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Tables of Critically Evaluated Oscillator Strengths for the Lithium Isoelectronic Sequence*

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Oscillator strengths for the lithium isoelectronic sequence have been critically evaluated and compiled by means of a new generalized analysis which makes use of several types of systematic trends and fundamental spectroscopic constraints. Relativistic effects have also been considered. The data are presented in separate tables for each ion of the sequence from Li I through Ni XXVI, and are arranged within each table according to spectral series. Separate tables are presented for the $2s$–$2p$ and $2s$–$3p$ transitions, with both relativistic and nonrelativistic f-values listed for all ions of the sequence through Ni XXVI, as well as for a few selected ions of higher nuclear charge. The general tables contain transitions of the type ms–np, mp–ns, and mp–nd, with $2 \leq m \leq 4$ (m is the lower principal quantum number) and $3 \leq n \leq 7$. Since most recommended data were determined from a nonrelativistic analysis, hydrogenic relativistic considerations were applied to estimate when the data would be significantly altered by the inclusion of relativistic effects, and such f-values were excluded from the tabulation.

Key words: f-values; isoelectronic sequence; lithium sequence; oscillator strengths; relativistic effects; spectral series; systematic trends.

Contents

1. Introduction

This critical evaluation and compilation was undertaken in view of the large volume of oscillator strength (f-value) data for the lithium atom and its isoelectronic sequence and the need for f-values of highly ionized, relatively simple spectra for thermonuclear fusion research. These factors indicated the desirability and feasibility of arriving at a single internally consistent and critically evaluated set of "best" data. The internal consistency is achieved by applying a new type of general analysis, in which the data are subjected simultaneously to several fundamental spectroscopic constraints, and are adjusted until the best overall fit is obtained. Our primary source material was obtained from the bibliographies on atomic transition probabilities [1][1] and from the more recent literature collected in the NBS data center.

Tables of f-values are presented for all ions of the Li sequence from Li I through Ni XXVI. Relativistic effects

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[1] Figures in brackets indicate the literature references.

have to be considered for the higher ions, and, for a few prominent lines, recent relativistic calculations of f-values could be utilized. For all other lines, the data were excluded from this compilation when it was estimated that relativistic corrections would have modified our results significantly.

2. Summary of the Method

The first step in the analysis consisted of studying each literature source to obtain a general evaluation of the available data and their accuracy. In this evaluation we were guided by critical factors discussed by one of us elsewhere [2]. The factors essentially involve (a) the author's own accuracy estimate and his discussion of possible systematic errors affecting the results; (b) the evaluator's assessment of the general accuracy obtained by a given experimental or theoretical method, as well as special circumstances affecting the use of that method for a particular ion, isoelectronic sequence, or class of transitions; and (c) the agreement of the author's data with results obtained by other reliable methods.

The evaluated data have been interrelated and built up into a consistent set by applying a new general analysis which has been described by us in detail [3] and will therefore not be discussed here again. Basically, this technique makes use of four analytical tools: (a) the dependence of the f-value for a given transition on the nuclear charge Z; (b) regularities of f-values for a particular ion within a spectral series; (c) the condition of continuity of the oscillator strength across the ionization limit; and (d) fulfillment of the Wigner-Kirkwood oscillator strength sum rule.

3. Principal Data Sources

For some transitions, systematic trends of f-values along the isoelectronic sequence have already been investigated by Smith and Wiese [4], and in updating these graphs slight modifications have been made in some cases. However, relativistic effects may drastically alter the general trend of the curve for ions of very high nuclear charge, and this topic will be discussed in more detail later in this paper.

The most advanced theoretical techniques used in calculating oscillator strengths incorporate a multiconfigurational treatment. For the lithium sequence, calculations of this type have been carried out by Weiss [5] and Doschek et al. [6].

A second theoretical approach encompasses the various self-consistent field calculations. These have been used for the determination of oscillator strengths for members of the lithium sequence by Weiss [5], Chapman [7], Moitra and Mukherjee [8], Cohen and Kelly [9], Lunell [10], and Kelly [11].

Pseudopotential calculations of fairly high sophistication have been undertaken by Caves and Dalgarno [12], Leibowitz [13], McGinn [14], Zapol' et al. [15], Beigman et al. [16], Veselov and Shtoff [17], and Hameed et al. [18]. In addition, the scaled Thomas-Fermi calculations of Warner [19], the Coulomb approximation calculations of Kantseryavichyus and Zhilionite [20], and the modified Coulomb approximation of Druetta et al. [21] can be included in the general category of semiempirical approaches.

Finally, a theoretical technique which has been used extensively in the calculation of oscillator strengths for the lithium sequence is the nuclear charge expansion method. Calculations of this type have been undertaken by Laughlin et al. [22] and by Ali and Schaad [23], and relativistic corrections have been incorporated by Safronova [24]. Probably the most accurate Z-expansion calculations for the lithium sequence have been reported by Onello [25] and Onello et al. [26], who have based their expansion coefficients for the entire sequence on a multiconfigurational treatment for lithium-like oxygen.

Most of the experimental f-value data have been derived from atomic lifetimes determined by the beam-foil method. Lifetime data for the upper states of many transitions included in this investigation are available in refs. [27] through [59]. However, it is often not possible or meaningful to convert the experimental lifetimes to oscillator strengths. The presence of cascades or blends will affect the accuracy of the observed lifetimes. Besides this, it is necessary to know the branching ratios for all downward transitions from the upper state in order to make the conversion to oscillator strengths for individual transitions. A further problem arises when the f-values for one or more of the downward transitions are so small that, even though the branching ratios may have been determined independently from another source, the precision of the observed lifetime is not sufficiently great to provide f-values for those transitions.

Atomic lifetimes have also been determined by Karstensen and Schramm [60] with the delayed coincidence technique and by Brog et al. [61] with the Hanle effect (zero-field level crossing) technique.

The anomalous dispersion (hook) measurements by Filippov [62] have provided relative f-values for the principal series of neutral lithium. The absolute scale used here is taken from ref. [63], in which Filippov's results were normalized to the f-value calculated by Weiss [5] for the resonance transition.

The photoionization cross section data of Hudson and Carter [64] have provided the differential oscillator strength distribution for the principal series of neutral lithium, and the theoretical results of McDowell and Chang [65], determined by incorporating polarization and correlation effects into a Hartree-Fock treatment, have been used for the continuum contribution to the principal series of Be II through Ne VIII. For the $2p$–s

and $2p-d$ series, the pseudopotential calculations of Leibowitz [13] for C IV constituted the only usable source of data for the continuum.

To obtain the contribution from the high energy region of the continuum beyond the range of energies for which data were available in the literature, it was necessary to carry out an extrapolation. This was done according to a formula given by Fano and Cooper [66] which states that the differential oscillator strength distribution $df/d\epsilon$ is proportional to $E^{-7/2}$ (where E is the photon energy of the bound-free transition and ϵ is the kinetic energy of the ejected electron).

4. Relativistic Effects

As noted earlier, for large values of Z it becomes necessary to include relativistic effects in a theoretical treatment of oscillator strengths. For some transitions, the inclusion of relativistic corrections causes drastic changes in the dependence of the f-value on the nuclear charge. In some cases the lines of a multiplet are separated in wavelength to such an extent that the concept of a "multiplet" f-value becomes meaningless at high Z.

Studies on relativistic corrections to f-values and wavelengths for the lithium sequence have been undertaken by Kim and Desclaux [67] and by Weiss [68] for the $2s-2p$ and $2s-3p$ transitions. They show that the major changes are due to the difference between the relativistic and nonrelativistic transition energies. This is particularly true for transitions in which the principal quantum numbers of the upper and lower states are the same ($\Delta n=0$ transitions), since for the hydrogenic case the nonrelativistic energies of the upper and lower states are equal and the f-value vanishes. Relativistically, however, the energies are no longer degenerate, and the hydrogenic f-values increase for high-Z ions. Since it is the hydrogenic f-values that provide the constant term in the nonrelativistic $1/Z$-expansion for the f-values (see ref. [3]), one must generally expect, for high Z, significant changes in the systematic trends from the nonrelativistic case. An estimate of the magnitude of the changes may be obtained from the work of Younger and Weiss [69], who calculated relativistic hydrogenic f-values for numerous transitions.

5. Discussion of Tabulated Results

5.1. Scope of Tables

The critically evaluated "best" data are all presented in tabular form. The data for the prominent $2s-2p$ and $2s-3p$ transitions are given separately in tables 1 and 2, respectively, mainly because relativistic f-value data are available in these two special cases. To show the magnitude of the relativistic effects, both nonrelativistic and relativistic results for the f-values are provided for comparison. The relativistic results incorporate the line and multiplet data of Kim and Desclaux [67]. Their wavelengths and f-values are given for a few high-Z ions beyond Ni XXVI to indicate the drastic changes that occur, particularly for the $2s-2p$ transition.

The *multiplet* f-values for all other transitions treated in this study are presented in the main tables according to atomic species, i.e., element and stage of ionization, from Li I ($Z=3$) through Ni XXVI ($Z=28$). For all these transitions, however, only nonrelativistic data are available. Therefore, the results are only listed up to a certain value of Z, which varies with the transition involved, since the nonrelativistic multiplet f-values should become meaningless beyond this point. In order to determine the cutoff, some quantitative criterion had to be established. The earlier-mentioned relativistic calculations of hydrogenic f-values by Younger and Weiss [69] based on Dirac hydrogenic wave functions provide a means of evaluating the magnitude of relativistic corrections, especially since the lithium sequence is similar in structure to the hydrogenic case.

The method of arriving at the cutoff point for any given multiplet was specifically as follows: f-values for individual lines of each multiplet were calculated using the wave functions of Younger and Weiss [69], for all values of Z from 1 through 40. Within a multiplet, ratios of the weighted f-values $g_i f$ of the possible combinations of individual lines (this amounted to one ratio for $s-p$ and $p-s$ transitions, and three ratios for $p-d$ transitions) were calculated, and these were in turn compared to the theoretical line strength ratios that result in the case of pure LS-coupling. ($g_i=2J_i+1$ is the statistical weight of the lower state, where J_i is the total angular momentum quantum number.) Whenever the deviation of the f-value ratios from the LS-coupling line strength ratios exceeded 5 percent for a particular value of Z in the hydrogenic case, the data were not presented in these tables for the corresponding member of the lithium sequence with the nuclear charge of $(Z+2)$, as well as for all higher ions. (This "shifting" of the Z coordinate was done to account for the fact that lithium has two electrons in a closed shell, aside from the valence electron, so that the effective core charge Z_c^{eff} for a lithium-like ion is approximately two less than the nuclear charge.)

The rationale underlying the choice of the criterion used here was to determine not only the deviations from LS-coupling that would result from the relativistic treatment, but rather the combination of the relativistic effects of spin-orbit coupling and changes in the energy level structure *acting simultaneously*.

The results of applying this test to the various transitions treated here are given in table 3. The column heading "Z_{max} (actually used in tables)" indicates the maximum value of Z for which we have tabulated results for any given transition. Since we have cut off our tabulation at Ni XXVI ($Z=28$), the upper end of the iron group, we have also listed the value of Z_{max} which is

TABLE 1. Relativistic and nonrelativistic f-values for the $2s$–$2p$ transition of the Li sequence

Ion	Z	λ(Å)		f			
				Multiplet		Lines relativistic	
		$s_{1/2}$–$p_{3/2}$	$s_{1/2}$–$p_{1/2}$	non-relativistic	relativistic	$s_{1/2}$–$p_{3/2}$	$s_{1/2}$–$p_{1/2}$
Li I	3	6707.761	6707.912	0.753		0.502	0.251
Be II	4	3130.420	3131.066	0.505			
B III	5	2065.776	2067.233	0.366			
C IV	6	1548.202	1550.774	0.286			
N V	7	1238.821	1242.804	0.235		ratio of	
O VI	8	1031.945	1037.627	0.199		2 : 1 is	
F VII	9	883.097	890.762	0.176		maintained	
Ne VIII	10	770.409	780.324	0.157			
Na IX	11	681.72	694.17	0.138			
Mg X	12	609.79	624.94	0.125			
Al XI	13	550.05	568.12	0.115			
Si XII	14	499.43	520.72	0.106			
P XIII	15	455.78	480.42	0.098	0.099	0.067	0.031
S XIV	16	417.67	445.71	0.092	0.094	0.064	0.030
Cl XV	17	383.96	415.50	0.086	0.089	0.060	0.028
Ar XVI	18	353.88	389.11	0.081	0.085	0.058	0.026
K XVII	19	326.71	[363.9]	0.077	0.081	0.056	0.025
Ca XVIII	20	302.19	344.76	0.073	0.078	0.054	0.024
Sc XIX	21	[278.7]	[324.0]	0.069	0.076	0.053	0.023
Ti XX	22	[258.2]	[306.9]	0.065	0.073	0.051	0.021
V XXI	23	[239.5]	[291.5]	0.062	0.071	0.050	0.020
Cr XXII	24	223.00	279.69	0.059	0.069	0.049	0.020
Mn XXIII	25	206.90	266.88	0.056	0.067	0.048	0.019
Fe XXIV	26	192.04	255.10	0.053	0.066	0.048	0.018
Co XXV	27	[177.8]	[241.5]	0.051	0.065	0.048	0.018
Ni XXVI	28	[165.43]	234.20	0.050	0.064	0.048	0.017
.	.						
.	.						
.	.						
Kr XXXIV	36	[90.01]	[169.5]	0.040	0.063	0.050	0.013
.	.						
.	.						
.	.						
Mo XL	42	[57.78]	[139.0]	0.033	0.068	0.056	0.011
.	.						
.	.						
.	.						
Xe LII	54	[24.88]	[97.59]	0.027	0.085	0.076	0.0090
.	.						
.	.						
.	.						
W LXXII	74	[7.23]	[57.67]	0.020	0.136	0.129	0.0069
.	.						
.	.						
.	.						
Au LXXVII	79	[5.46]	[50.93]	0.018	0.153	0.147	0.0066

indicated by the criterion described above, since this is greater than $Z=28$ for some transitions. We carried out the hydrogenic ratio comparisons through $Z=40$ (corresponding to $Z=42$ for the lithium sequence). Thus the value of "Z_{max} (indicated by analysis)" for any transition for which the deviation of the hydrogenic f-value ratios from the LS-coupling line strength ratios was within 5 percent through $Z=40$ is given in table 3 as >42, but the exact value of the cutoff was not determined.

