9,85+0
313	323	3,9814	3,92+0	6,90+1	313	125	3,9887	3,72-2	6,90+1

$1s2s(^3S)2p(^4P)3d-1s^22s3d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
323	125	3,9929	1,89-2	8,23+0	335	325	3,9882	1,86+0	4,11+0
113	325	3,9634	6,68-2	9,85+0	315	327	3,9814	4,65+0	1,17-1
313	325	3,9815	5,45+0	6,90+1	125	327	3,9838	5,11-1	6,44-1
323	325	3,9858	3,45+0	8,23+0	325	327	3,9858	3,35+0	6,43-1
315	323	3,9810	3,57-3	1,17-1	335	327	3,9884	5,27-2	4,11+0
125	323	3,9834	2,24+0	6,44-1	327	125	3,9742	8,80-3	6,39-2
325	323	3,9855	1,17+0	6,43-1	137	125	3,9717	1,49-1	4,78-1
335	323	3,9881	4,54+0	4,11+0	337	125	3,9941	1,03-1	8,22-1
315	125	3,9883	1,94+0	1,17-1	327	325	3,9671	1,00-1	6,39-2
125	125	3,9907	3,17+0	6,44-1	137	325	3,9646	8,17-6	4,78-1
325	125	3,9927	6,40-1	6,43-1	337	325	3,9869	4,72+0	8,22-1
335	125	3,9954	4,27-1	4,11+0	327	327	3,9673	4,93-1	6,39-2
315	325	3,9812	1,93+0	1,17-1	137	327	3,9648	8,31-3	4,78-1
125	325	3,9836	1,83+0	6,44-1	337	327	3,9871	2,77+0	8,22-1
325	325	3,9856	3,78+0	6,43-1	339	327	3,9854	8,56+0	9,98-1

$1s2s(^3S)2p(^2P)3d-1s^22s3d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	323	3,9643	1,06+0	5,35-2	315	325	3,9645	2,00-1	8,22-2
113	323	3,9733	2,45-2	1,59+0	125	325	3,9684	1,00-2	4,82-1
313	323	3,9645	2,32-1	3,09+1	125	325	3,9674	2,73-1	1,70-1
323	323	3,9676	4,30-1	7,38+0	335	325	3,9691	7,41-1	1,22+0
113	125	3,9805	9,66+0	1,59+0	315	327	3,9647	1,42+0	8,22-2
313	125	3,9717	1,25-1	3,09+1	125	327	3,9686	3,65-4	4,82-1
323	125	3,9748	8,16-1	7,38+0	325	327	3,9676	5,82-1	1,70-1
113	325	3,9734	2,54-1	1,59+0	335	327	3,9693	6,33-2	1,22+0
313	325	3,9646	9,01-1	3,09+1	327	125	3,9917	8,73-4	2,07-1
323	325	3,9677	5,50-1	7,38+0	137	125	3,9844	1,04+1	9,66-1
315	323	3,9643	9,65-3	8,22-2	337	125	3,9761	1,28-1	3,94-1
125	323	3,9683	1,98-2	4,82-1	327	325	3,9845	3,50+0	2,07-1
325	323	3,9673	1,01-1	1,70-1	137	325	3,9773	1,14-1	9,66-1
335	323	3,9689	2,12+0	1,22+0	337	325	3,9690	1,79+0	3,94-1
315	125	3,9716	1,38-2	8,22-2	327	327	3,9847	6,63+0	2,07-1
125	125	3,9755	4,13+0	4,82-1	137	327	3,9775	6,41-2	9,66-1
325	125	3,9745	3,50-1	1,70-1	337	327	3,9692	6,69-1	3,94-1
335	125	3,9762	1,25-1	1,22+0	339	327	3,9689	1,64+0	3,17-1

$1s2s(^3S)2p(^4P)3d-1s^22s3d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	323	4,0039	1,46-1	3,17-2	315	325	4,0063	2,58-4	5,57-2
521	323	4,0173	2,52-2	8,97-5	515	325	4,0140	1,15-3	1,45-3
313	323	4,0046	9,46-3	2,23-1	325	325	4,0162	2,79-3	5,42-2
513	323	4,0137	1,86-4	3,82-4	525	325	4,0177	2,37-2	4,51-3
323	323	4,0161	1,85-2	1,57+0	335	325	4,0103	1,82-1	1,03+0
523	323	4,0174	1,92-2	6,42-2	535	325	4,0236	2,93-3	1,49-3
533	323	4,0240	1,40-2	1,30-2	315	327	4,0065	2,24-1	5,57-2
313	125	4,0120	6,40-3	2,23+1	515	327	4,0142	1,72-4	1,45-3
513	125	4,0211	3,58-5	3,82-4	325	327	4,0164	4,12-3	5,42-2
323	125	4,0235	1,52-2	1,57+0	525	327	4,0179	5,54-3	4,51-3
523	125	4,0248	1,40-4	6,42-2	335	327	4,0105	1,45-3	1,03+0
533	125	4,0315	9,07-5	1,30-2	535	327	4,0238	1,71-3	1,49-3
313	325	4,0048	1,66-1	2,23+1	517	125	4,0215	2,68-3	5,70-3
513	325	4,0138	1,64-5	3,82-4	327	125	4,0227	9,28-3	2,48-2
323	325	4,0162	1,13-5	1,57+0	527	125	4,0252	1,19-3	3,39-3
523	325	4,0175	9,38-3	6,42-2	337	125	4,0159	1,40-2	4,05-2
533	325	4,0242	5,26-3	1,30-2	537	125	4,0301	1,41-6	2,46-3
315	323	4,0062	7,01-4	5,57-2	517	325	4,0142	5,62-3	5,70-3
515	323	4,0139	2,13-4	1,45-3	327	325	4,0154	5,24-2	2,48-2
325	323	4,0160	4,73-2	5,42-2	527	325	4,0179	1,15-2	3,39-2
525	323	4,0175	9,19-3	4,51-3	337	325	4,0086	5,02-1	4,05-2
335	323	4,0102	5,33-1	1,03+0	537	325	4,0228	2,16-2	2,46-3
535	323	4,0235	1,66-2	1,49-3	517	327	4,0145	8,46-4	5,70-3
315	125	4,0135	1,04-2	5,57-2	327	327	4,0156	3,63-3	2,48-2
515	125	4,0213	1,90-5	1,45-3	527	327	4,0181	3,52-2	3,39-3
325	125	4,0235	1,41-3	5,42-2	337	327	4,0088	1,58-1	4,05-2
525	125	4,0249	4,28-5	4,51-3	537	327	4,0230	4,46-4	2,46-3
335	125	4,0176	1,71-2	1,03+0	529	327	4,0155	5,94-3	1,76-3
535	125	4,0309	2,55-3	1,49-3	339	327	4,0069	5,94-1	5,57-2
					539	327	4,0217	1,96-2	3,09-3

$1s2s(^3S)2p(^2P)4s-1s^22s4s$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
311	303	3,9859	8,53+0	1,63-1	113	303	3,9818	1,51+0	1,10+0
113	101	3,9844	8,11+0	1,10+0	313	303	3,9855	7,57+0	2,70-1
313	101	3,9881	9,87-1	2,70-1	315	303	3,9834	1,00+1	5,41-1

