

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.

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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 Saronova [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 Kars-tensen 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 $g_l f$ 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. ($g_l = 2J_l + 1$ is the statistical weight of the lower state, where J_l 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	$\lambda(\text{\AA})$		f			
		$s_{1/2}-p_{3/2}$	$s_{1/2}-\tilde{p}_{1/2}$	Multiplet		Lines	
				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		
O VI	8	1031.945	1037.627		0.199		
F VII	9	883.097	890.762		0.176		
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	$\lambda(\text{\AA})$		f			
		$s_{1/2}-p_{3/2}$	$s_{1/2}-p_{1/2}$	Multiplet		Lines relativistic	
				non-relativistic	relativistic	$s_{1/2}-p_{3/2}$	$s_{1/2}-p_{1/2}$
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

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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

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

Nv ($Z=7$)

I.P. = 97.89 eV

Transition	Component wavelengths (Å)				Multiplet <i>f</i> -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 ² S-4p ² P ^o	[162.564]	[162.556]			0.0696
2s ² S-5p ² P ^o	[147.427]	[147.424]			0.0322
2s ² S-6p ² P ^o	[140.358]	[140.356]			0.0170
2s ² S-7p ² P ^o		136.429			0.0102
2p ² P ^o -3s ² S	266.196	266.379			0.0322
2p ² P ^o -4s ² S	[190.155]	[190.249]			0.0062
2p ² P ^o -5s ² S	[168.514]	[168.587]			0.0028
2p ² P ^o -6s ² S	[158.862]	[158.928]			0.0014
2p ² P ^o -7s ² S	153.624	153.683			7.8 (-4) ^c
2p ² P ^o -3d ² D		247.561	[247.719]	247.706	0.658
2p ² P ^o -4d ² D		[186.063]	[186.152]	[186.149]	0.124
2p ² P ^o -5d ² D		[166.875]		[166.946]	0.0469
2p ² P ^o -6d ² D		[158.024]		[158.088]	0.0230
2p ² P ^o -7d ² D		153.136		153.192	0.0136
3s ² S-3p ² P ^o	4619.98	4603.73			0.393
3s ² S-4p ² P ^o	628.874	628.744			0.277
3s ² S-5p ² P ^o	450.105	[450.072]			0.083
3s ² S-6p ² P ^o	[390.116]	[390.102]			0.0376
3s ² S-7p ² P ^o	[361.17]	[361.16]			0.0209
3p ² P ^o -4s ² S	777.712	778.172			0.073
3p ² P ^o -5s ² S	[509.896]	[510.096]			0.0136
3p ² P ^o -6s ² S	[430.714]	[430.857]			0.0055
3p ² P ^o -7s ² S	[394.228]	[394.348]			0.0028