An important exception to table 3 exists for the $\Delta n=0$ transitions ($3s$–$3p$, $3p$–$3d$, $4s$–$4p$, $4p$–$4d$). Since the situation for the lithium sequence does not correspond to the hydrogenic case of in-shell degeneracy, the criterion applied to the other transitions is not a meaningful test for these special transitions. We therefore

TABLE 2. Relativistic and nonrelativistic f-values for the $2s$–$3p$ transition of the Li sequence

Ion	Z	λ(Å) $s_{1/2}$–$p_{3/2}$	λ(Å) $s_{1/2}$–$p_{1/2}$	f Multiplet non-relativistic	f Multiplet relativistic	f Lines relativistic $s_{1/2}$–$p_{3/2}$	f Lines relativistic $s_{1/2}$–$p_{1/2}$
Li I	3	3232.634		0.0055		0.0036	0.0018
Be II	4	[1036.299]	[1036.319]	0.0804			
B III	5	518.254		0.151			
C IV	6	312.418	312.455	0.197			
N V	7	[209.274]	[209.308]	0.233		ratio of	
O VI	8	150.127		0.257		2 : 1 is	
F VII	9	112.935	112.976	0.277		maintained	
Ne VIII	10	88.092		0.293			
Na IX	11	70.615	70.653	0.304			
Mg X	12	57.876	57.920	0.316			
Al XI	13	48.298	48.338	0.324			
Si XII	14	40.911	40.951	0.333			
P XIII	15	35.095	35.136	0.340			
S XIV	16	30.423	30.463	0.345			
Cl XV	17	26.66	26.67	0.350			
Ar XVI	18	[23.51]	[23.55]	0.356			
K XVII	19	[20.89]	[20.94]	0.360	0.359	0.240	0.122
Ca XVIII	20	18.691	18.732	0.363	0.363	0.241	0.123
Sc XIX	21	16.819	16.861	0.367	0.365	0.242	0.124
Ti XX	22	15.217	15.252	0.370	0.368	0.243	0.125
V XXI	23	13.823	13.865	0.372	0.370	0.244	0.126
Cr XXII	24	12.620	12.662	0.375	0.373	0.245	0.127
Mn XXIII	25	[11.55]	[11.60]	0.377	0.374	0.246	0.128
Fe XXIV	26	10.61	10.64	0.379	0.374	0.246	0.128
Co XXV	27	[9.80]	[9.84]	0.381	0.375	0.247	0.129
Ni XXVI	28	[9.06]	[9.10]	0.383	0.375	0.246	0.129
.	.						
.	.						
.	.						
Kr XXXIV	36	[5.28]	[5.33]	0.396	0.377	0.245	0.132
.	.						
.	.						
.	.						
Mo XL	42	[3.79]	[3.83]	0.401	0.374	0.240	0.134
.	.						
.	.						
.	.						
Xe LII	54	[2.19]	[2.23]	0.409	0.360	0.224	0.135
.	.						
.	.						
.	.						
W LXXII	74	[1.06]	[1.10]	0.416	0.319	0.183	0.136
.	.						
.	.						
.	.						
Au LXXVII	79	[0.907]	[0.949]	0.418	0.305	0.170	0.136

utilized the fact, documented in table 1, that the deviation of the relativistic f-values from the nonrelativistic results for the resonance transition $2s$–$2p$ exceeds 5 percent beyond $Z=18$ (Ar XVI). We adopted this same cutoff value of Z for the four transitions listed above, followed by an asterisk in table 3 to indicate that this decision was not arrived at on the same basis as the other transitions.

TABLE 3. List of transitions included in this compilation and corresponding maximum values of the nuclear charge (Z_{max}) for which the f-values are tabulated

Transition	Z_{max}		Transition	Z_{max}		Transition	Z_{max}	
	Actually used in tables	Indicated by analysis[c]		Actually used in tables	Indicated by analysis		Actually used in tables	Indicated by analysis
$2s-2p$ [a]								
$2s-3p$ [b]			$3s-3p$	18*				
$2s-4p$	28	>42	$3s-4p$	28	29	$4s-4p$	18*	
$2s-5p$	28	>42	$3s-5p$	28	36	$4s-5p$	28	28
$2s-6p$	28	>42	$3s-6p$	28	39	$4s-6p$	28	33
$2s-7p$	28	>42	$3s-7p$	28	>42	$4s-7p$	28	36
$2p-3s$	20	20						
$2p-4s$	22	22	$3p-4s$	20	20			
$2p-5s$	23	23	$3p-5s$	22	22	$4p-5s$	21	21
$2p-6s$	23	23	$3p-6s$	23	23	$4p-6s$	23	23
$2p-7s$	23	23	$3p-7s$	24	24	$4p-7s$	24	24
$2p-3d$	28	>42	$3p-3d$	18*				
$2p-4d$	28	>42	$3p-4d$	28	39	$4p-4d$	18*	
$2p-5d$	28	>42	$3p-5d$	28	>42	$4p-5d$	28	31
$2p-6d$	28	39	$3p-6d$	28	>42	$4p-6d$	28	41
$2p-7d$	28	39	$3p-7d$	28	>42	$4p-7d$	28	>42

[a] See table 1.
[b] See table 2.
[c] See section 5.1.

5.2. General Arrangement of the Tables

For each ion of the sequence, from neutral lithium through Ni XXVI, the main tables include the f-value data for all transitions for which we estimated, according to the criteria discussed above, that a nonrelativistic analysis is adequate. Within each table, the transitions are grouped according to spectral series. Only the multiplet oscillator strengths, f_m, are given explicitly; the line oscillator strengths may be found, according to LS-coupling rules, from the following ratios:

$$s-p \text{ multiplets} \begin{cases} f(1/2-3/2) = 2/3\, f_m \\ f(1/2-1/2) = 1/3\, f_m \end{cases}$$

$$p-s \text{ multiplets} \begin{cases} f(3/2-1/2) = f_m \\ f(1/2-1/2) = f_m \end{cases}$$

$$p-d \text{ multiplets} \begin{cases} f(3/2-5/2) = 9/10\, f_m \\ f(1/2-3/2) = f_m \\ f(3/2-3/2) = 1/10\, f_m \end{cases}$$

Wavelength information taken from the literature can be found in the columns at the center. Whenever the individual line data were available and the J-values known, they are indicated as such. If the lines of a multiplet were completely unresolved or no J-values were listed in the source material, the multiplet wavelength is listed. Wavelengths which have been calculated either from an experimentally derived term scheme or by an accurate theoretical method are given in square brackets. (This is not necessarily an indication, however, that the lines have never been observed, since in some cases the wavelengths determined from energy level differences were more precise than the available observed wavelengths.) The only wavelengths taken from theoretical calculations were those of Safronova [24] and—for the lines of the $2s-2p$ and $2s-3p$ transitions for the high-Z ions ($Z > 28$) included in tables 1 and 2—those of Kim and Desclaux [67]. Whenever a predicted wavelength coincided exactly with experimentally determined wavelengths of other lines from the same multiplet (to the degree of precision that would have been appropriate for the calculated wavelength), the predicted wavelength was not tabulated.

A complete listing of the sources of wavelengths used in the tables is listed by individual ion in table 4. This includes the references for the lines of the $2s-2p$ and $2s-3p$ transitions for $Z \leq 28$.

The ionization potentials for all ions from Li I through Ca XVIII were taken from Moore [70]; for Sc XIX through Mn XXIII—from Goldsmith et al. [71]; for Fe XXIV—from Reader and Sugar [72]; for Co XXV—from Lotz [73]; and for Ni XXVI—from Kim and Desclaux [67].

TABLE 4. Key to sources of wavelength data for Li I through Ni XXVI. Complete citations are given below.

Ion	References	Ion	References
Li I	1, 2, 3	S XIV	23, 30, 31, 32, 39
Be II	4, 5, 6, 7	Cl XV	22, 23
B III	8, 9	Ar XVI	22, 33, 39
C IV	10	K XVII	22, 33, 34
N V	11	Ca XVIII	22, 33, 34, 39
O VI	7, 12, 13, 14, 15	Sc XIX	22, 34
F VII	7, 15, 16, 17, 18	Ti XX	22, 34, 35
Ne VIII	15, 19, 20, 21, 22, 40	V XXI	22, 34, 35
Na IX	7, 23, 24	Cr XXII	22, 34, 35, 39
Mg X	7, 17, 23, 24, 25, 39, 40	Mn XXIII	22, 34, 39
Al XI	7, 17, 23, 25, 26, 39	Fe XXIV	22, 23, 33, 36, 37, 38, 39
Si XII	7, 17, 23, 25, 27, 28, 39, 40	Co XXV	22
P XIII	23, 29, 30, 40	Ni XXVI	22, 39

[1] Johansson, I., Ark. Fys. **15,** 169 (1959).
[2] Meissner, K. W., Mundie, L. G., and Stelson, P. H., Phys. Rev. **74,** 932 (1948).
[3] Lidén, K., and Starfelt, N., as quoted in [1].
[4] Johansson, L., Ark. Fys. **20,** 489 (1961).
[5] Holmström, J.-E., and Johansson, L., Ark. Fys. **40,** 133 (1969).
[6] Esteva, J. M., Mehlman-Balloffet, G., and Romand, J., J. Quant. Spectrosc. Radiat. Transfer **12,** 1291 (1972).
[7] Moore, C. E., *Atomic Energy Levels (As Derived From the Analyses of Optical Spectra),* Vol. I, Nat. Bur. Stand. (U.S.), Circ. 467 (June 1949).
[8] Ölme, A., Ark. Fys. **40,** 35 (1969).
[9] Berry, H. G., and Subtil, J. L., Phys. Scr. **9,** 217 (1974).
[10] Moore, C. E., *Selected Tables of Atomic Spectra,* Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 3, Sec. 3, 71 pages (Nov. 1970).
[11] Moore, C. E., *Selected Tables of Atomic Spectra,* Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 3, Sec. 4, 46 pages (Aug. 1971).
[12] Edlén, B., Nova Acta Regiae Soc. Sci. Ups. **9,** No. 6, 44 (1934).
[13] Roth, N. V., and Elton, R. C., Naval Research Laboratory Report 6638 (Feb. 16, 1968).
[14] Peacock, N. J., Proc. Phys. Soc., London **84,** 803 (1964).
[15] Bockasten, K., Hallin, R., and Hughes, T. P., Proc. Phys. Soc., London **81,** 522 (1963).
[16] Edlén, B., Z. Phys. **89,** 179 (1934).
[17] Fawcett, B. C., J. Phys. B **4,** 1115 (1971).
[18] Peacock, N. J., Hobby, M. G., and Galanti, M., J. Phys. B **6,** L298 (1973).
[19] Tondello, G., and Paget, T. M., J. Phys. B **3,** 1757 (1970).
[20] Johnston, W. D., III, and Kunze, H.-J., Astrophys. J. **157,** 1469 (1969).
[21] Druetta, M., Datla, R. U., and Kunze, H.-J., Astrophys. J. **174,** 215 (1972).
[22] Safronova, U. I., J. Quant. Spectrosc. Radiat. Transfer **14,** 251 (1974).
[23] Fawcett, B. C., J. Phys. B **3,** 1152 (1970).
[24] Söderqvist, J., Ark. Mat., Astron. Fys. **30A,** No. 11, 1 (1944).
[25] Feldman, U., Cohen, L., and Behring, W., J. Opt. Soc. Am. **60,** 891 (1970).
[26] Ferner, E., Ark. Mat., Astron. Fys. **36A,** No. 1, 1 (1948).
[27] Tondello, G., J. Phys. B **2,** 727 (1969).
[28] Ferner, E., Ark. Mat., Astron. Fys. **28A,** No. 4, 1 (1941).
[29] Goldsmith, S., Oren (Katz), L., and Cohen, L., J. Opt. Soc. Am. **63,** 352 (1973).
[30] Fawcett, B. C., Hardcastle, R. A., and Tondello, G., J. Phys. B **3,** 564 (1970).
[31] Goldsmith, S., Oren, L., and Cohen, L., Astrophys. J. **188,** 197 (1974).
[32] Fawcett, B. C., and Hayes, R. W., Phys. Scr. **8,** 244 (1973).
[33] Purcell, J. D., and Widing, K. G., Astrophys. J. **176,** 239 (1972).
[34] Goldsmith, S., Feldman, U., Oren (Katz), L., and Cohen, L., Astrophys. J. **174,** 209 (1972).
[35] Aglitskii, E. V., Boiko, V. A., Pikuz, S. A., and Faenov, A. Ya., Kvantovaya Elektron. (Moscow) **1,** 1731 (1974).
[36] Neupert, W. M., Swartz, M., and Kastner, S. O., Sol. Phys. **31,** 171 (1973).
[37] Doschek, G. A., Meekins, J. F., and Cowan, R. D., Astrophys. J. **177,** 261 (1972).
[38] Reader, J., and Sugar, J., J. Phys. Chem. Ref. Data **4,** 353 (1975).
[39] Widing, K. G., and Purcell, J. D., to be published (1976).
[40] Bashkin, S., and Stoner, J. O., Jr., *Atomic Energy Levels and Grotrian Diagrams, Volume I. Hydrogen I–Phosphorus XV,* 615 pages, North-Holland Publishing Co., Amsterdam (1975).

5.3. Accuracy of Results

The most comprehensive analysis was undertaken for the $2s-p$ series. For the $2p-s$ and $2p-d$ series the evaluation was not so extensive, mainly because of the lack of f-value data for the continuum (except for C IV). Nevertheless, the internal consistency achieved in the data sets was generally in the 10 percent range.

Thus, for most of the transitions of these three series the recommended "best" data are estimated to be ac-

curate to within 10 percent for the stronger lines and 25 percent for the weaker ones. For the prominent transitions, $2s-2p$ and $2s-3p$, the uncertainty is estimated to be near 5 percent for the nonrelativistic range. For transitions with relatively small f-values, however, the accuracy will decrease considerably and ultimately approach a factor of 2. The contributions of these f-values—e.g., to the f-sums for an entire series (see ref. [3])—are insignificant, so that the consistency tests become insensitive in these cases.

