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A PRACTICAL FIT FORMULA FOR IONIZATION RATE COEFFICIENTS OF ATOMS AND IONS BY ELECTRON IMPACT: $Z = 1–28$

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Ionization rates for atoms and ions from H to Ni recommended by the Belfast group, supplemented by data derived from several other sources, are fitted to an analytical expression with four fit parameters. On the grounds of its very simple form and its ability to generally replicate the input data to within a few percentage points, we present this expression as a practical formula for use in computer modeling of plasma processes.

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CONTENTS

INTRODUCTION

Ionization of atoms and ions by electron impact is one of the most important processes in plasma physics and its applications. In particular, the need for data on ionization cross sections and rates arises on a large scale in connection with fusion research. An extensive effort has been made to collect, analyze, and compare the available data on ionization rates and cross sections, and some reviews of recommended data have been published [1–5]. In this report, we attempt to summarize the data on ionization rates from these works by means of a simple fit formula suitable for certain applications.

There is a very broad range of electron temperatures of interest—from some eV up to some tens of keV—in astrophysical and in fusion plasmas. Empirical formulas are widely used in plasma physics for interpolation and extrapolation of available data over this wide range, among them several formulas for ionization rates. Critical reviews of these formulas and comparisons with available data have been done in Refs. [4] and [6].

Ordinarily, empirical formulas are designed to fit the available data as closely as possible while conforming to the energy dependence of the cross section expected on theoretical grounds. However, the formulas thus derived are not necessarily very practical from the point of view of users. Atomic data usage in plasma and fusion research has some specific features: they are used in large codes which typically deal with several atoms and some tens of ionic charge states, and hence they enter into the ionization rate computations for all these species at thousands of spatial and temporal steps. The currently available empirical formulas are very inconvenient for such computations. Some of them include inconvenient functions such as the exponential integral, and all of them are complicated and require calling up special subroutines. It would be desirable to find a simple formula which could be included into codes as a one-line operation and here we propose such an empirical formula.

Recommended Data on Ionization Rates

In the present work we include only the data for ionization from the ground state of the atom or ion. The ionization from excited and especially metastable levels may be very important in some instances. But this is a special case and would need special consideration.

The input data we use are mainly those from Bell et al. [1a] and Lennon et al. [1b], also widely known as the ''Belfast recommended data.'' These authors compiled, analyzed, and recommended data for electron impact ionization cross sections and rates for atoms and ions in the range from hydrogen to nickel. Note that Lennon et al. [1b] have revised the Bell et al. [1a] data for B^{2+}, C^{3+}, and O^{5+} and that we are using the revised data here.

Kato et al. [4] have compared the Belfast data with data from other sources [2,3,5] and have found generally good agreement except for neutral atoms and low stages of ionization. Some small errors were found for highly ionized ions from Sc to Ni, and a correction factor of 1.626 for the cross section and ionization rate values has been suggested by these authors. We accept this correction and use the data as shown in Ref. [4] for these ions instead of the original Belfast data.

Since the Belfast group does not provide data for some ions (V^{15+}–V^{22+}, Cr^{23+}, Mn^{24+}, Co^{18+}–Co^{26+}, Ni^{26+}, Ni^{27+}), we use for these ions the Lotz values [3] computed and shown in Ref. [4].

In some cases, for example the Na-like sequence from P^{4+} to Ni^{17+}, Kato et al. [4] consider the Belfast

values as too low, noting that the Belfast data do not include autoionization whereas the data of Arnaud and Rothenflug [2] do. We accept this assessment and use for the Na-like sequence data from Ref. [2].

The temperature range of the Belfast data is limited to $T_e < 10$ keV. To meet the needs of fusion research we extend the temperature range to 20 KeV. The temperature range of recommended data for ions with ionization energy >1 keV was expanded in Ref. [4] to 100 keV. We adopt this expansion as well.

We refer to the above-described set of input data collectively as the ''recommended data'' to indicate that we have drawn mainly from the Belfast recommended data [1] as corrected or extended by Kato et al. [4] In Table I, where we have listed the source of data for each species, we identify the Belfast data with Ref. [1], the corrected or extended values of these with Ref. [4], and the other supplemental data with the respective publications in which they were originally presented. The numerical values given for these input data were calculated from the fit formulas given in the various sources.

The ionization energy for the ground state of atoms and ions we have taken from Ref. [7], keeping only one digit after the decimal point. In a few cases, for example Al^{8+}, Si^{3+}, Ar^{3+}, the Belfast values for the threshold energy differ from more recent values for the ionization energy of these ions, but we kept the Belfast threshold energy values to fit the recommended data for low temperature.

The Fit Formula

The best fit formula we find after several attempts [8] is

$$\langle \sigma v \rangle = A \frac{(1 + P*U^{1/2})}{(X + U)} U^K e^{-U} \text{ cm}^3/\text{s} \qquad (1)$$

with

$$U = dE/T_e.$$

Here $\langle \sigma v \rangle$ is the rate coefficient, i.e., the Maxwellian averaged product of ionization cross section and electron velocity; U is the (dimensionless) relative temperature; dE is threshold energy; and T_e is the electron temperature. A, K, and X are adjustable parameters which we find from the fit to the recommended data. The parameter P was included to better fit the particular cross-section behavior for certain ions near threshold; it only takes on the value 0 or 1.

Equation (1) is nonlinear. Therefore we use a two-step procedure to find the best-fit values for P, K, X, and A. We fix the value of P and step K in the range 0–1 with a step size of 0.01. For each K, the best values of X and A are found by the least squares method.

As the measure of the fit accuracy we use the discrepancy function

$$D = \left[\frac{1}{N} \sum \left(\frac{\langle \sigma v \rangle_r - \langle \sigma v \rangle}{\langle \sigma v \rangle_r} \right)^2 \right]^{1/2}. \qquad (2)$$

Here $\langle \sigma v \rangle_r$ is the input rate data, $\langle \sigma v \rangle$ is the rate given by Eq. (1), and N is the number of fitted points (which was usually about 20).

This procedure was repeated for both values of the parameter P. The point where $D(K)$ had the lowest value was accepted as the best-fit point and the corresponding values of P, K, X, and A were accepted as the best-fit values. These fit parameters are given in Table I.

Conclusion

Equation (1) appears to be a good-fit formula for the ionization rate of atoms and ions by electron impact from the ground state. We tested it on more than 400 cases from H to Ni^{27+}. The results are shown in Table II. Given in this table are the values of the input ionization rates and the ratios (in percent) of the rates defined by Eq. (1) to the recommended rates. As seen from the percentage values in Table II, the values given by the fit formula Eq. (1) are very close to the recommended rates. The deviation of the fit values from the recommended data, less than 10% in most cases, is far less than the estimated accuracy of the recommended data, which is 40–60%.

Thus, we may conclude that when the empirical formula Eq. (1) is used in place of the recommended data in computer modeling of plasma processes, the overall accuracy would remain substantially the same whereas the computations would be greatly simplified.

Acknowledgment

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EXPLANATION OF TABLES

TABLE I Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

The best-fit values for the parameters of Eq. (1) are tabulated for the ionization rate from the ground state of atoms and ions from H to Ni^{27+}

ION	Element symbol and stage of ionization
dE	Ionization energy dE in eV
P, A, X, K	Fit parameters in Eq. (1) giving the ionization rate in cm^3/s as function of $U = dE/T_e$, where T_e is the electron temperature in eV
Tmin, Tmax	Electron temperature range over which the fit has been made, with the lower bound listed in eV and the upper in keV
Ref	Source of the input data; the source being identified as Ref. [4] indicates that data taken from Ref. [1] either have been multiplied by a correction factor 1.626 or have been expanded in their range of application from 10 to 100 keV (see text)

TABLE II Comparison of Fitted and Recommended Ionization Rates

The input recommended data for the ionization rate and the percentage ratio of fitted to recommended data at selected electron temperatures T_e in the range 1–100,000 eV are shown

Ion	Element symbol and stage of ionization
Te	Electron temperature in eV
Rec. data	Recommended data on the rate of ionization in cm^3/s; the recommended rates have been calculated from various fit formulas in Refs. [1–3] and include some correction and/or extrapolation made in Ref. [4] (see text)
Fit/Rec	Ratio of fitted to recommended data as a percentage

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
H	13.6	0	0.291E-07	0.232	0.39	1	20	1
He	24.6	0	0.175E-07	0.180	0.35	1	20	1
He 1+	54.4	1	0.205E-08	0.265	0.25	3	20	1
Li	5.4	0	0.139E-06	0.438	0.41	1	20	1
Li 1+	75.6	1	0.201E-08	0.209	0.23	4	20	1
Li 2+	122.4	1	0.960E-09	0.582	0.17	5	20	1
Be	9.3	0	0.102E-06	0.375	0.27	1	20	1
Be 1+	18.2	1	0.208E-07	0.439	0.21	1	20	1
Be 2+	153.9	0	0.267E-08	0.612	0.27	7	20	1
Be 3+	217.7	1	0.427E-09	0.658	0.15	10	20	1
B	8.3	0	0.649E-07	0.200	0.26	1	20	1
B 1+	25.2	1	0.124E-07	0.267	0.22	2	20	1
B 2+	37.9	1	0.327E-08	0.295	0.23	2	20	1
B 3+	259.4	1	0.495E-09	0.489	0.09	20	20	1
B 4+	340.2	1	0.219E-09	0.657	0.15	20	20	1
C	11.3	0	0.685E-07	0.193	0.25	1	20	1
C 1+	24.4	1	0.186E-07	0.286	0.24	1	20	1
C 2+	47.9	1	0.635E-08	0.427	0.21	2	20	1
C 3+	64.5	1	0.150E-08	0.416	0.13	3	20	1
C 4+	392.1	1	0.299E-09	0.666	0.02	20	20	1
C 5+	490.0	1	0.123E-09	0.620	0.16	20	20	1
N	14.5	0	0.482E-07	0.0652	0.42	1	20	1
N 1+	29.6	0	0.298E-07	0.310	0.30	2	20	1
N 2+	47.5	1	0.810E-08	0.350	0.24	2	20	1
N 3+	77.5	1	0.371E-08	0.549	0.18	4	20	1
N 4+	97.9	0	0.151E-08	0.0167	0.74	4	20	1
N 5+	552.1	0	0.371E-09	0.546	0.29	30	20	1
N 6+	667.0	1	0.777E-10	0.624	0.16	30	20	1
O	13.6	0	0.359E-07	0.073	0.34	1	20	1
O 1+	35.1	1	0.139E-07	0.212	0.22	2	20	1
O 2+	54.9	1	0.931E-08	0.270	0.27	3	20	1
O 3+	77.4	0	0.102E-07	0.614	0.27	4	20	1
O 4+	113.9	1	0.219E-08	0.630	0.17	5	20	1
O 5+	138.1	0	0.195E-08	0.360	0.54	7	20	1
O 6+	739.3	0	0.212E-09	0.396	0.35	30	20	1
O 7+	871.4	1	0.521E-10	0.629	0.16	40	20	1
F	17.4	1	0.700E-07	0.178	0.29	1	20	1
F 1+	35.0	0	0.541E-07	0.571	0.27	2	20	1
F 2+	62.7	1	0.937E-08	0.319	0.20	3	20	1
F 3+	87.1	1	0.492E-08	0.323	0.24	4	20	1
F 4+	114.2	0	0.706E-08	0.684	0.27	5	20	1
F 5+	157.2	1	0.128E-08	0.648	0.16	7	20	1
F 6+	185.2	1	0.561E-09	0.738	0.16	10	20	1
F 7+	953.9	0	0.166E-09	0.542	0.29	40	100	4
F 8+	1103.1	1	0.374E-10	0.659	0.15	50	100	4

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Ne	21.6	1	0.150E-07	0.0329	0.43	1	20	1
Ne 1+	41.0	0	0.198E-07	0.295	0.20	3	20	1
Ne 2+	63.5	1	0.703E-08	0.0677	0.39	3	20	1
Ne 3+	97.1	1	0.424E-08	0.0482	0.58	5	20	1
Ne 4+	126.2	1	0.279E-08	0.305	0.25	7	20	1
Ne 5+	157.9	0	0.345E-08	0.581	0.28	7	20	1
Ne 6+	207.3	1	0.956E-09	0.749	0.14	10	20	1
Ne 7+	239.1	1	0.473E-09	0.992	0.04	10	20	1
Ne 8+	1196.0	1	0.392E-10	0.262	0.20	50	100	4
Ne 9+	1360.6	1	0.277E-10	0.661	0.13	70	100	4
Na	5.1	1	0.101E-06	0.275	0.23	1	20	1
Na 1+	47.3	1	0.735E-08	0.056	0.35	2	20	1
Na 2+	71.6	1	0.810E-08	0.148	0.32	3	20	1
Na 3+	98.9	0	0.114E-07	0.553	0.28	4	20	1
Na 4+	138.4	1	0.263E-08	0.230	0.29	7	20	1
Na 5+	172.2	1	0.185E-08	0.363	0.22	7	20	1
Na 6+	208.5	0	0.282E-08	0.674	0.27	10	20	1
Na 7+	264.2	1	0.672E-09	0.752	0.14	20	20	1
Na 8+	299.9	1	0.280E-09	0.781	0.15	20	20	1
Na 9+	1465.1	1	0.463E-10	0.558	0.16	70	100	4
Na10+	1648.7	1	0.216E-10	0.743	0.13	70	100	4
Mg	7.6	0	0.621E-06	0.592	0.39	1	20	1
Mg 1+	15.2	0	0.192E-07	0.0027	0.85	1	20	1
Mg 2+	80.1	1	0.556E-08	0.107	0.30	4	20	1
Mg 3+	109.3	1	0.435E-08	0.159	0.31	5	20	1
Mg 4+	141.3	0	0.710E-08	0.658	0.25	7	20	1
Mg 5+	186.5	1	0.170E-08	0.242	0.28	10	20	1
Mg 6+	224.9	1	0.122E-08	0.343	0.23	10	20	1
Mg 7+	266.0	0	0.220E-08	0.897	0.22	20	20	1
Mg 8+	328.2	1	0.486E-09	0.751	0.14	20	20	1
Mg 9+	367.5	1	0.235E-09	1.030	0.10	20	20	1
Mg10+	1761.8	1	0.206E-10	0.196	0.25	100	100	4
Mg11+	1962.7	1	0.175E-10	0.835	0.11	100	100	4
Al	6.0	1	0.228E-06	0.387	0.25	1	20	1
Al 1+	18.8	0	0.118E-06	2.21	0.25	1	20	1
Al 2+	28.5	1	0.440E-08	0.106	0.24	2	20	1
Al 3+	120.0	0	0.175E-07	0.872	0.22	5	20	1
Al 4+	153.8	1	0.261E-08	0.159	0.31	7	20	1
Al 5+	198.5	1	0.185E-08	0.152	0.36	10	20	1
Al 6+	241.4	1	0.114E-08	0.228	0.29	10	20	1
Al 7+	284.6	1	0.800E-09	0.417	0.16	20	20	1
Al 8+	390.2	1	0.583E-09	0.497	0.23	20	20	1
Al 9+	399.4	0	0.493E-09	0.706	0.16	20	20	1
Al10+	442.0	1	0.977E-10	0.278	0.17	20	20	1
Al11+	2086.6	0	0.394E-10	0.286	0.36	100	100	4
Al12+	2304.1	1	0.138E-10	0.835	0.11	100	100	4