3p ² P ^o -3d ² D		[15061.34]	[15234]	[15185.80]	0.0544
3p ² P ^o -4d ² D		713.518	[713.907]	713.860	0.548
3p ² P ^o -5d ² D		[495.180]	[495.37]	[495.356]	0.134
3p ² P ^o -6d ² D		424.61	[424.74]	424.75	0.0555
3p ² P ^o -7d ² D		[391.008]	[391.124]	[391.123]	0.0289
4s ² S-4p ² P ^o	[11368.92]	[11327.57]			0.54
4s ² S-5p ² P ^o	1389.822	1389.514			0.319
4s ² S-6p ² P ^o	[942.361]	[942.278]			0.097
4s ² S-7p ² P ^o	[789.55]	[789.51]			0.045
4p ² P ^o -5s ² S	1702.25	1703.218			0.112
4p ² P ^o -6s ² S	[1054.871]	[1055.229]			0.0224
4p ² P ^o -7s ² S	[859.961]	[860.203]			0.0089
4p ² P ^o -4d ² D		[36022]	[36453]	[36331]	0.103
4p ² P ^o -5d ² D		[1548.647]	[1549.45]	1549.336	0.527
4p ² P ^o -6d ² D		[1018.973]	[1019.311]	[1019.278]	0.136
4p ² P ^o -7d ² D		[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 ² S-4p ² P°		115.832			0.0766
2s ² S-5p ² P°		104.809			0.0343
2s ² S-6p ² P°		99.68			0.0181
2s ² S-7p ² P°		96.78			0.0107
2p ² P°-3s ² S		184.021			0.0287
2p ² P°-4s ² S		132.292			0.0056
2p ² P°-5s ² S		117.40			0.0026
2p ² P°-6s ² S		110.69			0.0013
2p ² P°-7s ² S	[107.0]				7.3 (-4) ^c
2p ² P°-3d ² D		172.936		173.082	0.662
2p ² P°-4d ² D		[129.78]		129.875	0.123
2p ² P°-5d ² D				116.43	0.0466
2p ² P°-6d ² D				110.25	0.0229
2p ² P°-7d ² D				106.79	0.0135
3s ² S-3p ² P°	3834.24	3811.35			0.335
3s ² S-4p ² P°	447.840	447.712			0.305
3s ² S-5p ² P°		[318.43]			0.088
3s ² S-6p ² P°		[275.41]			0.0397
3s ² S-7p ² P°		[254.72]			0.0219
3p ² P°-4s ² S	[536.0]	[536.4]			0.065
3p ² P°-5s ² S	[353.9]	[354.1]			0.0125
3p ² P°-6s ² S	[299.4]	[299.6]			0.0051
3p ² P°-7s ² S	[274.2]	[274.3]			0.0026
3p ² P°-3d ² D		[11740]	[11960]	[11890]	0.0481
3p ² P°-4d ² D		[498.1]	[498.5]	[498.4]	0.555
3p ² P°-5d ² D		[345.1]		[345.3]	0.135
3p ² P°-6d ² D		[295.8]		[295.9]	0.0555
3p ² P°-7d ² D		[272.3]		[272.4]	0.0289
4s ² S-4p ² P°	[9398]	[9342]			0.45
4s ² S-5p ² P°		[986.4]			0.349
4s ² S-6p ² P°		[664.7]			0.105
4s ² S-7p ² P°		[555.8]			0.047
4p ² P°-5s ² S		[1172]			0.099
4p ² P°-6s ² S	[731.3]	[731.6]			0.0205
4p ² P°-7s ² S	[597.2]	[597.4]			0.0082
4p ² P°-4d ² D		[28190]	[28710]	[28530]	0.091
4p ² P°-5d ² D		[1081]		[1082]	0.536
4p ² P°-6d ² D		[710.0]		[710.3]	0.136
4p ² P°-7d ² D		[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)				Multiplet <i>f</i> -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 ² S-4p ² P°		86.728			0.0814