Annex 2, continued

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
1s2s(^{3}S)2p(^{2}P)4s - 1s^{2}2s4s									
311	303	3,9692	2,30+0	4,28-1	113	303	3,9666	2,42-3	5,57-1
113	101	3,9691	1,42+0	5,57-1	313	303	3,9689	1,74+0	4,85-1
313	101	3,9715	2,93-1	4,85-1	315	303	3,9682	7,85-1	5,39-2
1s2s(^{3}S)2p(^{4}P)4s - 1s^{2}2s4s									
311	303	4,0157	8,24-3	1,23+0	513	303	4,0195	1,59-2	1,83-2
313	101	4,0169	3,09-2	1,21+0	315	303	4,0113	7,54-3	1,20+0
513	101	4,0222	3,06-4	1,83-2	515	303	4,0179	3,89-2	2,51-2
313	303	4,0143	2,28-3	1,21+0					
1s2s(^{1}S)2p(^{2}P)4p - 1s^{2}2s4p									
101	113	3,9667	4,50-1	6,37-1	323	313	3,9876	4,15+0	1,57-1
311	113	3,9869	9,08-2	4,43-1	303	315	3,9837	1,68+0	8,69-1
101	313	3,9655	2,02-2	6,37-1	113	315	3,9865	5,46+0	7,03+0
311	313	3,9857	8,80+0	4,43-1	313	315	3,9845	1,42+0	9,43-1
303	311	3,9832	1,62+0	8,69-1	323	315	3,9879	2,71-2	1,57+1
113	311	3,9861	4,12-2	7,03+0	315	113	3,9851	8,38-1	1,01+2
313	311	3,9840	4,83+0	9,43-1	125	113	3,9842	7,37+0	3,95+2
323	311	3,9875	2,88+0	1,57+1	325	113	3,9876	1,51+0	7,72+0
303	113	3,9845	2,44+0	8,69-1	315	313	3,9839	6,91+0	1,01+2
113	113	3,9874	2,50+0	7,03+0	125	313	3,9830	1,57-5	3,95+2
313	113	3,9853	2,78+0	9,43-1	325	313	3,9864	2,80+0	7,72+0
323	113	3,9888	1,01+0	1,57+1	315	315	3,9842	2,23+0	1,01+2
303	313	3,9833	3,84+0	8,69-1	125	315	3,9833	2,85+0	3,95+2
113	313	3,9862	2,44-1	7,03+0	325	315	3,9867	4,20+0	7,72+0
313	313	3,9841	6,93-1	9,43-1	327	315	3,9846	9,80+0	8,20-1
1s2s(^{3}S)2p(^{2}P)4p - 1s^{2}2s4p									
101	113	3,9826	1,02+1	1,56+0	303	113	3,9697	5,25-1	8,76-1
311	113	3,9710	9,64-2	3,77-1	113	113	3,9690	1,41+0	2,64-1
101	313	3,9814	1,97-1	1,56+0	313	113	3,9706	9,77-2	3,83+0
311	313	3,9698	1,79+0	3,77-1	323	113	3,9716	3,32-2	1,36+1
303	311	3,9684	1,16-1	8,76-1	303	313	3,9685	4,55-1	8,76-1
113	311	3,9677	2,88-2	2,64-1	113	313	3,9678	2,29-2	2,64-1
313	311	3,9693	2,53-1	3,83+0	313	313	3,9694	7,26-2	3,83+0
323	311	3,9702	1,02+0	1,36+1	323	313	3,9703	1,33+0	1,36+1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
1s2s(^{3}S)2p(^{2}P)4p - 1s^{2}2s4p									
303	315	3,9688	8,18-1	8,76-1	315	313	3,9689	2,36-1	1,15-1
113	315	3,9682	1,25-1	2,64-1	125	313	3,9674	7,56-4	6,43+1
313	315	3,9697	1,12+0	3,83+0	325	313	3,9699	8,23-1	1,20+2
323	315	3,9707	1,44-1	1,36+1	315	315	3,9692	5,76-1	1,15-1
315	113	3,9701	6,72-2	1,15-1	125	315	3,9677	3,75-3	6,43+1
125	113	3,9686	6,82-1	6,43+1	325	315	3,9703	9,26-1	1,20+2
325	113	3,9712	3,39-1	1,20+2	327	315	3,9696	1,00+0	9,11-1
1s2s(^{3}S)2p(^{4}P)4p - 1s^{2}2s4p									
311	113	4,0186	2,33-2	1,83-1	513	315	4,0179	8,35-5	3,19+0
521	113	4,0224	1,14-4	1,12-2	323	315	4,0159	3,47-4	4,20+0
311	313	4,0174	7,31-3	1,83-1	523	315	4,0211	4,16-3	9,57-2
521	313	4,0212	2,19-2	1,12-2	505	113	4,0199	5,13-4	2,17+0
303	311	4,0110	6,25-4	8,81-1	315	113	4,0175	2,00-2	2,61+1
313	311	4,0179	2,80-2	4,84+0	515	113	4,0164	2,31-4	4,53-1
513	311	4,0175	8,08-7	3,19+0	325	113	4,0148	5,62-3	1,61+1
323	311	4,0155	2,09-3	4,20+0	525	113	4,0213	8,96-4	2,54-1
523	311	4,0207	1,73-2	9,57-2	505	313	4,0186	2,67-2	2,17+0
303	113	4,0124	5,25-3	8,81-1	315	313	4,0162	1,64-2	2,61+1
313	113	4,0192	1,75-3	4,84+0	515	313	4,0151	3,88-5	4,53-1
513	113	4,0188	4,10-4	3,19+0	325	313	4,0135	1,63-5	1,61+1
323	113	4,0168	3,47-2	4,20+0	525	313	4,0200	1,66-2	2,54-1
523	113	4,0220	3,98-4	9,57-2	505	315	4,0189	2,66-2	2,17+0
303	313	4,0111	1,62-5	8,81-1	315	315	4,0166	3,22-4	2,61+1
313	313	4,0180	9,22-3	4,84+0	515	315	4,0155	5,26-5	4,53-1
513	313	4,0176	8,43-3	3,19+0	325	315	4,0139	2,48-2	1,61+1
323	313	4,0156	1,56-2	4,20+0	525	315	4,0204	1,83-3	2,54-1
523	313	4,0208	1,15-4	9,57-2	517	315	4,0153	2,20-3	5,19-2
303	315	4,0115	2,78-2	8,81-1	327	315	4,0127	1,13-3	1,55+0
313	315	4,0183	3,49-3	4,84+0	527	315	4,0189	3,12-2	3,90-2
1s2s(^{1}S)2p(^{2}P)4d - 1s^{2}2s4d									
311	323	3,9815	9,87+0	6,96-2	323	323	3,9843	3,66+0	6,67-1
113	323	3,9790	5,29-2	1,19+0	113	125	3,9813	9,30+0	1,19+0
313	323	3,9817	6,15+0	3,90+1	313	125	3,9840	1,87-2	3,90+1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^1S)2p(^2P)4d - 1s^22s4d$									
323	125	3,9866	3,11-1	6,67-1	335	325	3,9858	2,60+0	2,09+0
113	325	3,9791	6,47-1	1,19+0	315	327	3,9846	5,50+0	1,69-1
313	325	3,9818	3,61+0	3,90+1	125	327	3,9815	2,79+0	6,41-2
323	325	3,9844	4,92+0	6,67-1	325	327	3,9825	2,71-1	1,79-1
315	323	3,9845	4,28-1	1,69-1	335	327	3,9859	1,18-1	2,09+0
125	323	3,9814	3,37-2	6,41-2	327	125	3,9850	6,09-3	1,47-1
325	323	3,9823	3,67+0	1,79-1	137	125	3,9686	2,41-1	1,23-1
335	323	3,9858	4,80+0	2,09+0	337	125	3,9872	4,77-1	3,71-1
315	125	3,9868	1,40+0	1,69-1	327	325	3,9827	5,18+0	1,47-1
125	125	3,9837	4,97+0	6,41-2	137	325	3,9664	6,69-4	1,23-1
325	125	3,9846	1,66+0	1,79-1	337	325	3,9850	3,92+0	3,71-1
335	125	3,9880	5,61-1	2,09+0	327	327	3,9828	4,82+0	1,47-1
315	325	3,9845	1,02+0	1,69-1	137	327	3,9665	1,26-1	1,23-1
125	325	3,9814	1,65+0	6,41-2	337	327	3,9851	4,11+0	3,71-1
325	325	3,9824	4,15+0	1,79-1	339	327	3,9832	9,68+0	4,80-1
$1s2s(^3S)2p(^2P)4d - 1s^22s4d$									
311	323	3,9658	9,46-1	2,86-2	315	325	3,9660	2,56-1	2,47-2
113	323	3,9655	3,82-2	7,49+0	125	325	3,9678	2,09-1	1,25-1
313	323	3,9660	2,85-1	1,57+1	325	325	3,9673	1,86-1	1,03-1
323	323	3,9676	6,31-1	2,10+0	335	325	3,9682	7,20-1	8,19-1
113	125	3,9677	5,37-1	7,49+0	315	327	3,9661	1,02+0	2,47-2
313	125	3,9683	2,28-1	1,57+1	125	327	3,9678	4,66-1	1,25-1
323	125	3,9699	3,63-1	2,10+0	325	327	3,9674	5,69-1	1,03-1
113	325	3,9655	1,44-1	7,49+0	335	327	3,9682	2,75-2	8,19-1
313	325	3,9661	5,80-1	1,57+1	327	125	3,9693	6,37-2	4,10-2
323	325	3,9677	9,22-1	2,10+0	137	125	3,9823	9,63+0	5,69-1
315	323	3,9660	2,17-2	2,47-2	337	125	3,9702	3,99-1	1,34-1
125	323	3,9677	1,22-1	1,25-1	327	325	3,9671	4,29-1	4,10-2
325	323	3,9673	4,11-1	1,03-1	137	325	3,9800	2,65-1	5,69-1
335	323	3,9681	1,27+0	8,19-1	337	325	3,9680	9,69-1	1,34-1
315	125	3,9683	2,51-4	2,47-2	327	327	3,9671	3,08-1	4,10-2
125	125	3,9700	1,42+0	1,25-1	137	327	3,9801	4,75-1	5,69-1
325	125	3,9696	2,04-2	1,03-1	337	327	3,9681	9,55-1	1,34-1
335	125	3,9704	7,81-1	8,19-1	339	327	3,9675	1,10+0	1,18-1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^4P)4d - 1s^22s4d$									
311	323	4,0094	6,75-3	8,47-3	515	325	4,0130	5,00-5	1,43-3
521	323	4,0160	3,09-2	9,90-5	325	325	4,0159	1,29-2	3,35-2
313	323	4,0099	1,31-5	6,83+0	525	325	4,0164	1,18-2	1,78-2
513	323	4,0128	9,99-5	4,22-3	335	325	4,0134	2,27-2	2,59-1
323	323	4,0154	1,11-6	1,67-1	535	325	4,0189	7,76-4	1,23-3
523	323	4,0161	2,14-2	1,01-1	315	327	4,0110	2,14-2	9,02-3
533	323	4,0192	1,07-2	7,19-3	515	327	4,0131	1,65-4	1,43-3
313	125	4,0122	2,99-3	6,83+0	325	327	4,0160	4,61-3	3,35-2
513	125	4,0151	1,03-5	4,22-3	525	327	4,0165	1,23-2	1,78-2
323	125	4,0177	2,37-2	1,67-1	335	327	4,0135	2,51-3	2,59-1
523	125	4,0184	5,03-4	1,01-1	535	327	4,0190	2,41-3	1,23-3
533	125	4,0216	5,66-4	7,19-3	517	125	4,0190	2,10-3	1,68-3
313	325	4,0099	1,30-2	6,83+0	327	125	4,0170	2,12-2	2,00-2
513	325	4,0129	6,59-7	4,22-3	527	125	4,0155	4,52-4	1,32-3
323	325	4,0155	2,77-3	1,67-1	337	125	4,0137	5,50-3	3,94-2
523	325	4,0161	1,22-2	1,01-1	537	125	4,0206	2,13-4	2,89-3
533	325	4,0193	6,12-3	7,19-3	517	325	4,0167	1,80-2	1,68-3
315	323	4,0108	2,40-4	9,02-3	327	325	4,0147	2,01-2	2,00-2
515	323	4,0129	8,55-4	1,43-3	527	325	4,0132	4,82-7	1,32-3
325	323	4,0158	6,50-3	3,35-2	337	325	4,0114	2,51-2	3,94-2
525	323	4,0164	1,85-2	1,78-2	537	325	4,0183	1,50-2	2,89-3
335	323	4,0134	4,65-2	2,59-1	517	327	4,0168	2,13-2	1,68-3
535	323	4,0188	1,40-2	1,23-3	327	327	4,0148	6,89-3	2,00-2
315	125	4,0132	3,16-3	9,02-3	527	327	4,0133	1,57-3	1,32-3
515	125	4,0152	3,46-4	1,43-3	337	327	4,0115	1,95-2	3,94-2
325	125	4,0182	6,13-4	3,35-2	537	327	4,0184	7,51-4	2,89-3
525	125	4,0187	9,22-5	1,78-2	529	327	4,0137	1,64-3	8,98-4
335	125	4,0157	2,81-2	2,59-1	339	327	4,0103	3,22-2	5,87-2
535	125	4,0212	2,55-4	1,23-3	539	327	4,0171	2,70-2	4,39-3
315	325	4,0109	1,93-3	9,02-3					
$1s2s(^1S)2p(^2P)4f - 1s^22s4f$									
323	335	3,9806	9,96+0	5,42-4	335	335	3,9839	4,22+0	5,11-4
125	335	3,9803	5,51-2	2,17-4	125	137	3,9808	7,02+0	2,17-4
325	335	3,9811	5,39+0	3,89-4	325	137	3,9816	1,61+0	3,89-4

Annex 2, continued

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^1S)2p(^2P)4f - 1s^22s4f$									
335	137	3,9844	8,93-1	5,11-4	347	337	3,9840	4,65+0	1,19-2
125	337	3,9803	2,88+0	2,17-4	327	339	3,9812	4,30+0	6,47-4
325	337	3,9811	2,85+0	3,89-4	137	339	4,9839	3,22+0	1,04-4
335	337	3,9840	3,47+0	5,11-4	337	339	3,9817	4,97-3	2,93-3
327	335	3,9811	1,28-2	6,47-4	347	339	3,9840	1,27+0	1,19-2
137	335	3,9839	1,37+0	1,04-2	339	137	3,9821	8,95-1	1,32-2
337	335	3,9816	5,43+0	2,93-3	149	137	3,9812	6,78+0	2,93-2
347	335	3,9840	2,26+0	1,19-2	349	137	3,9843	1,77+0	1,35-2
327	137	3,9816	2,86+0	6,74-4	339	337	3.9816	5,93+0	1,32-2
137	137	3,9844	3,72+0	1,04-2	149	337	3,9807	2,55+0	2,93-2
337	137	3,9821	2,53+0	2,93-3	349	337	3,9838	1,13+0	1,35-2
347	137	3,9845	2,88-1	1,19-2	339	339	3,9817	3,07+0	1,32-2
327	337	3,9811	2,69+0	6,47-4	149	339	3,9808	6,51-1	2,93-2
137	337	3,9839	1,48-1	1,04-4	349	339	3,9839	5,63+0	1,35-2
337	337	3,9816	1,92+0	2,93-3	3411	339	3,9811	9,94+0	2,76-2
$1s2s(^3S)2p(^2P)4f - 1s^22s4f$									
323	335	3,9654	8,64-1	1,81-4	327	337	3,9658	1,34-1	1,54-4
125	335	3,9658	1,04-1	6,14-4	137	337	3,9674	8,91-3	1,76-3
325	335	3,9654	5,06-2	6,61-4	337	337	3,9673	1,24+0	1,91-3
335	335	3,9674	1,00+0	1,59-4	347	337	3,9664	1,97-2	4,08-3
125	137	3,9663	6,28-1	6,14-4	327	339	3,9658	1,14+0	1,54-4
325	137	3,9658	4,28-1	6,61-4	137	339	3,9674	3,57-1	1,76-3
335	137	3,9678	2,49-1	1,59-4	337	339	3,9674	5,53-1	1,91-3
125	337	3,9658	5,23-1	6,14-4	347	339	3,9665	6,35-4	4,08-3
325	337	3,9654	3,76-1	6,61-4	339	137	3,9677	4,16-1	2,39-3
335	337	3,9674	7,44-1	1,59-4	149	137	3,9663	4,65-1	2,00-3
327	335	3,9657	4,73-3	1,54-4	349	137	3,9668	5,09-1	3,06-3
137	335	3,9674	3,15-1	1,76-3	339	337	3,9672	1,27-1	2,39-3
337	335	3,9673	1,62-1	1,91-3	149	337	3,9659	3,36-1	2,00-3
347	335	3,9664	1,27+0	4,08-3	349	337	3,9663	7,48-1	3,06-3
327	137	3,9662	5,15-3	1,54-4	339	339	3,9673	1,44+0	2,39-3
137	137	3,9678	1,36+0	1,76-3	149	339	3,9659	2,69-2	2,00-3
337	137	3,9678	8,84-3	1,91-3	349	339	3,9664	3,98-3	3,06-3
347	137	3,9669	4,39-2	4,08-3	3411	339	3,9659	8,80-1	3,13-3