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See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Si	8.2	1	0.188E-06	0.376	0.25	1	20	1
Si 1+	16.4	1	0.643E-07	0.632	0.20	1	20	1
Si 2+	33.5	1	0.201E-07	0.473	0.22	2	20	1
Si 3+	54.0	1	0.494E-08	0.172	0.23	3	20	1
Si 4+	166.8	1	0.176E-08	0.102	0.31	7	20	1
Si 5+	205.3	1	0.174E-08	0.180	0.29	10	20	1
Si 6+	246.5	1	0.123E-08	0.518	0.07	10	20	1
Si 7+	303.5	1	0.827E-09	0.239	0.28	20	20	1
Si 8+	351.1	1	0.601E-09	0.305	0.25	20	20	1
Si 9+	401.4	1	0.465E-09	0.666	0.04	20	20	1
Si10+	476.4	1	0.263E-09	0.666	0.16	20	20	1
Si11+	523.5	1	0.118E-09	0.734	0.16	30	20	1
Si12+	2437.7	0	0.336E-10	0.336	0.37	100	100	4
Si13+	2673.2	1	0.119E-10	0.989	0.08	200	100	4
P	10.5	1	0.199E-06	0.535	0.24	1	20	1
P 1+	19.8	1	0.588E-07	0.537	0.21	1	20	1
P 2+	30.2	1	0.296E-07	0.865	0.16	2	20	1
P 3+	51.4	1	0.101E-07	0.546	0.20	3	20	1
P 4+	65.0	1	0.236E-08	0.192	0.17	7	20	2
P 5+	220.4	0	0.666E-08	1.000	0.18	10	20	1
P 6+	263.2	1	0.124E-08	0.215	0.26	20	20	1
P 7+	309.4	0	0.227E-08	0.734	0.23	20	20	1
P 8+	371.7	1	0.614E-09	0.256	0.27	20	20	1
P 9+	424.5	1	0.469E-09	0.342	0.23	20	20	1
P10+	479.6	0	0.614E-09	0.334	0.39	20	20	1
P11+	560.4	0	0.322E-09	0.850	0.12	30	20	1
P12+	611.9	1	0.932E-10	0.734	0.16	30	20	1
P13+	2816.9	0	0.379E-10	0.805	0.22	200	100	4
P14+	3069.9	1	0.973E-11	0.991	0.08	200	100	4
S	10.4	1	0.549E-07	0.100	0.25	1	20	1
S 1+	23.3	1	0.681E-07	0.693	0.21	1	20	1
S 2+	34.8	1	0.214E-07	0.353	0.24	2	20	1
S 3+	47.3	1	0.166E-07	1.030	0.14	2	20	1
S 4+	72.6	1	0.612E-08	0.580	0.19	3	20	1
S 5+	88.1	1	0.133E-08	0.0688	0.35	10	20	2
S 6+	280.9	0	0.493E-08	1.130	0.16	20	20	1
S 7+	328.2	1	0.873E-09	0.193	0.28	20	20	1
S 8+	379.1	0	0.135E-08	0.431	0.32	20	20	1
S 9+	447.1	1	0.459E-09	0.242	0.28	20	20	1
S10+	504.8	1	0.349E-09	0.305	0.25	30	20	1
S11+	564.7	0	0.523E-09	0.428	0.35	30	20	1
S12+	651.6	0	0.259E-09	0.854	0.12	30	20	1
S13+	707.2	1	0.750E-10	0.734	0.16	30	20	1
S14+	3223.9	0	0.267E-10	0.572	0.28	200	100	4
S15+	3494.2	1	0.632E-11	0.585	0.17	200	100	4

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Cl	13.0	1	0.169E-06	0.430	0.24	1	20	1
Cl 1+	23.8	1	0.696E-07	0.670	0.20	1	20	1
Cl 2+	39.6	1	0.340E-07	0.865	0.18	2	20	1
Cl 3+	53.5	1	0.110E-07	0.328	0.25	3	20	1
Cl 4+	67.8	1	0.111E-07	1.370	0.10	3	20	1
Cl 5+	97.0	1	0.317E-08	0.330	0.24	4	20	1
Cl 6+	114.2	1	0.101E-08	0.196	0.16	20	20	2
Cl 7+	348.3	0	0.211E-08	0.313	0.37	20	20	1
Cl 8+	400.1	1	0.632E-09	0.173	0.30	20	20	1
Cl 9+	455.6	0	0.948E-09	0.344	0.36	20	20	1
Cl10+	529.3	1	0.369E-09	0.273	0.26	30	20	1
Cl11+	592.0	1	0.285E-09	0.343	0.23	30	20	1
Cl12+	656.7	0	0.481E-09	0.658	0.27	30	20	1
Cl13+	749.8	1	0.131E-09	0.623	0.16	30	20	1
Cl14+	809.4	1	0.613E-10	0.736	0.16	40	20	1
Cl15+	3658.4	0	0.190E-10	0.379	0.36	200	100	4
Cl16+	3946.3	1	0.514E-11	0.553	0.18	200	100	4
Ar	15.8	1	0.599E-07	0.136	0.26	1	20	1
Ar 1+	27.6	1	0.607E-07	0.544	0.21	2	20	1
Ar 2+	40.9	1	0.343E-07	0.834	0.17	2	20	1
Ar 3+	52.3	0	0.300E-07	1.030	0.25	3	20	1
Ar 4+	75.0	1	0.873E-08	0.366	0.31	3	20	1
Ar 5+	91.0	1	0.578E-08	0.314	0.34	4	20	1
Ar 6+	124.3	1	0.298E-08	0.703	0.16	5	20	1
Ar 7+	143.5	1	0.725E-09	0.207	0.15	20	20	2
Ar 8+	422.4	1	0.140E-08	0.696	0.13	20	20	1
Ar 9+	478.7	1	0.478E-09	0.164	0.31	20	20	1
Ar10+	539.0	0	0.802E-09	0.439	0.32	30	20	1
Ar11+	618.3	1	0.288E-09	0.259	0.27	30	20	1
Ar12+	686.1	1	0.232E-09	0.362	0.22	30	20	1
Ar13+	755.7	0	0.333E-09	0.412	0.36	40	20	1
Ar14+	854.8	1	0.127E-09	0.910	0.13	40	20	1
Ar15+	918.0	1	0.521E-10	0.781	0.15	40	20	1
Ar16+	4120.7	0	0.166E-10	0.435	0.33	200	100	4
Ar17+	4426.2	1	0.432E-11	0.554	0.18	200	100	4
K	4.3	1	0.202E-06	0.272	0.31	1	20	1
K 1+	31.6	1	0.401E-07	0.371	0.22	2	20	1
K 2+	45.8	1	0.150E-07	0.433	0.21	2	20	1
K 3+	60.9	1	0.194E-07	0.889	0.16	3	20	1
K 4+	82.7	1	0.695E-08	0.494	0.18	4	20	1
K 5+	99.4	1	0.411E-08	0.540	0.17	4	20	1
K 6+	117.6	1	0.223E-08	0.519	0.16	5	20	1
K 7+	154.7	1	0.215E-08	0.828	0.14	7	20	1
K 8+	175.8	0	0.161E-08	0.642	0.13	20	20	2
K 9+	504.0	1	0.107E-08	0.695	0.13	30	20	1
K10+	564.7	1	0.378E-09	0.173	0.30	30	20	1
K11+	629.4	0	0.624E-09	0.418	0.33	30	20	1
K12+	714.6	1	0.229E-09	0.245	0.28	30	20	1
K13+	786.6	1	0.186E-09	0.344	0.23	40	20	1
K14+	861.1	0	0.269E-09	0.396	0.37	40	20	1
K15+	968.0	1	0.106E-09	0.912	0.13	40	20	1
K16+	1053.4	1	0.424E-10	0.737	0.16	50	100	4
K17+	4610.9	0	0.138E-10	0.416	0.34	200	100	4
K18+	4934.1	1	0.367E-11	0.555	0.18	200	100	4

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Ca	6.1	0	0.440E-06	0.848	0.33	1	20	1
Ca 1+	11.9	0	0.522E-07	0.151	0.34	1	20	1
Ca 2+	50.9	1	0.206E-07	0.418	0.20	3	20	1
Ca 3+	67.3	1	0.172E-07	0.638	0.19	3	20	1
Ca 4+	84.5	1	0.126E-07	1.010	0.14	4	20	1
Ca 5+	108.8	1	0.472E-08	0.526	0.17	5	20	1
Ca 6+	127.2	1	0.289E-08	0.548	0.17	7	20	1
Ca 7+	147.2	1	0.164E-08	0.552	0.15	7	20	1
Ca 8+	188.3	1	0.157E-08	0.799	0.14	10	20	1
Ca 9+	211.3	1	0.432E-09	0.232	0.14	30	20	2
Ca10+	591.9	0	0.947E-09	0.311	0.38	30	20	1
Ca11+	657.2	1	0.298E-09	0.163	0.31	30	20	1
Ca12+	726.6	0	0.478E-09	0.359	0.36	30	20	1
Ca13+	817.6	1	0.186E-09	0.244	0.28	40	20	1
Ca14+	894.5	1	0.156E-09	0.364	0.22	40	20	1
Ca15+	974.0	0	0.216E-09	0.357	0.39	40	20	1
Ca16+	1087.0	1	0.770E-10	0.655	0.15	50	100	4
Ca17+	1157.0	1	0.358E-10	0.736	0.16	50	100	4
Ca18+	5128.9	0	0.128E-10	0.520	0.30	300	100	4
Ca19+	5469.9	1	0.308E-11	0.528	0.19	300	100	4
Sc	6.6	1	0.316E-06	0.204	0.28	1	20	1
Sc1+	12.8	1	0.861E-07	0.181	0.25	1	20	1
Sc2+	24.8	1	0.508E-07	0.357	0.24	1	20	1
Sc3+	73.5	1	0.100E-07	0.453	0.15	3	20	1
Sc4+	91.9	1	0.676E-08	0.460	0.15	4	20	1
Sc5+	110.7	1	0.527E-08	0.561	0.17	5	20	1
Sc6+	138.0	1	0.340E-08	0.560	0.16	7	20	1
Sc7+	158.1	1	0.218E-08	0.612	0.15	7	20	1
Sc8+	180.0	1	0.126E-08	0.610	0.14	10	20	1
Sc9+	225.1	1	0.124E-08	0.852	0.13	10	20	1
Sc10+	249.8	1	0.362E-09	0.349	0.05	30	20	2
Sc11+	687.4	1	0.552E-09	0.375	0.28	30	20	1
Sc12+	756.7	1	0.564E-09	0.873	0.15	40	20	1
Sc13+	830.8	1	0.450E-09	1.050	0.13	40	20	1
Sc14+	927.5	1	0.273E-09	0.866	0.15	40	20	1
Sc15+	1009.0	1	0.156E-09	0.715	0.17	50	100	4
Sc16+	1094.0	0	0.181E-09	1.140	0.36	50	100	4
Sc17+	1213.0	1	0.429E-10	0.784	0.15	50	100	4
Sc18+	1288.0	0	0.221E-10	0.027	0.82	70	100	4
Sc19+	5674.9	1	0.451E-11	0.918	0.04	300	100	4
Sc20+	6033.8	0	0.203E-11	0.017	0.70	300	100	4

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Ti	6.8	1	0.160E-06	0.360	0.28	1	20	1
Ti1+	13.6	0	0.214E-06	0.880	0.28	1	20	1
Ti2+	27.5	1	0.285E-07	0.227	0.21	2	20	1
Ti3+	43.3	1	0.348E-07	0.390	0.23	2	20	1
Ti4+	99.3	1	0.100E-07	0.579	0.18	4	20	1
Ti5+	119.5	1	0.701E-08	0.638	0.17	5	20	1
Ti6+	140.8	1	0.495E-08	0.717	0.16	7	20	1
Ti7+	170.4	1	0.299E-08	0.693	0.17	7	20	1
Ti8+	192.1	1	0.210E-08	0.722	0.16	10	20	1
Ti9+	215.9	1	0.162E-08	0.765	0.14	10	20	1
Ti10+	265.0	1	0.111E-08	0.885	0.12	20	20	1
Ti11+	291.5	0	0.909E-09	0.972	0.06	30	20	2
Ti12+	787.8	1	0.441E-09	0.359	0.29	40	20	1
Ti13+	863.1	1	0.439E-09	0.781	0.17	40	20	1
Ti14+	941.9	1	0.373E-09	1.050	0.13	40	20	1
Ti15+	1044.0	1	0.228E-09	0.858	0.15	50	100	4
Ti16+	1131.0	1	0.134E-09	0.757	0.16	50	100	4
Ti17+	1221.0	0	0.155E-09	1.150	0.36	50	100	4
Ti18+	1346.0	1	0.380E-10	0.835	0.14	70	100	4
Ti19+	1426.0	0	0.189E-10	0.028	0.82	70	100	4
Ti20+	6249.1	1	0.401E-11	0.968	0.03	300	100	4
Ti21+	6625.0	1	0.162E-11	0.657	0.14	300	100	4
V	6.7	0	0.882E-06	0.359	0.32	1	20	1
V 1+	14.7	0	0.311E-06	0.432	0.29	1	20	1
V 2+	29.3	1	0.350E-07	0.247	0.25	2	20	1
V 3+	46.7	0	0.532E-07	1.110	0.16	2	20	1
V 4+	65.3	1	0.898E-08	0.140	0.37	3	20	1
V 5+	128.1	1	0.587E-08	0.517	0.17	7	20	1
V 6+	150.6	1	0.511E-08	0.679	0.16	7	20	1
V 7+	173.4	1	0.371E-08	0.761	0.15	7	20	1
V 8+	205.8	1	0.224E-08	0.711	0.17	10	20	1
V 9+	230.5	1	0.165E-08	0.764	0.15	10	20	1
V10+	256.0	1	0.126E-08	0.762	0.14	20	20	1
V11+	308.0	1	0.886E-09	0.886	0.12	20	20	1
V12+	336.3	0	0.389E-09	0.142	0.39	40	20	2
V13+	896.0	1	0.380E-09	0.409	0.27	40	20	1
V14+	976.0	0	0.484E-09	0.173	0.57	40	20	1
V15+	1060.0	1	0.249E-09	0.650	0.14	200	100	3
V16+	1168.0	0	0.591E-09	1.610	0.18	200	100	3
V17+	1260.0	0	0.502E-09	2.120	0.15	200	100	3
V18+	1355.0	1	0.538E-10	0.137	0.40	200	100	3
V19+	1486.0	1	0.556E-10	0.708	0.10	200	100	3
V20+	1571.0	0	0.284E-10	0.024	0.79	200	100	3
V21+	6851.3	0	0.254E-10	2.920	0.09	1000	100	3
V22+	7246.1	0	0.132E-10	3.510	0.07	1000	100	3

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Cr	6.8	1	0.103E-06	0.217	0.27	1	20	1
Cr1+	16.5	0	0.245E-06	0.381	0.32	1	20	1
Cr2+	31.0	0	0.109E-06	0.518	0.27	2	20	1
Cr3+	49.1	1	0.152E-07	0.182	0.30	2	20	1
Cr4+	69.5	0	0.325E-07	1.360	0.13	3	20	1
Cr5+	90.6	1	0.550E-08	0.143	0.37	4	20	1
Cr6+	160.2	1	0.513E-08	0.657	0.16	7	20	1
Cr7+	184.7	1	0.385E-08	0.722	0.15	10	20	1
Cr8+	209.3	1	0.281E-08	0.759	0.15	10	20	1
Cr9+	244.4	1	0.176E-08	0.732	0.16	10	20	1
Cr10+	271.0	1	0.130E-08	0.764	0.15	20	20	1
Cr11+	298.0	1	0.102E-08	0.810	0.13	20	20	1
Cr12+	354.8	1	0.719E-09	0.887	0.12	20	20	1
Cr13+	384.2	1	0.161E-09	0.150	0.22	50	20	2
Cr14+	1011.0	1	0.464E-09	0.971	0.12	50	100	4
Cr15+	1097.0	1	0.331E-09	0.924	0.14	50	100	4
Cr16+	1185.0	1	0.249E-09	0.931	0.15	50	100	4
Cr17+	1299.0	1	0.168E-09	0.910	0.14	70	100	4
Cr18+	1396.0	1	0.101E-09	0.805	0.15	70	100	4
Cr19+	1496.0	0	0.117E-09	1.210	0.35	70	100	4
Cr20+	1634.0	1	0.291E-10	0.884	0.13	70	100	4
Cr21+	1721.0	0	0.145E-10	0.035	0.80	70	100	4
Cr22+	7482.0	1	0.307E-11	0.967	0.03	300	100	4
Cr23+	7894.8	1	0.146E-11	0.183	0.39	1000	100	3
Mn	7.4	1	0.856E-07	0.132	0.26	1	20	1
Mn1+	15.6	0	0.118E-06	0.359	0.19	2	20	1
Mn2+	33.7	0	0.854E-07	0.397	0.32	2	20	1
Mn3+	51.2	1	0.180E-07	0.272	0.18	3	20	1
Mn4+	72.4	1	0.822E-08	0.161	0.32	3	20	1
Mn5+	95.0	0	0.215E-07	1.540	0.11	4	20	1
Mn6+	119.3	1	0.365E-08	0.147	0.37	5	20	1
Mn7+	194.5	1	0.391E-08	0.699	0.15	10	20	1
Mn8+	221.8	1	0.292E-08	0.719	0.15	10	20	1
Mn9+	248.3	1	0.223E-08	0.806	0.14	10	20	1
Mn10+	286.0	1	0.139E-08	0.735	0.16	20	20	1
Mn11+	314.4	1	0.104E-08	0.761	0.15	20	20	1
Mn12+	343.6	1	0.828E-09	0.809	0.13	20	20	1
Mn13+	403.0	1	0.560E-09	0.787	0.14	20	20	1
Mn14+	435.2	1	0.152E-09	0.299	0.08	50	20	2
Mn15+	1133.0	1	0.403E-09	1.04	0.11	50	100	4
Mn16+	1244.0	1	0.274E-09	0.923	0.14	50	100	4
Mn17+	1317.0	1	0.218E-09	0.990	0.14	70	100	4
Mn18+	1437.0	1	0.149E-09	0.968	0.13	70	100	4
Mn19+	1539.0	1	0.870E-10	0.802	0.15	70	100	4
Mn20+	1644.0	0	0.102E-09	1.220	0.35	70	100	4
Mn21+	1788.0	1	0.254E-10	0.883	0.13	100	100	4
Mn22+	1880.0	0	0.128E-10	0.033	0.81	100	100	4
Mn23+	8141.0	1	0.277E-11	1.010	0.02	400	100	4
Mn24+	8571.9	1	0.132E-11	0.219	0.37	1000	100	3