For all additional series, the first and second members of the series are usually the most prominent. Their f-values have been determined by several independent investigators, and normally good agreement is obtained, so that the "best" values should be rather accurate, to within about 25 percent (except in the case of very small values). The higher members of spectral series are estimated to be accurate to within 50 percent, and when they are very weak, to within a factor of 2.

6. References

[1] Miles, B. M., and Wiese, W. L., *Bibliography on Atomic Transition Probabilities (January 1916 through June 1969)*, 111 pp., Nat. Bur. Stand. (U.S.), Spec. Publ. 320 (Feb. 1970); Fuhr, J. R., and Wiese, W. L., *Bibliography on Atomic Transition Probabilities (July 1969 through June 1971)*, 67 pp., Nat. Bur. Stand. (U.S.), Spec. Publ. 320, Suppl. 1 (Sept. 1971); Fuhr, J. R., and Wiese, W. L., *Bibliography on Atomic Transition Probabilities (July 1971 through June 1973)*, 63 pp., Nat. Bur. Stand. (U.S.), Spec. Publ. 320, Suppl. 2 (Nov. 1973).

[2] Wiese, W. L., Smith, M. W., and Miles, B. M., *Atomic Transition Probabilities—Sodium through Calcium (A Critical Data Compilation)*, Vol. II, 306 pp., Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 22 (Oct. 1969).

[3] Martin, G. A., and Wiese, W. L., Phys. Rev. A **13**, 699 (1976).

[4] Smith, M. W., and Wiese, W. L., Astrophys. J. Suppl. Ser. **23**, No. 196, 103 (1971).

[5] Weiss, A. W., Astrophys. J. **138**, 1262 (1963).

[6] Doschek, G. A., Meekins, J. F., and Cowan, R. D., Astrophys. J. **177**, 261 (1972).

[7] Chapman, R. D., Astrophys. J. **156**, 87 (1969).

[8] Moitra, R. K., and Mukherjee, P. K., Int. J. Quantum Chem. **6**, 211 (1972).

[9] Cohen, M., and Kelly, P. S., Can. J. Phys. **45**, 1661 (1967).

[10] Lunell, S., Phys. Rev. A **7**, 1229 (1973).

[11] Kelly, P. S., J. Quant. Spectrosc. Radiat. Transfer **4**, 117 (1964).

[12] Caves, T. C., and Dalgarno, A., J. Quant. Spectrosc. Radiat. Transfer **12**, 1539 (1972).

[13] Leibowitz, E. M., J. Quant. Spectrosc. Radiat. Transfer **12**, 299 (1972).

[14] McGinn, G., J. Chem. Phys. **50**, 1404 (1969).

[15] Zapol', B. P., Kunin, P. E., Lyubimov, A. V., Taksar, I. M., and Fabrikant, I. I., Izv. Akad. Nauk Latv. SSR, Ser. Fiz. Tekh. Nauk No. 6, 14 (1971).

[16] Beigman, I. L., Vainshtein, L. A., and Shevelko, V. P., Opt. Spectrosc. (USSR) **28**, 229 (1970).

[17] Veselov, M. G., and Shtoff, A. V., Opt. Spectrosc. (USSR) **26**, 177 (1969).

[18] Hameed, S., Herzenberg, A., and James, M. G., J. Phys. B **1**, 822 (1968).

[19] Warner, B., Mon. Not. R. Astron. Soc. **141**, 273 (1968).

[20] Kantseryavichyus, A. Yu., and Zhilionite, S. V., Liet. Fiz. Rinkinys **7**, 73 (1967).

[21] Druetta, M., Datla, R. U., and Kunze, H. J., Astrophys. J. **174**, 215 (1972).

[22] Laughlin, C., Lewis, M. N., and Horak, Z. J., J. Phys. B **6**, 1953 (1973).

[23] Ali, M. A., and Schaad, L. J., J. Phys. B **2**, 1304 (1969).

[24] Safranova, U. I., J. Quant. Spectrosc. Radiat. Transfer **14**, 251 (1974).

[25] Onello, J. S., Phys. Rev. A **11**, 743 (1975).

[26] Onello, J. S., Ford, L., and Dalgarno, A., Phys. Rev. A **10**, 9 (1974).

[27] Andersen, T., Jessen, K. A., and Sørensen, G., Phys. Lett. A **29**, 384 (1969).

[28] Andersen, T., Jessen, K. A., and Sørensen, G., Phys. Rev. **188**, 76 (1969).

[29] Barrette, L., and Drouin, R., Phys. Scr. **10**, 213 (1974).

[30] Barrette, L., Knystautas, E. J., and Drouin, R., Nucl. Instrum. Methods **110**, 29 (1973).

[31] Barrette, L., Knystautas, E. J., Neveu, B., and Drouin, R., Phys. Lett. A **32**, 435 (1970).

[32] Barrette, L., Knystautas, E. J., Neveu, B., and Drouin, R., Nucl. Instrum. Methods **90**, 59 (1970).

[33] Berkner, K., Cooper, W. S., III, Kaplan, S. N., and Pyle, R. V., Phys. Lett. **16**, 35 (1965).

[34] Berry, H. G., Bickel, W. S., Bashkin, S., Desesquelles, J., and Schectman, R. M., J. Opt. Soc. Am. **61**, 947 (1971).

[35] Berry, H. G., Bromander, J., Martinson, I., and Buchta, R., Phys. Scr. **3**, 63 (1971).

[36] Bickel, W. S., Berry, H. G., Desesquelles, J., and Bashkin, S., J. Quant. Spectrosc. Radiat. Transfer **9**, 1145 (1969).

[37] Bickel, W. S., Martinson, I., Lundin, L., Buchta, R., Bromander, J., and Bergström, I., J. Opt. Soc. Am. **59**, 830 (1969).

[38] Bromander, J., Phys. Scr. **4**, 61 (1971).

[39] Bromander, J., Nucl. Instrum. Methods **110**, 11 (1973).

[40] Buchet, J. P., and Buchet-Poulizac, M. C., J. Opt. Soc. Am. **64**, 1011 (1974).

[41] Buchet, J. P., Buchet-Poulizac, M. C., Do Cao, G., and Desesquelles, J., Nucl. Instrum. Methods **110**, 19 (1973).

[42] Buchet, J. P., Denis, A., Desesquelles, J., and Dufay, M., C. R. Acad. Sci., Ser. B **265**, 471 (1967).

[43] Buchet, J. P., Poulizac, M. C., and Carre, M., J. Opt. Soc. Am. **62**, 623 (1972).

[44] Buchet-Poulizac, M. C., and Buchet, J. P., Phys. Scr. **8**, 40 (1973).

[45] Desesquelles, J., Ann. Phys. (Paris) **6**, 71 (1971).

[46] Dufay, M., Denis, A., and Desesquelles, J., Nucl. Instrum. Methods **90**, 85 (1970).

[47] Dumont, P. D., Physica (Utrecht) **62**, 104 (1972).

[48] Heroux, L., Phys. Rev. **153**, 156 (1967).

[49] Hontzeas, S., Martinson, I., Erman, P., and Buchta, R., Phys. Scr. **6**, 55 (1972).

[50] Kernahan, J. A., Livingston, A. E., and Pinnington, E. H., Can. J. Phys. **52**, 1895 (1974).

[51] Knystautas, E. J., Barrette, L., Neveu, B., and Drouin, R., J. Quant. Spectrosc. Radiat. Transfer **11**, 75 (1971).

[52] Martinson, I., Berry, H. G., Bickel, W. S., and Oona, H., J. Opt. Soc. Am. **61**, 519 (1971).

[53] Martinson, I., and Bickel, W. S., Phys. Lett. A **31**, 25 (1970).

[54] Martinson, I., Bickel, W. S., and Ölme, A., J. Opt. Soc. Am. **60**, 1213 (1970).

[55] Pinnington, E. H., Irwin, D. J. G., Livingston, A. E., and Kernahan, J. A., Can. J. Phys. **52**, 1961 (1974).

[56] Poulizac, M. C., and Buchet, J. P., Phys. Scr. **4**, 191 (1971).

[57] Poulizac, M. C., Druetta, M., and Ceyzeriat, P., Phys. Lett. A **30**, 87 (1969).

[58] Poulizac, M. C., Druetta, M., and Ceyzeriat, P., J. Quant. Spectrosc. Radiat. Transfer **11**, 1087 (1971).

[59] Roberts, W. A., and Head, C. E., Nucl. Instrum. Methods **110**, 99 (1973).

[60] Karstensen, F., and Schramm, J., J. Opt. Soc. Am. **57**, 654 (1967).
[61] Brog, K. C., Eck, T. G., and Wieder, H., Phys. Rev. **153**, 91 (1967).
[62] Filippov, A. N., Zh. Eksp. Teor. Fiz. **2**, 24 (1932).
[63] Wiese, W. L., Smith, M. W., and Glennon, B. M., *Atomic Transition Probabilities—Hydrogen Through Neon (A Critical Data Compilation)*, Vol. I., 157 pp., Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 4 (May 1966).
[64] Hudson, R. D., and Carter, V. L., J. Opt. Soc. Am. **57**, 651 (1967).
[65] McDowell, M. R. C., and Chang, E. S., Mon. Not. R. Astron. Soc. **142**, 465 (1969).
[66] Fano, U., and Cooper, J. W., Rev. Mod. Phys. **40**, 441 (1968).
[67] Kim, Y. K., and Desclaux, J. P., private communication (1975).
[68] Weiss, A. W., private communication (1975).
[69] Younger, S. M., and Weiss, A. W., J. Res. Nat. Bur. Stand., Sect. A, **79**, 629 (1975).
[70] Moore, C. E., *Ionization Potentials and Ionization Limits Derived from the Analyses of Optical Spectra*, 22 pp., Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 34 (Sept. 1970).
[71] Goldsmith, S., Feldman, U., Oren (Katz), L., and Cohen, L., Astrophys. J. **174**, 209 (1972).
[72] Reader, J., and Sugar, J., J. Phys. Chem. Ref. Data **4**, 353 (1975).
[73] Lotz, W., J. Opt. Soc. Am. **57**, 873 (1967).

Note Added in Proof

After this publication had gone to press, we were informed of the unpublished results of calculations by P. Blanchard, G. A. Victor, and A. Dalgarno (private communication, 1976) for numerous transitions of lithium-like nitrogen and oxygen. They used the model potential method of Caves and Dalgarno [12], so that their results should be quite accurate. By comparison with our previously determined values, we found very good agreement, i.e., within 10 percent for more than three-fourths of the transitions in common, and better than 20 percent for the remaining ones.

7. Tables of Spectra

Li I ($Z=3$)

I.P. = 5.392 eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^o$	2741.186				0.0045
$2s\ ^2S-5p\ ^2P^o$	2562.305				0.0027
$2s\ ^2S-6p\ ^2P^o$	2475.057				0.0017
$2s\ ^2S-7p\ ^2P^o$	2425.414				0.0011
$2p\ ^2P^o-3s\ ^2S$	8126.231	8126.452			0.115
$2p\ ^2P^o-4s\ ^2S$	4971.661	4971.745			0.014
$2p\ ^2P^o-5s\ ^2S$	4273.066	4273.127			0.0044
$2p\ ^2P^o-6s\ ^2S$	3985.485	3985.538			0.0021
$2p\ ^2P^o-7s\ ^2S$	[3835.6]				0.0012
$2p\ ^2P^o-3d\ ^2D$		6103.538	6103.664	6103.649	0.667
$2p\ ^2P^o-4d\ ^2D$		4602.826	[4602.90]	4602.894	0.125
$2p\ ^2P^o-5d\ ^2D$		4132.562		4132.618	0.0470
$2p\ ^2P^o-6d\ ^2D$		3915.295		3915.346	0.0239
$2p\ ^2P^o-7d\ ^2D$		[3795.0]	[3795.1]		0.0135
$3s\ ^2S-3p\ ^2P^o$	26877.82				1.23
$3s\ ^2S-4p\ ^2P^o$	[10792]				6.0 (−5) [d]
$3s\ ^2S-5p\ ^2P^o$	8465.352				0.0014
$3s\ ^2S-6p\ ^2P^o$	7582.169				0.0014
$3s\ ^2S-7p\ ^2P^o$	7135.040				9.0 (−4)
$3p\ ^2P^o-4s\ ^2S$	24464.66				0.231
$3p\ ^2P^o-5s\ ^2S$	13557.75				0.0269
$3p\ ^2P^o-6s\ ^2S$	11032.09				0.0089
$3p\ ^2P^o-7s\ ^2S$	9955.09				0.0044
$3p\ ^2P^o-3d\ ^2D$			[279700] [c]		0.0743
$3p\ ^2P^o-4d\ ^2D$			17546.05 [c]		0.553
$3p\ ^2P^o-5d\ ^2D$			12237.67 [c]		0.136
$3p\ ^2P^o-6d\ ^2D$			10510.60 [c]		0.0567
$3p\ ^2P^o-7d\ ^2D$			9686.37 [c]		0.0299
$4s\ ^2S-4p\ ^2P^o$	[68580]				1.51
$4s\ ^2S-5p\ ^2P^o$	[24970]				0.0021
$4s\ ^2S-6p\ ^2P^o$	[18585]				3.7 (−4)
$4s\ ^2S-7p\ ^2P^o$	[16110]				5.6 (−4)
$4p\ ^2P^o-5s\ ^2S$	[54639]				0.359
$4p\ ^2P^o-6s\ ^2S$	[28419]				0.0400
$4p\ ^2P^o-7s\ ^2S$	[22225]				0.0136
$4p\ ^2P^o-4d\ ^2D$			[651000] [c]		0.155
$4p\ ^2P^o-5d\ ^2D$			[38083] [c]		0.532
$4p\ ^2P^o-6d\ ^2D$			[25198] [c]		0.147
$4p\ ^2P^o-7d\ ^2D$			[20929] [c]		0.0591

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Be II (Z = 4)