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^4P)4f - 1s^22s4f$									
323	335	4,0109	4,81-5	4,10-4	327	337	4,0117	1,55-5	1,00-4
523	335	4,0115	5,61-4	1,89-5	527	337	4,0121	9,92-4	2,21-4
533	335	4,0155	3,50-2	1,37-5	337	337	4,0164	1,67-3	2,59-4
325	335	4,0112	1,01-4	3,21-4	537	337	4,0167	1,16-3	7,98-5
529	335	4,0117	8,05-4	5,93-5	347	337	4,0143	9,52-5	5,92-4
335	335	4,0149	2,37-2	1,58-4	547	337	4,0149	2,80-2	1,12-4
535	335	4,0154	7, 9-3	1,18-4	327	339	4,0117	1,17-3	1,00-4
545	335	4,0168	2,14-3	4,79-5	527	339	4,0121	4,06-6	2,21-4
325	137	4,0117	1,21-3	3,21-4	337	339	4,0164	1,02-2	2,59-4
525	137	4,0122	1,56-4	5,93-5	537	339	4,0168	3,75-3	7,98-5
335	137	4,0154	1,36-2	1,58-4	347	339	4,0143	3,84-3	5,92-4
535	137	4,0159	1,21-2	1,18-4	547	339	4,0149	2,16-3	1,12-4
545	137	4,0172	3,43-3	4,79-5	529	137	4,0127	1,37-4	1,56-5
325	337	4,0112	4,17-4	3,21-4	339	137	4,0156	1,40-2	2,58-4
525	337	4,0117	3,21-4	5,93-5	539	137	4,0171	3,72-3	1,47-4
335	337	4,0149	2,60-5	1,58-4	349	137	4,0123	9,73-4	4,23-4
535	337	4,0154	1,67-2	1,18-4	549	137	4,0150	9,90-3	2,82-
545	337	4,0168	7,70-3	4,79-5	529	337	4,0122	1,72-4	1,56-5
327	335	4,0116	8,40-5	1,00-4	339	337	4,0152	2,57-2	2,58-4
527	335	4,0120	2,17-6	2,21-4	539	337	4,0166	4,12-3	1,47-4
337	335	4,0163	4,82-3	2,59-4	349	337	4,0119	8,11-4	4,23-4
537	335	4,0167	6,60-3	7,98-5	549	337	4,0145	4,05-3	2,82-4
347	335	4,0143	1,03-2	5,92-4	529	339	4,0123	7,09-4	1,56-5
547	335	4,0148	6,65-3	1,12-4	339	339	4,0152	1,25-4	2,58-4
327	137	4,0121	4,82-4	1,00-4	539	339	4,0167	4,91-3	1,47-4
527	137	4,0125	5,19-5	2,21-4	349	339	4,0119	8,69-5	4,23-4
337	137	4,0168	7,24-6	2,59-4	549	339	4,0145	2,59-2	2,82-4
537	137	4,0172	1,61-3	7,98-5	5311	339	4,0153	3,54-2	2,49-4
347	137	4,0148	2,96-2	5,92-4	3411	339	4,0114	4,60-5	7,10-4
547	137	4,0153	1,58-3	1,12-4	5411	339	4,0123	7,30-4	1,63-5

Annex 3

WAVELENGTHS (A), RADIATIVE TRANSITION PROBABILITIES A AND AUTO-IONIZATION PROBABILITIES Γ(10^{13} s^{-1}) FOR K XVIII, K XVII AND K XVI

SLJ	$S'L'J'$	λ	A	Γ	SLJ	$S'L'J'$	λ	A	Γ
$1s2p - 1s^2$									
113	101	3,5310	1,40+1	0	315	101	3,5456	4,97-5	
313	101	3,5495	2,61-1	0					
$2s^2 - 1s2p$									
101	113	3,4156	2,85+0	3,79+1	101	313	3,3985	5,48-2	3,79+1
$2s2p - 1s2s$									
311	303	3,3760	7,90+0	1,95+0	113	303	3,3450	5,64-2	2,07+1
113	101	3,3641	7,93+0	2,07+1	313	303	3,3745	7,86+0	2,11+0
313	101	3,3939	5,40-2	2,11+0	315	303	3,3708	7,94+0	1,94+0
$2p^2 - 1s2p$									
311	113	3,3945	1,52-2	4,46-1	313	315	3,3786	6,61+0	0
101	113	3,3649	1,61+1	1,54+1	315	113	3,3892	6,39-1	2,58+0
311	313	3,3776	1,59+1	4,46-1	125	113	3,3798	1,50+1	3,19+1
101	313	3,3483	1,58-2	1,54+1	315	313	3,3723	4,21+0	2,50+0
313	311	3,3738	5,31+0	0	125	313	3,3630	9,66-5	3,19+1
313	113	3,3920	7,27-2	0	315	315	3,3758	1,11+1	2,58+0
313	313	3,3751	3,91+0	0	125	315	3,3665	8,75-1	3,19+1

SLJ	$S'L'J'$	λ	A	Γ	SLJ	$S'L'J'$	λ	A	Γ
$1s2s^2 - 1s^22p$									
202	212	3,6329	1,89-1	1,14+1	202	214	3,6372	3,77-1	1,14+1
$1s2s(^1S)2p - 1s^22s$									
212	202	3,5596	1,10+1	1,94+0	214	202	3,5451	5,05-1	5,25-1
$1s2s(^3S)2p - 1s^22s$									
212	202	3,5464	2,72+0	7,25+0	214	202	3,5573	1,32+1	8,65+0
412	202	3,5892	2,30-2	2,25-3	414	202	3,5876	6,73-2	7,35-3
$1s2p^2 - 1s^22p$									
212	212	3,5612	1,52+1	2,72-1	414	212	3,5835	6,24-4	3,28-2
412	212	3,5855	1,04-1	9,33-2	224	212	3,5646	7,92+0	1,43+1
202	212	3,5474	5,67-1	7,55+0	214	214	3,5607	1,81+1	1,40+0
212	214	3,5653	4,61+0	2,72-1	414	214	3,5876	5,27-2	3,28-2
412	214	3,5897	1,28-2	9,33-2	224	214	3,5686	3,93-2	1,43+1
202	214	3,5514	6,75+0	7,55+0	416	214	3,5850	1,32-1	3,19-1
214	212	3,5566	1,13+0	1,40+0	226	214	3,5677	6,63+0	1,54+1
$1s2p(^1P)3s - 1s^23s$									
212	202	3,5358	1,41+1	8,14-2	214	202	3,5355	1,38+1	2,26=3
$1s2p(^3P)3s - 1s^23s$									
212	202	3,5505	1,10-1	1,84+0	214	202	3,5469	2,43-1	1,88+0
412	202	3,5574	5,17-2	2,49-2	414	202	3,5560	2,26-1	6,36-2
$1s2p(^1P)3p - 1s^23p$									
202	212	3,5321	1,43+0	2,89+0	224	212	3,5371	1,25+1	4,13+0
212	212	3,5361	1,22+1	4,94-2	214	214	3,5357	1,25+1	4,39-1
202	214	3,5333	1,04+1	2,09+0	224	214	3,5383	4,34-1	4,13+0
212	214	3,5373	1,36+0	4,94-2	226	214	3,5379	1,37+1	3,47+0
214	212	3,5345	5,32-1	4,39-1					

SLJ	$S'L'J'$	λ	A	Γ	SLJ	$S'L'J'$	λ	A	Γ
$1s2p(^3P)3p - 1s^2 3p$									
202	212	3,5437	2,91-2	8,56-1	224	212	3,5499	5,38-1	2,25+0
212	212	3,5559	4,72-1	2,34-3	424	212	3,5601	2,11-1	9,38-3
412	212	3,5541	3,94-2	9,54-2	404	214	3,5550	3,29-2	1,43-1
422	212	3,5613	1,32-1	5,26-4	214	214	3,5583	3,52-1	4,61-2
202	214	3,5449	2,94+0	8,56-1	414	214	3,5532	1,74-3	3,50-2
212	214	3,5571	3,97-6	2,34-3	224	214	3,5511	9,12-1	2,25+0
412	214	3,5553	1,20-2	9,54-2	424	214	3,5613	4,97-2	9,38-3
422	214	3,5625	2,77-2	5,26-4	416	214	3,5521	2,68-2	2,40-1
404	212	3,5538	2,76-1	1,43-1	226	214	3,5476	4,26-1	3,28+0
214	212	3,5571	1,90-1	4,61-2	426	214	3,5592	1,30-1	6,14-2
414	212	3,5520	1,04-3	3,50-2					
$1s2p(^1P)3d - 1s^2 3d$									
212	224	3,5302	1,37+1	6,29-2	226	224	3,5336	3,09+0	6,66-2
214	224	3,5293	8,16-1	6,06-2	236	224	3,5310	8,81+0	1,40+0
224	224	3,5340	1,31+1	7,40-4	226	226	3,5340	1,08+1	6,66-2
214	226	3,5297	1,26+1	6,06-2	236	226	3,5314	2,63+0	1,40+0
224	226	3,5344	6,87-1	7,40-4	238	226	3,5323	1,18+1	1,46+0
$1s2p(^3P)3d - 1s^2 3d$									
212	224	3,5421	5,41-1	4,29-3	416	224	3,5474	2,59-1	2,52-3
412	224	3,5471	2,83-4	5,93-7	226	224	3,5539	3,28-1	7,36-4
422	224	3,5511	1,32-1	5,65-4	426	224	3,5507	2,24-1	2,66-3
214	224	3,5442	7,51-2	5,45-3	236	224	3,5484	1,44+0	5,44-3
414	224	3,5473	7,23-3	1,50-5	436	224	3,5563	1,72-1	9,80-3
224	224	3,5537	8,88-2	8,31-4	416	226	3,5479	3,66-2	2,52-3
424	224	3,5511	7,84-2	9,02-5	226	226	3,5543	8,21-2	7,36-4
434	224	3,5574	1,12-1	2,88-5	426	226	3,5511	1,80-1	2,66-3
214	226	3,5446	1,02+0	5,45-3	236	226	3,5488	5,65-1	5,44-3
414	226	3,5477	4,50-3	1,50-5	436	226	3,5567	3,13-2	9,80-3
224	226	3,5541	9,00-2	8,31-4	428	226	3,5488	1,86-2	6,98-3
424	226	3,5515	7,42-3	9,02-5	238	226	3,5453	2,40+0	5,31-3
434	226	3,5578	1,61-3	2,88-5	438	226	3,5551	1,11-1	1,55-2