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Fe	7.9	0	0.252E-06	0.701	0.25	1	20	1
Fe1+	16.2	1	0.221E-07	0.033	0.45	1	20	1
Fe2+	30.6	0	0.410E-07	0.366	0.17	2	20	1
Fe3+	54.8	0	0.353E-07	0.243	0.39	3	20	1
Fe4+	75.0	1	0.104E-07	0.285	0.17	3	20	1
Fe5+	99.0	1	0.123E-07	0.411	0.21	4	20	1
Fe6+	125.0	1	0.947E-08	0.458	0.21	5	20	1
Fe7+	151.1	1	0.471E-08	0.280	0.28	7	20	1
Fe8+	233.6	1	0.302E-08	0.697	0.15	10	20	1
Fe9+	262.1	1	0.234E-08	0.764	0.14	20	20	1
Fe10+	290.0	1	0.176E-08	0.805	0.14	20	20	1
Fe11+	331.0	1	0.114E-08	0.773	0.15	20	20	1
Fe12+	361.0	1	0.866E-09	0.805	0.14	20	20	1
Fe13+	392.0	1	0.661E-09	0.762	0.14	20	20	1
Fe14+	457.0	1	0.441E-09	0.698	0.16	20	20	1
Fe15+	489.3	1	0.118E-09	0.211	0.15	70	20	2
Fe16+	1262.0	1	0.361E-09	1.160	0.09	70	100	4
Fe17+	1360.0	1	0.245E-09	0.978	0.13	70	100	4
Fe18+	1470.0	1	0.187E-09	0.988	0.14	70	100	4
Fe19+	1582.0	1	0.133E-09	1.030	0.12	70	100	4
Fe20+	1690.0	1	0.784E-10	0.848	0.14	70	100	4
Fe21+	1800.0	0	0.890E-10	1.200	0.35	100	100	4
Fe22+	1960.0	1	0.229E-10	0.936	0.12	100	100	4
Fe23+	2046.0	0	0.112E-10	0.034	0.81	100	100	4
Fe24+	8828.0	1	0.246E-11	1.02	0.02	400	100	4
Fe25+	9277.7	1	0.979E-12	0.664	0.14	400	100	4
Co	7.9	1	0.889E-07	0.127	0.24	1	20	1
Co1+	17.1	1	0.565E-07	0.194	0.23	1	20	1
Co2+	33.5	1	0.306E-07	0.201	0.22	2	20	1
Co3+	51.3	0	0.227E-07	0.574	0.10	4	20	1
Co4+	79.5	0	0.193E-07	0.195	0.42	4	20	1
Co5+	102.0	0	0.127E-07	0.126	0.47	5	20	1
Co6+	129.0	1	0.358E-08	0.194	0.29	7	20	1
Co7+	158.0	0	0.117E-07	1.980	0.07	7	20	1
Co8+	186.1	1	0.178E-08	0.112	0.42	10	20	1
Co9+	275.0	1	0.241E-08	0.739	0.14	20	20	1
Co10+	305.0	1	0.186E-08	0.762	0.14	20	20	1
Co11+	336.0	1	0.141E-08	0.804	0.14	20	20	1
Co12+	379.0	1	0.954E-09	0.813	0.14	20	20	1
Co13+	411.0	1	0.712E-09	0.803	0.14	20	20	1
Co14+	444.0	1	0.534E-09	0.718	0.15	20	20	1
Co15+	512.0	1	0.362E-09	0.658	0.17	30	20	1
Co16+	546.6	1	0.105E-09	0.252	0.12	70	20	2
Co17+	1397.0	1	0.310E-09	1.170	0.09	70	100	4
Co18+	1486.0	1	0.156E-09	0.572	0.15	100	100	3
Co19+	1603.0	1	0.132E-09	0.682	0.13	100	100	3
Co20+	1735.0	1	0.908E-10	0.511	0.17	300	100	3
Co21+	1846.0	0	0.345E-09	2.840	0.11	200	100	3
Co22+	1962.0	1	0.501E-10	0.714	0.11	300	100	3
Co23+	2119.0	1	0.192E-10	0.117	0.42	300	100	3
Co24+	2219.0	1	0.195E-10	1.200	0.00	300	100	3
Co25+	9544.0	0	0.168E-10	3.520	0.05	1000	100	3
Co26+	10012.1	1	0.145E-11	0.635	0.15	2000	1000	3

TABLE I. Fit Parameters for the Ionization Rates of Atoms and Ions by Electron Impact

See page 5 for Explanation of Tables

ION	dE eV	P	A cm^3/s	X	K	Tmin eV	Tmax keV	Ref
Ni	7.6	0	0.165E-06	0.452	0.28	1	20	1
Ni1+	18.2	0	0.842E-07	0.619	0.16	1	20	1
Ni2+	35.3	1	0.189E-07	0.220	0.21	2	20	1
Ni3+	54.9	1	0.148E-07	0.216	0.21	3	20	1
Ni4+	76.0	0	0.113E-07	0.518	0.09	4	20	1
Ni5+	108.0	0	0.116E-07	0.185	0.44	5	20	1
Ni6+	133.0	0	0.868E-08	0.138	0.46	7	20	1
Ni7+	162.0	1	0.245E-08	0.163	0.32	7	20	1
Ni8+	193.0	0	0.924E-08	2.250	0.05	10	20	1
Ni9+	225.0	0	0.241E-08	0.027	0.79	10	20	1
Ni10+	321.0	1	0.192E-08	0.738	0.14	20	20	1
Ni11+	352.0	1	0.150E-08	0.761	0.14	20	20	1
Ni12+	384.0	1	0.116E-08	0.803	0.14	20	20	1
Ni13+	430.0	1	0.808E-09	0.856	0.13	20	20	1
Ni14+	464.0	1	0.609E-09	0.850	0.13	20	20	1
Ni15+	499.0	1	0.448E-09	0.718	0.15	20	20	1
Ni16+	571.3	1	0.300E-09	0.622	0.18	30	20	1
Ni17+	607.0	1	0.790E-10	0.160	0.19	70	20	2
Ni18+	1541.0	1	0.278E-09	1.250	0.08	70	100	4
Ni19+	1648.0	1	0.192E-09	1.040	0.12	70	100	4
Ni20+	1756.0	1	0.151E-09	1.110	0.12	100	100	4
Ni21+	1894.0	1	0.105E-09	1.090	0.11	100	100	4
Ni22+	2011.0	1	0.604E-10	0.849	0.14	100	100	4
Ni23+	2131.0	0	0.691E-10	1.210	0.35	100	100	4
Ni24+	2295.0	1	0.184E-10	0.991	0.11	100	100	4
Ni25+	2399.0	0	0.903E-11	0.042	0.79	100	100	4
Ni26+	10290.0	1	0.261E-11	0.568	0.16	2000	1000	3
Ni27+	10775.3	1	0.139E-11	0.729	0.13	2000	1000	3