I.P. = 18.21 eV

Transition	Component wavelengths (Å) 1/2–1/2[b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value[a]
$2s\ ^2S–4p\ ^2P^o$	[842.031]	[842.025]			0.0306
$2s\ ^2S–5p\ ^2P^o$	[775.365]	[775.362]			0.0156
$2s\ ^2S–6p\ ^2P^o$	[743.57]				0.0085
$2s\ ^2S–7p\ ^2P^o$	725.7				0.0052
$2p\ ^2P^o–3s\ ^2S$	1776.100	1776.307			0.0665
$2p\ ^2P^o–4s\ ^2S$	[1197.094]	[1197.188]			0.010
$2p\ ^2P^o–5s\ ^2S$	[1048.147]	[1048.220]			0.0038
$2p\ ^2P^o–6s\ ^2S$	[983.984]	[984.048]			0.0019
$2p\ ^2P^o–7s\ ^2S$	[949.69]	[949.75]			0.0011
$2p\ ^2P^o–3d\ ^2D$		1512.258	1512.412		0.652
$2p\ ^2P^o–4d\ ^2D$		[1142.956]	[1143.042]	[1143.039]	0.124
$2p\ ^2P^o–5d\ ^2D$		[1026.890]	[1026.960]	[1026.959]	0.0477
$2p\ ^2P^o–6d\ ^2D$		[973.21]	[973.28]		0.0240
$2p\ ^2P^o–7d\ ^2D$		[943.48]	[943.54]		0.0140
$3s\ ^2S–3p\ ^2P^o$	12098.18	12095.36			0.839
$3s\ ^2S–4p\ ^2P^o$	3274.670	3274.584			0.089
$3s\ ^2S–5p\ ^2P^o$	2453.844				0.0385
$3s\ ^2S–6p\ ^2P^o$	[2161.32]				0.0193
$3s\ ^2S–7p\ ^2P^o$		[2016.9]			0.0118
$3p\ ^2P^o–4s\ ^2S$	5270.284	5270.811			0.137
$3p\ ^2P^o–5s\ ^2S$	3241.625	3241.827			0.0222
$3p\ ^2P^o–6s\ ^2S$	2697.455	2697.585			0.0080
$3p\ ^2P^o–7s\ ^2S$					0.0040
$3p\ ^2P^o–3d\ ^2D$		[64117.6]	[64196.6]	[64173.9]	0.0808
$3p\ ^2P^o–4d\ ^2D$		4360.663	[4361.030]	4360.988	0.533
$3p\ ^2P^o–5d\ ^2D$		3046.524	[3046.700	3046.691	0.134
$3p\ ^2P^o–6d\ ^2D$		2617.985	2618.133		0.0555
$3p\ ^2P^o–7d\ ^2D$		2413.340	2413.455		0.0294
$4s\ ^2S–4p\ ^2P^o$	[30330.3]	[30323.1]			1.17
$4s\ ^2S–5p\ ^2P^o$	7401.43	7401.20			0.073
$4s\ ^2S–6p\ ^2P^o$	5255.86				0.0318
$4s\ ^2S–7p\ ^2P^o$		[4476.9]			0.0170
$4p\ ^2P^o–5s\ ^2S$	11659	11660.25			0.224
$4p\ ^2P^o–6s\ ^2S$	6756.72	6757.13			0.0351
$4p\ ^2P^o–7s\ ^2S$		[5413.9]			0.0123
$4p\ ^2P^o–4d\ ^2D$		[151320]	[151500]	[151450]	0.150
$4p\ ^2P^o–5d\ ^2D$		9476.426	[9477.142]	9477.029	0.509
$4p\ ^2P^o–6d\ ^2D$		6279.427	6279.730		0.141
$4p\ ^2P^o–7d\ ^2D$		5218.115	5218.326		0.0585

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.

B III (Z = 5)

I.P. = 37.93 eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^o$	[411.811]	[411.804]			0.0486
$2s\ ^2S-5p\ ^2P^o$	[376.333]	[376.330]			0.0241
$2s\ ^2S-6p\ ^2P^o$					0.0129
$2s\ ^2S-7p\ ^2P^o$					0.0078
$2p\ ^2P^o-3s\ ^2S$	758.476	758.668			0.0470
$2p\ ^2P^o-4s\ ^2S$	[528.150]	[528.245]			0.0081
$2p\ ^2P^o-5s\ ^2S$	[465.546]	[465.620]			0.0033
$2p\ ^2P^o-6s\ ^2S$					0.0017
$2p\ ^2P^o-7s\ ^2S$					9.6 (−4) [d]
$2p\ ^2P^o-3d\ ^2D$		676.996	677.142		0.651
$2p\ ^2P^o-4d\ ^2D$		[510.768]	[510.857]	[510.854]	0.124
$2p\ ^2P^o-5d\ ^2D$		[458.646]	[458.718]	[458.716]	0.0475
$2p\ ^2P^o-6d\ ^2D$		[434.56]	[434.63]		0.0235
$2p\ ^2P^o-7d\ ^2D$					0.0140
$3s\ ^2S-3p\ ^2P^o$	7841.41	7835.25			0.614
$3s\ ^2S-4p\ ^2P^o$	1596.66				0.182
$3s\ ^2S-5p\ ^2P^o$	[1169.32]	[1169.29]			0.0635
$3s\ ^2S-6p\ ^2P^o$					0.0288
$3s\ ^2S-7p\ ^2P^o$					0.0164
$3p\ ^2P^o-4s\ ^2S$	2234.088	2234.593			0.102
$3p\ ^2P^o-5s\ ^2S$	[1424.33]	[1424.53]			0.0178
$3p\ ^2P^o-6s\ ^2S$					0.0068
$3p\ ^2P^o-7s\ ^2S$					0.0035
$3p\ ^2P^o-3d\ ^2D$		[32068]	[32172]	[32142]	0.0719
$3p\ ^2P^o-4d\ ^2D$		1953.495	1953.827		0.537
$3p\ ^2P^o-5d\ ^2D$		[1361.66]	[1361.84]	[1361.83]	0.134
$3p\ ^2P^o-6d\ ^2D$			[1169.4] [c]		0.0555
$3p\ ^2P^o-7d\ ^2D$					0.0291
$4s\ ^2S-4p\ ^2P^o$	[19483]	[19468]			0.91
$4s\ ^2S-5p\ ^2P^o$	3567.43	3567.17			0.211
$4s\ ^2S-6p\ ^2P^o$	2475.1				0.068
$4s\ ^2S-7p\ ^2P^o$					0.0335
$4p\ ^2P^o-5s\ ^2S$	4917.43	4918.43			0.166
$4p\ ^2P^o-6s\ ^2S$	2958.2				0.0297
$4p\ ^2P^o-7s\ ^2S$					0.0110
$4p\ ^2P^o-4d\ ^2D$		[76189]	[76429]	[76357]	0.133
$4p\ ^2P^o-5d\ ^2D$		4242.98	4243.61		0.510
$4p\ ^2P^o-6d\ ^2D$			2804.78 [c]		0.139
$4p\ ^2P^o-7d\ ^2D$			2330.0 [c]		0.0590

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

C IV (Z = 6)

I.P. = 64.49 eV

Transition	Component wavelengths (Å)				Multiplet *f*-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^o$		244.907			0.0610
$2s\ ^2S-5p\ ^2P^o$		222.791			0.0290
$2s\ ^2S-6p\ ^2P^o$		212.421			0.0156
$2s\ ^2S-7p\ ^2P^o$		206.641			0.0092
$2p\ ^2P^o-3s\ ^2S$	419.525	419.714			0.0376
$2p\ ^2P^o-4s\ ^2S$	296.857	296.951			0.0069
$2p\ ^2P^o-5s\ ^2S$	262.550	262.624			0.0030
$2p\ ^2P^o-6s\ ^2S$	247.357	247.415			0.0015
$2p\ ^2P^o-7s\ ^2S$	239 11	239.196			8.6 (−4) [c]
$2p\ ^2P^o-3d\ ^2D$		384.032	[384.19]	384.178	0.654
$2p\ ^2P^o-4d\ ^2D$		289.143		289.230	0.124
$2p\ ^2P^o-5d\ ^2D$		259.471		259.542	0.0472
$2p\ ^2P^o-6d\ ^2D$		245.775		245.830	0.0234
$2p\ ^2P^o-7d\ ^2D$		238.200		238.250	0.0139
$3s\ ^2S-3p\ ^2P^o$	5811.98	5801.33			0.481
$3s\ ^2S-4p\ ^2P^o$	948.214	948.098			0.240
$3s\ ^2S-5p\ ^2P^o$	[684.90]	[684.87]			0.076
$3s\ ^2S-6p\ ^2P^o$	[595.50]	[595.49]			0.0344
$3s\ ^2S-7p\ ^2P^o$		[552.18]			0.0193
$3p\ ^2P^o-4s\ ^2S$	1230.046	1230.511			0.083
$3p\ ^2P^o-5s\ ^2S$	[797.97]	[798.17]			0.0152
$3p\ ^2P^o-6s\ ^2S$	[672.34]	[672.48]			0.0060
$3p\ ^2P^o-7s\ ^2S$	[614.79]	[614.91]			0.0031
$3p\ ^2P^o-3d\ ^2D$		[20700]	[20836]	[20790]	0.0623
$3p\ ^2P^o-4d\ ^2D$		1107.600	[1108.0]	1107.933	0.545
$3p\ ^2P^o-5d\ ^2D$		[770.19]		770.379	0.134
$3p\ ^2P^o-6d\ ^2D$		[660.85]	[660.99]	[660.98]	0.0555
$3p\ ^2P^o-7d\ ^2D$		[608.75]		[608.87]	0.0290
$4s\ ^2S-4p\ ^2P^o$	[14358]	[14331]			0.68
$4s\ ^2S-5p\ ^2P^o$	2104.24	2103.94			0.278
$4s\ ^2S-6p\ ^2P^o$	[1440.4]	[1440.3]			0.086
$4s\ ^2S-7p\ ^2P^o$		[1210.6]			0.040
$4p\ ^2P^o-5s\ ^2S$	2697.75	2698.67			0.129
$4p\ ^2P^o-6s\ ^2S$	[1653.6]	[1654.0]			0.0253
$4p\ ^2P^o-7s\ ^2S$	[1344.2]	[1344.4]			0.0099
$4p\ ^2P^o-4d\ ^2D$		[49369]	[49691]	[49592]	0.117
$4p\ ^2P^o-5d\ ^2D$		2404.44	[2405.20]	2405.10	0.518
$4p\ ^2P^o-6d\ ^2D$		[1585.8]		[1586.1]	0.137
$4p\ ^2P^o-7d\ ^2D$		[1315.6]		[1315.9]	0.0594

[a] The *f*-values for the multiplet components (lines) can be derived according to *LS*-coupling rules, as explained in section 5.2.

[b] Total angular momentum quantum numbers.

[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

N v (Z=7)

I.P.=97.89 eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^o$	[162.564]	[162.556]			0.0696
$2s\ ^2S-5p\ ^2P^o$	[147.427]	[147.424]			0.0322
$2s\ ^2S-6p\ ^2P^o$	[140.358]	[140.356]			0.0170
$2s\ ^2S-7p\ ^2P^o$		136.429			0.0102
$2p\ ^2P^o-3s\ ^2S$	266.196	266.379			0.0322
$2p\ ^2P^o-4s\ ^2S$	[190.155]	[190.249]			0.0062
$2p\ ^2P^o-5s\ ^2S$	[168.514]	[168.587]			0.0028
$2p\ ^2P^o-6s\ ^2S$	[158.862]	[158.928]			0.0014
$2p\ ^2P^o-7s\ ^2S$	153.624	153.683			7.8 (−4) [c]
$2p\ ^2P^o-3d\ ^2D$		247.561	[247.719]	247.706	0.658
$2p\ ^2P^o-4d\ ^2D$		[186.063]	[186.152]	[186.149]	0.124
$2p\ ^2P^o-5d\ ^2D$		[166.875]	[166.946]		0.0469
$2p\ ^2P^o-6d\ ^2D$		[158.024]	[158.088]		0.0230
$2p\ ^2P^o-7d\ ^2D$		153.136		153.192	0.0136
$3s\ ^2S-3p\ ^2P^o$	4619.98	4603.73			0.393
$3s\ ^2S-4p\ ^2P^o$	628.874	628.744			0.277
$3s\ ^2S-5p\ ^2P^o$	450.105	[450.072]			0.083
$3s\ ^2S-6p\ ^2P^o$	[390.116]	[390.102]			0.0376
$3s\ ^2S-7p\ ^2P^o$	[361.17]	[361.16]			0.0209
$3p\ ^2P^o-4s\ ^2S$	777.712	778.172			0.073
$3p\ ^2P^o-5s\ ^2S$	[509.896]	[510.096]			0.0136
$3p\ ^2P^o-6s\ ^2S$	[430.714]	[430.857]			0.0055
$3p\ ^2P^o-7s\ ^2S$	[394.228]	[394.348]			0.0028
$3p\ ^2P^o-3d\ ^2D$		[15061.34]	[15234]	[15185.80]	0.0544
$3p\ ^2P^o-4d\ ^2D$		713.518	[713.907]	713.860	0.548
$3p\ ^2P^o-5d\ ^2D$		[495.180]	[495.37]	[495.356]	0.134
$3p\ ^2P^o-6d\ ^2D$		424.61	[424.74]	424.75	0.0555
$3p\ ^2P^o-7d\ ^2D$		[391.008]	[391.124]	[391.123]	0.0289
$4s\ ^2S-4p\ ^2P^o$	[11368.92]	[11327.57]			0.54
$4s\ ^2S-5p\ ^2P^o$	1389.822	1389.514			0.319
$4s\ ^2S-6p\ ^2P^o$	[942.361]	[942.278]			0.097
$4s\ ^2S-7p\ ^2P^o$	[789.55]	[789.51]			0.045
$4p\ ^2P^o-5s\ ^2S$	1702.25	1703.218			0.112
$4p\ ^2P^o-6s\ ^2S$	[1054.871]	[1055.229]			0.0224
$4p\ ^2P^o-7s\ ^2S$	[859.961]	[860.203]			0.0089
$4p\ ^2P^o-4d\ ^2D$		[36022]	[36453]	[36331]	0.103
$4p\ ^2P^o-5d\ ^2D$		[1548.647]	[1549.45]	1549.336	0.527
$4p\ ^2P^o-6d\ ^2D$		[1018.973]	[1019.311]	[1019.278]	0.136
$4p\ ^2P^o-7d\ ^2D$		[844.78]	[845.01]	[845.00]	0.0597