SLJ	$S'L'J'$	λ	A	Γ	SLJ	$S'L'J'$	λ	A	Γ
$1s2p(^1P)4s - 1s^2 4s$									
212	202	3,5324	1,41+1	4,83-2	214	202	3,5323	1,40+1	3,37-3
$1s2p(^3P)4s - 1s^2 4s$									
212	202	3,5497	1,68-1	6,46-1	214	202	3,5459	4,72-2	6,68-1
412	202	3,5529	3,70-2	3,85-2	414	202	3,5516	2,58-1	5,98-2
$1s2p(^1P)4p - 1s^2 4p$									
202	212	3,5314	2,32+0	7,82-1	224	212	3,5330	1,35+1	1,22+0
212	212	3,5329	1,18+1	3,67-3	214	214	3,5327	1,35+1	1,47-1
202	214	3,5319	1,17+1	7,82-1	224	214	3,5335	4,19-1	1,22+0
212	214	3,5334	2,30+0	3,67-3	226	214	3,5332	1,41+1	9,35-1
214	212	3,5322	4,17-1	1,47-1					
$1s2p(^3P)4p - 1s^2 4p$									
202	212	3,5445	1,76-2	6,76-1	224	212	3,5500	1,28-1	7,49-1
212	212	3,5507	9,69-3	1,08-1	424	212	3,5532	1,15-1	4,31-2
412	212	3,5513	1,78-1	1,62-2	404	214	3,5527	1,26-1	5,99-2
422	212	3,5541	6,29-2	3,85-3	214	214	3,5478	1,74-1	5,11-1
202	214	3,5450	2,53-1	6,76-1	414	214	3,5484	1,30-2	6,94-2
212	214	3,5512	4,53-2	1,08-1	224	214	3,5505	1,34-1	7,49-1
412	214	3,5518	7,38-2	1,62-2	424	214	3,5537	3,13-3	4,31-2
422	214	3,5546	1,15-2	3,85-3	416	214	3,5482	9,80-3	1,19-1
404	212	3,5522	1,55-1	5,99-2	226	214	3,5461	3,19-3	1,60+0
214	212	3,5473	1,46-3	5,11-1	426	214	3,5523	1,98-1	1,42-1
414	212	3,5479	7,56-6	6,94-2					
$1s2p(^1P)4d - 1s^2 4d$									
212	224	3,5306	1,42+1	3,59-2	226	224	3,5317	5,55+0	1,06-1
214	224	3,5302	9,34-1	3,52-2	236	224	3,5312	8,21+0	6,37-1
224	224	3,5318	1,32+1	1,76-4	226	226	3,5319	8,52+0	1,06-1
214	226	3,5304	1,31+1	3,52-2	236	226	3,5314	5,43+0	6,37-1
224	226	3,5320	9,12-1	1,76-4	238	226	3,5318	1,40+1	6,98-1

Annex 3, continued

slj	s'l'j'	λ	A	Γ	slj	s'l'j'	λ	A	Γ
$1s2p(^3P)4d - 1s^24d$									
212	224	3,5441	2,57-2	2,92-4	416	224	3,5461	4,66-2	2,52-3
412	224	3,5460	1,08-4	3,89-8	226	224	3,5510	2,38-1	3,24-4
422	224	3,5498	1,86-1	4,04-4	426	224	3,5466	7,79-2	1,15-2
214	224	3,5452	2,43-2	5,39-4	236	224	3,5493	1,64-1	7,13-3
414	224	3,5461	4,36-3	1,25-5	436	224	3,5518	6,85-2	9,46-3
224	224	3,5504	1,77-2	7,28-4	416	226	3,5462	1,50-2	2,52-3
424	224	3,5498	1,48-1	4,63-7	226	226	3,5511	4,15-2	3,24-4
434	224	3,5527	5,84-2	2,06-5	426	226	3,5468	8,61-2	1,15-2
214	226	3,5454	1,35-1	5,39-4	236	226	3,5495	2,58-1	7,13-3
414	226	3,5462	4,01-3	1,25-5	436	226	3,5520	4,54-3	9,46-3
224	226	3,5506	2,16-1	7,28-4	428	226	3,5468	3,56-3	3,88-3
424	226	3,5500	4,37-3	4,63-7	238	226	3,5448	1,52-1	5,02-2
434	226	3,5528	1,46-4	2,06-5	438	226	3,5508	1,63-1	2,26-2
$1s2p(^1P)4f - 1s^24f$									
224	236	3,5297	1,42+1	1,00-4	238	236	3,5310	7,34-1	4,17-5
226	236	3,5296	5,65-1	7,00-5	248	236	3,5301	1,34+1	4,62-2
236	236	3,5310	1,35+1	2,97-6	238	238	3,5310	1,33+1	4,17-5
226	238	3,5297	1,36+1	7,00-5	248	238	3,5302	7,28-1	4,62-2
236	238	3,5331	5,60-1	2,97-6	2410	238	3,5302	1,41+1	4,48-2
$1s2p(^3P)4f - 1s^24f$									
224	236	3,5443	1,89-5	2,19-4	428	236	3,5503	5,12-7	1,64-4
424	236	3,5448	5,38-3	4,47-5	238	236	3,5452	3,04-3	5,57-5
434	236	3,5493	2,17-1	1,66-5	438	236	3,5454	8,40-3	4,15-5
226	236	3,5452	5,90-3	7,79-5	248	236	3,5485	2,57-4	1,30-4
426	236	3,5448	1,24-5	8,30-5	448	236	3,5492	2,59-1	3,33-4
236	236	3,5487	2,55-1	9,47-5	428	238	3,5504	3,37-4	1,64-4
436	236	3,5493	1,08-2	1,71-5	238	238	3,5453	8,95-4	5,57-5
446	236	3,5505	1,19-3	3,52-5	438	238	3,5455	3,35-3	4,15-5
226	238	3,5453	7,77-4	7,79-5	248	238	3,5486	2,00-1	1,30-4
426	238	3,5448	1,23-2	8,30-5	448	238	3,5493	7,43-7	3,33-4
236	238	3,5487	2,31-2	9,47-5	4310	238	3,5491	2,25-1	1,41-3
436	238	3,5493	2,10-1	1,71-5	2410	238	3,5448	4,01-4	7,04-4
446	238	3,5506	3,94-5	3,52-5	4410	238	3,5455	2,99-3	5,68-5

slj	s'l'j'	λ	A	Γ	slj	s'l'j'	λ	A	Γ
$1s2s^22p - 1s^22s^2$									
113	101	3,5828	1,28+1	6,71+0	313	101	3,6006	2,29-1	1,23+1
315	101	3,5969	4,41-5	1,24+1	311				1,24+1
$1s2s(^1S)2p^2 - 1s^22s2p$									
311	113	3,6234	2,27-4	2,44+0	313	315	3,5935	3,59+0	5,26+0
101	113	3,5836	6,27+0	1,83+1	315	113	3,6185	2,73-2	6,47+0
311	313	3,5916	1,79+1	2,44+0	125	113	3,6006	5,34+0	2,48+1
101	313	3,5525	1,72-3	1,83-1	315	313	3,5867	6,92-1	6,47+0
313	311	3,5896	1,01+1	5,26+0	125	313	3,5692	2,24-2	2,48+1
313	113	3,6226	8,59-4	5,26+0	315	315	3,5895	1,47+1	6,47+0
313	313	3,5908	9,79-1	5,26+0	125	315	3,5719	6,40+0	2,48+1
$1s2s(^3S)2p^2 - 1s^22s2p$									
311	113	3,6012	2,53-1	1,26+1	113	315	3,5565	2,65-3	3,59+0
311	313	3,5698	1,44+0	1,26+1	313	315	3,5702	1,82+0	1,61+1
113	311	3,5526	8,74-3	3,59+0	513	315	3,6283	2,59-3	4,24-2
313	311	3,5664	6,71-2	1,61+1	303	315	3,5769	3,44+0	9,32+0
513	311	3,6242	1,11-2	4,24-2	323	315	3,5915	3,02+0	1,39+1
303	311	3,5729	4,97-1	9,32+0	315	113	3,5963	1,03+0	1,39+1
323	311	3,5875	2,73-2	1,39+1	515	113	3,6560	1,45-6	1,95-2
113	113	3,5850	1,92+1	3,59+0	325	113	3,6218	8,18-3	1,25+1
313	113	3,5989	8,83-2	1,61+1	315	313	3,5649	8,11-2	1,39+1
513	113	3,6579	2,13-7	4,24-2	515	313	3,6236	5,80-5	1,95-2
303	113	3,6056	9,59-2	9,32+0	325	313	3,5901	8,87+0	1,25+1
323	113	3,6205	1,37-2	1,39+1	315	315	3,5677	4,41-1	1,39+1
113	313	3,5538	1,50-3	3,59+0	515	315	3,6264	2,23-2	1,95-2
313	313	3,5675	2,09-2	1,61+1	325	315	3,5928	4,98-1	1,25+1
513	313	3,6255	2,98-2	4,24-2	517	315	3,6240	3,40-2	9,27-2
303	313	3,5741	1,82+0	9,32+0	327	315	3,5918	6,40+0	1,67+1
323	313	3,5887	6,89+0	1,39+1					
$1s2s(^1S)2p(^2P)3s - 1s^22s3s$									
311	303	3,5657	1,08+1	4,81-1	113	303	3,5587	1,02+0	2,95+0
113	101	3,5658	9,91+1	2,95+0	313	303	3,5651	1,07+1	5,06-1
313	101	3,5723	3,25-1	5,06-1	315	303	3,5500	7,49-1	1,50+0

Annex 3, continued

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
1s2s(³S)2p(²P)3s - 1s²2s3s									
311	303	3,5512	2,82+0	1,12+0	113	303	3,5464	3,97-2	1,82+0
113	101	3,5535	2,77+0	1,82+0	313	303	3,5507	1,83+0	1,37+0
313	101	3,5578	5,38-1	1,37+0	315	303	3,5633	1,27+1	1,21-1
1s2s(³S)2p(⁴P)3s - 1s²2s3s									
311	303	3,5865	1,40-2	3,46+0	513	303	3,5959	2,66-2	1,12-2
313	101	3,5924	5,16-2	3,45+0	315	303	3,5822	4,55-2	3,41+0
513	101	3,6032	7,61-5	1,12-2	515	303	3,5943	6,11-2	2,07-2
313	303	3,5852	1,06-3	3,45+0					
1s2s(¹S)2p(²P)3p - 1s²2s3p									
101	113	3,5412	5,46-2	2,57+0	323	313	3,5672	4,40+0	2,48+0
311	113	3,5522	4,74-2	7,42-1	303	315	3,5619	4,52+0	1,77+0
101	313	3,5381	4,81-3	2,57+0	113	315	3,5654	1,04+0	1,72+0
311	313	3,5492	6,50-1	7,42-1	313	315	3,5493	7,54-2	7,99-1
303	311	3,5608	6,37-1	1,77+0	323	315	3,5680	4,25-2	2,48+0
113	311	3,5642	2,40-1	1,72+0	315	113	3,5505	2,96-2	1,91+0
313	311	3,5482	6,72-2	7,99-1	125	113	3,5467	2,01-2	3,43+0
323	311	3,5669	3,48+0	2,48+0	325	113	3,5684	2,28-1	3,02+0
303	113	3,5642	1,76+0	1,77+0	315	313	3,5474	8,25-3	1,91+0
113	113	3,5676	5,73+0	1,72+0	125	313	3,5437	2,68-3	3,43+0
313	113	3,5515	1,08-2	7,99-1	325	313	3,5653	7,58+0	3,02+0
323	113	3,5703	1,23+0	2,48+0	315	315	3,5483	2,44-1	1,91+0
303	313	3,5611	2,94+0	1,77+0	125	315	3,5445	7,42-3	3,43+0
113	313	3,5645	1,35-2	1,72+0	325	315	3,5662	2,54+0	3,02+0
313	313	3,5485	1,76-1	7,99-1	327	315	3,5645	1,12+1	2,13+0
1s2s(³S)2p(²P)3p - 1s²2s3p									
101	113	3,5603	1,24+1	2,99+0	303	113	3,5503	2,58-1	1,88+0
311	113	3,5653	2,18-2	9,90-1	113	113	3,5486	3,35+0	2,02-1
101	313	3,5572	7,55-3	2,99+0	313	113	3,5647	2,37-2	1,19+0
311	313	3,5622	1,15+1	9,90-1	323	113	3,5549	2,86-2	2,98+0
303	311	3,5470	7,69-2	1,88+0	303	313	3,5473	4,42-1	1,88+0
113	311	3,5453	1,74-2	2,02-1	113	313	3,5456	1,47-3	2,02-1
313	311	3,5614	4,39+0	1,19+0	313	313	3,5617	2,91+0	1,19+0
323	311	3,8516	1,09+0	2,98+0	323	313	3,5519	1,27+0	2,98+0