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
H	Rec. data	.762E-14	.117E-09	.530E-08	.200E-07	.309E-07	.295E-07	.222E-07	.151E-07	.949E-08		
	Fit/Rec	95 %	101 %	100 %	99 %	103 %	102 %	99 %	99 %	100 %		
He	Rec. data	.467E-19	.119E-11	.769E-09	.730E-08	.199E-07	.252E-07	.231E-07	.174E-07	.116E-07		
	Fit/Rec	97 %	101 %	101 %	99 %	99 %	102 %	99 %	99 %	101 %		
He 1+	Rec. data		.139E-16	.798E-11	.463E-09	.231E-08	.373E-08	.375E-08	.300E-08	.202E-08		
	Fit/Rec		100 %	93 %	93 %	99 %	110 %	116 %	107 %	91 %		
Li	Rec. data	.200E-09	.136E-07	.647E-07	.899E-07	.792E-07	.582E-07	.372E-07	.238E-07	.144E-07		
	Fit/Rec	108 %	97 %	99 %	103 %	102 %	99 %	98 %	99 %	101 %		
Li 1+	Rec. data			.772E-12	.184E-09	.178E-08	.390E-08	.465E-08	.418E-08	.313E-08		
	Fit/Rec			102 %	100 %	93 %	96 %	111 %	112 %	96 %		
Li 2+	Rec. data			.252E-14	.137E-10	.333E-09	.869E-09	.114E-08	.107E-08	.843E-09		
	Fit/Rec			98 %	98 %	102 %	104 %	100 %	97 %	99 %		
Be	Rec. data	.169E-11	.183E-08	.300E-07	.760E-07	.101E-06	.965E-07	.775E-07	.579E-07	.397E-07		
	Fit/Rec	101 %	97 %	100 %	104 %	103 %	99 %	96 %	97 %	103 %		
Be 1+	Rec. data	.140E-15	.332E-10	.419E-08	.201E-07	.275E-07	.251E-07	.215E-07	.174E-07	.127E-07		
	Fit/Rec	95 %	112 %	95 %	86 %	101 %	108 %	102 %	99 %	102 %		
Be 2+	Rec. data			.737E-16	.424E-11	.294E-09	.114E-08	.176E-08	.174E-08	.140E-08		
	Fit/Rec			98 %	101 %	102 %	104 %	102 %	99 %	97 %		
Be 3+	Rec. data			.607E-19	.194E-12	.472E-10	.253E-09	.449E-09	.476E-09	.404E-09		
	Fit/Rec			99 %	97 %	101 %	104 %	102 %	98 %	98 %		
B	Rec. data	.263E-11	.181E-08	.282E-07	.757E-07	.108E-06	.109E-06	.913E-07	.702E-07	.491E-07		
	Fit/Rec	125 %	99 %	93 %	98 %	102 %	100 %	97 %	98 %	104 %		
B 1+	Rec. data		.190E-11	.120E-08	.938E-08	.206E-07	.241E-07	.218E-07	.173E-07	.124E-07		
	Fit/Rec		107 %	95 %	95 %	100 %	101 %	98 %	98 %	104 %		
B 2+	Rec. data		.695E-14	.745E-10	.130E-08	.401E-08	.545E-08	.535E-08	.445E-08	.327E-08		
	Fit/Rec		96 %	97 %	103 %	107 %	106 %	99 %	96 %	98 %		
B 3+	Rec. data				.408E-13	.365E-10	.323E-09	.725E-09	.824E-09	.716E-09		
	Fit/Rec				99 %	100 %	102 %	101 %	99 %	99 %		
B 4+	Rec. data				.139E-14	.619E-11	.799E-10	.203E-09	.246E-09	.224E-09		
	Fit/Rec				98 %	99 %	103 %	104 %	99 %	97 %		
C	Rec. data	.134E-12	.560E-09	.181E-07	.659E-07	.112E-06	.124E-06	.111E-06	.883E-07	.633E-07		
	Fit/Rec	105 %	101 %	96 %	98 %	103 %	101 %	98 %	97 %	102 %		
C 1+	Rec. data	.246E-18	.433E-11	.193E-08	.132E-07	.278E-07	.320E-07	.285E-07	.225E-07	.159E-07		
	Fit/Rec	101 %	96 %	98 %	103 %	105 %	103 %	97 %	96 %	101 %		
C 2+	Rec. data		.388E-15	.466E-10	.164E-08	.620E-08	.864E-08	.838E-08	.686E-08	.496E-08		
	Fit/Rec		104 %	96 %	97 %	101 %	102 %	98 %	97 %	103 %		
C 3+	Rec. data		.220E-18	.174E-11	.195E-09	.119E-08	.220E-08	.266E-08	.245E-08	.191E-08		
	Fit/Rec		121 %	90 %	95 %	107 %	104 %	97 %	95 %	104 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
C 4+	Rec. data				.202E-15	.413E-11	.972E-10	.330E-09	.439E-09	.413E-09		
	Fit/Rec				100 %	99 %	100 %	104 %	102 %	97 %		
C 5+	Rec. data				.467E-17	.706E-12	.259E-10	.988E-10	.139E-09	.136E-09		
	Fit/Rec				99 %	98 %	102 %	104 %	101 %	97 %		
N	Rec. data	.638E-14	.150E-09	.863E-08	.418E-07	.835E-07	.978E-07	.895E-07	.719E-07	.518E-07		
	Fit/Rec	105 %	113 %	100 %	88 %	91 %	96 %	98 %	102 %	111 %		
N 1+	Rec. data		.275E-12	.675E-09	.915E-08	.265E-07	.334E-07	.300E-07	.230E-07	.157E-07		
	Fit/Rec		110 %	97 %	93 %	96 %	99 %	99 %	100 %	105 %		
N 2+	Rec. data		.573E-15	.675E-10	.237E-08	.911E-08	.127E-07	.118E-07	.910E-08	.604E-08		
	Fit/Rec		90 %	102 %	112 %	110 %	101 %	95 %	94 %	102 %		
N 3+	Rec. data			.109E-11	.280E-09	.222E-08	.403E-08	.447E-08	.393E-08	.298E-08		
	Fit/Rec			97 %	99 %	104 %	104 %	99 %	96 %	100 %		
N 4+	Rec. data			.461E-13	.447E-10	.597E-09	.143E-08	.207E-08	.214E-08	.182E-08		
	Fit/Rec			101 %	94 %	94 %	97 %	103 %	110 %	101 %		
N 5+	Rec. data				.489E-18	.403E-12	.296E-10	.159E-09	.253E-09	.258E-09		
	Fit/Rec				95 %	100 %	100 %	103 %	102 %	98 %		
N 6+	Rec. data				.704E-20	.673E-13	.835E-11	.505E-10	.833E-10	.882E-10		
	Fit/Rec				100 %	97 %	100 %	104 %	102 %	97 %		
O	Rec. data	.961E-14	.135E-09	.695E-08	.345E-07	.740E-07	.922E-07	.889E-07	.741E-07	.548E-07		
	Fit/Rec	81 %	103 %	102 %	96 %	103 %	110 %	107 %	99 %	93 %		
O 1+	Rec. data		.666E-13	.415E-09	.712E-08	.241E-07	.333E-07	.319E-07	.253E-07	.176E-07		
	Fit/Rec		109 %	101 %	94 %	91 %	94 %	96 %	101 %	111 %		
O 2+	Rec. data		.603E-16	.364E-10	.201E-08	.962E-08	.153E-07	.154E-07	.125E-07	.870E-08		
	Fit/Rec		107 %	97 %	98 %	101 %	101 %	99 %	97 %	102 %		
O 3+	Rec. data			.912E-12	.314E-09	.309E-08	.612E-08	.686E-08	.595E-08	.441E-08		
	Fit/Rec			101 %	100 %	102 %	103 %	100 %	97 %	100 %		
O 4+	Rec. data			.139E-13	.420E-10	.818E-09	.196E-08	.245E-08	.224E-08	.174E-08		
	Fit/Rec			98 %	98 %	102 %	104 %	99 %	97 %	100 %		
O 5+	Rec. data			.642E-15	.946E-11	.299E-09	.969E-09	.131E-08	.721E-09	.524E-09		
	Fit/Rec			89 %	95 %	112 %	102 %	89 %	121 %	97 %		
O 6+	Rec. data				.555E-21	.330E-13	.887E-11	.795E-10	.153E-09	.170E-09		
	Fit/Rec				93 %	102 %	97 %	101 %	103 %	99 %		
O 7+	Rec. data					.524E-14	.261E-11	.266E-10	.521E-10	.599E-10		
	Fit/Rec					98 %	99 %	103 %	103 %	98 %		
F	Rec. data	.139E-14	.190E-09	.171E-07	.815E-07	.144E-06	.148E-06	.123E-06	.928E-07	.638E-07		
	Fit/Rec	92 %	105 %	102 %	95 %	99 %	103 %	100 %	99 %	101 %		
F 1+	Rec. data		.754E-13	.566E-09	.981E-08	.297E-07	.383E-07	.358E-07	.286E-07	.204E-07		
	Fit/Rec		98 %	99 %	103 %	105 %	102 %	97 %	96 %	100 %		
F 2+	Rec. data		.354E-17	.135E-10	.142E-08	.900E-08	.157E-07	.169E-07	.145E-07	.107E-07		
	Fit/Rec		107 %	101 %	96 %	96 %	98 %	98 %	99 %	105 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
F 3+	Rec. data			.614E-12	.299E-09	.318E-08	.677E-08	.798E-08	.699E-08	.506E-08		
	Fit/Rec			97 %	97 %	101 %	101 %	99 %	97 %	102 %		
F 4+	Rec. data			.124E-13	.491E-10	.121E-08	.331E-08	.434E-08	.401E-08	.309E-08		
	Fit/Rec			99 %	102 %	105 %	105 %	101 %	97 %	97 %		
F 5+	Rec. data			.897E-16	.508E-11	.291E-09	.981E-09	.141E-08	.137E-08	.110E-08		
	Fit/Rec			101 %	98 %	100 %	103 %	100 %	97 %	100 %		
F 6+	Rec. data			.224E-17	.806E-12	.874E-10	.357E-09	.550E-09	.541E-09	.438E-09		
	Fit/Rec			100 %	98 %	101 %	103 %	100 %	97 %	100 %		
F 7+	Rec. data					.222E-14	.258E-11	.407E-10	.956E-10	.117E-09	.105E-09	.801E-10
	Fit/Rec					102 %	100 %	103 %	105 %	102 %	98 %	96 %
F 8+	Rec. data					.329E-15	.785E-12	.142E-10	.337E-10	.421E-10	.388E-10	.304E-10
	Fit/Rec					98 %	99 %	103 %	104 %	99 %	97 %	102 %
Ne	Rec. data	.716E-17	.143E-10	.218E-08	.148E-07	.421E-07	.560E-07	.552E-07	.454E-07	.331E-07		
	Fit/Rec	88 %	94 %	125 %	105 %	87 %	97 %	107 %	106 %	96 %		
Ne 1+	Rec. data		.193E-14	.106E-09	.363E-08	.171E-07	.283E-07	.306E-07	.265E-07	.199E-07		
	Fit/Rec		132 %	87 %	84 %	88 %	94 %	98 %	104 %	116 %		
Ne 2+	Rec. data		.379E-17	.144E-10	.128E-08	.820E-08	.163E-07	.200E-07	.187E-07	.148E-07		
	Fit/Rec		105 %	97 %	100 %	97 %	99 %	108 %	105 %	96 %		
Ne 3+	Rec. data			.360E-12	.253E-09	.324E-08	.728E-08	.886E-08	.776E-08	.545E-08		
	Fit/Rec			112 %	111 %	95 %	92 %	101 %	106 %	99 %		
Ne 4+	Rec. data			.610E-14	.415E-10	.113E-08	.328E-08	.457E-08	.428E-08	.325E-08		
	Fit/Rec			100 %	97 %	101 %	102 %	101 %	98 %	100 %		
Ne 5+	Rec. data			.637E-16	.482E-11	.370E-09	.148E-08	.231E-08	.228E-08	.183E-08		
	Fit/Rec			99 %	101 %	101 %	104 %	103 %	99 %	97 %		
Ne 6+	Rec. data			.373E-18	.604E-12	.115E-09	.560E-09	.941E-09	.972E-09	.811E-09		
	Fit/Rec			101 %	98 %	100 %	103 %	101 %	97 %	100 %		
Ne 7+	Rec. data			.554E-20	.804E-13	.318E-10	.205E-09	.424E-09	.498E-09	.458E-09		
	Fit/Rec			95 %	94 %	106 %	109 %	100 %	95 %	99 %		
Ne 8+	Rec. data					.154E-15	.662E-12	.175E-10	.567E-10	.811E-10	.780E-10	.619E-10
	Fit/Rec					98 %	102 %	101 %	95 %	99 %	101 %	105 %
Ne 9+	Rec. data					.158E-16	.221E-12	.783E-11	.233E-10	.324E-10	.312E-10	.251E-10
	Fit/Rec					100 %	99 %	101 %	102 %	99 %	98 %	103 %
Na	Rec. data	.500E-09	.262E-07	.110E-06	.163E-06	.176E-06	.157E-06	.123E-06	.913E-07	.624E-07		
	Fit/Rec	104 %	92 %	103 %	111 %	104 %	97 %	93 %	96 %	106 %		
Na 1+	Rec. data		.982E-15	.570E-10	.213E-08	.130E-07	.236E-07	.273E-07	.250E-07	.198E-07		
	Fit/Rec		88 %	130 %	116 %	87 %	91 %	104 %	106 %	99 %		
Na 2+	Rec. data		.256E-18	.555E-11	.946E-09	.798E-08	.160E-07	.179E-07	.157E-07	.118E-07		
	Fit/Rec		92 %	107 %	104 %	95 %	97 %	104 %	102 %	98 %		
Na 3+	Rec. data			.104E-12	.151E-09	.261E-08	.640E-08	.811E-08	.745E-08	.577E-08		
	Fit/Rec			101 %	102 %	105 %	107 %	103 %	97 %	96 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Na 4+	Rec. data			.180E-14	.258E-10	.999E-09	.326E-08	.478E-08	.456E-08	.342E-08		
	Fit/Rec			102 %	102 %	98 %	99 %	101 %	99 %	100 %		
Na 5+	Rec. data			.334E-16	.505E-11	.411E-09	.168E-08	.278E-08	.279E-08	.222E-08		
	Fit/Rec			101 %	96 %	101 %	103 %	101 %	99 %	100 %		
Na 6+	Rec. data			.300E-18	.600E-12	.151E-09	.887E-09	.165E-08	.174E-08	.145E-08		
	Fit/Rec			88 %	100 %	102 %	105 %	103 %	99 %	96 %		
Na 7+	Rec. data				.579E-13	.422E-10	.313E-09	.626E-09	.690E-09	.596E-09		
	Fit/Rec				98 %	100 %	104 %	102 %	98 %	99 %		
Na 8+	Rec. data				.708E-14	.119E-10	.112E-09	.243E-09	.272E-09	.235E-09		
	Fit/Rec				98 %	100 %	103 %	102 %	98 %	99 %		
Na 9+	Rec. data					.985E-17	.268E-12	.123E-10	.402E-10	.575E-10	.558E-10	.449E-10
	Fit/Rec					99 %	99 %	101 %	102 %	100 %	98 %	101 %
Na 10+	Rec. data					.646E-18	.604E-13	.413E-11	.149E-10	.225E-10	.223E-10	.183E-10
	Fit/Rec					98 %	98 %	103 %	104 %	100 %	97 %	101 %
Mg	Rec. data	.963E-10	.225E-07	.176E-06	.312E-06	.312E-06	.245E-06	.161E-06	.103E-06	.621E-07		
	Fit/Rec	110 %	99 %	96 %	100 %	103 %	100 %	98 %	99 %	102 %		
Mg 1+	Rec. data	.312E-14	.928E-10	.395E-08	.128E-07	.234E-07	.296E-07	.290E-07	.243E-07	.181E-07		
	Fit/Rec	103 %	102 %	100 %	99 %	92 %	92 %	104 %	113 %	101 %		
Mg 2+	Rec. data			.145E-11	.434E-09	.521E-08	.126E-07	.160E-07	.152E-07	.124E-07		
	Fit/Rec			111 %	113 %	94 %	92 %	103 %	104 %	99 %		
Mg 3+	Rec. data			.625E-13	.122E-09	.250E-08	.714E-08	.948E-08	.892E-08	.699E-08		
	Fit/Rec			102 %	107 %	98 %	95 %	103 %	103 %	99 %		
Mg 4+	Rec. data			.708E-15	.174E-10	.878E-09	.310E-08	.464E-08	.457E-08	.369E-08		
	Fit/Rec			96 %	101 %	104 %	105 %	102 %	98 %	97 %		
Mg 5+	Rec. data			.885E-17	.297E-11	.357E-09	.168E-08	.293E-08	.300E-08	.239E-08		
	Fit/Rec			97 %	103 %	98 %	98 %	101 %	100 %	100 %		
Mg 6+	Rec. data			.101E-18	.530E-12	.150E-09	.895E-09	.176E-08	.190E-08	.159E-08		
	Fit/Rec			106 %	97 %	99 %	103 %	102 %	100 %	98 %		
Mg 7+	Rec. data				.526E-13	.527E-10	.477E-09	.107E-08	.122E-08	.106E-08		
	Fit/Rec				98 %	102 %	104 %	101 %	98 %	99 %		
Mg 8+	Rec. data				.454E-14	.151E-10	.176E-09	.425E-09	.501E-09	.448E-09		
	Fit/Rec				98 %	100 %	104 %	103 %	99 %	98 %		
Mg 9+	Rec. data				.510E-15	.414E-11	.621E-10	.165E-09	.202E-09	.185E-09		
	Fit/Rec				96 %	102 %	106 %	103 %	97 %	98 %		
Mg 10+	Rec. data					.287E-18	.504E-13	.468E-11	.232E-10	.435E-10	.460E-10	.388E-10
	Fit/Rec					96 %	101 %	104 %	97 %	98 %	101 %	101 %
Mg 11+	Rec. data					.200E-19	.153E-13	.222E-11	.102E-10	.169E-10	.175E-10	.146E-10
	Fit/Rec					97 %	98 %	102 %	104 %	100 %	97 %	102 %