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

O VI (Z=8)

I.P. = 138.1 eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^o$		115.832			0.0766
$2s\ ^2S–5p\ ^2P^o$		104.809			0.0343
$2s\ ^2S–6p\ ^2P^o$		99.68			0.0181
$2s\ ^2S–7p\ ^2P^o$		96.78			0.0107
$2p\ ^2P^o–3s\ ^2S$		184.021			0.0287
$2p\ ^2P^o–4s\ ^2S$		132.292			0.0056
$2p\ ^2P^o–5s\ ^2S$		117.40			0.0026
$2p\ ^2P^o–6s\ ^2S$		110.69			0.0013
$2p\ ^2P^o–7s\ ^2S$		[107.0]			7.3 (−4) [c]
$2p\ ^2P^o–3d\ ^2D$		172.936		173.082	0.662
$2p\ ^2P^o–4d\ ^2D$		[129.78]		129.875	0.123
$2p\ ^2P^o–5d\ ^2D$				116.43	0.0466
$2p\ ^2P^o–6d\ ^2D$				110.25	0.0229
$2p\ ^2P^o–7d\ ^2D$				106.79	0.0135
$3s\ ^2S–3p\ ^2P^o$	3834.24	3811.35			0.335
$3s\ ^2S–4p\ ^2P^o$	447.840	447.712			0.305
$3s\ ^2S–5p\ ^2P^o$		[318.43]			0.088
$3s\ ^2S–6p\ ^2P^o$		[275.41]			0.0397
$3s\ ^2S–7p\ ^2P^o$		[254.72]			0.0219
$3p\ ^2P^o–4s\ ^2S$	[536.0]	[536.4]			0.065
$3p\ ^2P^o–5s\ ^2S$	[353.9]	[354.1]			0.0125
$3p\ ^2P^o–6s\ ^2S$	[299.4]	[299.6]			0.0051
$3p\ ^2P^o–7s\ ^2S$	[274.2]	[274.3]			0.0026
$3p\ ^2P^o–3d\ ^2D$		[11740]	[11960]	[11890]	0.0481
$3p\ ^2P^o–4d\ ^2D$		[498.1]	[498.5]	[498.4]	0.555
$3p\ ^2P^o–5d\ ^2D$		[345.1]	[345.3]		0.135
$3p\ ^2P^o–6d\ ^2D$		[295.8]	[295.9]		0.0555
$3p\ ^2P^o–7d\ ^2D$		[272.3]	[272.4]		0.0289
$4s\ ^2S–4p\ ^2P^o$	[9398]	[9342]			0.45
$4s\ ^2S–5p\ ^2P^o$		[986.4]			0.349
$4s\ ^2S–6p\ ^2P^o$		[664.7]			0.105
$4s\ ^2S–7p\ ^2P^o$		[555.8]			0.047
$4p\ ^2P^o–5s\ ^2S$		[1172]			0.099
$4p\ ^2P^o–6s\ ^2S$	[731.3]	[731.6]			0.0205
$4p\ ^2P^o–7s\ ^2S$	[597.2]	[597.4]			0.0082
$4p\ ^2P^o–4d\ ^2D$		[28190]	[28710]	[28530]	0.091
$4p\ ^2P^o–5d\ ^2D$		[1081]	[1082]		0.536
$4p\ ^2P^o–6d\ ^2D$		[710.0]	[710.3]		0.136
$4p\ ^2P^o–7d\ ^2D$		[588.3]	[588.5]		0.0600

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.

[b] Total angular momentum quantum numbers.

[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

F VII (Z=9)

I.P. = 185.2 eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^\circ$		86.728			0.0814
$2s\ ^2S-5p\ ^2P^\circ$		78.36			0.0358
$2s\ ^2S-6p\ ^2P^\circ$		74.47			0.0188
$2s\ ^2S-7p\ ^2P^\circ$		72.30			0.0112
$2p\ ^2P^\circ-3s\ ^2S$	134.703	134.882			0.0263
$2p\ ^2P^\circ-4s\ ^2S$	97.26	97.36			0.0052
$2p\ ^2P^\circ-5s\ ^2S$		86.47			0.0024
$2p\ ^2P^\circ-6s\ ^2S$	[81.51]	[81.57]			0.0012
$2p\ ^2P^\circ-7s\ ^2S$	[78.83]	[78.89]			6.8 (−4) [d]
$2p\ ^2P^\circ-3d\ ^2D$		127.653	[127.81]	127.796	0.666
$2p\ ^2P^\circ-4d\ ^2D$		95.697	[95.79]	95.775	0.123
$2p\ ^2P^\circ-5d\ ^2D$				85.80 [c]	0.0464
$2p\ ^2P^\circ-6d\ ^2D$				81.18 [c]	0.0227
$2p\ ^2P^\circ-7d\ ^2D$				78.66 [c]	0.0134
$3s\ ^2S-3p\ ^2P^\circ$	[3278]	[3247]			0.290
$3s\ ^2S-4p\ ^2P^\circ$		335.27			0.324
$3s\ ^2S-5p\ ^2P^\circ$		[237.2]			0.092
$3s\ ^2S-6p\ ^2P^\circ$		[204.8]			0.041
$3s\ ^2S-7p\ ^2P^\circ$		[189.3]			0.0225
$3p\ ^2P^\circ-4s\ ^2S$		391.76			0.059
$3p\ ^2P^\circ-5s\ ^2S$	[260.0]	[260.1]			0.0119
$3p\ ^2P^\circ-6s\ ^2S$	[220.2]	[220.4]			0.0049
$3p\ ^2P^\circ-7s\ ^2S$	[201.8]	[201.9]			0.0025
$3p\ ^2P^\circ-3d\ ^2D$		[9525]	[9789]	[9702]	0.0432
$3p\ ^2P^\circ-4d\ ^2D$		367.43		367.87	0.56
$3p\ ^2P^\circ-5d\ ^2D$		[254.3]		[254.5]	0.135
$3p\ ^2P^\circ-6d\ ^2D$		[217.9]		[218.0]	0.0555
$3p\ ^2P^\circ-7d\ ^2D$		[200.5]		[200.6]	0.0289
$4s\ ^2S-4p\ ^2P^\circ$	[7959]				0.382
$4s\ ^2S-5p\ ^2P^\circ$	[736.5]				0.370
$4s\ ^2S-6p\ ^2P^\circ$	[493.9]				0.109
$4s\ ^2S-7p\ ^2P^\circ$	[412.5]				0.049
$4p\ ^2P^\circ-5s\ ^2S$	[855.8]				0.092
$4p\ ^2P^\circ-6s\ ^2S$	[536.9]				0.0193
$4p\ ^2P^\circ-7s\ ^2S$	[439.0]				0.0077
$4p\ ^2P^\circ-4d\ ^2D$			[23500]	[23400]	0.083
$4p\ ^2P^\circ-5d\ ^2D$				[797.3] [c]	0.543
$4p\ ^2P^\circ-6d\ ^2D$				[523.1] [c]	0.136
$4p\ ^2P^\circ-7d\ ^2D$				[433.2] [c]	0.0602

[a] The *f*-values for the multiplet components (lines) can be derived according to *LS*-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Ne VIII (Z = 10)

I.P. = 239.1 eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^o$		67.382			0.0850
$2s\ ^2S–5p\ ^2P^o$		60.796			0.0365
$2s\ ^2S–6p\ ^2P^o$		57.747			0.0194
$2s\ ^2S–7p\ ^2P^o$		56.043			0.0114
$2p\ ^2P^o–3s\ ^2S$	102.911	103.085			0.0245
$2p\ ^2P^o–4s\ ^2S$	74.541	74.637			0.0049
$2p\ ^2P^o–5s\ ^2S$	66.259	66.330			0.0023
$2p\ ^2P^o–6s\ ^2S$		62.58			0.0011
$2p\ ^2P^o–7s\ ^2S$		60.49			6.5 (−4) [d]
$2p\ ^2P^o–3d\ ^2D$		98.115		98.260	0.667
$2p\ ^2P^o–4d\ ^2D$		73.470		73.563	0.123
$2p\ ^2P^o–5d\ ^2D$		65.822		65.895	0.0461
$2p\ ^2P^o–6d\ ^2D$		62.297		62.361	0.0226
$2p\ ^2P^o–7d\ ^2D$		60.351		60.413	0.0132
$3s\ ^2S–3p\ ^2P^o$	2860.1	2820.7			0.256
$3s\ ^2S–4p\ ^2P^o$		260.34			0.337
$3s\ ^2S–5p\ ^2P^o$		[182.8]			0.094
$3s\ ^2S–6p\ ^2P^o$		[158.6]			0.042
$3s\ ^2S–7p\ ^2P^o$		[145.5]			0.0230
$3p\ ^2P^o–4s\ ^2S$	298.70	299.13			0.055
$3p\ ^2P^o–5s\ ^2S$	198.98	199.17			0.0114
$3p\ ^2P^o–6s\ ^2S$	[168.7]	[168.8]			0.0047
$3p\ ^2P^o–7s\ ^2S$	[154.3]	[154.4]			0.0024
$3p\ ^2P^o–3d\ ^2D$		[8062]	[8399]	[8297]	0.0382
$3p\ ^2P^o–4d\ ^2D$		282.27		282.61	0.56
$3p\ ^2P^o–5d\ ^2D$		[194.9]	[195.1]		0.135
$3p\ ^2P^o–6d\ ^2D$		[166.9]	[167.1]		0.0555
$3p\ ^2P^o–7d\ ^2D$		[153.9]	[154.0]		0.0289
$4s\ ^2S–4p\ ^2P^o$		[6991]			0.340
$4s\ ^2S–5p\ ^2P^o$		[563.7]			0.387
$4s\ ^2S–6p\ ^2P^o$		[383.4]			0.113
$4s\ ^2S–7p\ ^2P^o$		[314.6]			0.050
$4p\ ^2P^o–5s\ ^2S$		[651.4]			0.086
$4p\ ^2P^o–6s\ ^2S$		[411.0]			0.0184
$4p\ ^2P^o–7s\ ^2S$		[335.0]			0.0074
$4p\ ^2P^o–4d\ ^2D$			[18180] [c]		0.075
$4p\ ^2P^o–5d\ ^2D$			[611.2] [c]		0.549
$4p\ ^2P^o–6d\ ^2D$			[400.8] [c]		0.137
$4p\ ^2P^o–7d\ ^2D$			[333.1] [c]		0.0604

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Na IX (Z=11)

I.P.=299.9 eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^o$		53.860			0.088
$2s\ ^2S-5p\ ^2P^o$		48.553			0.0373
$2s\ ^2S-6p\ ^2P^o$		46.090			0.0197
$2s\ ^2S-7p\ ^2P^o$		44.723			0.0116
$2p\ ^2P^o-3s\ ^2S$	81.175	81.350			0.0231
$2p\ ^2P^o-4s\ ^2S$	58.954	59.042			0.0047
$2p\ ^2P^o-5s\ ^2S$		52.487			0.0022
$2p\ ^2P^o-6s\ ^2S$					0.0011
$2p\ ^2P^o-7s\ ^2S$					6.2 (−4)
$2p\ ^2P^o-3d\ ^2D$		77.764	[77.93]	77.911	0.67
$2p\ ^2P^o-4d\ ^2D$		58.201	[58.29]	58.279	0.12
$2p\ ^2P^o-5d\ ^2D$		52.116	52.186		0.0460
$2p\ ^2P^o-6d\ ^2D$		49.326	49.386		0.0225
$2p\ ^2P^o-7d\ ^2D$		47.776	47.836		0.0131
$3s\ ^2S-3p\ ^2P^o$	[2536]	[2488]			0.230
$3s\ ^2S-4p\ ^2P^o$	[208.0]				0.348
$3s\ ^2S-5p\ ^2P^o$	[146.3]				0.096
$3s\ ^2S-6p\ ^2P^o$	[126.0]				0.043
$3s\ ^2S-7p\ ^2P^o$	[116.3]				0.0233
$3p\ ^2P^o-4s\ ^2S$	[235.3]	[235.7]			0.052
$3p\ ^2P^o-5s\ ^2S$	[157]				0.0110
$3p\ ^2P^o-6s\ ^2S$					0.0046
$3p\ ^2P^o-7s\ ^2S$					0.0023
$3p\ ^2P^o-3d\ ^2D$		[6842]	[7218]	[7103]	0.0354
$3p\ ^2P^o-4d\ ^2D$		[223.8]	[224.2]	[224.0]	0.57
$3p\ ^2P^o-5d\ ^2D$		[154.5]	[154.6]		0.136
$3p\ ^2P^o-6d\ ^2D$		[132.3]	[132.4]		0.0555
$3p\ ^2P^o-7d\ ^2D$		[121.7]	[121.8]		0.0289
$4s\ ^2S-4p\ ^2P^o$	[6122]				0.304
$4s\ ^2S-5p\ ^2P^o$	[456.1]				0.399
$4s\ ^2S-6p\ ^2P^o$	[303.6]				0.116
$4s\ ^2S-7p\ ^2P^o$	[252.8]				0.051
$4p\ ^2P^o-5s\ ^2S$	[512]				0.082
$4p\ ^2P^o-6s\ ^2S$					0.0177
$4p\ ^2P^o-7s\ ^2S$					0.0071
$4p\ ^2P^o-4d\ ^2D$			[18000]	[16900]	0.069
$4p\ ^2P^o-5d\ ^2D$				[485] [c]	0.554
$4p\ ^2P^o-6d\ ^2D$				[318] [c]	0.138
$4p\ ^2P^o-7d\ ^2D$				[263] [c]	0.0606

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Mg x (Z=12)