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
1s2s(³S)2p(²P)3p - 1s²2s3p									
303	315	3,5481	1,82+0	1,88+0	315	313	3,5603	6,57-1	2,72+0
113	315	3,5464	2,00-2	2,02-1	125	313	3,5612	2,97+0	3,66+0
313	315	3,5625	4,32+0	1,19+0	325	313	3,5512	9,38-1	4,29+0
323	315	3,5527	1,19-1	2,98+0	315	315	3,5612	4,66+0	2,72+0
315	113	3,5634	6,88+0	2,72+0	125	315	3,5620	3,84+0	3,66+0
125	113	3,5642	5,02+0	3,66+0	325	315	3,5520	7,89-1	4,29+0
325	113	3,5542	2,57-1	4,29+0	327	315	3,5511	1,07+0	2,54+0
1s2s(³S)2p(⁴P)3p - 1s²2s3p									
311	113	3,5931	5,43-3	4,76-1	513	315	3,5903	2,00-3	1,59-1
521	113	3,6003	7,74-5	1,72-2	323	315	3,5851	1,98-2	3,48+0
311	313	3,5900	2,79-1	4,76-1	523	315	3,5976	7,18-3	1,41-2
521	313	3,5972	3,57-2	1,72-2	505	113	3,5955	3,72-5	9,28-2
303	311	3,5778	1,40-2	1,85+0	315	113	3,5920	3,03-2	6,07-1
313	311	3,5897	1,72-1	4,14-1	515	113	3,5913	9,87-5	4,07-2
513	311	3,5892	2,84-3	1,59-1	325	113	3,5863	1,96-2	4,24+0
323	311	3,5840	7,89-2	3,48+0	525	113	3,5989	2,70-4	1,43-2
523	311	3,5964	2,99-2	1,41-2	505	313	3,5924	3,27-2	9,28-2
303	113	3,5812	2,89-2	1,85+0	315	313	3,5889	1,41-1	6,07-1
313	113	3,5931	1,29-2	4,14-1	515	313	3,5882	8,12-4	4,07-2
513	113	3,5925	3,27-6	1,59-1	325	313	3,5832	8,61-2	4,24+0
323	113	3,5874	4,06-2	3,48+0	525	313	3,5958	3,63-2	1,43-2
523	113	3,5998	1,77-4	1,41-2	505	315	3,5932	6,96-2	9,28-2
303	313	3,5781	7,65-2	1,85+0	315	315	3,5898	1,48-1	6,07-1
313	313	3,5900	7,37-2	4,14-1	515	315	3,5890	6,46-3	4,07-2
513	313	3,5894	8,70-3	1,59-1	325	315	3,5841	1,58-1	4,24+0
323	313	3,5843	1,42-1	3,48+0	525	315	3,5966	1,93-3	1,43-2
523	313	3,5967	8,49-4	1,41-2	517	315	3,5879	5,32-3	1,21-1
303	315	3,5790	4,35-1	1,85+0	327	315	3,5826	1,23-1	3,76+0
313	315	3,5909	4,75-2	4,14-1	527	315	3,5951	2,19-2	1,63-2
1s2s(¹S)2p(²P)3d - 1s²3d									
311	323	3,5588	1,22+1	1,34-1	323	323	3,5629	7,34+0	9,17-2
113	323	3,5438	4,68-2	3,92-1	113	125	3,5500	1,61-1	3,92-1
313	323	3,5591	5,32+0	2,24-1	313	125	3,5654	6,38-2	2,24-1

Annex 3, continued

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^1S)2p(^2P)3d - 1s^22s3d$									
323	125	3,5692	3,43-2	9,17-2	335	325	3,5654	2,26+0	8,49-1
113	325	3,5439	8,46-2	3,92-1	315	327	3,5590	5,43+0	1,28-1
313	325	3,5593	6,47+0	2,24-1	125	327	3,5612	4,94-1	2,74-1
323	325	3,5630	4,49+0	9,17-2	325	327	3,5631	4,56+0	1,03-1
315	323	3,5587	1,98-5	1,28-1	335	327	3,5656	5,10-2	8,49-1
125	323	3,5609	3,42+0	2,74-1	327	125	3,5533	1,03-2	1,10-1
325	323	3,5628	1,08+0	1,03-1	137	125	3,5510	2,52-1	4,77-1
335	323	3,5653	5,37+0	8,49-1	337	125	3,5702	1,78-1	8,46-1
315	125	3,5650	2,72+0	1,28-1	327	325	3,5472	1,19-1	1,10-1
125	125	3,5672	3,24+0	2,74-1	137	325	3,5449	3,35-6	4,77-1
325	125	3,5691	1,01+0	1,03-1	337	325	3,5640	5,55+0	8,46-1
335	125	3,5716	6,23-1	8,49-1	327	327	3,5474	5,84-1	1,10-1
315	325	3,5588	2,41+0	1,28-1	137	327	3,5451	1,13-2	4,77-1
125	325	3,5610	3,00+0	2,74-1	337	327	3,5642	3,59+0	8,46-1
325	325	3,5629	4,05+0	1,03-1	339	327	3,5625	1,08+1	9,96-1
$1s2s(^3S)2p(^2P)3d - 1s^22s3d$									
311	323	3,5448	1,25+0	5,12-2	315	325	3,5449	2,40-1	3,67-2
113	323	3,5522	4,19-2	1,13-1	125	325	3,5483	2,17-2	1,09-1
313	323	3,5450	2,63-1	3,45-2	325	325	3,5474	2,96-1	3,67-2
323	323	3,5475	5,08-1	3,01-2	335	325	3,5489	1,02+0	5,56-1
113	125	3,5585	1,17+1	1,13-1	315	327	3,5451	1,81+0	3,67-2
313	125	3,5512	1,66-1	3,45-2	125	327	3,5485	6,44-3	1,09-1
323	125	3,5538	1,47+0	3,01-2	325	327	3,5476	8,55-1	3,67-2
113	325	3,5524	4,72-1	1,13-1	335	327	3,5490	9,89-2	5,56-1
313	325	3,5451	1,10+0	3,45-2	327	125	3,5679	2,54-3	1,86-1
323	325	3,5477	7,61-1	3,01-2	137	125	3,5618	1,29+1	9,96-1
315	323	3,5448	1,02-2	3,67-2	337	125	3,5549	2,23-1	4,63-1
125	323	3,5481	2,64-2	1,09-1	327	325	3,5618	4,69+0	1,86-1
325	323	3,5473	1,12-1	3,67-2	137	325	3,5557	2,01-1	9,96-1
335	323	3,5487	2,78+0	5,56-1	337	325	3,5488	2,26+0	4,63-1
315	125	3,5510	2,49-2	3,67-2	327	327	3,5620	8,06+0	1,86-1
125	125	3,5544	5,05+0	1,09-1	137	327	3,5559	1,10-1	9,96-1
325	125	3,5535	6,99-1	3,67-2	337	327	3,5490	9,56-1	4,63-1
335	125	3,5550	1,70-1	5,56-1	339	327	[illegible]	[illegible]	3,57-1

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^4P)3d - 1s^22s3d$									
311	323	3,5770	1,05-1	3,07-2	315	325	3,5802	1,47-4	2,56-2
521	323	3,5898	4,43-2	1,35-4	515	325	3,5866	2,36-3	2,37-4
313	323	3,5786	8,25-3	6,84-2	325	325	3,5888	7,16-4	1,03-2
513	323	3,5863	2,94-1	6,53-5	525	325	3,5902	3,89-2	8,17-4
323	323	3,5887	2,08-2	1,69-2	335	325	3,5839	2,50-1	9,35-2
523	323	3,5899	3,34-2	2,42-4	535	325	3,5954	4,53-3	1,60-3
533	323	3,5958	2,32-2	1,11-4	315	327	3,5804	3,05-1	2,56-2
313	125	3,5849	1,07-2	6,84-2	515	327	3,5868	4,31-4	2,37-4
513	125	3,5927	6,17-5	6,53-5	325	327	3,5890	9,69-3	1,03-2
323	125	3,5950	2,68-2	1,69-2	525	327	3,5904	1,03-2	8,17-4
523	125	3,5963	2,78-4	2,42-4	335	327	3,5841	7,45-4	9,35-2
533	125	3,6022	1,85-4	1,11-4	535	327	3,5956	2,84-3	1,60-3
313	325	3,5787	2,24-1	6,84-2	517	125	3,5967	2,24-3	1,39-3
513	325	3,5865	7,59-6	6,53-5	327	125	3,5942	1,79-2	1,09-2
323	325	3,5888	4,48-4	1,69-2	527	125	3,5931	4,36-3	3,31-3
523	325	3,5900	1,66-2	2,42-4	337	125	3,5884	2,19-2	7,80-2
533	325	3,5960	8,82-3	1,11-4	537	125	3,6008	2,08-6	3,46-3
315	323	3,5801	1,12-3	2,56-2	517	325	3,5905	2,09-2	1,39-3
515	323	3,5865	4,28-4	2,37-4	327	325	3,5890	8,61-2	1,09-2
325	323	3,5887	7,35-2	1,03-2	527	325	3,5868	7,72-3	3,31-3
525	323	3,5901	1,73-2	8,17-4	337	325	3,5822	6,29-1	7,80-2
335	323	3,5838	6,84-1	9,35-2	537	325	3,5946	3,74-2	3,46-3
535	323	3,5953	2,85-2	1,60-3	517	327	3,5907	5,62-2	1,38-3
315	125	3,5864	1,61-2	2,56-2	327	327	3,5882	1,35-3	1,09-2
515	125	3,5929	1,47-5	2,37-4	527	327	3,5870	2,99-3	3,31-3
325	125	3,5951	2,20-3	1,03-2	337	327	3,5824	2,25-1	7,80-2
525	125	3,5964	7,94-5	8,17-4	537	327	3,5948	5,47-4	3,46-3
335	125	3,5901	3,09-2	9,35-2	529	327	3,5879	9,44-3	2,32-3
535	125	3,6017	5,44-5	1,60-3	339	327	3,5805	7,68-1	5,09-2
					539	327	3,5935	3,52-2	4,56-3
$1s2s(^1S)2p(^2P)4s - 1s^22s4s$									
311	303	3,5633	1,05+1	2,10-1	113	303	3,5594	2,24+0	1,11+0
113	101	3,5616	9,97+0	1,10+0	313	303	3,5629	9,07+0	3,51-1
313	101	3,5651	1,42+0	3,51-1	315	303	3,5480	8,79-1	6,56-2