2s ² S-5p ² P°		78.36			0.0358
2s ² S-6p ² P°		74.47			0.0188
2s ² S-7p ² P°		72.30			0.0112
2p ² P°-3s ² S	134.703	134.882			0.0263
2p ² P°-4s ² S	97.26	97.36			0.0052
2p ² P°-5s ² S		86.47			0.0024
2p ² P°-6s ² S	[81.51]	[81.57]			0.0012
2p ² P°-7s ² S	[78.83]	[78.89]			6.8 (-4) ^d
2p ² P°-3d ² D		127.653	[127.81]	127.796	0.666
2p ² P°-4d ² D		95.697	[95.79]	95.775	0.123
2p ² P°-5d ² D				85.80 ^c	0.0464
2p ² P°-6d ² D				81.18 ^c	0.0227
2p ² P°-7d ² D				78.66 ^c	0.0134
3s ² S-3p ² P°	[3278]	[3247]			0.290
3s ² S-4p ² P°		335.27			0.324
3s ² S-5p ² P°		[237.2]			0.092
3s ² S-6p ² P°		[204.8]			0.041
3s ² S-7p ² P°		[189.3]			0.0225
3p ² P°-4s ² S		391.76			0.059
3p ² P°-5s ² S	[260.0]	[260.1]			0.0119
3p ² P°-6s ² S	[220.2]	[220.4]			0.0049
3p ² P°-7s ² S	[201.8]	[201.9]			0.0025
3p ² P°-3d ² D		[9525]	[9789]	[9702]	0.0432
3p ² P°-4d ² D		367.43		367.87	0.56
3p ² P°-5d ² D		[254.3]		[254.5]	0.135
3p ² P°-6d ² D		[217.9]		[218.0]	0.0555
3p ² P°-7d ² D		[200.5]		[200.6]	0.0289
4s ² S-4p ² P°	[7959]				0.382
4s ² S-5p ² P°	[736.5]				0.370
4s ² S-6p ² P°	[493.9]				0.109
4s ² S-7p ² P°	[412.5]				0.049
4p ² P°-5s ² S	[855.8]				0.092
4p ² P°-6s ² S	[536.9]				0.0193
4p ² P°-7s ² S	[439.0]				0.0077
4p ² P°-4d ² D		[23500]		[23400]	0.083
4p ² P°-5d ² D				[797.3] ^c	0.543
4p ² P°-6d ² D				[523.1] ^c	0.136
4p ² P°-7d ² D				[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 <i>f</i> -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°		67.382			0.0850
2s 2S-5p 2P°		60.796			0.0365
2s 2S-6p 2P°		57.747			0.0194
2s 2S-7p 2P°		56.043			0.0114
2p 2P°-3s 2S	102.911	103.085			0.0245
2p 2P°-4s 2S	74.541	74.637			0.0049
2p 2P°-5s 2S	66.259	66.330			0.0023
2p 2P°-6s 2S		62.58			0.0011
2p 2P°-7s 2S		60.49			6.5 (-4) ^d
2p 2P°-3d 2D		98.115		98.260	0.667
2p 2P°-4d 2D		73.470		73.563	0.123
2p 2P°-5d 2D		65.822		65.895	0.0461
2p 2P°-6d 2D		62.297		62.361	0.0226
2p 2P°-7d 2D		60.351		60.413	0.0132
3s 2S-3p 2P°	2860.1	2820.7			0.256
3s 2S-4p 2P°		260.34			0.337
3s 2S-5p 2P°		[182.8]			0.094
3s 2S-6p 2P°		[158.6]			0.042
3s 2S-7p 2P°		[145.5]			0.0230
3p 2P°-4s 2S	298.70	299.13			0.055
3p 2P°-5s 2S	198.98	199.17			0.0114
3p 2P°-6s 2S	[168.7]	[168.8]			0.0047
3p 2P°-7s 2S	[154.3]	[154.4]			0.0024
3p 2P°-3d 2D		[8062]	[8399]	[8297]	0.0382
3p 2P°-4d 2D		282.27		282.61	0.56