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Al	Rec. data	.604E-09	.388E-07	.177E-06	.275E-06	.288E-06	.248E-06	.185E-06	.133E-06	.888E-07		
	Fit/Rec	80 %	96 %	112 %	112 %	102 %	95 %	93 %	97 %	106 %		
Al 1+	Rec. data	.772E-16	.434E-10	.495E-08	.185E-07	.264E-07	.255E-07	.203E-07	.152E-07	.104E-07		
	Fit/Rec	100 %	95 %	103 %	107 %	101 %	96 %	94 %	98 %	106 %		
Al 2+	Rec. data		.242E-12	.302E-09	.304E-08	.101E-07	.151E-07	.157E-07	.135E-07	.102E-07		
	Fit/Rec		101 %	99 %	104 %	96 %	98 %	100 %	100 %	102 %		
Al 3+	Rec. data			.150E-13	.850E-10	.241E-08	.703E-08	.978E-08	.948E-08	.764E-08		
	Fit/Rec			111 %	97 %	92 %	95 %	97 %	99 %	109 %		
Al 4+	Rec. data			.415E-15	.148E-10	.839E-09	.343E-08	.554E-08	.557E-08	.455E-08		
	Fit/Rec			97 %	107 %	101 %	95 %	100 %	103 %	100 %		
Al 5+	Rec. data			.403E-17	.241E-11	.380E-09	.192E-08	.340E-08	.357E-08	.300E-08		
	Fit/Rec			88 %	108 %	97 %	96 %	103 %	105 %	98 %		
Al 6+	Rec. data			.240E-19	.297E-12	.128E-09	.897E-09	.187E-08	.207E-08	.174E-08		
	Fit/Rec			95 %	104 %	99 %	98 %	100 %	101 %	99 %		
Al 7+	Rec. data				.350E-13	.445E-10	.458E-09	.110E-08	.126E-08	.114E-08		
	Fit/Rec				102 %	102 %	97 %	98 %	101 %	101 %		
Al 8+	Rec. data				.800E-15	.110E-10	.200E-09	.584E-09	.697E-09	.593E-09		
	Fit/Rec				101 %	99 %	100 %	100 %	100 %	100 %		
Al 9+	Rec. data				.768E-16	.256E-11	.740E-10	.275E-09	.373E-09	.349E-09		
	Fit/Rec				114 %	94 %	90 %	94 %	100 %	109 %		
Al 10+	Rec. data				.199E-16	.101E-11	.303E-10	.124E-09	.194E-09	.210E-09		
	Fit/Rec				100 %	99 %	100 %	102 %	102 %	98 %		
Al 11+	Rec. data					.530E-20	.987E-14	.279E-11	.179E-10	.352E-10	.383E-10	.330E-10
	Fit/Rec					91 %	106 %	96 %	98 %	104 %	103 %	95 %
Al 12+	Rec. data					.483E-21	.361E-14	.119E-11	.698E-11	.129E-10	.139E-10	.119E-10
	Fit/Rec					97 %	98 %	102 %	104 %	101 %	97 %	101 %
Si	Rec. data	.490E-10	.145E-07	.116E-06	.217E-06	.248E-06	.222E-06	.171E-06	.124E-06	.837E-07		
	Fit/Rec	85 %	94 %	109 %	112 %	105 %	97 %	93 %	96 %	104 %		
Si 1+	Rec. data	.320E-14	.233E-09	.126E-07	.417E-07	.628E-07	.634E-07	.527E-07	.400E-07	.277E-07		
	Fit/Rec	83 %	91 %	110 %	117 %	107 %	96 %	92 %	95 %	105 %		
Si 2+	Rec. data		.184E-12	.703E-09	.848E-08	.207E-07	.246E-07	.222E-07	.176E-07	.125E-07		
	Fit/Rec		98 %	97 %	103 %	107 %	103 %	97 %	96 %	101 %		
Si 3+	Rec. data		.412E-16	.191E-10	.104E-08	.646E-08	.134E-07	.127E-07	.111E-07	.850E-08		
	Fit/Rec		102 %	103 %	107 %	94 %	84 %	103 %	103 %	105 %		
Si 4+	Rec. data			.791E-16	.582E-11	.483E-09	.248E-08	.465E-08	.514E-08	.457E-08		
	Fit/Rec			92 %	118 %	104 %	90 %	96 %	104 %	102 %		
Si 5+	Rec. data			.152E-17	.159E-11	.290E-09	.173E-08	.344E-08	.369E-08	.314E-08		
	Fit/Rec			89 %	105 %	103 %	96 %	98 %	103 %	100 %		
Si 6+	Rec. data			.652E-20	.159E-12	.103E-09	.830E-09	.181E-08	.206E-08	.180E-08		
	Fit/Rec			92 %	101 %	96 %	101 %	107 %	105 %	95 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Si 7+	Rec. data				.255E-13	.453E-10	.489E-09	.125E-08	.163E-08	.130E-08		
	Fit/Rec				101 %	100 %	99 %	100 %	93 %	101 %		
Si 8+	Rec. data				.339E-14	.190E-10	.272E-09	.774E-09	.988E-09	.895E-09		
	Fit/Rec				100 %	97 %	101 %	102 %	101 %	98 %		
Si 9+	Rec. data				.243E-15	.589E-11	.143E-09	.490E-09	.654E-09	.614E-09		
	Fit/Rec				100 %	98 %	100 %	105 %	105 %	96 %		
Si 10+	Rec. data				.158E-16	.173E-11	.571E-10	.206E-09	.282E-09	.271E-09		
	Fit/Rec				99 %	98 %	102 %	104 %	101 %	97 %		
Si 11+	Rec. data				.141E-17	.460E-12	.207E-10	.835E-10	.116E-09	.112E-09		
	Fit/Rec				100 %	98 %	102 %	103 %	100 %	98 %		
Si 12+	Rec. data					.122E-21	.249E-14	.153E-11	.120E-10	.256E-10	.285E-10	.245E-10
	Fit/Rec					94 %	103 %	96 %	100 %	105 %	103 %	94 %
Si 13+	Rec. data						.794E-15	.629E-12	.483E-11	.994E-11	.112E-10	.976E-11
	Fit/Rec						97 %	102 %	104 %	100 %	97 %	102 %
P	Rec. data	.430E-11	.617E-08	.839E-07	.176E-06	.208E-06	.186E-06	.144E-06	.105E-06	.704E-07		
	Fit/Rec	87 %	94 %	108 %	112 %	104 %	96 %	93 %	96 %	105 %		
P 1+	Rec. data	.865E-16	.657E-10	.853E-08	.370E-07	.621E-07	.653E-07	.556E-07	.428E-07	.299E-07		
	Fit/Rec	88 %	91 %	105 %	114 %	109 %	99 %	93 %	95 %	103 %		
P 2+	Rec. data		.797E-12	.116E-08	.992E-08	.218E-07	.259E-07	.235E-07	.188E-07	.134E-07		
	Fit/Rec		87 %	104 %	117 %	110 %	98 %	91 %	94 %	106 %		
P 3+	Rec. data		.188E-15	.488E-10	.205E-08	.807E-08	.114E-07	.112E-07	.925E-08	.677E-08		
	Fit/Rec		99 %	96 %	101 %	106 %	104 %	97 %	96 %	101 %		
P 4+	Rec. data			.285E-11	.351E-09	.258E-08	.542E-08	.686E-08	.652E-08	.527E-08		
	Fit/Rec			90 %	92 %	95 %	97 %	99 %	99 %	103 %		
P 5+	Rec. data			.151E-18	.739E-12	.254E-09	.166E-08	.330E-08	.373E-08	.327E-08		
	Fit/Rec			89 %	100 %	104 %	105 %	101 %	96 %	98 %		
P 6+	Rec. data				.150E-12	.101E-09	.900E-09	.220E-08	.256E-08	.227E-08		
	Fit/Rec				99 %	105 %	99 %	97 %	101 %	100 %		
P 7+	Rec. data				.120E-13	.346E-10	.446E-09	.119E-08	.146E-08	.133E-08		
	Fit/Rec				98 %	101 %	104 %	103 %	99 %	97 %		
P 8+	Rec. data				.179E-14	.155E-10	.271E-09	.832E-09	.109E-08	.999E-09		
	Fit/Rec				101 %	101 %	98 %	100 %	101 %	99 %		
P 9+	Rec. data				.204E-15	.645E-11	.152E-09	.528E-09	.734E-09	.694E-09		
	Fit/Rec				100 %	97 %	101 %	103 %	101 %	98 %		
P 10+	Rec. data				.125E-16	.186E-11	.791E-10	.339E-09	.492E-09	.481E-09		
	Fit/Rec				101 %	98 %	98 %	104 %	105 %	97 %		
P 11+	Rec. data				.173E-18	.229E-12	.217E-10	.131E-09	.214E-09	.218E-09		
	Fit/Rec				104 %	99 %	91 %	93 %	98 %	109 %		
P 12+	Rec. data				.546E-19	.142E-12	.118E-10	.598E-10	.904E-10	.900E-10		
	Fit/Rec				100 %	98 %	101 %	103 %	101 %	98 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
P 13+	Rec. data						.514E-15	.782E-12	.818E-11	.197E-10	.231E-10	.203E-10
	Fit/Rec						99 %	101 %	102 %	101 %	99 %	99 %
P 14+	Rec. data						.162E-15	.329E-12	.336E-11	.775E-11	.908E-11	.813E-11
	Fit/Rec						97 %	102 %	104 %	101 %	97 %	101 %
S	Rec. data	.129E-11	.191E-08	.351E-07	.107E-06	.176E-06	.194E-06	.175E-06	.140E-06	.101E-06		
	Fit/Rec	98 %	100 %	99 %	99 %	103 %	104 %	99 %	97 %	100 %		
S 1+	Rec. data	.250E-17	.213E-10	.637E-08	.339E-07	.588E-07	.618E-07	.522E-07	.399E-07	.278E-07		
	Fit/Rec	93 %	92 %	103 %	112 %	108 %	99 %	93 %	95 %	103 %		
S 2+	Rec. data		.138E-12	.678E-09	.899E-08	.243E-07	.308E-07	.288E-07	.232E-07	.166E-07		
	Fit/Rec		93 %	98 %	106 %	109 %	105 %	98 %	95 %	98 %		
S 3+	Rec. data		.118E-14	.996E-10	.273E-08	.919E-08	.129E-07	.127E-07	.106E-07	.781E-08		
	Fit/Rec		87 %	101 %	116 %	114 %	100 %	92 %	93 %	104 %		
S 4+	Rec. data		.826E-19	.308E-11	.551E-09	.375E-08	.636E-08	.682E-08	.587E-08	.441E-08		
	Fit/Rec		100 %	96 %	100 %	106 %	105 %	99 %	96 %	100 %		
S 5+	Rec. data			.248E-12	.811E-10	.114E-08	.300E-08	.425E-08	.426E-08	.357E-08		
	Fit/Rec			77 %	115 %	95 %	92 %	101 %	105 %	99 %		
S 6+	Rec. data				.598E-13	.856E-10	.879E-09	.215E-08	.259E-08	.237E-08		
	Fit/Rec				96 %	104 %	105 %	100 %	97 %	99 %		
S 7+	Rec. data				.119E-13	.349E-10	.480E-09	.145E-08	.182E-08	.169E-08		
	Fit/Rec				99 %	106 %	99 %	96 %	102 %	100 %		
S 8+	Rec. data				.763E-15	.113E-10	.242E-09	.799E-09	.107E-08	.101E-08		
	Fit/Rec				99 %	98 %	101 %	105 %	104 %	96 %		
S 9+	Rec. data				.105E-15	.517E-11	.151E-09	.571E-09	.815E-09	.780E-09		
	Fit/Rec				101 %	102 %	98 %	99 %	101 %	100 %		
S 10+	Rec. data				.997E-17	.210E-11	.856E-10	.366E-09	.555E-09	.548E-09		
	Fit/Rec				104 %	97 %	100 %	102 %	101 %	99 %		
S 11+	Rec. data				.531E-18	.563E-12	.435E-10	.237E-09	.377E-09	.384E-09		
	Fit/Rec				96 %	99 %	99 %	104 %	104 %	97 %		
S 12+	Rec. data				.633E-20	.638E-13	.117E-10	.915E-10	.166E-09	.176E-09		
	Fit/Rec				97 %	102 %	92 %	93 %	98 %	108 %		
S 13+	Rec. data				.172E-20	.418E-13	.666E-11	.432E-10	.711E-10	.735E-10		
	Fit/Rec				101 %	98 %	100 %	103 %	101 %	98 %		
S 14+	Rec. data						.990E-16	.394E-12	.558E-11	.153E-10	.188E-10	.170E-10
	Fit/Rec						100 %	99 %	101 %	103 %	101 %	96 %
S 15+	Rec. data						.308E-16	.170E-12	.234E-11	.610E-11	.747E-11	.684E-11
	Fit/Rec						98 %	98 %	103 %	104 %	100 %	97 %
Cl	Rec. data	.286E-12	.220E-08	.576E-07	.155E-06	.208E-06	.198E-06	.158E-06	.117E-06	.800E-07		
	Fit/Rec	88 %	94 %	106 %	111 %	106 %	98 %	94 %	95 %	103 %		
Cl 1+	Rec. data	.151E-17	.180E-10	.625E-08	.351E-07	.623E-07	.667E-07	.573E-07	.446E-07	.314E-07		
	Fit/Rec	95 %	93 %	102 %	111 %	108 %	99 %	94 %	95 %	103 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Cl 2+ Rec. data		.359E-13	.515E-09	.853E-08	.229E-07	.282E-07	.259E-07	.207E-07	.148E-07		
Fit/Rec		92 %	100 %	110 %	110 %	100 %	94 %	94 %	103 %		
Cl 3+ Rec. data		.124E-15	.490E-10	.231E-08	.101E-07	.155E-07	.159E-07	.134E-07	.991E-08		
Fit/Rec		95 %	95 %	102 %	109 %	108 %	101 %	96 %	96 %		
Cl 4+ Rec. data		.642E-18	.697E-11	.769E-09	.424E-08	.703E-08	.761E-08	.665E-08	.503E-08		
Fit/Rec		87 %	97 %	113 %	114 %	101 %	92 %	93 %	105 %		
Cl 5+ Rec. data			.137E-12	.136E-09	.185E-08	.446E-08	.451E-08	.404E-08	.311E-08		
Fit/Rec			100 %	96 %	98 %	94 %	112 %	108 %	107 %		
Cl 6+ Rec. data				.120E-10	.515E-09	.174E-08	.278E-08	.294E-08	.254E-08		
Fit/Rec				112 %	85 %	93 %	99 %	101 %	106 %		
Cl 7+ Rec. data				.402E-14	.282E-10	.474E-09	.142E-08	.186E-08	.177E-08		
Fit/Rec				99 %	96 %	100 %	107 %	106 %	96 %		
Cl 8+ Rec. data				.779E-15	.118E-10	.260E-09	.968E-09	.134E-08	.129E-08		
Fit/Rec				98 %	107 %	100 %	95 %	101 %	101 %		
Cl 9+ Rec. data				.407E-16	.358E-11	.132E-09	.546E-09	.795E-09	.787E-09		
Fit/Rec				101 %	98 %	98 %	104 %	105 %	97 %		
Cl 10+Rec. data				.511E-17	.166E-11	.842E-10	.397E-09	.618E-09	.618E-09		
Fit/Rec				96 %	102 %	99 %	100 %	101 %	100 %		
Cl 11+Rec. data				.397E-18	.654E-12	.482E-10	.257E-09	.426E-09	.438E-09		
Fit/Rec				104 %	96 %	100 %	103 %	101 %	99 %		
Cl 12+Rec. data				.153E-19	.157E-12	.234E-10	.165E-09	.297E-09	.308E-09		
Fit/Rec				100 %	99 %	99 %	100 %	102 %	97 %		
Cl 13+Rec. data				.719E-21	.475E-13	.104E-10	.775E-10	.137E-09	.151E-09		
Fit/Rec				100 %	97 %	100 %	104 %	102 %	97 %		
Cl 14+Rec. data					.117E-13	.373E-11	.314E-10	.564E-10	.607E-10		
Fit/Rec					98 %	100 %	103 %	102 %	98 %		
Cl 15+Rec. data						.187E-16	.198E-12	.382E-11	.119E-10	.145E-10	.144E-10
Fit/Rec						101 %	98 %	99 %	104 %	109 %	94 %
Cl 16+Rec. data						.539E-17	.866E-13	.164E-11	.483E-11	.619E-11	.580E-11
Fit/Rec						99 %	98 %	102 %	104 %	101 %	96 %
Ar Rec. data	.563E-14	.298E-09	.183E-07	.788E-07	.147E-06	.166E-06	.150E-06	.119E-06	.853E-07		
Fit/Rec	97 %	99 %	100 %	99 %	103 %	104 %	100 %	97 %	99 %		
Ar 1+ Rec. data		.442E-11	.375E-08	.286E-07	.601E-07	.681E-07	.600E-07	.470E-07	.332E-07		
Fit/Rec		91 %	102 %	111 %	109 %	101 %	94 %	95 %	102 %		
Ar 2+ Rec. data		.224E-13	.452E-09	.841E-08	.236E-07	.299E-07	.280E-07	.228E-07	.165E-07		
Fit/Rec		93 %	99 %	109 %	109 %	101 %	94 %	94 %	103 %		
Ar 3+ Rec. data		.778E-16	.420E-10	.219E-08	.929E-08	.133E-07	.129E-07	.104E-07	.754E-08		
Fit/Rec		114 %	92 %	99 %	104 %	101 %	97 %	97 %	102 %		
Ar 4+ Rec. data		.740E-19	.447E-11	.852E-09	.612E-08	.119E-07	.937E-08	.766E-08	.557E-08		
Fit/Rec		105 %	96 %	101 %	103 %	91 %	112 %	105 %	99 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Ar 5+ Rec. data			.609E-12	.329E-09	.345E-08	.796E-08	.620E-08	.528E-08	.394E-08		
Fit/Rec			96 %	101 %	104 %	90 %	121 %	110 %	99 %		
Ar 6+ Rec. data			.636E-14	.378E-10	.929E-09	.240E-08	.310E-08	.289E-08	.228E-08		
Fit/Rec			97 %	98 %	104 %	105 %	100 %	96 %	100 %		
Ar 7+ Rec. data				.451E-11	.236E-09	.105E-08	.188E-08	.210E-08	.188E-08		
Fit/Rec				109 %	103 %	95 %	98 %	100 %	102 %		
Ar 8+ Rec. data				.487E-15	.156E-10	.368E-09	.118E-08	.155E-08	.147E-08		
Fit/Rec				100 %	98 %	101 %	102 %	100 %	99 %		
Ar 9+ Rec. data				.423E-16	.387E-11	.142E-09	.657E-09	.100E-08	.101E-08		
Fit/Rec				97 %	108 %	102 %	95 %	100 %	102 %		
Ar 10+Rec. data				.181E-17	.109E-11	.724E-10	.378E-09	.603E-09	.622E-09		
Fit/Rec				96 %	99 %	99 %	104 %	104 %	97 %		
Ar 11+Rec. data				.204E-18	.511E-12	.470E-10	.280E-09	.476E-09	.497E-09		
Fit/Rec				95 %	103 %	100 %	99 %	101 %	100 %		
Ar 12+Rec. data				.128E-19	.194E-12	.270E-10	.182E-09	.330E-09	.355E-09		
Fit/Rec				105 %	96 %	99 %	103 %	101 %	99 %		
Ar 13+Rec. data					.450E-13	.130E-10	.118E-09	.228E-09	.253E-09		
Fit/Rec					100 %	98 %	102 %	104 %	99 %		
Ar 14+Rec. data					.138E-13	.601E-11	.559E-10	.103E-09	.113E-09		
Fit/Rec					98 %	100 %	103 %	101 %	98 %		
Ar 15+Rec. data					.310E-14	.207E-11	.229E-10	.452E-10	.506E-10		
Fit/Rec					98 %	100 %	103 %	102 %	98 %		
Ar 16+Rec. data						.296E-17	.964E-13	.262E-11	.942E-11	.129E-10	.122E-10
Fit/Rec						102 %	98 %	99 %	103 %	102 %	96 %
Ar 17+Rec. data						.872E-18	.433E-13	.115E-11	.385E-11	.517E-11	.495E-11
Fit/Rec						100 %	97 %	101 %	104 %	101 %	96 %
K Rec. data	.270E-08	.703E-07	.243E-06	.394E-06	.247E-06	.202E-06	.147E-06	.104E-06	.681E-07		
Fit/Rec	103 %	97 %	98 %	81 %	113 %	104 %	98 %	97 %	101 %		
K 1+ Rec. data		.666E-12	.181E-08	.207E-07	.504E-07	.603E-07	.546E-07	.434E-07	.309E-07		
Fit/Rec		104 %	95 %	97 %	102 %	102 %	98 %	97 %	103 %		
K 2+ Rec. data		.194E-14	.138E-09	.407E-08	.145E-07	.199E-07	.194E-07	.160E-07	.117E-07		
Fit/Rec		100 %	96 %	100 %	105 %	104 %	98 %	96 %	101 %		
K 3+ Rec. data		.133E-16	.302E-10	.223E-08	.105E-07	.157E-07	.160E-07	.136E-07	.101E-07		
Fit/Rec		94 %	96 %	106 %	110 %	104 %	96 %	94 %	101 %		
K 4+ Rec. data			.115E-11	.450E-09	.427E-08	.818E-08	.923E-08	.811E-08	.615E-08		
Fit/Rec			100 %	96 %	99 %	101 %	99 %	97 %	103 %		
K 5+ Rec. data			.114E-12	.140E-09	.204E-08	.443E-08	.525E-08	.468E-08	.357E-08		
Fit/Rec			102 %	95 %	97 %	100 %	98 %	98 %	104 %		
K 6+ Rec. data			.893E-14	.383E-10	.899E-09	.233E-08	.301E-08	.280E-08	.219E-08		
Fit/Rec			105 %	97 %	97 %	99 %	99 %	98 %	103 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
K 7+	Rec. data			.191E-15	.864E-11	.441E-09	.143E-08	.199E-08	.195E-08	.160E-08		
	Fit/Rec			96 %	99 %	104 %	105 %	101 %	96 %	99 %		
K 8+	Rec. data				.101E-11	.109E-09	.646E-09	.131E-08	.155E-08	.143E-08		
	Fit/Rec				88 %	114 %	105 %	100 %	97 %	99 %		
K 9+	Rec. data				.228E-16	.494E-11	.206E-09	.825E-09	.117E-08	.116E-08		
	Fit/Rec				100 %	98 %	101 %	103 %	100 %	98 %		
K 10+	Rec. data				.185E-17	.122E-11	.780E-10	.451E-09	.766E-09	.799E-09		
	Fit/Rec				93 %	107 %	103 %	95 %	98 %	102 %		
K 11+	Rec. data				.647E-19	.316E-12	.395E-10	.265E-09	.463E-09	.499E-09		
	Fit/Rec				95 %	100 %	98 %	103 %	104 %	98 %		
K 12+	Rec. data				.652E-20	.149E-12	.261E-10	.198E-09	.370E-09	.405E-09		
	Fit/Rec				94 %	104 %	100 %	99 %	101 %	101 %		
K 13+	Rec. data					.549E-13	.151E-10	.130E-09	.258E-09	.292E-09		
	Fit/Rec					97 %	99 %	102 %	101 %	99 %		
K 14+	Rec. data					.119E-13	.704E-11	.846E-10	.180E-09	.209E-09		
	Fit/Rec					102 %	98 %	101 %	104 %	99 %		
K 15+	Rec. data					.351E-14	.330E-11	.408E-10	.824E-10	.941E-10		
	Fit/Rec					98 %	100 %	103 %	102 %	98 %		
K 16+	Rec. data					.633E-15	.106E-11	.164E-10	.361E-10	.426E-10	.378E-10	.289E-10
	Fit/Rec					98 %	99 %	103 %	102 %	98 %	98 %	103 %
K 17+	Rec. data						.459E-18	.465E-13	.179E-11	.745E-11	.107E-10	.105E-10
	Fit/Rec						102 %	99 %	98 %	103 %	103 %	96 %
K 18+	Rec. data						.130E-18	.213E-13	.801E-12	.308E-11	.434E-11	.426E-11
	Fit/Rec						100 %	97 %	100 %	104 %	101 %	96 %
Ca	Rec. data	.260E-09	.256E-07	.135E-06	.195E-06	.182E-06	.142E-06	.986E-07	.677E-07	.434E-07		
	Fit/Rec	98 %	98 %	103 %	104 %	100 %	97 %	97 %	99 %	104 %		
Ca 1+	Rec. data	.617E-13	.335E-09	.133E-07	.551E-07	.918E-07	.889E-07	.692E-07	.488E-07	.316E-07		
	Fit/Rec	114 %	116 %	95 %	85 %	91 %	98 %	101 %	104 %	110 %		
Ca 2+	Rec. data		.426E-15	.107E-09	.476E-08	.198E-07	.288E-07	.287E-07	.239E-07	.176E-07		
	Fit/Rec		107 %	97 %	96 %	101 %	102 %	98 %	97 %	103 %		
Ca 3+	Rec. data		.155E-17	.151E-10	.172E-08	.998E-08	.165E-07	.176E-07	.151E-07	.113E-07		
	Fit/Rec		90 %	95 %	107 %	113 %	107 %	98 %	94 %	98 %		
Ca 4+	Rec. data			.158E-11	.587E-09	.497E-08	.898E-08	.100E-07	.885E-08	.679E-08		
	Fit/Rec			95 %	104 %	110 %	105 %	96 %	94 %	101 %		
Ca 5+	Rec. data			.495E-13	.113E-09	.206E-08	.492E-08	.614E-08	.563E-08	.438E-08		
	Fit/Rec			102 %	97 %	99 %	101 %	99 %	98 %	102 %		
Ca 6+	Rec. data			.433E-14	.349E-10	.101E-08	.277E-08	.363E-08	.337E-08	.264E-08		
	Fit/Rec			106 %	97 %	97 %	100 %	99 %	98 %	102 %		
Ca 7+	Rec. data			.296E-15	.922E-11	.449E-09	.148E-08	.212E-08	.205E-08	.165E-08		
	Fit/Rec			106 %	98 %	97 %	99 %	99 %	98 %	103 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Ca 8+ Rec. data			.446E-17	.195E-11	.225E-09	.939E-09	.149E-08	.151E-08	.125E-08		
Fit/Rec			96 %	97 %	103 %	105 %	101 %	97 %	99 %		
Ca 9+ Rec. data				.204E-12	.581E-10	.404E-09	.934E-09	.117E-08	.111E-08		
Fit/Rec				122 %	105 %	99 %	99 %	99 %	101 %		
Ca 10+Rec. data				.409E-18	.818E-12	.768E-10	.460E-09	.779E-09	.842E-09		
Fit/Rec				97 %	98 %	97 %	103 %	106 %	98 %		
Ca 11+Rec. data				.665E-19	.369E-12	.430E-10	.313E-09	.591E-09	.643E-09		
Fit/Rec				92 %	107 %	104 %	95 %	97 %	102 %		
Ca 12+Rec. data				.199E-20	.880E-13	.215E-10	.187E-09	.360E-09	.405E-09		
Fit/Rec				93 %	102 %	98 %	101 %	104 %	99 %		
Ca 13+Rec. data					.417E-13	.144E-10	.142E-09	.290E-09	.334E-09		
Fit/Rec					104 %	100 %	98 %	100 %	101 %		
Ca 14+Rec. data					.147E-13	.835E-11	.938E-10	.204E-09	.243E-09		
Fit/Rec					96 %	98 %	103 %	102 %	99 %		
Ca 15+Rec. data					.296E-14	.377E-11	.607E-10	.143E-09	.175E-09		
Fit/Rec					104 %	98 %	100 %	103 %	99 %		
Ca 16+Rec. data					.800E-15	.172E-11	.298E-10	.699E-10	.871E-10	.801E-10	.627E-10
Fit/Rec					98 %	99 %	103 %	104 %	99 %	97 %	102 %
Ca 17+Rec. data					.182E-15	.615E-12	.123E-10	.295E-10	.360E-10	.324E-10	.250E-10
Fit/Rec					98 %	99 %	103 %	103 %	99 %	98 %	103 %
Ca 18+Rec. data						.659E-19	.221E-13	.123E-11	.592E-11	.903E-11	.904E-11
Fit/Rec						97 %	99 %	99 %	102 %	102 %	97 %
Ca 19+Rec. data						.179E-19	.103E-13	.559E-12	.248E-11	.367E-11	.369E-11
Fit/Rec						101 %	97 %	100 %	104 %	102 %	96 %
Sc Rec. data	.372E-09	.460E-07	.322E-06	.570E-06	.619E-06	.539E-06	.407E-06	.294E-06	.197E-06		
Fit/Rec	107 %	99 %	95 %	101 %	104 %	100 %	97 %	98 %	103 %		
Sc 1+ Rec. data	.123E-12	.125E-08	.397E-07	.122E-06	.194E-06	.203E-06	.171E-06	.129E-06	.890E-07		
Fit/Rec	129 %	96 %	94 %	101 %	103 %	100 %	96 %	98 %	104 %		
Sc 2+ Rec. data	.481E-18	.111E-10	.474E-08	.303E-07	.631E-07	.724E-07	.645E-07	.504E-07	.354E-07		
Fit/Rec	96 %	89 %	102 %	113 %	111 %	104 %	96 %	94 %	99 %		
Sc 3+ Rec. data		.796E-19	.408E-11	.943E-09	.762E-08	.140E-07	.156E-07	.137E-07	.103E-07		
Fit/Rec		111 %	101 %	93 %	94 %	97 %	97 %	99 %	108 %		
Sc 4+ Rec. data			.388E-12	.307E-09	.398E-08	.867E-08	.104E-07	.945E-08	.729E-08		
Fit/Rec			104 %	95 %	95 %	98 %	98 %	99 %	106 %		
Sc 5+ Rec. data			.452E-13	.116E-09	.220E-08	.524E-08	.650E-08	.592E-08	.458E-08		
Fit/Rec			101 %	97 %	99 %	101 %	99 %	98 %	102 %		
Sc 6+ Rec. data			.167E-14	.272E-10	.102E-08	.308E-08	.426E-08	.407E-08	.325E-08		
Fit/Rec			103 %	98 %	99 %	101 %	100 %	98 %	101 %		
Sc 7+ Rec. data			.128E-15	.818E-11	.508E-09	.178E-08	.258E-08	.250E-08	.201E-08		
Fit/Rec			106 %	98 %	97 %	99 %	99 %	98 %	103 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Sc 8+ Rec. data			.750E-17	.208E-11	.225E-09	.959E-09	.153E-08	.147E-08	.126E-08		
Fit/Rec			108 %	100 %	97 %	98 %	97 %	101 %	101 %		
Sc 9+ Rec. data			.797E-19	.410E-12	.114E-09	.625E-09	.111E-08	.117E-08	.990E-09		
Fit/Rec			96 %	97 %	103 %	105 %	101 %	97 %	99 %		
Sc10+ Rec. data				.351E-13	.297E-10	.256E-09	.678E-09	.895E-09	.879E-09		
Fit/Rec				124 %	95 %	99 %	97 %	98 %	103 %		
Sc 11+Rec. data				.354E-19	.518E-12	.679E-10	.407E-09	.670E-09	.714E-09		
Fit/Rec				104 %	94 %	98 %	106 %	106 %	97 %		
Sc 12+Rec. data					.181E-12	.391E-10	.277E-09	.467E-09	.494E-09		
Fit/Rec					97 %	101 %	105 %	102 %	97 %		
Sc 13+Rec. data					.620E-13	.222E-10	.188E-09	.329E-09	.351E-09		
Fit/Rec					98 %	101 %	104 %	101 %	97 %		
Sc 14+Rec. data					.147E-13	.102E-10	.112E-09	.217E-09	.244E-09		
Fit/Rec					97 %	100 %	104 %	102 %	97 %		
Sc 15+Rec. data					.366E-14	.474E-11	.665E-10	.137E-09	.156E-09	.136E-09	.102E-09
Fit/Rec					101 %	97 %	99 %	101 %	99 %	98 %	105 %
Sc 16+Rec. data					.621E-15	.158E-11	.280E-10	.575E-10	.591E-10	.457E-10	.305E-10
Fit/Rec					101 %	100 %	100 %	101 %	99 %	99 %	101 %
Sc 17+Rec. data					.118E-15	.590E-12	.136E-10	.336E-10	.419E-10	.381E-10	.295E-10
Fit/Rec					99 %	98 %	102 %	103 %	99 %	98 %	103 %
Sc 18+Rec. data					.332E-16	.242E-12	.607E-11	.161E-10	.218E-10	.211E-10	.171E-10
Fit/Rec					107 %	95 %	94 %	98 %	106 %	108 %	90 %
Sc 19+Rec. data						.822E-20	.856E-14	.600E-12	.298E-11	.456E-11	.464E-11
Fit/Rec						101 %	99 %	98 %	99 %	99 %	104 %
Sc 21+Rec. data						.137E-20	.302E-14	.249E-12	.130E-11	.204E-11	.210E-11
Fit/Rec						101 %	98 %	100 %	103 %	101 %	98 %
Ti Rec. data	.167E-09	.202E-07	.122E-06	.197E-06	.199E-06	.166E-06	.122E-06	.867E-07	.573E-07		
Fit/Rec	90 %	97 %	104 %	107 %	104 %	98 %	95 %	97 %	103 %		
Ti 1+ Rec. data	.454E-13	.635E-09	.261E-07	.795E-07	.115E-06	.873E-07	.720E-07	.548E-07	.380E-07		
Fit/Rec	86 %	103 %	103 %	103 %	92 %	107 %	99 %	97 %	101 %		
Ti 2+ Rec. data		.190E-11	.221E-08	.199E-07	.488E-07	.641E-07	.618E-07	.502E-07	.361E-07		
Fit/Rec		107 %	91 %	96 %	103 %	100 %	97 %	97 %	105 %		
Ti 3+ Rec. data		.122E-13	.439E-09	.102E-07	.338E-07	.468E-07	.458E-07	.378E-07	.274E-07		
Fit/Rec		93 %	96 %	106 %	111 %	106 %	98 %	95 %	98 %		
Ti 4+ Rec. data			.297E-12	.339E-09	.463E-08	.989E-08	.117E-07	.105E-07	.805E-08		
Fit/Rec			98 %	97 %	102 %	103 %	99 %	97 %	101 %		
Ti 5+ Rec. data			.247E-13	.110E-09	.246E-08	.613E-08	.775E-08	.712E-08	.555E-08		
Fit/Rec			99 %	97 %	102 %	103 %	99 %	97 %	100 %		
Ti 6+ Rec. data			.188E-14	.348E-10	.129E-08	.376E-08	.506E-08	.477E-08	.377E-08		
Fit/Rec			99 %	98 %	102 %	104 %	100 %	97 %	100 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Ti 7+ Rec. data			.526E-16	.742E-11	.589E-09	.214E-08	.306E-08	.291E-08	.230E-08		
Fit/Rec			106 %	98 %	97 %	100 %	100 %	98 %	102 %		
Ti 8+ Rec. data			.404E-17	.237E-11	.310E-09	.133E-08	.208E-08	.207E-08	.169E-08		
Fit/Rec			102 %	98 %	100 %	103 %	101 %	98 %	100 %		
Ti 9+ Rec. data			.267E-18	.757E-12	.174E-09	.900E-09	.155E-08	.162E-08	.136E-08		
Fit/Rec			99 %	98 %	101 %	104 %	101 %	97 %	99 %		
Ti 10+Rec. data				.886E-13	.644E-10	.473E-09	.942E-09	.104E-08	.901E-09		
Fit/Rec				97 %	102 %	105 %	101 %	97 %	99 %		
Ti 11+Rec. data				.451E-14	.141E-10	.164E-09	.500E-09	.697E-09	.708E-09		
Fit/Rec				130 %	96 %	108 %	100 %	96 %	101 %		
Ti 12+Rec. data					.147E-12	.383E-10	.295E-09	.528E-09	.585E-09		
Fit/Rec					95 %	97 %	104 %	106 %	98 %		
Ti 13+Rec. data					.489E-13	.218E-10	.202E-09	.372E-09	.409E-09		
Fit/Rec					97 %	100 %	105 %	103 %	97 %		
Ti 14+Rec. data					.161E-13	.123E-10	.138E-09	.265E-09	.294E-09		
Fit/Rec					98 %	101 %	104 %	102 %	97 %		
Ti 15+Rec. data					.366E-14	.563E-11	.825E-10	.175E-09	.205E-09	.183E-09	.140E-09
Fit/Rec					97 %	99 %	104 %	103 %	98 %	97 %	103 %
Ti 16+Rec. data					.864E-15	.256E-11	.488E-10	.111E-09	.132E-09	.117E-09	.885E-10
Fit/Rec					101 %	97 %	99 %	101 %	98 %	99 %	105 %
Ti 17+Rec. data					.139E-15	.838E-12	.206E-10	.474E-10	.510E-10	.400E-10	.269E-10
Fit/Rec					102 %	100 %	101 %	101 %	99 %	99 %	100 %
Ti 18+Rec. data					.256E-16	.314E-12	.100E-10	.276E-10	.359E-10	.333E-10	.260E-10
Fit/Rec					99 %	98 %	102 %	102 %	99 %	97 %	104 %
Ti 19+Rec. data					.693E-17	.128E-12	.448E-11	.131E-10	.185E-10	.183E-10	.150E-10
Fit/Rec					108 %	96 %	94 %	97 %	105 %	108 %	91 %
Ti 20+Rec. data						.101E-20	.397E-14	.415E-12	.240E-11	.388E-11	.405E-11
Fit/Rec						100 %	100 %	99 %	99 %	99 %	104 %
Ti 21+Rec. data						.160E-21	.140E-14	.173E-12	.105E-11	.174E-11	.184E-11
Fit/Rec						100 %	98 %	100 %	103 %	101 %	98 %
V Rec. data	.300E-09	.451E-07	.373E-06	.805E-06	.763E-06	.656E-06	.490E-06	.352E-06	.234E-06		
Fit/Rec	90 %	103 %	103 %	93 %	107 %	102 %	99 %	98 %	101 %		
V 1+ Rec. data	.244E-13	.701E-09	.388E-07	.158E-06	.268E-06	.247E-06	.206E-06	.157E-06	.109E-06		
Fit/Rec	79 %	100 %	109 %	107 %	99 %	104 %	98 %	96 %	99 %		
V 2+ Rec. data		.143E-11	.203E-08	.220E-07	.552E-07	.656E-07	.598E-07	.476E-07	.340E-07		
Fit/Rec		102 %	102 %	96 %	99 %	103 %	100 %	98 %	101 %		
V 3+ Rec. data		.938E-15	.114E-09	.405E-08	.165E-07	.267E-07	.292E-07	.255E-07	.190E-07		
Fit/Rec		91 %	97 %	111 %	113 %	100 %	92 %	94 %	106 %		
V 4+ Rec. data		.243E-17	.155E-10	.153E-08	.877E-08	.153E-07	.168E-07	.147E-07	.111E-07		
Fit/Rec		106 %	90 %	95 %	104 %	110 %	111 %	102 %	92 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
V 5+	Rec. data			.866E-14	.689E-10	.198E-08	.558E-08	.762E-08	.731E-08	.585E-08		
	Fit/Rec			98 %	98 %	102 %	104 %	101 %	97 %	99 %		
V 6+	Rec. data			.706E-15	.254E-10	.122E-08	.388E-08	.543E-08	.521E-08	.416E-08		
	Fit/Rec			100 %	98 %	101 %	103 %	100 %	97 %	100 %		
V 7+	Rec. data			.483E-16	.794E-11	.652E-09	.243E-08	.363E-08	.357E-08	.289E-08		
	Fit/Rec			99 %	98 %	101 %	104 %	100 %	97 %	100 %		
V 8+	Rec. data			.104E-17	.156E-11	.292E-09	.139E-08	.222E-08	.210E-08	.176E-08		
	Fit/Rec			108 %	100 %	97 %	99 %	99 %	102 %	100 %		
V 9+	Rec. data			.617E-19	.469E-12	.154E-09	.884E-09	.156E-08	.162E-08	.135E-08		
	Fit/Rec			102 %	99 %	99 %	102 %	101 %	98 %	100 %		
V 10+	Rec. data				.145E-12	.865E-10	.601E-09	.117E-08	.128E-08	.110E-08		
	Fit/Rec				98 %	100 %	104 %	102 %	98 %	99 %		
V 11+	Rec. data				.159E-13	.321E-10	.320E-09	.721E-09	.834E-09	.739E-09		
	Fit/Rec				97 %	101 %	105 %	102 %	98 %	98 %		
V 12+	Rec. data					.746E-11	.105E-09	.373E-09	.551E-09	.577E-09		
	Fit/Rec					83 %	100 %	102 %	106 %	99 %		
V 13+	Rec. data					.394E-13	.214E-10	.215E-09	.420E-09	.485E-09		
	Fit/Rec					95 %	97 %	104 %	106 %	97 %		
V 14+	Rec. data					.107E-13	.110E-10	.149E-09	.360E-09	.342E-09		
	Fit/Rec					96 %	97 %	105 %	103 %	126 %		
V 15+	Rec. data						.652E-11	.100E-09	.241E-09	.287E-09	.270E-09	.213E-09
	Fit/Rec						92 %	103 %	100 %	100 %	97 %	102 %
V 16+	Rec. data						.363E-11	.638E-10	.172E-09	.213E-09	.195E-09	.152E-09
	Fit/Rec						77 %	107 %	98 %	97 %	99 %	106 %
V 17+	Rec. data						.175E-11	.419E-10	.113E-09	.147E-09	.138E-09	.118E-09
	Fit/Rec						84 %	104 %	101 %	98 %	100 %	102 %
V 18+	Rec. data						.675E-12	.232E-10	.698E-10	.100E-09	.970E-10	.755E-10
	Fit/Rec						107 %	98 %	102 %	106 %	102 %	94 %
V 19+	Rec. data						.273E-12	.129E-10	.422E-10	.665E-10	.650E-10	.517E-10
	Fit/Rec						96 %	103 %	106 %	96 %	97 %	108 %
V 20+	Rec. data						.100E-12	.539E-11	.187E-10	.299E-10	.327E-10	.275E-10
	Fit/Rec						106 %	98 %	99 %	104 %	105 %	96 %
V 21+	Rec. data							.339E-14	.552E-12	.339E-11	.556E-11	.612E-11
	Fit/Rec							97 %	97 %	101 %	101 %	102 %
V 22+	Rec. data							.100E-14	.212E-12	.146E-11	.251E-11	.286E-11
	Fit/Rec							100 %	100 %	101 %	100 %	100 %
Cr	Rec. data	.978E-10	.141E-07	.974E-07	.175E-06	.197E-06	.175E-06	.134E-06	.975E-07	.656E-07		
	Fit/Rec	105 %	96 %	99 %	104 %	104 %	99 %	96 %	97 %	103 %		
Cr 1+	Rec. data	.283E-14	.295E-09	.248E-07	.121E-06	.227E-06	.198E-06	.162E-06	.122E-06	.841E-07		
	Fit/Rec	84 %	99 %	109 %	104 %	94 %	106 %	100 %	98 %	98 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Cr 2+ Rec. data		.686E-12	.172E-08	.227E-07	.693E-07	.832E-07	.766E-07	.621E-07	.450E-07		
Fit/Rec		90 %	108 %	112 %	102 %	103 %	99 %	96 %	98 %		
Cr 3+ Rec. data		.868E-15	.105E-09	.437E-08	.196E-07	.291E-07	.295E-07	.247E-07	.183E-07		
Fit/Rec		96 %	109 %	98 %	97 %	105 %	105 %	100 %	96 %		
Cr 4+ Rec. data		.175E-18	.519E-11	.910E-09	.667E-08	.131E-07	.162E-07	.151E-07	.117E-07		
Fit/Rec		99 %	93 %	107 %	113 %	103 %	93 %	93 %	106 %		
Cr 5+ Rec. data			.686E-12	.377E-09	.393E-08	.842E-08	.104E-07	.952E-08	.738E-08		
Fit/Rec			91 %	93 %	101 %	108 %	111 %	104 %	93 %		
Cr 6+ Rec. data			.265E-15	.182E-10	.111E-08	.382E-08	.556E-08	.542E-08	.438E-08		
Fit/Rec			100 %	98 %	101 %	104 %	101 %	97 %	100 %		
Cr 7+ Rec. data			.156E-16	.554E-11	.606E-09	.250E-08	.390E-08	.390E-08	.320E-08		
Fit/Rec			100 %	98 %	101 %	103 %	100 %	97 %	100 %		
Cr 8+ Rec. data			.928E-18	.169E-11	.329E-09	.161E-08	.268E-08	.275E-08	.228E-08		
Fit/Rec			100 %	98 %	101 %	104 %	101 %	97 %	99 %		
Cr 9+ Rec. data			.157E-19	.308E-12	.146E-09	.930E-09	.167E-08	.174E-08	.143E-08		
Fit/Rec			107 %	100 %	97 %	99 %	100 %	99 %	101 %		
Cr 10+Rec. data				.891E-13	.773E-10	.595E-09	.118E-08	.128E-08	.109E-08		
Fit/Rec				99 %	99 %	102 %	102 %	98 %	99 %		
Cr 11+Rec. data				.265E-13	.431E-10	.404E-09	.888E-09	.102E-08	.894E-09		
Fit/Rec				98 %	100 %	104 %	102 %	98 %	98 %		
Cr 12+Rec. data				.255E-14	.156E-10	.216E-09	.555E-09	.674E-09	.612E-09		
Fit/Rec				97 %	101 %	105 %	103 %	98 %	98 %		
Cr 13+Rec. data					.351E-11	.677E-10	.281E-09	.440E-09	.476E-09		
Fit/Rec					98 %	104 %	96 %	100 %	101 %		
Cr 14+Rec. data					.998E-14	.118E-10	.158E-09	.336E-09	.405E-09	.369E-09	.287E-09
Fit/Rec					94 %	102 %	109 %	104 %	97 %	95 %	103 %
Cr 15+Rec. data					.299E-14	.653E-11	.108E-09	.240E-09	.287E-09	.258E-09	.198E-09
Fit/Rec					97 %	100 %	105 %	103 %	98 %	97 %	104 %
Cr 16+Rec. data					.916E-15	.364E-11	.745E-10	.174E-09	.209E-09	.187E-09	.143E-09
Fit/Rec					98 %	99 %	103 %	103 %	98 %	97 %	104 %
Cr 17+Rec. data					.188E-15	.162E-11	.445E-10	.116E-09	.148E-09	.136E-09	.106E-09
Fit/Rec					97 %	99 %	104 %	103 %	98 %	97 %	103 %
Cr 18+Rec. data					.404E-16	.715E-12	.263E-10	.744E-10	.964E-10	.882E-10	.682E-10
Fit/Rec					103 %	98 %	99 %	101 %	99 %	98 %	105 %
Cr 19+Rec. data					.588E-17	.225E-12	.111E-10	.324E-10	.382E-10	.312E-10	.213E-10
Fit/Rec					101 %	100 %	100 %	100 %	100 %	99 %	101 %
Cr 20+Rec. data					.984E-18	.835E-13	.539E-11	.185E-10	.264E-10	.254E-10	.203E-10
Fit/Rec					100 %	99 %	101 %	102 %	99 %	98 %	103 %
Cr 21+Rec. data					.254E-18	.346E-13	.244E-11	.880E-11	.137E-10	.140E-10	.118E-10
Fit/Rec					108 %	95 %	93 %	98 %	106 %	108 %	90 %