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^1S)2p(^2P)4s - 1s^22s4s$									
3II	303	3,5490	3,I4+0	4,I4-I	II3	303	3,5466	5,47-3	6,I8-I
II3	I0I	3,5488	I,70+0	6,I8-I	3I3	303	3,5487	2,29+0	4,88-I
3I3	I0I	3,5509	4,88-I	4,88-I	3I5	303	3,5607	I,27+I	5,6I-I
$1s2s(^3S)2p(^4P)4s - 1s^22s4s$									
3II	303	3,5888	I,55-2	I,32+0	5I3	303	3,5920	2,64-2	2,25-2
3I3	I0I	3,5896	5,32-2	I,30+0	3I5	303	3,5843	I,07-2	I,29+0
5I3	I0I	3,5942	6,43-4	2,25-2	5I5	303	3,5904	6,74-2	3,08-2
3I3	303	3,5873	5,26-3	1,30+0					
$1s2s(^1S)2p(^2P)4p - 1s^22s4p$									
I0I	II3	3,5467	4,90-I	5.74-I	323	3I3	3,5647	5,26+0	9,77-I
3II	II3	3,564I	I,I9-I	5,27-I	303	3I5	3,5609	2,I9+0	7,54-I
I0I	3I3	3,5456	3,36-2	5,74-I	II3	3I5	3,5638	7,06+0	5,6I-I
3II	3I3	3,5630	I,08+I	5,27-I	3I3	3I5	3,56I7	I,34+0	4,50-I
303	3II	3,5605	I,65+0	7,54-I	323	3I5	3,565I	2,47-2	9,77-I
II3	3II	3,5633	3,45-2	5,6I-I	3I5	II3	3,5622	I,08+0	I,65+0
3I3	3II	3,56I2	6,60+0	4,50-I	I25	II3	3,56I4	8,82+0	I,59+0
323	3II	3,5646	3,49+0	9,77-I	325	II3	3,5646	2,23+0	I,06+0
303	II3	3,56I7	3,90+0	7,54-I	3I5	3I3	3,56II	9,33+0	I,65+0
II3	II3	3,5645	2,78+0	5,6I-I	I25	3I3	3,5603	9,86-4	I,59+0
3I3	II3	3,5624	3,22+0	4,50-I	325	3I3	3,5636	2,97+0	I,06+0
323	II3	3,5658	I,II+0	9,77-I	3I5	3I5	3,56I5	2,2I+0	I,65+0
303	3I3	3,5606	4,37+0	7,54-I	I25	3I5	3,5607	4,I0+0	I,59+0
II3	3I3	3,5634	2,60-I	5,6I-I	325	3I5	3,5639	5,26+0	I,06+0
3I3	3I3	3,56I3	I,2I+0	4,50-I	327	3I5	3,56I7	I,24+I	8,02-I
$1s2s(^3S)2p(^2P)4p - 1s^22s4p$									
I0I	II3	3,560I	I,28+I	I,58+0	303	II3	3,5493	6,80-I	6,22-I
3II	II3	3,5506	I,54-I	3,36-I	II3	II3	3,5487	I,66+I	2,23-I
I0I	3I3	3,5590	2,80-I	I,58+0	3I3	II3	3,550I	I,57-I	3,89-I
3II	3I3	3,5495	2,45+0	3,36-I	323	II3	3,55I0	4,74-2	I,05+0
303	3II	3,548I	I,27-I	6,22-I	303	3I3	3,5482	5,54-I	6,22-I
II3	3II	3,5475	3,58-2	2,23-I	II3	3I3	3,5476	I,94-2	2,23-I
3I3	3II	3,5489	2,85-I	3,89-I	3I3	3I3	3,5490	7,II-2	3,89-I
323	3II	3,5498	I,33+0	I,05+0	323	3I3	3,5499	I,84+0	I,05+0

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^2P)4p - 1s^22s4p$									
303	3I5	3,5486	I,06+0	6,22-I	3I5	3I3	3,5485	2,68-I	8,37-I
II3	3I5	3,5480	I,49-I	2,23-I	I25	3I3	3,5472	8,57-4	8,92-I
3I3	3I5	3,5494	I,56+0	3,89-I	325	3I3	3,5495	9,56-I	I,52+0
323	3I5	3,5503	I,96-I	I,05+0	3I5	3I5	3,5489	6,82-I	8,37-I
3I5	II3	3,5496	I,09-I	8,37-I	I25	3I5	3,5476	4,40-3	8,92-I
I25	II3	3,5483	7,76-I	8,92-I	325	3I5	3,5498	I,28+0	I,52+0
325	II3	3,5506	5,65-I	I,52+0	327	3I5	3,5492	I,I4+0	9,27-I
$1s2s(^3S)2p(^4P)4p - 1s^22s4p$									
3II	II3	3,59I0	4,I5-2	I,88-I	5I3	3I5	3,5905	I,42-4	2,37-I
52I	II3	3,5945	I,69-4	I,27-2	323	3I5	3,5887	5,45-5	I,27+0
3II	3I3	3,5899	7,3I-3	I,88-I	523	3I5	3,5934	6,46-3	I,55-2
52I	3I3	3,5934	3,53-2	I,27-2	505	II3	3,5922	7,77-4	5,07-2
303	3II	3,584I	I,34-3	8,39-I	3I5	II3	3,5900	3,63-2	7,08-I
3I3	3II	3,5904	4,06-2	3,25-I	5I5	II3	3,5887	3,79-4	4,08-2
5I3	3II	3,590I	2,I2-3	2,37-I	325	II3	3,5873	7,24-3	I,33+0
323	3II	3,5883	2,98-3	I,27+0	525	II3	3,5934	2,0I-3	3,I6-2
523	3II	3,5929	2,8I-2	I,55-2	505	3I3	3,59I0	4,87-2	5,07-2
303	II3	3,5853	7,32-3	8,39-I	3I5	3I3	3,5889	2,23-2	7,08-I
3I3	II3	3,59I6	2,45-3	3,25-I	5I5	3I3	3,5876	9,95-5	4,08-2
5I3	II3	3,59I3	8,52-5	2,37-I	325	3I3	3,5862	I,47-4	I,33+0
323	II3	3,5895	6,27-2	I,27+0	525	3I3	3,5923	2,5I-2	3,I6-2
523	II3	3,5942	7,34-4	I,55-2	505	3I5	3,59I4	4,0I-2	5,07-2
303	3I3	3,5842	4,27-5	8,39-I	3I5	3I5	3,5892	3,07-3	7,08-I
3I3	3I3	3,5905	8,74-3	3,25-I	5I5	3I5	3,5879	2,09-4	4,08-2
5I3	3I3	3,5902	2,I6-2	2,37-I	325	3I5	3,5866	3,37-2	I,33+0
323	3I3	3,5884	I,98-2	I,27+0	525	3I5	3,5927	4,28-3	3,I6-2
523	3I3	3,593I	3,96-4	I,55-2	5I7	3I5	3,5878	3,17-3	6,52-2
303	3I5	3,5845	3,78-2	8,39-I	327	3I5	3,5855	I,I5-3	I,58+0
3I3	3I5	3,5909	8,36-3	3,25-I	527	3I5	3,59I2	5,53-2	5,I2-2
$1s2s(^1S)2p(^2P)4d - 1s^22s4d$									
3II	323	3,559I	I,25+I	7,57-2	323	323	3,56I8	4,I8+0	6,77-2
II3	323	3,557I	7,54-2	9,28-2	II3	I25	3,5590	I,I5+I	9,28-2
3I3	323	3,5593	8,I9+0	9,88-2	3I3	I25	3,56I2	I,33-I	9,88-2

Annex 3, continued

$1s2s(^1S)2p(^2P)4d - 1s^22s4d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
323	I25	3,5638	4,89-I	6,77-2	335	325	3,5632	3,22+0	4,43-I
II3	325	3,557I	I,04+0	9,28-2	3I5	327	3,5622	7,0I+0	7,I8-2
3I3	325	3,5594	4,I6+0	9,88-2	I25	327	3,559I	3,40+0	6,86-2
323	325	3,56I9	6,25+0	6,77-2	325	327	3,5600	2,67-I	I,2I-I
3I5	323	3,5620	3,86-I	7,I8-2	335	327	3,5633	I,24-I	4,43-I
I25	323	3,5589	6,84-2	6,86-2	327	I25	3,562I	5,49-3	I,67-I
325	323	3,5598	4,92+0	I,2I-I	I37	I25	3,5483	2,30-I	9,73-2
335	323	3,5632	5,78+0	4,43-I	337	I25	3,5643	7,58-I	4,0I-I
3I5	I25	3,5640	I,77+0	7,I8-2	327	325	3,5602	6,85+0	I,67-I
I25	I25	3,5609	6,45+0	6,86-2	I37	325	3,5464	6,72-4	9,73-2
325	I25	3,56I8	I,78+0	I,2I-I	337	325	3,5624	4,52+0	4,0I-I
335	I25	3,565I	7,80-I	4,43-I	327	327	3,5602	5,80+0	I,67-I
3I5	325	3,562I	I,I2+0	7,I8-2	I37	327	3,5465	I,55-I	9,73-2
I25	325	3,5590	2,05+0	6,86-2	337	327	3,5625	5,20+0	4,0I-I
325	325	3,5599	5,42+0	I,2I-I	339	327	3,5605	I,23+I	5,I4-I

$1s2s(^3S)2p(^2P)4d - 1s^22s4d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
3II	323	3,5460	I,08+0	2,90-2	3I5	325	3,5462	3,03-I	I,90-2
II3	323	3,5456	4,5I-2	I,90-I	I25	325	3,5477	2,46-I	9,00-2
3I3	323	3,546I	3,28-I	I,62-2	325	325	3,5473	I,7I-I	5,06-2
323	323	3,5476	7,65-I	I,67-2	335	325	3,548I	I,03+0	2,I2-I
II3	I25	3,5476	5,84-I	I,90-I	3I5	327	3,5463	I,2I+0	I,90-2
3I3	I25	3,548I	2,65-I	I,62-2	I25	327	3,5478	7,96-I	9,00-2
323	I25	3,5495	5,95-I	I,67-2	325	327	3,5474	7,29-I	5,06-2
II3	325	3,5457	I,65-I	I,90-I	335	327	3,548I	4,85-2	2,I2-I
3I3	325	3,5462	6,68-I	I,62-2	327	I25	3,5489	7,25-2	9,85-2
323	325	3,5476	I,3I+0	I,67-2	I37	I25	3,5598	I,I9+I	6,37-I
3I5	323	3,546I	2,55-2	I,90-2	337	I25	3,5498	6,26-I	I,66-I
I25	323	3,5476	9,66-2	9,00-2	327	325	3,5470	5,I6-I	9,85-2
325	323	3,5472	5,I5-I	5,06-2	I37	325	3,5579	4,30-I	6,37-I
335	323	3,5480	I,72+0	2,I2-I	337	325	3,5479	I,20+0	I,66-I
3I5	I25	3,548I	2,48-4	I,90-2	327	327	3,547I	3,2I-I	9,85-2
I25	I25	3,5496	I,82+0	9,00-2	I37	327	3,5580	7,62-I	6,37-I
325	I25	3,5492	3,52-2	5,06-2	337	327	3,5480	I,32+0	I,66-I
335	I25	3,5500	9,42-I	2,I2-I	339	327	3,5474	I,27+0	I,42-I

$1s2s(^3S)2p(^4P)4d - 1s^22s4d$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
3II	323	3.5827	7,84-3	8,08-3	5I5	325	3,5857	3,I2-4	8,I5-5
52I	323	3,5889	5,43-2	I,I9-4	325	325	3,5898	3,22-2	7,64-3
3I3	323	3,583I	I,29-4	I,66-2	525	325	3,5892	1,26-2	4,6I-3
5I3	323	3,5856	I,44-4	I,93-5	335	325	3,5866	2,94-2	5,20-2
323	323	3,5882	2,76-4	8,07-3	535	325	3,59I4	8,88-4	I,59-3
523	323	3,5889	3,73-2	2,02-4	3I5	327	3,584I	2,70-2	7,82-3
533	323	3,59I8	I,7I-2	I,97-4	5I5	327	3,5858	2,08-4	8,I5-5
3I3	I25	3,585I	4,48-3	I,66-2	325	327	3,5889	4,42-3	7,64-3
5I3	I25	3,5876	I,6I-5	I,93-5	525	327	3,5893	2,42-2	4,6I-3
323	I25	3,5902	4,I6-2	8,07-3	335	327	3,5867	5,8I-3	5,20-2
523	I25	3,5909	9,22-4	2,02-4	535	327	3,59I5	4,I2-3	I,59-3
533	I25	3,5938	I,II-3	I,97-4	5I7	I25	3,59I4	3,82-3	8,I6-4
3I3	325	3,5832	I,67-2	I,66-2	327	I25	3,5895	3,84-2	I,9I-2
5I3	325	3,5856	I,83-7	I,93-5	527	I25	3,5879	6,02-4	I,75-3
323	325	3,5883	5,4I-3	8,07-3	337	I25	3,5864	7,I4-3	4,6I-2
523	325	3,5889	2,I2-2	2,02-4	537	I25	3,5928	5,64-4	4,08-3
533	325	3,59I8	I,04-2	I,97-4	5I7	325	3,5894	3,49-2	8,I6-4
3I5	323	3,5840	3,I7-4	7,82-3	327	325	3,5876	2,92-2	I,9I-2
5I5	323	3,5857	5,26-4	8,I5-5	527	325	3,5859	8,I3-6	I,75-3
325	323	3,5887	4,09-3	7,64-3	337	325	3,5845	2,85-2	4,6I-2
525	323	3,5892	3,54-2	4,6I-3	537	325	3,5909	2,30-2	4,08-3
335	323	3,5866	6,I8-2	5,20-2	5I7	327	5,3895	3,34-2	8,I6-4
535	323	3,59I4	2,32-2	I,59-3	327	327	3,5877	I,59-2	I,9I-2
3I5	I25	3,5860	4,0I-3	7,82-3	527	327	3,5860	2,36-3	I,75-3
5I5	I25	3,5877	I,98-4	8,I5-5	337	327	3,5846	2,55-2	4,6I-2
325	I25	3,5907	6,39-4	7,64-3	537	327	3,59I0	2,22-3	4,08-3
525	I25	3,59I2	I,87-4	4,6I-3	529	327	3,5864	2,22-3	I,I5-3
335	I25	3,5886	5,06-2	5,20-2	339	327	3,5835	3,92-2	6,I9-2
535	I25	3,5934	5,34-4	I,59-3	539	327	3,5897	4,84-2	6,42-3
3I5	325	3,5840	3,49-3	7,82-3					