3p 2P°-5d 2D		[194.9]	[195.1]		0.135
3p 2P°-6d 2D		[166.9]	[167.1]		0.0555
3p 2P°-7d 2D		[153.9]	[154.0]		0.0289
4s 2S-4p 2P°		[6991]			0.340
4s 2S-5p 2P°		[563.7]			0.387
4s 2S-6p 2P°		[383.4]			0.113
4s 2S-7p 2P°		[314.6]			0.050
4p 2P°-5s 2S		[651.4]			0.086
4p 2P°-6s 2S		[411.0]			0.0184
4p 2P°-7s 2S		[335.0]			0.0074
4p 2P°-4d 2D			[18180] ^c		0.075
4p 2P°-5d 2D			[611.2] ^c		0.549
4p 2P°-6d 2D			[400.8] ^c		0.137
4p 2P°-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)				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	
$2s^2S-4p^2P^o$		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 <i>f</i> -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 ² S-4p ² P ^o		44.050			0.089
2s ² S-5p ² P ^o		39.669			0.0379
2s ² S-6p ² P ^o		37.644			0.0200
2s ² S-7p ² P ^o		36.518			0.0118
2p ² P ^o -3s ² S	65.672	65.847			0.0221
2p ² P ^o -4s ² S	[47.78]	[47.87]			0.0045
2p ² P ^o -5s ² S	42.523	42.596			0.0021
2p ² P ^o -6s ² S					0.0010
2p ² P ^o -7s ² S					6.0 (-4) ^d
2p ² P ^o -3d ² D		63.152	[63.31]	63.295	0.67
2p ² P ^o -4d ² D		47.231	[47.32]	47.310	0.12
2p ² P ^o -5d ² D		42.294	[42.37]	42.363	0.0459
2p ² P ^o -6d ² D		40.022	[40.09]	40.080	0.0225
2p ² P ^o -7d ² D		38.769	[38.83]	38.823	0.0130
3s ² S-3p ² P ^o	[2279]	[2212]			0.210
3s ² S-4p ² P ^o		[170.2]			0.359
3s ² S-5p ² P ^o		[119.3]			0.098
3s ² S-6p ² P ^o		[102.7]			0.044
3s ² S-7p ² P ^o		[94.7]			0.0237
3p ² P ^o -4s ² S	[189.9]	[190.4]			0.050
3p ² P ^o -5s ² S	[127.4]	[127.6]			0.0106
3p ² P ^o -6s ² S					0.0044
3p ² P ^o -7s ² S					0.0022
3p ² P ^o -3d ² D		[5919]	[6418]	[6230]	0.0324
3p ² P ^o -4d ² D		181.50		181.86	0.57
3p ² P ^o -5d ² D		[125.3]	[125.6]	[125.5]	0.136
3p ² P ^o -6d ² D		[107.3]		[107.4]	0.0555
3p ² P ^o -7d ² D		[98.7]		[98.8]	0.0289
4s ² S-4p ² P ^o	[5830]				0.282
4s ² S-5p ² P ^o	[373.3]				0.410
4s ² S-6p ² P ^o	[247.8]				0.118
4s ² S-7p ² P ^o	[206.0]				0.052
4p ² P ^o -5s ² S	[414.2]				0.078
4p ² P ^o -6s ² S					0.0172
4p ² P ^o -7s ² S					0.0069
4p ² P ^o -4d ² D		[14200]		[13200]	0.063
4p ² P ^o -5d ² D				[393] ^c	0.558
4p ² P ^o -6d ² D				[257] ^c	0.138
4p ² P ^o -7d ² D				[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)				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	
$2s^2S-4p^2P^{\circ}$		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.