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Cr 22+Rec. data						.117E-22	.806E-15	.196E-12	.158E-11	.285E-11	.313E-11
Fit/Rec						98 %	101 %	99 %	99 %	99 %	103 %
Cr 23+Rec. data							.586E-15	.135E-12	.118E-11	.216E-11	.253E-11
Fit/Rec							98 %	106 %	99 %	104 %	97 %
Mn Rec. data	.525E-10	.972E-08	.762E-07	.160E-06	.223E-06	.228E-06	.193E-06	.149E-06	.104E-06		
Fit/Rec	80 %	92 %	105 %	114 %	112 %	104 %	96 %	94 %	98 %		
Mn 1+ Rec. data		.164E-09	.147E-07	.675E-07	.132E-06	.158E-06	.148E-06	.120E-06	.890E-07		
Fit/Rec		98 %	96 %	105 %	105 %	99 %	95 %	99 %	108 %		
Mn 2+ Rec. data		.237E-12	.109E-08	.172E-07	.595E-07	.736E-07	.631E-07	.502E-07	.358E-07		
Fit/Rec		90 %	106 %	111 %	99 %	101 %	103 %	98 %	96 %		
Mn 3+ Rec. data		.321E-15	.829E-10	.436E-08	.233E-07	.403E-07	.380E-07	.325E-07	.244E-07		
Fit/Rec		107 %	105 %	96 %	90 %	88 %	100 %	102 %	110 %		
Mn 4+ Rec. data		.214E-18	.497E-11	.956E-09	.797E-08	.151E-07	.169E-07	.149E-07	.114E-07		
Fit/Rec		85 %	111 %	101 %	94 %	101 %	107 %	102 %	96 %		
Mn 5+ Rec. data			.206E-12	.213E-09	.297E-08	.712E-08	.998E-08	.979E-08	.789E-08		
Fit/Rec			91 %	103 %	112 %	105 %	93 %	93 %	105 %		
Mn 6+ Rec. data			.236E-13	.906E-10	.186E-08	.492E-08	.677E-08	.654E-08	.523E-08		
Fit/Rec			94 %	92 %	99 %	106 %	110 %	105 %	94 %		
Mn 7+ Rec. data			.585E-17	.399E-11	.556E-09	.248E-08	.403E-08	.410E-08	.339E-08		
Fit/Rec			100 %	98 %	101 %	103 %	101 %	97 %	99 %		
Mn 8+ Rec. data			.269E-18	.114E-11	.303E-09	.165E-08	.288E-08	.301E-08	.253E-08		
Fit/Rec			101 %	98 %	100 %	103 %	101 %	98 %	99 %		
Mn 9+ Rec. data			.135E-19	.333E-12	.165E-09	.107E-08	.201E-08	.215E-08	.183E-08		
Fit/Rec			100 %	98 %	101 %	104 %	101 %	98 %	99 %		
Mn 10+Rec. data				.567E-13	.726E-10	.628E-09	.128E-08	.139E-08	.117E-08		
Fit/Rec				102 %	97 %	99 %	101 %	99 %	100 %		
Mn 11+Rec. data				.157E-13	.383E-10	.403E-09	.907E-09	.103E-08	.900E-09		
Fit/Rec				99 %	99 %	102 %	102 %	99 %	99 %		
Mn 12+Rec. data				.442E-14	.211E-10	.274E-09	.685E-09	.821E-09	.740E-09		
Fit/Rec				98 %	100 %	104 %	103 %	98 %	98 %		
Mn 13+Rec. data				.399E-15	.761E-11	.148E-09	.434E-09	.552E-09	.514E-09		
Fit/Rec				97 %	99 %	104 %	104 %	99 %	97 %		
Mn 14+Rec. data					.179E-11	.436E-10	.213E-09	.355E-09	.397E-09		
Fit/Rec					82 %	106 %	98 %	99 %	101 %		
Mn 15+Rec. data					.237E-14	.640E-11	.115E-09	.270E-09	.339E-09	.314E-09	.248E-09
Fit/Rec					94 %	102 %	109 %	105 %	97 %	95 %	103 %
Mn 16+Rec. data					.542E-15	.319E-11	.762E-10	.190E-09	.238E-09	.218E-09	.170E-09
Fit/Rec					97 %	99 %	105 %	104 %	98 %	97 %	103 %
Mn 17+Rec. data					.200E-15	.194E-11	.549E-10	.142E-09	.179E-09	.163E-09	.126E-09
Fit/Rec					98 %	99 %	103 %	103 %	98 %	97 %	104 %