I.P.=367.5 eV

Transition	Component wavelengths (Å)				Multiplet *f*-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^o$		44.050			0.089
$2s\ ^2S–5p\ ^2P^o$		39.669			0.0379
$2s\ ^2S–6p\ ^2P^o$		37.644			0.0200
$2s\ ^2S–7p\ ^2P^o$		36.518			0.0118
$2p\ ^2P^o–3s\ ^2S$	65.672	65.847			0.0221
$2p\ ^2P^o–4s\ ^2S$	[47.78]	[47.87]			0.0045
$2p\ ^2P^o–5s\ ^2S$	42.523	42.596			0.0021
$2p\ ^2P^o–6s\ ^2S$					0.0010
$2p\ ^2P^o–7s\ ^2S$					6.0 (−4) [d]
$2p\ ^2P^o–3d\ ^2D$		63.152	[63.31]	63.295	0.67
$2p\ ^2P^o–4d\ ^2D$		47.231	[47.32]	47.310	0.12
$2p\ ^2P^o–5d\ ^2D$		42.294	[42.37]	42.363	0.0459
$2p\ ^2P^o–6d\ ^2D$		40.022	[40.09]	40.080	0.0225
$2p\ ^2P^o–7d\ ^2D$		38.769	[38.83]	38.823	0.0130
$3s\ ^2S–3p\ ^2P^o$	[2279]	[2212]			0.210
$3s\ ^2S–4p\ ^2P^o$	[170.2]				0.359
$3s\ ^2S–5p\ ^2P^o$	[119.3]				0.098
$3s\ ^2S–6p\ ^2P^o$	[102.7]				0.044
$3s\ ^2S–7p\ ^2P^o$	[94.7]				0.0237
$3p\ ^2P^o–4s\ ^2S$	[189.9]	[190.4]			0.050
$3p\ ^2P^o–5s\ ^2S$	[127.4]	[127.6]			0.0106
$3p\ ^2P^o–6s\ ^2S$					0.0044
$3p\ ^2P^o–7s\ ^2S$					0.0022
$3p\ ^2P^o–3d\ ^2D$		[5919]	[6418]	[6230]	0.0324
$3p\ ^2P^o–4d\ ^2D$		181.50	181.86		0.57
$3p\ ^2P^o–5d\ ^2D$		[125.3]	[125.6]	[125.5]	0.136
$3p\ ^2P^o–6d\ ^2D$		[107.3]	[107.4]		0.0555
$3p\ ^2P^o–7d\ ^2D$		[98.7]	[98.8]		0.0289
$4s\ ^2S–4p\ ^2P^o$	[5830]				0.282
$4s\ ^2S–5p\ ^2P^o$	[373.3]				0.410
$4s\ ^2S–6p\ ^2P^o$	[247.8]				0.118
$4s\ ^2S–7p\ ^2P^o$	[206.0]				0.052
$4p\ ^2P^o–5s\ ^2S$	[414.2]				0.078
$4p\ ^2P^o–6s\ ^2S$					0.0172
$4p\ ^2P^o–7s\ ^2S$					0.0069
$4p\ ^2P^o–4d\ ^2D$			[14200]	[13200]	0.063
$4p\ ^2P^o–5d\ ^2D$				[393] [c]	0.558
$4p\ ^2P^o–6d\ ^2D$				[257] [c]	0.138
$4p\ ^2P^o–7d\ ^2D$				[213] [c]	0.0608

[a] The *f*-values for the multiplet components (lines) can be derived according to *LS*-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Al XI (Z = 13)

I.P. = 442.1 eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^\circ$		36.675			0.092
$2s\ ^2S-5p\ ^2P^\circ$		33.007			0.0384
$2s\ ^2S-6p\ ^2P^\circ$		31.313			0.0202
$2s\ ^2S-7p\ ^2P^\circ$		30.376			0.0119
$2p\ ^2P^\circ-3s\ ^2S$	54.217	54.388			0.0213
$2p\ ^2P^\circ-4s\ ^2S$	39.530	39.623			0.0044
$2p\ ^2P^\circ-5s\ ^2S$	35.163	35.239			0.0021
$2p\ ^2P^\circ-6s\ ^2S$					0.0010
$2p\ ^2P^\circ-7s\ ^2S$					5.8 (−4) [d]
$2p\ ^2P^\circ-3d\ ^2D$		52.299	[52.46]	52.446	0.67
$2p\ ^2P^\circ-4d\ ^2D$		39.091		39.180	0.12
$2p\ ^2P^\circ-5d\ ^2D$		34.994		35.065	0.0457
$2p\ ^2P^\circ-6d\ ^2D$		33.109		33.172	0.0224
$2p\ ^2P^\circ-7d\ ^2D$		32.068		32.128	0.0130
$3s\ ^2S-3p\ ^2P^\circ$	[2069]	[1998]			0.191
$3s\ ^2S-4p\ ^2P^\circ$	[141.6]				0.367
$3s\ ^2S-5p\ ^2P^\circ$	[99.1]				0.099
$3s\ ^2S-6p\ ^2P^\circ$	[85.2]				0.044
$3s\ ^2S-7p\ ^2P^\circ$	[78.6]				0.0238
$3p\ ^2P^\circ-4s\ ^2S$	[157.0]	[157.5]			0.048
$3p\ ^2P^\circ-5s\ ^2S$	[105.2]	[105.4]			0.0104
$3p\ ^2P^\circ-6s\ ^2S$					0.0043
$3p\ ^2P^\circ-7s\ ^2S$					0.0021
$3p\ ^2P^\circ-3d\ ^2D$		[5204]	[5726]	[5548]	0.0303
$3p\ ^2P^\circ-4d\ ^2D$		150.31	150.61		0.57
$3p\ ^2P^\circ-5d\ ^2D$		[103.7]	[103.8]		0.136
$3p\ ^2P^\circ-6d\ ^2D$		[88.7]	[88.8]		0.0556
$3p\ ^2P^\circ-7d\ ^2D$		[81.6]	[81.7]		0.0289
$4s\ ^2S-4p\ ^2P^\circ$	[4738]				0.260
$4s\ ^2S-5p\ ^2P^\circ$	[308.6]				0.422
$4s\ ^2S-6p\ ^2P^\circ$	[204.9]				0.119
$4s\ ^2S-7p\ ^2P^\circ$	[170.5]				0.052
$4p\ ^2P^\circ-5s\ ^2S$	[341.3]				0.076
$4p\ ^2P^\circ-6s\ ^2S$					0.0168
$4p\ ^2P^\circ-7s\ ^2S$					0.0068
$4p\ ^2P^\circ-4d\ ^2D$			[13700]	[13400]	0.059
$4p\ ^2P^\circ-5d\ ^2D$			[326] [c]		0.562
$4p\ ^2P^\circ-6d\ ^2D$			[213] [c]		0.139
$4p\ ^2P^\circ-7d\ ^2D$			[176] [c]		0.0609

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Si XII ($Z = 14$)

I.P. = 523.5 eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^o$		31.015			0.094
$2s\ ^2S–5p\ ^2P^o$		27.909			0.0388
$2s\ ^2S–6p\ ^2P^o$		26.460			0.0204
$2s\ ^2S–7p\ ^2P^o$		25.655			0.0120
$2p\ ^2P^o–3s\ ^2S$	45.519	45.692			0.0206
$2p\ ^2P^o–4s\ ^2S$	[33.19]	[33.28]			0.0042
$2p\ ^2P^o–5s\ ^2S$	29.574	29.645			0.0020
$2p\ ^2P^o–6s\ ^2S$					9.9 (−4) [d]
$2p\ ^2P^o–7s\ ^2S$					5.6 (−4)
$2p\ ^2P^o–3d\ ^2D$		44.021	[44.18]	44.165	0.67
$2p\ ^2P^o–4d\ ^2D$		32.888	[32.98]	32.972	0.12
$2p\ ^2P^o–5d\ ^2D$		29.439		29.509	0.0456
$2p\ ^2P^o–6d\ ^2D$		27.850		27.919	0.0224
$2p\ ^2P^o–7d\ ^2D$		26.977		27.035	0.0130
$3s\ ^2S–3p\ ^2P^o$	[1949]	[1862]			0.176
$3s\ ^2S–4p\ ^2P^o$	[120.0]				0.375
$3s\ ^2S–5p\ ^2P^o$	[83.9]				0.10
$3s\ ^2S–6p\ ^2P^o$	[72.0]				0.045
$3s\ ^2S–7p\ ^2P^o$	[67.1]				0.0240
$3p\ ^2P^o–4s\ ^2S$	[131.1]	[131.5]			0.046
$3p\ ^2P^o–5s\ ^2S$	[88.4]	[88.6]			0.0101
$3p\ ^2P^o–6s\ ^2S$					0.0042
$3p\ ^2P^o–7s\ ^2S$					0.0021
$3p\ ^2P^o–3d\ ^2D$		[4620]	[5196]	[4942]	0.0279
$3p\ ^2P^o–4d\ ^2D$		126.43		126.77	0.58
$3p\ ^2P^o–5d\ ^2D$		[87.2]		[87.4]	0.136
$3p\ ^2P^o–6d\ ^2D$		[74.6]		[74.7]	0.0556
$3p\ ^2P^o–7d\ ^2D$				[68.7]	0.0289
$4s\ ^2S–4p\ ^2P^o$	[5207]				0.243
$4s\ ^2S–5p\ ^2P^o$	[264.5]				0.428
$4s\ ^2S–6p\ ^2P^o$	[174.1]				0.121
$4s\ ^2S–7p\ ^2P^o$	[144.3]				0.053
$4p\ ^2P^o–5s\ ^2S$	[286.3]				0.074
$4p\ ^2P^o–6s\ ^2S$					0.0164
$4p\ ^2P^o–7s\ ^2S$					0.0066
$4p\ ^2P^o–4d\ ^2D$			[12000]	[11100]	0.055
$4p\ ^2P^o–5d\ ^2D$				[274] [c]	0.565
$4p\ ^2P^o–6d\ ^2D$				[179] [c]	0.139
$4p\ ^2P^o–7d\ ^2D$				[148] [c]	0.0610

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

P XIII (Z = 15)

I.P. = 611.9 eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S–4p\ ^2P^o$		26.608			0.095
$2s\ ^2S–5p\ ^2P^o$					0.0391
$2s\ ^2S–6p\ ^2P^o$					0.0205
$2s\ ^2S–7p\ ^2P^o$					0.0121
$2p\ ^2P^o–3s\ ^2S$	38.754	38.921			0.0200
$2p\ ^2P^o–4s\ ^2S$	28.55	28.66			0.0041
$2p\ ^2P^o–5s\ ^2S$					0.0020
$2p\ ^2P^o–6s\ ^2S$					9.6 (−4) [d]
$2p\ ^2P^o–7s\ ^2S$					5.5 (−4)
$2p\ ^2P^o–3d\ ^2D$		37.561	37.723	37.706	0.68
$2p\ ^2P^o–4d\ ^2D$		28.044		28.128	0.12
$2p\ ^2P^o–5d\ ^2D$		25.103		25.169	0.0455
$2p\ ^2P^o–6d\ ^2D$				23.810	0.0223
$2p\ ^2P^o–7d\ ^2D$			23.08 [c]		0.0129
$3s\ ^2S–3p\ ^2P^o$	[1739]	[1645]			0.163
$3s\ ^2S–4p\ ^2P^o$		[103.1]			0.382
$3s\ ^2S–5p\ ^2P^o$					0.102
$3s\ ^2S–6p\ ^2P^o$					0.045
$3s\ ^2S–7p\ ^2P^o$					0.0242
$3p\ ^2P^o–4s\ ^2S$					0.045
$3p\ ^2P^o–5s\ ^2S$					0.0099
$3p\ ^2P^o–6s\ ^2S$					0.0042
$3p\ ^2P^o–7s\ ^2S$					0.0020
$3p\ ^2P^o–3d\ ^2D$		[4097]	[4738]	[4524]	0.0260
$3p\ ^2P^o–4d\ ^2D$		[107.8]	[108.2]	[108.1]	0.58
$3p\ ^2P^o–5d\ ^2D$		[74.3]	[74.5]		0.137
$3p\ ^2P^o–6d\ ^2D$				[63.7]	0.0556
$3p\ ^2P^o–7d\ ^2D$		[58.6]	[58.7]		0.0289
$4s\ ^2S–4p\ ^2P^o$					0.229
$4s\ ^2S–5p\ ^2P^o$					0.435
$4s\ ^2S–6p\ ^2P^o$					0.122
$4s\ ^2S–7p\ ^2P^o$					0.053
$4p\ ^2P^o–5s\ ^2S$					0.072
$4p\ ^2P^o–6s\ ^2S$					0.0161
$4p\ ^2P^o–7s\ ^2S$					0.0065
$4p\ ^2P^o–4d\ ^2D$			[6368]	[6133]	0.051
$4p\ ^2P^o–5d\ ^2D$			[230.7]	[230.4]	0.568
$4p\ ^2P^o–6d\ ^2D$				[151.4]	0.140
$4p\ ^2P^o–7d\ ^2D$		[125.9]	[126.0]		0.0611

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

S XIV (Z = 16)

I.P. = 707.2 eV

Transition	Component wavelengths (Å)				Multiplet *f*-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^o$		23.04			0.095
$2s\ ^2S–5p\ ^2P^o$					0.0394
$2s\ ^2S–6p\ ^2P^o$					0.0207
$2s\ ^2S–7p\ ^2P^o$					0.0122
$2p\ ^2P^o–3s\ ^2S$	33.259	33.426			0.0195
$2p\ ^2P^o–4s\ ^2S$		24.43			0.0040
$2p\ ^2P^o–5s\ ^2S$					0.0019
$2p\ ^2P^o–6s\ ^2S$					9.4 (−4) [d]
$2p\ ^2P^o–7s\ ^2S$					5.4 (−4)
$2p\ ^2P^o–3d\ ^2D$		32.430		32.554	0.68
$2p\ ^2P^o–4d\ ^2D$				24.26 [c]	0.12
$2p\ ^2P^o–5d\ ^2D$				21.79 [c]	0.0455
$2p\ ^2P^o–6d\ ^2D$					0.0222
$2p\ ^2P^o–7d\ ^2D$					0.0129
$3s\ ^2S–3p\ ^2P^o$	[1663]	[1550]			0.152
$3s\ ^2S–4p\ ^2P^o$					0.387
$3s\ ^2S–5p\ ^2P^o$					0.103
$3s\ ^2S–6p\ ^2P^o$					0.046
$3s\ ^2S–7p\ ^2P^o$					0.0244
$3p\ ^2P^o–4s\ ^2S$					0.044
$3p\ ^2P^o–5s\ ^2S$					0.0098
$3p\ ^2P^o–6s\ ^2S$					0.0041
$3p\ ^2P^o–7s\ ^2S$					0.0020
$3p\ ^2P^o–3d\ ^2D$		[3967]	[4797]	[4153]	0.0248
$3p\ ^2P^o–4d\ ^2D$					0.58
$3p\ ^2P^o–5d\ ^2D$					0.137
$3p\ ^2P^o–6d\ ^2D$					0.0556
$3p\ ^2P^o–7d\ ^2D$					0.0289
$4s\ ^2S–4p\ ^2P^o$					0.222
$4s\ ^2S–5p\ ^2P^o$					0.440
$4s\ ^2S–6p\ ^2P^o$					0.123
$4s\ ^2S–7p\ ^2P^o$					0.054
$4p\ ^2P^o–5s\ ^2S$					0.071
$4p\ ^2P^o–6s\ ^2S$					0.0159
$4p\ ^2P^o–7s\ ^2S$					0.0065
$4p\ ^2P^o–4d\ ^2D$					0.049
$4p\ ^2P^o–5d\ ^2D$					0.570
$4p\ ^2P^o–6d\ ^2D$					0.140
$4p\ ^2P^o–7d\ ^2D$					0.0612