$1s2s(^1S)2p(^2P)4f - 1s^22s4f$

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
323	335	3,5583	I,26+I	5,90-4	335	335	3,56I6	4,79+0	5,86-I
I25	335	3,5580	7,27-2	6,79+I	I25	I37	3,5585	8,83+0	6,79+I
325	335	3,5588	7,32+0	I,42+2	325	I37	3,5592	I,95+0	I,43+2

Annex 3, continued

SLJ	S'L'J'	λ	Λ	I	SLJ	S'L'J'	λ	Λ	Γ
$1s2s(^1S)2p(^2P)4f - 1s^22s4f$									
335	I37	3,5620	I,22+0	5,66-I	347	337	3,56I6	5,I6+0	I,77-2
I25	337	3,558I	3,72+0	6,79+I	327	339	3,5588	5,02+0	I,09-3
325	337	3,5587	3,23+0	I,43+2	I37	339	3,56I6	4,89+0	2,99-3
335	337	3,56I6	4,5I+0	5,86-I	337	339	3,5593	8,24-3	9,8I-3
327	335	3,5587	7,27-3	I,09-3	347	339	3,56I7	9,63-I	I,77-2
I37	335	3,56I5	I,08+0	2,99-3	339	I37	3,56I9	2,44+0	I,44-2
337	335	3,5592	6,64+0	9,8I-3	I49	I37	3,5588	8,27+0	2,97-2
347	335	3,56I6	3,58+0	I,77-2	349	I37	3,5596	I,I0+0	I,I8-2
327	I37	3,5592	4,I8+0	I,09-3	339	337	3,56I5	I,50+0	I,44-2
I37	I37	3,56I9	3,99+0	2,99-3	I49	337	3,5584	3,49+0	2,97-2
337	I37	3,5596	2,98+0	9,8I-3	349	337	3,5592	7,I3+0	I,I8-2
347	I37	3,5620	6,63-I	I,77-2	339	339	3,56I5	6,5I+0	I,44-2
327	337	3,5588	3,30+0	I,09-3	I49	339	3,5585	8,88-I	2,97-2
I37	337	3,56I5	4,30-I	2,99-3	349	339	3,5592	4,32+0	I,I8-2
337	337	3,5592	2,9I+0	9,8I-3	34II	339	3,5587	I,26+I	2,78-2
$1s2s(^3S)2p(^2P)4f - 1s^22s4f$									
323	335	3,5456	9,75-I	I,73-4	327	337	3,5459	I,57-I	9,35-5
I25	335	3,5460	I,23-I	2,II+0	I37	337	3,5474	8,92-2	4,77-3
325	335	3,5455	5,6I-I	8,76+I	337	337	3,5473	I,53+0	I,5I-3
335	335	3,5474	I,23+0	I,I6+I	347	337	3,5465	I,69-2	6,I3-3
I25	I37	3,5464	7,2I-I	2,II+0	327	339	3,5460	I,35+0	9,35-5
325	I37	3,5460	4,96-I	8,76+I	I37	339	3,5474	4,25-I	4,77-3
335	I37	3,5478	3,99-I	I,I6+I	337	339	3,5474	9,62-I	I,5I-3
I25	337	3,5460	6,40-I	2,II+0	347	339	3,5465	I,26-3	6,I3-3
325	337	3,5456	4,I0-I	8,76+I	339	I37	3,5476	6,92-I	2,45-3
335	337	3,5474	I,II+0	I,I6+I	I49	I37	3,5464	5,II-I	2,52-3
327	335	3,5459	5,40-3	9,35-5	349	I37	3,5468	5,90-I	4,57-3
I37	335	3,5473	5,88-I	4,77-3	339	337	3,5472	2,38-I	2,45-3
337	335	3,5473	2,32-I	I,5I-3	I49	337	3,5460	3,86-I	2,52-3
347	335	3,5465	I,48+0	6,I3-3	349	337	3,5463	8,49-I	4,57-3
327	I37	3,5463	6,57-3	9,35-5	339	339	3,5473	I,83+0	2,45-3
I37	I37	3,5478	I,7I+0	4,77-3	I49	339	3,546I	3,I6-2	2,52-3
337	I37	3,5477	5,2I-3	I,5I-3	349	339	3,5464	9,46-3	4,57-3
347	I37	3,5469	6,06-2	6,I3-3	34II	339	3,5460	9,95-I	3,83-3

SLJ	S'L'J'	λ	A	Γ	SLJ	S'L'J'	λ	A	Γ
$1s2s(^3S)2p(^4P)4f - 1s^22s4f$									
323	335	3,5839	7,8I-5	4,02-4	327	337	3,5846	I,8I-5	2,20-4
523	335	3,5844	7,98-4	I,73-5	527	337	5,5850	I,27-3	8,45-5
533	335	3,5884	6,I0-2	I,40-5	337	337	3,5893	3,23-3	7,I3-4
325	335	3,5842	I,34-4	8,27+I	537	337	3,5896	2,04-3	I,36-4
525	335	3,5847	I,09-3	I,38+I	347	337	3,5873	2,I5-4	2,42-3
335	335	3,5878	4,02-2	2,I3+0	547	337	3,5878	4,79-2	2,02-4
535	335	3,5883	I,42-2	2,00+0	327	339	3,5846	I,53-3	2,20-4
545	335	3,5896	3,99-3	9,96-2	527	339	3,5850	7,47-6	8,45-5
325	I37	3,5846	I,69-3	8,27+I	337	339	3,5893	I,7I-2	7,I3-4
525	I37	3,585I	2,07-4	I,38+I	537	339	3,5897	5,88-3	I,36-4
335	I37	3,5882	3,49-2	2,I3+0	347	339	3,5874	7,06-3	2,42-3
535	I37	3,5887	2,05-2	2,00+0	547	339	3,5879	4,20-3	2,02-4
545	I37	3,590I	5,57-3	9,96-2	529	I37	3,5899	6,70-3	I,73-4
325	337	3,5842	5,5I-4	8,27+I	339	I37	3,5879	I,83-2	3,21-4
525	337	3,5847	4,46-I	I,38+I	539	I37	3,5855	I,82-4	I,45-5
335	337	3,5878	3,08-5	2,I3+0	349	I37	3,5852	I,22-3	4,I3-4
535	337	3,5883	2,89-2	2,00+0	549	I37	3,5885	2,27-2	2,76-4
545	337	3,5897	I,30-2	9,96-2	529	337	3,5895	6,57-3	I,73-4
327	335	3,5846	I,20-4	2,20-4	339	337	3,5875	6,44-3	3,2I-4
527	335	3,5849	4,42-6	8,45-5	539	337	3,585I	2,57-4	I,45-5
337	335	3,5893	7,32-3	7,I3-4	349	337	3,5848	I,06-3	4,I3-4
537	335	3,5896	I,I4-2	I,36-4	549	337	3,588I	4,58-2	2,76-4
347	335	3,5873	I,68-2	2,42-3	529	339	3,5896	8,5I-3	I,73-4
547	335	3,5878	I,23-2	2,02-4	339	339	3,5875	4,47-2	3,2I-4
327	I37	3,5850	6,I0-4	2,20-4	539	339	3,585I	8,79-4	I,45-5
527	I37	3,5854	5,I4-5	8,45-5	349	339	3,5848	I,00-4	4,I3-4
337	I37	3,5897	5,79-5	7,I3-4	549	339	3,588I	2,70-4	2,76-4
537	I37	3,5900	2,96-3	I,36-4	53II	339	3,5882	6,I9-2	3,29-4
347	I37	3,5877	5,I2-2	2,42-3	34II	339	3,5843	5,00-5	7,I2-4
547	I37	3,5882	2,70-3	2,02-4	54II	339	3,585I	9,50-4	I,47-5

Annex 4

AUTO-IONIZATION PROBABILITIES (10^{13} s^{-1}) OF STATES OF FOUR-ELECTRON IONS OF CHLORINE, ARGON AND POTASSIUM SUMMED FOR ALL PATHS $1s^2 2l\epsilon l$

SLJ	Cl XIV	Ar XV	K XVI	SLJ	Cl XIV	Ar XV	K XVI
$1s2s(^1S)2p^2$				$1s2s^2 2p$			
3II	3,07-2	6,89-2	6,49-2	3II	4,86+0	5,59+0	5,82+0
IOI	6,86+0	8,I5+0	6,85+0	II3	5,42-2	8,39-2	I,08-I
3I5	5,74+0	3,64+0	4,45+0	3I5	4,85+0	5,58+0	5,8I+0
3I3	I,03+0	I,56+0	9,96-I	3I3	4,80+0	5,5I+0	5,7I+0
I25	I,35+I	I,42+I	I,30+I				
$1s2s(^3S)2p^2$							
3II	I,34-I	I,76-I	2,I0-I				
II3	3,54-2	7,0I-2	7,I7-2				
3I3	4,2I-I	5,76+0	3,24+0				
5I3	I,75-2	3,44-2	3,62-2				
303	6,6I+0	6,8I+0	6,I4+0				
323	I,35+I	I,I6+I	I,I9+I				
3I5	8,27-I	2,92+0	I,93+0				
5I5	7,82-3	I,52-2	I,63-2				
325	8,76+0	I,38+I	I,08+I				
5I7	3,74-2	7,62-2	8,35-2				
327	I,I4+I	I,73+I	I,50+I				
$1s2s(^1S)2p(^2P)3s$				$1s2s(^1S)2p(^2P)4s$			
3II	I,I2-2	4,83-3	8,67-3	3II	3,75-3	2,23-3	3,54-3
II3	2,98-I	3,36-I	4,82-I	II3	8,37-2	8,70-2	I,I3-I
3I3	3,47-2	3,86-2	6,77-2	3I3	2,62-2	3,23-2	5,27-2
3I5	I,38-2	I,22-I	I,50+0	3I5	2,88-3	5,98-2	I,68-3
$1s2s(^3S)2p(^2P)3s$				$1s2s(^3S)2p(^2P)4s$			
3II	I,3I-I	I,52-I	I,77-I	3II	6,27-2	7,I0-2	8,I6-2
II3	I,I2+0	I,I5+0	I,26+0	II3	4,54-I	4,74-I	5,06-I
3I3	I,20-I	I,33-I	I,65-I	3I3	6,II-2	6,82-2	7,I2-2
3I5	I,I2-I	6,I5-3	I,2I-I	3I5	5,52-2	I,I5-3	6,6I-2