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Mn 18+Rec. data					.389E-16	.851E-12	.328E-10	.949E-10	.126E-09	.118E-09	.935E-10
Fit/Rec					97 %	99 %	103 %	103 %	98 %	97 %	103 %
Mn 19+Rec. data					.799E-17	.369E-12	.193E-10	.612E-10	.829E-10	.773E-10	.604E-10
Fit/Rec					103 %	98 %	99 %	101 %	99 %	98 %	104 %
Mn 20+Rec. data					.111E-17	.114E-12	.817E-11	.269E-10	.333E-10	.277E-10	.191E-10
Fit/Rec					101 %	101 %	100 %	101 %	100 %	99 %	101 %
Mn 21+Rec. data					.177E-18	.422E-13	.396E-11	.153E-10	.229E-10	.224E-10	.181E-10
Fit/Rec					100 %	98 %	101 %	103 %	99 %	98 %	103 %
Mn 22+Rec. data					.439E-19	.174E-13	.180E-11	.726E-11	.118E-10	.123E-10	.105E-10
Fit/Rec					114 %	98 %	94 %	98 %	104 %	107 %	91 %
Mn 23+Rec. data							.351E-15	.134E-12	.128E-11	.245E-11	.277E-11
Fit/Rec							101 %	99 %	99 %	99 %	103 %
Mn 24+Rec. data							.253E-15	.100E-12	.100E-11	.189E-11	.216E-11
Fit/Rec							98 %	98 %	95 %	101 %	96 %
Fe Rec. data	.189E-10	.723E-08	.692E-07	.133E-06	.155E-06	.141E-06	.112E-06	.835E-07	.573E-07		
Fit/Rec	96 %	95 %	104 %	108 %	102 %	96 %	94 %	97 %	105 %		
Fe 1+ Rec. data	.232E-14	.134E-09	.804E-08	.315E-07	.587E-07	.715E-07	.680E-07	.561E-07	.411E-07		
Fit/Rec	96 %	98 %	93 %	94 %	102 %	112 %	115 %	106 %	90 %		
Fe 2+ Rec. data		.185E-12	.789E-09	.114E-07	.359E-07	.536E-07	.574E-07	.506E-07	.390E-07		
Fit/Rec		114 %	86 %	93 %	102 %	100 %	97 %	98 %	106 %		
Fe 3+ Rec. data		.773E-16	.504E-10	.328E-08	.198E-07	.367E-07	.324E-07	.271E-07	.199E-07		
Fit/Rec		89 %	99 %	106 %	103 %	97 %	112 %	103 %	93 %		
Fe 4+ Rec. data		.595E-19	.358E-11	.922E-09	.902E-08	.203E-07	.217E-07	.196E-07	.152E-07		
Fit/Rec		99 %	108 %	100 %	93 %	88 %	101 %	103 %	109 %		
Fe 5+ Rec. data			.417E-12	.451E-09	.625E-08	.141E-07	.174E-07	.159E-07	.123E-07		
Fit/Rec			96 %	98 %	104 %	106 %	102 %	97 %	98 %		
Fe 6+ Rec. data			.229E-13	.134E-09	.329E-08	.885E-08	.120E-07	.115E-07	.928E-08		
Fit/Rec			92 %	97 %	107 %	110 %	104 %	97 %	95 %		
Fe 7+ Rec. data			.922E-15	.316E-10	.143E-08	.471E-08	.710E-08	.709E-08	.582E-08		
Fit/Rec			95 %	93 %	101 %	109 %	108 %	101 %	94 %		
Fe 8+ Rec. data			.836E-19	.777E-12	.276E-09	.165E-08	.301E-08	.321E-08	.272E-08		
Fit/Rec			100 %	98 %	100 %	103 %	102 %	98 %	99 %		
Fe 9+ Rec. data				.216E-12	.151E-09	.110E-08	.216E-08	.237E-08	.203E-08		
Fit/Rec				98 %	100 %	103 %	102 %	98 %	99 %		
Fe 10+Rec. data				.614E-13	.820E-10	.720E-09	.152E-08	.171E-08	.148E-08		
Fit/Rec				98 %	100 %	104 %	102 %	98 %	99 %		
Fe 11+Rec. data				.950E-14	.354E-10	.425E-09	.989E-09	.112E-08	.968E-09		
Fit/Rec				102 %	97 %	99 %	100 %	99 %	101 %		
Fe 12+Rec. data				.255E-14	.187E-10	.274E-09	.705E-09	.841E-09	.750E-09		
Fit/Rec				100 %	99 %	102 %	102 %	99 %	99 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Fe 13+Rec. data				.682E-15	.102E-10	.187E-09	.533E-09	.670E-09	.619E-09		
Fit/Rec				98 %	99 %	103 %	104 %	99 %	98 %		
Fe 14+Rec. data				.520E-16	.354E-11	.100E-09	.340E-09	.455E-09	.435E-09		
Fit/Rec				98 %	98 %	103 %	105 %	101 %	97 %		
Fe 15+Rec. data					.811E-12	.281E-10	.163E-09	.288E-09	.333E-09		
Fit/Rec					87 %	109 %	97 %	100 %	101 %		
Fe 16+Rec. data					.533E-15	.344E-11	.847E-10	.219E-09	.287E-09	.271E-09	.216E-09
Fit/Rec					93 %	101 %	108 %	104 %	96 %	96 %	105 %
Fe 17+Rec. data					.142E-15	.184E-11	.581E-10	.158E-09	.206E-09	.192E-09	.151E-09
Fit/Rec					96 %	99 %	104 %	104 %	98 %	97 %	103 %
Fe 18+Rec. data					.353E-16	.961E-12	.396E-10	.115E-09	.152E-09	.141E-09	.111E-09
Fit/Rec					98 %	99 %	103 %	103 %	99 %	97 %	103 %
Fe 19+Rec. data					.758E-17	.440E-12	.241E-10	.780E-10	.109E-09	.104E-09	.827E-10
Fit/Rec					97 %	99 %	103 %	103 %	98 %	97 %	103 %
Fe 20+Rec. data					.149E-17	.189E-12	.143E-10	.509E-10	.724E-10	.688E-10	.543E-10
Fit/Rec					103 %	98 %	99 %	100 %	99 %	99 %	105 %
Fe 21+Rec. data					.196E-18	.572E-13	.603E-11	.226E-10	.294E-10	.250E-10	.174E-10
Fit/Rec					99 %	100 %	100 %	100 %	100 %	99 %	101 %
Fe 22+Rec. data					.268E-19	.202E-13	.286E-11	.126E-10	.199E-10	.199E-10	.162E-10
Fit/Rec					99 %	99 %	101 %	102 %	99 %	98 %	103 %
Fe 23+Rec. data					.709E-20	.863E-14	.132E-11	.600E-11	.102E-10	.109E-10	.939E-11
Fit/Rec					116 %	98 %	94 %	97 %	104 %	107 %	92 %
Fe 24+Rec. data							.150E-15	.915E-13	.104E-11	.212E-11	.246E-11
Fit/Rec							101 %	99 %	99 %	99 %	103 %
Fe 25+Rec. data							.515E-16	.386E-13	.462E-12	.960E-12	.113E-11
Fit/Rec							99 %	99 %	102 %	102 %	98 %
Co Rec. data	.225E-10	.836E-08	.808E-07	.184E-06	.267E-06	.273E-06	.231E-06	.178E-06	.125E-06		
Fit/Rec	119 %	93 %	98 %	105 %	104 %	100 %	96 %	97 %	103 %		
Co 1+ Rec. data	.117E-14	.165E-09	.144E-07	.646E-07	.118E-06	.133E-06	.119E-06	.952E-07	.683E-07		
Fit/Rec	105 %	99 %	97 %	100 %	104 %	102 %	98 %	97 %	101 %		
Co 2+ Rec. data		.266E-12	.112E-08	.164E-07	.545E-07	.757E-07	.718E-07	.590E-07	.428E-07		
Fit/Rec		106 %	100 %	98 %	93 %	96 %	99 %	100 %	106 %		
Co 3+ Rec. data			.305E-10	.204E-08	.115E-07	.216E-07	.266E-07	.251E-07	.204E-07		
Fit/Rec			91 %	93 %	102 %	100 %	97 %	100 %	113 %		
Co 4+ Rec. data			.207E-11	.697E-09	.783E-08	.194E-07	.197E-07	.173E-07	.131E-07		
Fit/Rec			97 %	104 %	102 %	95 %	114 %	107 %	95 %		
Co 5+ Rec. data			.128E-12	.208E-09	.422E-08	.120E-07	.151E-07	.142E-07	.114E-07		
Fit/Rec			106 %	103 %	96 %	98 %	114 %	110 %	94 %		
Co 6+ Rec. data			.655E-14	.476E-10	.159E-08	.501E-08	.699E-08	.682E-08	.551E-08		
Fit/Rec			100 %	106 %	96 %	97 %	105 %	103 %	98 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Co 7+ Rec. data			.119E-15	.959E-11	.640E-09	.246E-08	.431E-08	.476E-08	.415E-08		
Fit/Rec			92 %	97 %	109 %	107 %	95 %	93 %	104 %		
Co 8+ Rec. data			.127E-16	.452E-11	.450E-09	.190E-08	.328E-08	.348E-08	.296E-08		
Fit/Rec			112 %	95 %	96 %	101 %	106 %	107 %	96 %		
Co 9+ Rec. data				.142E-12	.136E-09	.109E-08	.225E-08	.251E-08	.218E-08		
Fit/Rec				98 %	100 %	103 %	102 %	98 %	99 %		
Co 10+Rec. data				.386E-13	.746E-10	.740E-09	.165E-08	.190E-08	.167E-08		
Fit/Rec				98 %	99 %	103 %	102 %	98 %	99 %		
Co 11+Rec. data				.100E-13	.398E-10	.485E-09	.117E-08	.138E-08	.122E-08		
Fit/Rec				98 %	99 %	103 %	103 %	98 %	98 %		
Co 12+Rec. data				.147E-14	.171E-10	.289E-09	.771E-09	.918E-09	.809E-09		
Fit/Rec				102 %	98 %	99 %	100 %	99 %	101 %		
Co 13+Rec. data				.374E-15	.891E-11	.187E-09	.551E-09	.690E-09	.631E-09		
Fit/Rec				100 %	98 %	101 %	102 %	99 %	99 %		
Co 14+Rec. data				.948E-16	.483E-11	.127E-09	.418E-09	.552E-09	.523E-09		
Fit/Rec				98 %	98 %	102 %	104 %	100 %	97 %		
Co 15+Rec. data				.669E-17	.166E-11	.688E-10	.270E-09	.380E-09	.372E-09		
Fit/Rec				98 %	97 %	102 %	105 %	102 %	97 %		
Co 16+Rec. data					.323E-12	.212E-10	.126E-09	.236E-09	.282E-09		
Fit/Rec					99 %	98 %	98 %	100 %	100 %		
Co 17+Rec. data					.114E-15	.183E-11	.624E-10	.179E-09	.245E-09	.235E-09	.190E-09
Fit/Rec					93 %	100 %	108 %	105 %	97 %	96 %	104 %
Co 18+Rec. data						.910E-12	.419E-10	.132E-09	.196E-09	.191E-09	.152E-09
Fit/Rec						90 %	97 %	104 %	99 %	98 %	103 %
Co 19+Rec. data						.455E-12	.275E-10	.100E-09	.146E-09	.146E-09	.122E-09
Fit/Rec						95 %	102 %	102 %	101 %	98 %	101 %
Co 20+Rec. data						.213E-12	.185E-10	.721E-10	.118E-09	.120E-09	.950E-10
Fit/Rec						96 %	98 %	104 %	99 %	96 %	101 %
Co 21+Rec. data						.100E-12	.112E-10	.491E-10	.822E-10	.839E-10	.700E-10
Fit/Rec						100 %	111 %	104 %	96 %	98 %	109 %
Co 22+Rec. data						.455E-13	.724E-11	.334E-10	.539E-10	.572E-10	.490E-10
Fit/Rec						96 %	94 %	98 %	101 %	98 %	101 %
Co 23+Rec. data						.188E-13	.369E-11	.189E-10	.354E-10	.379E-10	.325E-10
Fit/Rec						101 %	94 %	97 %	102 %	105 %	95 %
Co 24+Rec. data						.554E-14	.146E-11	.846E-11	.166E-10	.190E-10	.171E-10
Fit/Rec						93 %	106 %	106 %	98 %	95 %	105 %
Co 25+Rec. data							.100E-15	.112E-12	.140E-11	.302E-11	.369E-11
Fit/Rec							103 %	98 %	103 %	99 %	102 %
Co 26+Rec. data								.415E-13	.638E-12	.147E-11	.170E-11
Fit/Rec								106 %	102 %	98 %	98 %