[a] The *f*-values for the multiplet components (lines) can be derived according to *LS*-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Cl XV ($Z=17$)

I.P. = 809.4 eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^\circ$		20.13			0.096
$2s\ ^2S-5p\ ^2P^\circ$		18.13			0.0397
$2s\ ^2S-6p\ ^2P^\circ$		17.25			0.0208
$2s\ ^2S-7p\ ^2P^\circ$					0.0122
$2p\ ^2P^\circ-3s\ ^2S$	28.93	29.09			0.0191
$2p\ ^2P^\circ-4s\ ^2S$		21.41			0.0040
$2p\ ^2P^\circ-5s\ ^2S$					0.0019
$2p\ ^2P^\circ-6s\ ^2S$					9.2 (−4) [d]
$2p\ ^2P^\circ-7s\ ^2S$					5.3 (−4)
$2p\ ^2P^\circ-3d\ ^2D$		28.27		28.42	0.68
$2p\ ^2P^\circ-4d\ ^2D$		21.10		21.18	0.12
$2p\ ^2P^\circ-5d\ ^2D$			18.99 [c]		0.0455
$2p\ ^2P^\circ-6d\ ^2D$			17.96 [c]		0.0222
$2p\ ^2P^\circ-7d\ ^2D$			17.46 [c]		0.0128
$3s\ ^2S-3p\ ^2P^\circ$	[1498]	[1378]			0.143
$3s\ ^2S-4p\ ^2P^\circ$					0.393
$3s\ ^2S-5p\ ^2P^\circ$					0.104
$3s\ ^2S-6p\ ^2P^\circ$					0.046
$3s\ ^2S-7p\ ^2P^\circ$					0.0245
$3p\ ^2P^\circ-4s\ ^2S$					0.043
$3p\ ^2P^\circ-5s\ ^2S$					0.0096
$3p\ ^2P^\circ-6s\ ^2S$					0.0040
$3p\ ^2P^\circ-7s\ ^2S$					0.0020
$3p\ ^2P^\circ-3d\ ^2D$		[3313]	[4105]	[3820]	0.0231
$3p\ ^2P^\circ-4d\ ^2D$					0.58
$3p\ ^2P^\circ-5d\ ^2D$					0.137
$3p\ ^2P^\circ-6d\ ^2D$					0.0556
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-4p\ ^2P^\circ$					0.212
$4s\ ^2S-5p\ ^2P^\circ$					0.447
$4s\ ^2S-6p\ ^2P^\circ$					0.124
$4s\ ^2S-7p\ ^2P^\circ$					0.054
$4p\ ^2P^\circ-5s\ ^2S$					0.070
$4p\ ^2P^\circ-6s\ ^2S$					0.0156
$4p\ ^2P^\circ-7s\ ^2S$					0.0064
$4p\ ^2P^\circ-4d\ ^2D$					0.046
$4p\ ^2P^\circ-5d\ ^2D$					0.573
$4p\ ^2P^\circ-6d\ ^2D$					0.140
$4p\ ^2P^\circ-7d\ ^2D$					0.0613

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] Multiplet wavelength (unresolved).
[d] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Ar XVI ($Z = 18$)

I.P. = [918.0] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^\circ$					0.097
$2s\ ^2S–5p\ ^2P^\circ$					0.0398
$2s\ ^2S–6p\ ^2P^\circ$					0.0208
$2s\ ^2S–7p\ ^2P^\circ$					0.0122
$2p\ ^2P^\circ–3s\ ^2S$	[25.53]	[25.70]			0.0187
$2p\ ^2P^\circ–4s\ ^2S$					0.0039
$2p\ ^2P^\circ–5s\ ^2S$					0.0018
$2p\ ^2P^\circ–6s\ ^2S$					9.1 (−4) [c]
$2p\ ^2P^\circ–7s\ ^2S$					5.2 (−4)
$2p\ ^2P^\circ–3d\ ^2D$		[24.86]	[25.02]	[25.01]	0.68
$2p\ ^2P^\circ–4d\ ^2D$					0.12
$2p\ ^2P^\circ–5d\ ^2D$					0.0454
$2p\ ^2P^\circ–6d\ ^2D$					0.0221
$2p\ ^2P^\circ–7d\ ^2D$					0.0128
$3s\ ^2S–3p\ ^2P^\circ$	[1401]	[1268]			0.134
$3s\ ^2S–4p\ ^2P^\circ$					0.396
$3s\ ^2S–5p\ ^2P^\circ$					0.104
$3s\ ^2S–6p\ ^2P^\circ$					0.046
$3s\ ^2S–7p\ ^2P^\circ$					0.0246
$3p\ ^2P^\circ–4s\ ^2S$					0.042
$3p\ ^2P^\circ–5s\ ^2S$					0.0095
$3p\ ^2P^\circ–6s\ ^2S$					0.0040
$3p\ ^2P^\circ–7s\ ^2S$					0.0020
$3p\ ^2P^\circ–3d\ ^2D$		[2975]	[3831]	[3514]	0.0216
$3p\ ^2P^\circ–4d\ ^2D$					0.58
$3p\ ^2P^\circ–5d\ ^2D$					0.137
$3p\ ^2P^\circ–6d\ ^2D$					0.0557
$3p\ ^2P^\circ–7d\ ^2D$					0.0289
$4s\ ^2S–4p\ ^2P^\circ$					0.203
$4s\ ^2S–5p\ ^2P^\circ$					0.450
$4s\ ^2S–6p\ ^2P^\circ$					0.124
$4s\ ^2S–7p\ ^2P^\circ$					0.054
$4p\ ^2P^\circ–5s\ ^2S$					0.069
$4p\ ^2P^\circ–6s\ ^2S$					0.0154
$4p\ ^2P^\circ–7s\ ^2S$					0.0063
$4p\ ^2P^\circ–4d\ ^2D$					0.044
$4p\ ^2P^\circ–5d\ ^2D$					0.574
$4p\ ^2P^\circ–6d\ ^2D$					0.140
$4p\ ^2P^\circ–7d\ ^2D$					0.0613

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.

[b] Total angular momentum quantum numbers.

[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

K XVII ($Z = 19$)

I.P. = [1034] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^\circ$					0.097
$2s\ ^2S-5p\ ^2P^\circ$					0.0399
$2s\ ^2S-6p\ ^2P^\circ$					0.0209
$2s\ ^2S-7p\ ^2P^\circ$					0.0123
$2p\ ^2P^\circ-3s\ ^2S$	[22.60]	[22.76]			0.0184
$2p\ ^2P^\circ-4s\ ^2S$					0.0038
$2p\ ^2P^\circ-5s\ ^2S$					0.0018
$2p\ ^2P^\circ-6s\ ^2S$					8.9 (−4) [c]
$2p\ ^2P^\circ-7s\ ^2S$					5.1 (−4)
$2p\ ^2P^\circ-3d\ ^2D$		22.020	[22.18]	22.163	0.68
$2p\ ^2P^\circ-4d\ ^2D$					0.12
$2p\ ^2P^\circ-5d\ ^2D$					0.0453
$2p\ ^2P^\circ-6d\ ^2D$					0.0221
$2p\ ^2P^\circ-7d\ ^2D$					0.0127
$3s\ ^2S-4p\ ^2P^\circ$					0.399
$3s\ ^2S-5p\ ^2P^\circ$					0.105
$3s\ ^2S-6p\ ^2P^\circ$					0.046
$3s\ ^2S-7p\ ^2P^\circ$					0.0247
$3p\ ^2P^\circ-4s\ ^2S$					0.042
$3p\ ^2P^\circ-5s\ ^2S$					0.0094
$3p\ ^2P^\circ-6s\ ^2S$					0.0039
$3p\ ^2P^\circ-7s\ ^2S$					0.0019
$3p\ ^2P^\circ-4d\ ^2D$					0.58
$3p\ ^2P^\circ-5d\ ^2D$					0.137
$3p\ ^2P^\circ-6d\ ^2D$					0.0557
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-5p\ ^2P^\circ$					0.455
$4s\ ^2S-6p\ ^2P^\circ$					0.125
$4s\ ^2S-7p\ ^2P^\circ$					0.055
$4p\ ^2P^\circ-5s\ ^2S$					0.068
$4p\ ^2P^\circ-6s\ ^2S$					0.0152
$4p\ ^2P^\circ-7s\ ^2S$					0.0062
$4p\ ^2P^\circ-5d\ ^2D$					0.576
$4p\ ^2P^\circ-6d\ ^2D$					0.140
$4p\ ^2P^\circ-7d\ ^2D$					0.0614

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Ca XVIII (Z = 20)

I.P. = [1157] eV

Transition	Component wavelengths (Å)				Multiplet *f*-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^o$		14.082			0.098
$2s\ ^2S–5p\ ^2P^o$		12.636			0.0400
$2s\ ^2S–6p\ ^2P^o$					0.0210
$2s\ ^2S–7p\ ^2P^o$					0.0123
$2p\ ^2P^o–3s\ ^2S$	20.052	20.220			0.0181
$2p\ ^2P^o–4s\ ^2S$					0.0038
$2p\ ^2P^o–5s\ ^2S$					0.0018
$2p\ ^2P^o–6s\ ^2S$					8.8 (−4) [c]
$2p\ ^2P^o–7s\ ^2S$					5.0 (−4)
$2p\ ^2P^o–3d\ ^2D$		19.642	[19.80]	19.789	0.68
$2p\ ^2P^o–4d\ ^2D$		14.658	[14.75]	14.738	0.12
$2p\ ^2P^o–5d\ ^2D$		13.118		13.191	0.0452
$2p\ ^2P^o–6d\ ^2D$				12.478	0.0220
$2p\ ^2P^o–7d\ ^2D$					0.0127
$3s\ ^2S–4p\ ^2P^o$					0.41
$3s\ ^2S–5p\ ^2P^o$					0.105
$3s\ ^2S–6p\ ^2P^o$					0.046
$3s\ ^2S–7p\ ^2P^o$					0.0247
$3p\ ^2P^o–4s\ ^2S$					0.041
$3p\ ^2P^o–5s\ ^2S$					0.0092
$3p\ ^2P^o–6s\ ^2S$					0.0039
$3p\ ^2P^o–7s\ ^2S$					0.0019
$3p\ ^2P^o–4d\ ^2D$					0.59
$3p\ ^2P^o–5d\ ^2D$					0.137
$3p\ ^2P^o–6d\ ^2D$					0.0557
$3p\ ^2P^o–7d\ ^2D$					0.0289
$4s\ ^2S–5p\ ^2P^o$					0.459
$4s\ ^2S–6p\ ^2P^o$					0.126
$4s\ ^2S–7p\ ^2P^o$					0.055
$4p\ ^2P^o–5s\ ^2S$					0.067
$4p\ ^2P^o–6s\ ^2S$					0.0150
$4p\ ^2P^o–7s\ ^2S$					0.0061
$4p\ ^2P^o–5d\ ^2D$					0.578
$4p\ ^2P^o–6d\ ^2D$					0.140
$4p\ ^2P^o–7d\ ^2D$					0.0615

[a] The *f*-values for the multiplet components (lines) can be derived according to *LS*-coupling rules, as explained in sec

[b] Total angular momentum quantum numbers.