SLJ	Cl XIV	Ar XV	K XVI	SLJ	Cl XIV	Ar XV	K XVI
$1s2s(^3S)2p(^4P)3s$				$1s2s(^3S)2p(^4P)4s$			
3II	I,30+0	I,36+0	I,63+0	3II	4,98-I	5,2I-I	5,80-I
3I3	I,30+0	I,36+0	I,63+0	3I3	4,92-I	5,I4-I	5,7I-I
5I3	3,75-3	5,50-3	7,04-3	5I3	6,6I-3	8,97-3	I,I6-2
3I5	I,3I+0	I,38+0	3,4I+0	3I5	4,96-I	5,20-I	5,80-I
5I5	6,84-3	I,02-2	2,07-2	5I5	9,65-3	I,29-I	I,68-2
$1s2s(^1S)2p(^2P)3p$				$1s2s(^1S)2p(^2P)4p$			
IOI	I,84+0	2,07+0	2,07+0	IOI	4,68-I	5,24-I	4,83-I
3II	4,92-2	7,06-2	I,06-I	3II	7,94-2	I,03-I	I,43-I
303	7,29-I	7,9I-I	6,77-I	303	3,2I-I	3,49-I	3,23-I
II3	4,II-I	4,58-I	4,36-I	II3	I,29-I	I,39-I	I,30-I
3I3	I,I6-I	3,28-3	I,72-I	3I3	7,33-2	8,87-2	9,42-2
323	6,I8-I	6,55-I	5,55-I	323	2,93-I	3,09-I	2,56-I
3I5	5,97-2	I,08-I	I,36-I	3I5	3,07-I	4,03-I	4,86-I
I25	2,95+0	3,35+0	3,27+0	I25	I,I2+0	I,06+0	I,07+0
325	I,09+0	I,20+0	I,II+0	325	5,I3-I	5,74-I	5,77-I
327	I,24+0	I,42+0	I,36+0	327	5,II-I	5,80-I	5,50-I
$1s2s(^3S)2p(^2P)3p$				$1s2s(^3S)2p(^2P)4p$			
IOI	I,45+0	I,4I+0	I,45+0	IOI	8,54-I	8,39-I	8,6I-I
3II	5,70-4	I,I8-3	4,22-4	3II	9,33-4	I,28-3	6,34-6
303	I,07+0	I,I7+0	I,35+0	303	2,34-I	2,26-I	3,I6-I
II3	I,46-I	I,37-I	I,08-I	II3	I,23-I	I,28-I	9,95-2
3I3	2,67-3	I,I7-I	I,93-2	3I3	I,72-2	3,26-2	I,07-2
323	I,94+0	2,I7+0	2,45+0	323	6,40-I	6,93-I	7,90-I
3I5	3,96-I	6,97-I	8,85-I	3I5	3,I5-2	5,34-2	3,74-2
I25	2,38+0	2,I2+0	2,24+0	I25	8,46-I	9,36-I	8,67-I
325	I,76+0	I,93+0	2,I6+0	325	5,68-I	5,94-I	6,79-I
327	I,49+0	I,56+0	I,72+0	327	4,74-I	4,72-I	5,I6-I
$1s2s(^3S)2p(^4P)3p$				$1s2s(^3S)2p(^4P)4p$			
3II	7,23-4	I,06-3	I,49-3	3II	4,02-4	5,77-4	8,08-4
52I	I,59-5	2,74-5	4,28-5	52I	I,88-5	3,09-5	4,77-5

Annex 4, continued

SLJ	Cl XIV	Ar XV	K XVI
	$1s2s(^3S)2p(^4P)3p$		
5I3	2,92-2	4,58-2	7,83-2
323	2,77+0	2,90+0	2,90+0
523	8,26-4	I,I3-3	I,44-3
505	I,06-2	I,53-2	2,0I-2
3I5	I,02-I	I,6I-I	2,I7-I
5I5	I,24-2	I,97-2	3,29-2
325	2,78+0	2,90+0	2,87+0
525	2,72-3	3,69-3	4,68-3
5I7	5,39-2	8,33-2	I,I0-I
327	3,00+0	3,2I+0	3,28+0
527	7,45-3	I,I4-2	I,62-2
	$1s2s(^1S)2p(^2P)3d$		
3II	3,89-2	4,30-2	4,47-2
II3	3,65-3	2,77-3	3,55-3
3I3	3,74-2	4,09-2	4,I5-2
323	4,56-4	6,48-4	I,II-3
3I5	3,62-2	4,4I-2	4,73-2
I25	7,I2-2	9,33-2	I,I2-I
325	5,09-3	I,26-3	5,58-3
335	6,I0-I	6,58-I	5,97-I
327	4,35-3	6,84-3	8,98-3
I37	I,78-I	2,42-I	2,54-I
337	6,63-I	7,32-I	6,92-I
339	7,93-I	9,I0-I	9,07-I
	$1s2s(^3S)2p(^2P)3d$		
3II	3,82-3	3,39-3	4,5I-3
II3	3,87-2	4,2I-2	4,I0-2
3I3	4,97-3	I,34-3	6,68-3
323	2,08-3	3,8I-3	6,79-3
3I5	5,45-3	5,38-3	7,4I-3
I25	I,22-2	I,37-2	6,II-4

SLJ	Cl XIV	Ar XV	K XVI
	$1s2s(^3S)2p(^4P)4p$		
5I3	I,03-I	I,72-I	I,9I-I
323	I,06+0	I,05+0	I,0I+0
523	3,70-3	5,I3-3	6,50-3
505	I,42-2	I,79-2	2,07-2
3I5	3,66-I	4,83-I	5,73-I
5I5	I,76-2	2,I2-2	2,53-2
325	8,85-I	8,27-I	7,50-I
525	I,42-2	2,05-2	2,67-2
5I7	3,42-2	4,66-2	5,85-2
327	I,30+0	I,37+0	I,39+0
527	2,54-2	3,66-2	4,83-2
	$1s2s(^1S)2p(^2P)4d$		
3II	2,I5-2	2,39-2	2,5I-2
II3	I,92-2	2,I6-2	2,20-2
3I3	I,87-2	2,05-2	2,05-2
323	2,27-3	2,86-3	3,78-3
3I5	4,56-2	5,I6-2	8,27-3
I25	2,30-2	2,80-2	3,I5-2
325	6,38-3	6,99-3	6,I4-2
335	3,I5-I	3,II-I	3,04-I
327	7,8I-2	9,2I-2	I,07-I
I37	I,48-2	2,I5-2	I,90-2
337	3,I9-I	3,I9-I	3,25-I
339	4,I5-I	4,33-I	4,62-I
	$1s2s(^3S)2p(^2P)4d$		
3II	I,77-3	I,63-3	2,I9-3
II3	2,97-3	2,4I-3	3,I8-3
3I3	2,57-3	2,32-3	3,40-3
323	9,44-4	I,50-3	I,85-3
3I5	2,34-3	2,26-3	3,3I-3
I25	3,68-2	3,08-2	3,08-2

SLJ	Cl XIV	Ar XV	K XVI
	$1s2s(^3S)2p(^2P)3d$		
325	9,I0-4	4,37-3	9,94-4
335	3,66-I	4,2I-I	5,I5-I
327	6,54-2	8,54-2	9,82-2
I37	8,96-I	9,64-I	9,9I-I
337	3,27-I	3,65-I	4,29-I
339	2,64-I	2,74-I	3,I8-I
	$1s2s(^3S)2p(^4P)3d$		
3II	2,36-3	2,66-3	2,75-3
52I	4,87-5	7,68-5	I,25-4
3I3	2,48-3	2,8I-3	2,94-3
5I3	I,55-7	I,83-7	2,85-7
323	9,20-5	I,45-4	2,06-4
523	4,82-5	7,75-5	I,22-4
533	3,38-7	6,76-7	I,II-6
3I5	2,73-3	3,I2-3	3,28-3
5I5	4,II-5	7,I9-5	9,03-5
325	2,0I-4	3,25-4	3,50-4
525	9,49-5	I,45-4	I,77-4
335	I,09-2	I,II-2	6,99-3
535	6,80-4	I,09-3	I,53-3
5I7	4,40-4	7,30-4	2,72-4
327	3,77-4	7,02-4	I,02-3
527	I,95-4	2,60-4	9,46-4
337	I,39-2	I,5I-2	I,I0-2
537	I,47-3	2,38-3	3,4I-3
529	I,I5-3	I,75-3	2,3I-3
339	I,73-2	I,94-2	I,52-2
539	I,84-3	3,09-3	4,55-3

SLJ	Cl XIV	Ar XV	K XVI
	$1s2s(^3S)2p(^2P)4d$		
325	I,I4-2	I,45-2	I,5I-2
335	I,I3-I	I,22-I	I,7I-I
327	I,84-2	2,00-2	2,56-2
I37	5,47-I	5,5I-I	6,06-I
337	I,I5-I	I,I3-I	I,47-I
339	I,03-I	I,I4-I	I,I7-I
	$1s2s(^3S)2p(^4P)4d$		
3II	4,85-4	3,85-4	4,34-4
52I	I,95-5	3,98-5	6,37-5
3I3	5,00-4	4,03-4	4,54-4
5I3	8,50-8	7,05-8	I,I7-7
323	7,84-5	I,04-4	I,5I-4
523	2,40-5	4,53-5	7,00-5
533	9,82-7	I,85-6	3,07-6
3I5	I,93-3	2,25-3	2,68-3
5I5	8,00-3	5,53-5	3,05-5
325	4,64-3	5,35-3	5,67-3
525	9,I6-4	I,82-3	2,95-3
335	2,4I-2	3,02-2	2,94-2
535	7,53-2	I,05-3	I,47-3
5I7	I,93-4	I,69-4	I,73-4
327	7,I9-3	9,97-3	I,27-2
527	I,05-3	I,20-3	I,42-3
337	3,49-2	3,30-2	3,24-2
537	2,02-3	2,87-3	4,03-3
529	7,43-4	8,66-4	I,I2-3
339	4,82-2	5,00-2	5,36-2
539	2,96-3	4,37-3	6,40-3

Annex 4, continued

SLJ	Cl XIV	Ar XV	K XVI
	$1s2s(^1S)2p(^2P)4f$		
323	I,6I-5	5,68-5	6,56-5
I25	6,30-6	I,87-5	2,I0-5
325	I,20-5	3,32-5	3,59-5
335	5,II-6	7,65-6	I,08-5
327	I,76-4	2,93-4	4,3I-4
I37	9,96-3	9,97-3	8,07-4
337	3,98-3	2,35-3	8,82-3
347	8,45-3	I,I5-2	I,33-2
339	I,I2-2	I,27-2	I,38-2
I49	2,70-2	2,92-2	2,95-2
349	I,27-2	I,30-2	I,I2-2
34II	2,49-2	2,7I-2	2,73-2
	$1s2s(^3S)2p(^2P)4f$		
323	I,24-5	6,8I-6	4,95-6
I25	I,07-4	I,I9-4	I,29-4
325	9,57-5	I,06-4	I,09-4
335	7,29-6	I,57-5	I,I0-5
327	I,I4-5	4,87-6	3,05-6
I37	4,0I-4	8,38-4	I,I7-3
337	I,I8-3	I,78-3	I,34-3
347	4,33-3	3,77-3	5,65-3
339	I,36-3	2,22-3	2,32-3
I49	I,68-3	I,39-3	I,88-3
349	3,II-3	2,63-3	4,06-3
34II	3,34-3	2,96-3	3,66-3

SLJ	Cl XIV	Ar XV	K XVI
	$1s2s(^3S)2p(^4P)4f$		
323	I,69-4	I,67-4	I,69-4
523	7,74-6	7,79-6	7,38-6
533	6,47-6	6,3I-6	6,69-6
325	I,25-4	I,2I-4	I,22-4
525	2,34-5	2,27-5	2,07-5
335	2,54-5	2,96-5	3,40-5
535	2,20-6	2,66-6	2,40-6
545	6,8I-6	6,73-6	6,80-6
327	7,80-5	3,52-5	7,9I-5
527	3,87-5	7,67-5	3,0I-5
337	9,58-5	I,0I-4	9,9I-5
537	4,I0-5	5,43-5	6,97-5
347	I,89-4	I,76-4	I,63-4
547	7,36-5	7,48-5	7,64-5
529	6,90-6	7,I3-6	I,42-4
339	3,45-5	4,52-5	2,37-4
539	9,0I-5	I,I6-4	6,47-6
349	2,09-4	2,02-4	I,96-4
549	I,69-4	2,03-4	6,I9-5
53II	I,70-4	2,39-4	3,20-4
34II	4,40-4	4,60-4	4,72-4
54II	I,47-5	I,39-5	I,29-5