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion	Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Ni	Rec. data	.157E-10	.586E-08	.592E-07	.118E-06	.138E-06	.123E-06	.947E-07	.692E-07	.467E-07		
	Fit/Rec	110 %	95 %	99 %	104 %	102 %	98 %	96 %	98 %	104 %		
Ni 1+	Rec. data	.677E-16	.475E-10	.617E-08	.296E-07	.615E-07	.776E-07	.748E-07	.620E-07	.456E-07		
	Fit/Rec	135 %	83 %	100 %	117 %	109 %	96 %	91 %	95 %	108 %		
Ni 2+	Rec. data		.908E-13	.568E-09	.911E-08	.290E-07	.412E-07	.422E-07	.362E-07	.273E-07		
	Fit/Rec		100 %	98 %	99 %	102 %	104 %	100 %	97 %	100 %		
Ni 3+	Rec. data		.828E-16	.508E-10	.313E-08	.176E-07	.335E-07	.347E-07	.304E-07	.229E-07		
	Fit/Rec		106 %	101 %	99 %	97 %	92 %	100 %	100 %	105 %		
Ni 4+	Rec. data			.948E-12	.391E-09	.431E-08	.101E-07	.143E-07	.145E-07	.122E-07		
	Fit/Rec			88 %	81 %	93 %	99 %	97 %	100 %	112 %		
Ni 5+	Rec. data			.647E-13	.146E-09	.312E-08	.969E-08	.123E-07	.108E-07	.842E-08		
	Fit/Rec			95 %	101 %	104 %	98 %	109 %	109 %	95 %		
Ni 6+	Rec. data			.356E-14	.425E-10	.184E-08	.679E-08	.106E-07	.986E-08	.812E-08		
	Fit/Rec			100 %	105 %	97 %	97 %	105 %	110 %	96 %		
Ni 7+	Rec. data			.171E-15	.103E-10	.744E-09	.306E-08	.486E-08	.496E-08	.412E-08		
	Fit/Rec			99 %	110 %	97 %	94 %	103 %	104 %	98 %		
Ni 8+	Rec. data			.219E-17	.196E-11	.309E-09	.154E-08	.299E-08	.349E-08	.315E-08		
	Fit/Rec			94 %	96 %	107 %	107 %	96 %	93 %	104 %		
Ni 9+	Rec. data			.178E-18	.886E-12	.222E-09	.122E-08	.237E-08	.265E-08	.232E-08		
	Fit/Rec			119 %	98 %	96 %	96 %	99 %	107 %	102 %		
Ni 10+	Rec. data				.229E-13	.650E-10	.727E-09	.172E-08	.201E-08	.179E-08		
	Fit/Rec				98 %	99 %	103 %	102 %	99 %	98 %		
Ni 11+	Rec. data				.611E-14	.359E-10	.498E-09	.127E-08	.153E-08	.138E-08		
	Fit/Rec				99 %	99 %	103 %	103 %	99 %	98 %		
Ni 12+	Rec. data				.156E-14	.193E-10	.331E-09	.911E-09	.112E-08	.102E-08		
	Fit/Rec				98 %	99 %	103 %	103 %	99 %	98 %		
Ni 13+	Rec. data				.209E-15	.808E-11	.197E-09	.606E-09	.758E-09	.685E-09		
	Fit/Rec				102 %	98 %	99 %	100 %	99 %	101 %		
Ni 14+	Rec. data				.505E-16	.419E-11	.127E-09	.434E-09	.572E-09	.536E-09		
	Fit/Rec				100 %	98 %	101 %	102 %	99 %	99 %		
Ni 15+	Rec. data				.121E-16	.225E-11	.865E-10	.330E-09	.459E-09	.446E-09		
	Fit/Rec				99 %	98 %	102 %	104 %	101 %	97 %		
Ni 16+	Rec. data				.750E-18	.748E-12	.468E-10	.214E-09	.318E-09	.319E-09		
	Fit/Rec				99 %	97 %	101 %	105 %	102 %	97 %		
Ni 17+	Rec. data					.187E-12	.116E-10	.972E-10	.195E-09	.241E-09		
	Fit/Rec					76 %	114 %	93 %	98 %	102 %		
Ni 18+	Rec. data					.224E-16	.949E-12	.459E-10	.146E-09	.210E-09	.206E-09	.168E-09
	Fit/Rec					93 %	100 %	108 %	105 %	97 %	95 %	104 %
Ni 19+	Rec. data					.561E-17	.503E-12	.321E-10	.109E-09	.155E-09		
	Fit/Rec					98 %	98 %	103 %	104 %	98 %		

TABLE II. Comparison of Fitted and Recommended Ionization Rates

See page 5 for Explanation of Tables

Ion Te eV	1	3	10	30	100	300	1 000	3 000	10 000	30 000	100 000
Ni 20+Rec. data					.143E-17	.267E-12	.221E-10	.801E-10	.115E-09	.111E-09	.885E-10
Fit/Rec					98 %	99 %	103 %	103 %	99 %	97 %	104 %
Ni 21+Rec. data					.239E-18	.113E-12	.132E-10	.538E-10	.825E-10	.818E-10	.665E-10
Fit/Rec					97 %	98 %	103 %	103 %	99 %	97 %	103 %
Ni 22+Rec. data					.426E-19	.463E-13	.763E-11	.348E-10	.546E-10	.539E-10	.434E-10
Fit/Rec					104 %	99 %	99 %	101 %	100 %	99 %	104 %
Ni 23+Rec. data					.513E-20	.135E-13	.320E-11	.156E-10	.227E-10	.201E-10	.142E-10
Fit/Rec					97 %	101 %	100 %	100 %	101 %	99 %	100 %
Ni 24+Rec. data					.685E-21	.484E-14	.154E-11	.867E-11	.152E-10	.158E-10	.131E-10
Fit/Rec					99 %	99 %	101 %	102 %	100 %	98 %	103 %
Ni 25+Rec. data					.153E-21	.201E-14	.712E-12	.413E-11	.780E-11	.865E-11	.762E-11
Fit/Rec					116 %	97 %	94 %	98 %	105 %	107 %	91 %
Ni 26+Rec. data								.727E-13	.118E-11	.264E-11	.325E-11
Fit/Rec								101 %	100 %	103 %	99 %
Ni 27+Rec. data								.302E-13	.524E-12	.122E-11	.152E-11
Fit/Rec								100 %	103 %	102 %	98 %