[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be m

Sc XIX (Z=21)

I.P. = [1288] eV

Transition	Component wavelengths (Å)				Multiplet *f*-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^\circ$	12.66				0.098
$2s\ ^2S-5p\ ^2P^\circ$					0.040
$2s\ ^2S-6p\ ^2P^\circ$					0.0211
$2s\ ^2S-7p\ ^2P^\circ$					0.0124
$2p\ ^2P^\circ-4s\ ^2S$					0.0037
$2p\ ^2P^\circ-5s\ ^2S$					0.0017
$2p\ ^2P^\circ-6s\ ^2S$					8.7 (−4) [c]
$2p\ ^2P^\circ-7s\ ^2S$					4.9 (−4)
$2p\ ^2P^\circ-3d\ ^2D$		17.634	[17.79]	17.779	0.68
$2p\ ^2P^\circ-4d\ ^2D$		13.160		13.236	0.12
$2p\ ^2P^\circ-5d\ ^2D$				11.84	0.0452
$2p\ ^2P^\circ-6d\ ^2D$					0.0220
$2p\ ^2P^\circ-7d\ ^2D$					0.0127
$3s\ ^2S-4p\ ^2P^\circ$					0.42
$3s\ ^2S-5p\ ^2P^\circ$					0.106
$3s\ ^2S-6p\ ^2P^\circ$					0.047
$3s\ ^2S-7p\ ^2P^\circ$					0.0248
$3p\ ^2P^\circ-5s\ ^2S$					0.0091
$3p\ ^2P^\circ-6s\ ^2S$					0.0039
$3p\ ^2P^\circ-7s\ ^2S$					0.0019
$3p\ ^2P^\circ-4d\ ^2D$					0.59
$3p\ ^2P^\circ-5d\ ^2D$					0.137
$3p\ ^2P^\circ-6d\ ^2D$					0.0557
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-5p\ ^2P^\circ$					0.464
$4s\ ^2S-6p\ ^2P^\circ$					0.127
$4s\ ^2S-7p\ ^2P^\circ$					0.055
$4p\ ^2P^\circ-5s\ ^2S$					0.066
$4p\ ^2P^\circ-6s\ ^2S$					0.0149
$4p\ ^2P^\circ-7s\ ^2S$					0.0061
$4p\ ^2P^\circ-5d\ ^2D$					0.579
$4p\ ^2P^\circ-6d\ ^2D$					0.141
$4p\ ^2P^\circ-7d\ ^2D$					0.0615

[a] The *f*-values for the multiplet components (lines) can be derived according to *LS*-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Ti XX (Z = 22)

I.P. = [1426] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^\circ$	11.452				0.099
$2s\ ^2S-5p\ ^2P^\circ$	10.278				0.040
$2s\ ^2S-6p\ ^2P^\circ$	9.733				0.0211
$2s\ ^2S-7p\ ^2P^\circ$	9.434				0.0124
$2p\ ^2P^\circ-4s\ ^2S$					0.0037
$2p\ ^2P^\circ-5s\ ^2S$					0.0017
$2p\ ^2P^\circ-6s\ ^2S$					8.5 (−4) [c]
$2p\ ^2P^\circ-7s\ ^2S$					4.9 (−4)
$2p\ ^2P^\circ-3d\ ^2D$		15.914	16.067	16.059	0.68
$2p\ ^2P^\circ-4d\ ^2D$		11.872	11.958		0.12
$2p\ ^2P^\circ-5d\ ^2D$		10.620	10.690		0.0451
$2p\ ^2P^\circ-6d\ ^2D$		10.046	10.109		0.0220
$2p\ ^2P^\circ-7d\ ^2D$		9.733	9.788		0.0126
$3s\ ^2S-4p\ ^2P^\circ$					0.42
$3s\ ^2S-5p\ ^2P^\circ$					0.107
$3s\ ^2S-6p\ ^2P^\circ$					0.047
$3s\ ^2S-7p\ ^2P^\circ$					0.0248
$3p\ ^2P^\circ-5s\ ^2S$					0.0090
$3p\ ^2P^\circ-6s\ ^2S$					0.0038
$3p\ ^2P^\circ-7s\ ^2S$					0.0019
$3p\ ^2P^\circ-4d\ ^2D$					0.59
$3p\ ^2P^\circ-5d\ ^2D$					0.137
$3p\ ^2P^\circ-6d\ ^2D$					0.0557
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-5p\ ^2P^\circ$					0.467
$4s\ ^2S-6p\ ^2P^\circ$					0.127
$4s\ ^2S-7p\ ^2P^\circ$					0.055
$4p\ ^2P^\circ-6s\ ^2S$					0.0147
$4p\ ^2P^\circ-7s\ ^2S$					0.0060
$4p\ ^2P^\circ-5d\ ^2D$					0.581
$4p\ ^2P^\circ-6d\ ^2D$					0.141
$4p\ ^2P^\circ-7d\ ^2D$					0.0615

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.

[b] Total angular momentum quantum numbers.

[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

V XXI (Z = 23)

I.P. = [1570] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^\circ$	10.412				0.099
$2s\ ^2S-5p\ ^2P^\circ$	9.352				0.040
$2s\ ^2S-6p\ ^2P^\circ$	8.843				0.0212
$2s\ ^2S-7p\ ^2P^\circ$	8.576				0.0124
$2p\ ^2P^\circ-5s\ ^2S$					0.0017
$2p\ ^2P^\circ-6s\ ^2S$					8.4 (−4) [c]
$2p\ ^2P^\circ-7s\ ^2S$					4.8 (−4)
$2p\ ^2P^\circ-3d\ ^2D$		14.430	14.592	14.572	0.68
$2p\ ^2P^\circ-4d\ ^2D$		10.770	[10.86]	10.853	0.12
$2p\ ^2P^\circ-5d\ ^2D$		9.633	9.704		0.0450
$2p\ ^2P^\circ-6d\ ^2D$		9.111	9.175		0.0220
$2p\ ^2P^\circ-7d\ ^2D$		8.826	8.882		0.0126
$3s\ ^2S-4p\ ^2P^\circ$					0.43
$3s\ ^2S-5p\ ^2P^\circ$					0.107
$3s\ ^2S-6p\ ^2P^\circ$					0.047
$3s\ ^2S-7p\ ^2P^\circ$					0.0249
$3p\ ^2P^\circ-6s\ ^2S$					0.0038
$3p\ ^2P^\circ-7s\ ^2S$					0.0018
$3p\ ^2P^\circ-4d\ ^2D$					0.59
$3p\ ^2P^\circ-5d\ ^2D$					0.138
$3p\ ^2P^\circ-6d\ ^2D$					0.0558
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-5p\ ^2P^\circ$					0.471
$4s\ ^2S-6p\ ^2P^\circ$					0.127
$4s\ ^2S-7p\ ^2P^\circ$					0.056
$4p\ ^2P^\circ-6s\ ^2S$					0.0146
$4p\ ^2P^\circ-7s\ ^2S$					0.0060
$4p\ ^2P^\circ-5d\ ^2D$					0.582
$4p\ ^2P^\circ-6d\ ^2D$					0.141
$4p\ ^2P^\circ-7d\ ^2D$					0.0616

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.
[c] The number in parentheses following the tabulated value indicates the power of ten by which this value has to be multiplied.

Cr XXII (Z = 24)

I.P. = [1722] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^\circ$	9.493				0.10
$2s\ ^2S-5p\ ^2P^\circ$					0.040
$2s\ ^2S-6p\ ^2P^\circ$					0.0212
$2s\ ^2S-7p\ ^2P^\circ$					0.0124
$2p\ ^2P^\circ-3d\ ^2D$		13.147		13.294	0.68
$2p\ ^2P^\circ-4d\ ^2D$		9.809	9.865		0.12
$2p\ ^2P^\circ-5d\ ^2D$					0.0450
$2p\ ^2P^\circ-6d\ ^2D$					0.0220
$2p\ ^2P^\circ-7d\ ^2D$					0.0126
$3s\ ^2S-4p\ ^2P^\circ$					0.43
$3s\ ^2S-5p\ ^2P^\circ$					0.107
$3s\ ^2S-6p\ ^2P^\circ$					0.047
$3s\ ^2S-7p\ ^2P^\circ$					0.0249
$3p\ ^2P^\circ-7s\ ^2S$					0.0018
$3p\ ^2P^\circ-4d\ ^2D$					0.59
$3p\ ^2P^\circ-5d\ ^2D$					0.138
$3p\ ^2P^\circ-6d\ ^2D$					0.0558
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-5p\ ^2P^\circ$					0.473
$4s\ ^2S-6p\ ^2P^\circ$					0.128
$4s\ ^2S-7p\ ^2P^\circ$					0.056
$4p\ ^2P^\circ-7s\ ^2S$					0.0060
$4p\ ^2P^\circ-5d\ ^2D$					0.583
$4p\ ^2P^\circ-6d\ ^2D$					0.141
$4p\ ^2P^\circ-7d\ ^2D$					0.0616

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.

Mn XXIII (Z = 25)

I.P. = [1881] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S-4p\ ^2P^\circ$					0.10
$2s\ ^2S-5p\ ^2P^\circ$					0.040
$2s\ ^2S-6p\ ^2P^\circ$					0.0212
$2s\ ^2S-7p\ ^2P^\circ$					0.0125
$2p\ ^2P^\circ-3d\ ^2D$		[12.03]		12.158	0.68
$2p\ ^2P^\circ-4d\ ^2D$					0.12
$2p\ ^2P^\circ-5d\ ^2D$					0.0450
$2p\ ^2P^\circ-6d\ ^2D$					0.0220
$2p\ ^2P^\circ-7d\ ^2D$					0.0126

Mn XXIII (Z = 25)—Continued

I.P. = [1881] eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$3s\ ^2S-4p\ ^2P^\circ$					0.44
$3s\ ^2S-5p\ ^2P^\circ$					0.108
$3s\ ^2S-6p\ ^2P^\circ$					0.047
$3s\ ^2S-7p\ ^2P^\circ$					0.0249
$3p\ ^2P^\circ-4d\ ^2D$					0.59
$3p\ ^2P^\circ-5d\ ^2D$					0.138
$3p\ ^2P^\circ-6d\ ^2D$					0.0558
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-5p\ ^2P^\circ$					0.475
$4s\ ^2S-6p\ ^2P^\circ$					0.128
$4s\ ^2S-7p\ ^2P^\circ$					0.056
$4p\ ^2P^\circ-5d\ ^2D$					0.584
$4p\ ^2P^\circ-6d\ ^2D$					0.142
$4p\ ^2P^\circ-7d\ ^2D$					0.0616

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.

Fe XXIV (Z = 26)

I.P. = [2023] eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^\circ$	7.990				0.10
$2s\ ^2S-5p\ ^2P^\circ$					0.040
$2s\ ^2S-6p\ ^2P^\circ$					0.0212
$2s\ ^2S-7p\ ^2P^\circ$					0.0125
$2p\ ^2P^\circ-3d\ ^2D$		11.02		11.17	0.68
$2p\ ^2P^\circ-4d\ ^2D$		8.233		8.317	0.12
$2p\ ^2P^\circ-5d\ ^2D$		7.36		7.41	0.0450
$2p\ ^2P^\circ-6d\ ^2D$		6.97			0.0220
$2p\ ^2P^\circ-7d\ ^2D$					0.0126
$3s\ ^2S-4p\ ^2P^\circ$	[32.09]				0.45
$3s\ ^2S-5p\ ^2P^\circ$					0.108
$3s\ ^2S-6p\ ^2P^\circ$					0.048
$3s\ ^2S-7p\ ^2P^\circ$					0.0250
$3p\ ^2P^\circ-4d\ ^2D$		[31.77]	[32.18]	[32.01]	0.60
$3p\ ^2P^\circ-5d\ ^2D$					0.138
$3p\ ^2P^\circ-6d\ ^2D$					0.0558
$3p\ ^2P^\circ-7d\ ^2D$					0.0289

Fe XXIV (Z = 26) — Continued

I.P. = [2023] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$4s\ ^2S–5p\ ^2P^\circ$					0.478
$4s\ ^2S–6p\ ^2P^\circ$					0.128
$4s\ ^2S–7p\ ^2P^\circ$					0.056
$4p\ ^2P^\circ–5d\ ^2D$					0.585
$4p\ ^2P^\circ–6d\ ^2D$					0.142
$4p\ ^2P^\circ–7d\ ^2D$					0.0617

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.

Co XXV (Z = 27)

I.P. = [2218] eV

Transition	Component wavelengths (Å)				Multiplet f-value [a]
	1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	
$2s\ ^2S–4p\ ^2P^\circ$					0.100
$2s\ ^2S–5p\ ^2P^\circ$					0.040
$2s\ ^2S–6p\ ^2P^\circ$					0.0213
$2s\ ^2S–7p\ ^2P^\circ$					0.0125
$2p\ ^2P^\circ–3d\ ^2D$		[10.17]	[10.32]	[10.31]	0.68
$2p\ ^2P^\circ–4d\ ^2D$					0.12
$2p\ ^2P^\circ–5d\ ^2D$					0.0450
$2p\ ^2P^\circ–6d\ ^2D$					0.0220
$2p\ ^2P^\circ–7d\ ^2D$					0.0126
$3s\ ^2S–4p\ ^2P^\circ$					0.45
$3s\ ^2S–5p\ ^2P^\circ$					0.108
$3s\ ^2S–6p\ ^2P^\circ$					0.048
$3s\ ^2S–7p\ ^2P^\circ$					0.0250
$3p\ ^2P^\circ–4d\ ^2D$					0.60
$3p\ ^2P^\circ–5d\ ^2D$					0.138
$3p\ ^2P^\circ–6d\ ^2D$					0.0558
$3p\ ^2P^\circ–7d\ ^2D$					0.0289
$4s\ ^2S–5p\ ^2P^\circ$					0.481
$4s\ ^2S–6p\ ^2P^\circ$					0.129
$4s\ ^2S–7p\ ^2P^\circ$					0.056
$4p\ ^2P^\circ–5d\ ^2D$					0.585
$4p\ ^2P^\circ–6d\ ^2D$					0.142
$4p\ ^2P^\circ–7d\ ^2D$					0.0617

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.

Ni XXVI (Z=28)

I.P. = [2399] eV

Transition	Component wavelengths (Å) 1/2–1/2 [b]	1/2–3/2 or 3/2–1/2	3/2–3/2	3/2–5/2	Multiplet f-value [a]
$2s\ ^2S-4p\ ^2P^\circ$					0.101
$2s\ ^2S-5p\ ^2P^\circ$					0.040
$2s\ ^2S-6p\ ^2P^\circ$					0.0213
$2s\ ^2S-7p\ ^2P^\circ$					0.0125
$2p\ ^2P^\circ-3d\ ^2D$		[9.39]	[9.55]	[9.53]	0.68
$2p\ ^2P^\circ-4d\ ^2D$					0.12
$2p\ ^2P^\circ-5d\ ^2D$					0.0450
$2p\ ^2P^\circ-6d\ ^2D$					0.0220
$2p\ ^2P^\circ-7d\ ^2D$					0.0125
$3s\ ^2S-4p\ ^2P^\circ$					0.45
$3s\ ^2S-5p\ ^2P^\circ$					0.108
$3s\ ^2S-6p\ ^2P^\circ$					0.048
$3s\ ^2S-7p\ ^2P^\circ$					0.0250
$3p\ ^2P^\circ-4d\ ^2D$					0.60
$3p\ ^2P^\circ-5d\ ^2D$					0.138
$3p\ ^2P^\circ-6d\ ^2D$					0.0558
$3p\ ^2P^\circ-7d\ ^2D$					0.0289
$4s\ ^2S-5p\ ^2P^\circ$					0.483
$4s\ ^2S-6p\ ^2P^\circ$					0.129
$4s\ ^2S-7p\ ^2P^\circ$					0.056
$4p\ ^2P^\circ-5d\ ^2D$					0.586
$4p\ ^2P^\circ-6d\ ^2D$					0.143
$4p\ ^2P^\circ-7d\ ^2D$					0.0618

[a] The f-values for the multiplet components (lines) can be derived according to LS-coupling rules, as explained in section 5.2.
[b] Total angular momentum quantum numbers.