SiXII ($Z=14$)

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 ² S-4p ² P°		31.015			0.094
2s ² S-5p ² P°		27.909			0.0388
2s ² S-6p ² P°		26.460			0.0204
2s ² S-7p ² P°		25.655			0.0120
2p ² P°-3s ² S	45.519	45.692			0.0206
2p ² P°-4s ² S	[33.19]	[33.28]			0.0042
2p ² P°-5s ² S	29.574	29.645			0.0020
2p ² P°-6s ² S					9.9 (-4) ^d
2p ² P°-7s ² S					5.6 (-4)
2p ² P°-3d ² D		44.021	[44.18]	44.165	0.67
2p ² P°-4d ² D		32.888	[32.98]	32.972	0.12
2p ² P°-5d ² D		29.439		29.509	0.0456
2p ² P°-6d ² D		27.850		27.919	0.0224
2p ² P°-7d ² D		26.977		27.035	0.0130
3s ² S-3p ² P°	[1949]	[1862]			0.176
3s ² S-4p ² P°		[120.0]			0.375
3s ² S-5p ² P°		[83.9]			0.10
3s ² S-6p ² P°		[72.0]			0.045
3s ² S-7p ² P°		[67.1]			0.0240
3p ² P°-4s ² S	[131.1]	[131.5]			0.046
3p ² P°-5s ² S	[88.4]	[88.6]			0.0101
3p ² P°-6s ² S					0.0042
3p ² P°-7s ² S					0.0021
3p ² P°-3d ² D		[4620]	[5196]	[4942]	0.0279
3p ² P°-4d ² D		126.43		126.77	0.58
3p ² P°-5d ² D		[87.2]		[87.4]	0.136
3p ² P°-6d ² D		[74.6]		[74.7]	0.0556
3p ² P°-7d ² D				[68.7]	0.0289
4s ² S-4p ² P°	[5207]				0.243
4s ² S-5p ² P°	[264.5]				0.428
4s ² S-6p ² P°	[174.1]				0.121
4s ² S-7p ² P°	[144.3]				0.053
4p ² P°-5s ² S	[286.3]				0.074
4p ² P°-6s ² S					0.0164
4p ² P°-7s ² S					0.0066
4p ² P°-4d ² D		[12000]		[11100]	0.055
4p ² P°-5d ² D				[274] ^c	0.565
4p ² P°-6d ² D				[179] ^c	0.139
4p ² P°-7d ² D				[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)				Multiplet <i>f</i> -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 ² S-4p ² P ^o		26.608			0.095
2s ² S-5p ² P ^o					0.0391
2s ² S-6p ² P ^o					0.0205
2s ² S-7p ² P ^o					0.0121
2p ² P ^o -3s ² S	38.754	38.921			0.0200
2p ² P ^o -4s ² S	28.55	28.66			0.0041
2p ² P ^o -5s ² S					0.0020
2p ² P ^o -6s ² S					9.6 (-4) ^d
2p ² P ^o -7s ² S					5.5 (-4)
2p ² P ^o -3d ² D		37.561	37.723	37.706	0.68
2p ² P ^o -4d ² D		28.044		28.128	0.12
2p ² P ^o -5d ² D		25.103		25.169	0.0455
2p ² P ^o -6d ² D				23.810	0.0223
2p ² P ^o -7d ² D				23.08 ^c	0.0129
3s ² S-3p ² P ^o	[1739]	[1645]			0.163
3s ² S-4p ² P ^o		[103.1]			0.382
3s ² S-5p ² P ^o					0.102
3s ² S-6p ² P ^o					0.045
3s ² S-7p ² P ^o					0.0242
3p ² P ^o -4s ² S					0.045
3p ² P ^o -5s ² S					0.0099
3p ² P ^o -6s ² S					0.0042
3p ² P ^o -7s ² S					0.0020
3p ² P ^o -3d ² D		[4097]	[4738]	[4524]	0.0260
3p ² P ^o -4d ² D		[107.8]	[108.2]	[108.1]	0.58
3p ² P ^o -5d ² D		[74.3]		[74.5]	0.137
3p ² P ^o -6d ² D				[63.7]	0.0556
3p ² P ^o -7d ² D		[58.6]		[58.7]	0.0289
4s ² S-4p ² P ^o					0.229
4s ² S-5p ² P ^o					0.435
4s ² S-6p ² P ^o					0.122
4s ² S-7p ² P ^o					0.053
4p ² P ^o -5s ² S					0.072
4p ² P ^o -6s ² S					0.0161
4p ² P ^o -7s ² S					0.0065
4p ² P ^o -4d ² D			[6368]	[6133]	0.051
4p ² P ^o -5d ² D			[230.7]	[230.4]	0.568
4p ² P ^o -6d ² D				[151.4]	0.140
4p ² P ^o -7d ² D		[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 <i>f</i> -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 ² S-4p ² P ^o		23.04			0.095
2s ² S-5p ² P ^o					0.0394
2s ² S-6p ² P ^o					0.0207
2s ² S-7p ² P ^o					0.0122
2p ² P ^o -3s ² S	33.259	33.426			0.0195
2p ² P ^o -4s ² S		24.43			0.0040
2p ² P ^o -5s ² S					0.0019
2p ² P ^o -6s ² S					9.4 (-4) ^d
2p ² P ^o -7s ² S					5.4 (-4)
2p ² P ^o -3d ² D		32.430		32.554	0.68
2p ² P ^o -4d ² D			24.26 ^c		0.12
2p ² P ^o -5d ² D			21.79 ^c		0.0455
2p ² P ^o -6d ² D					0.0222
2p ² P ^o -7d ² D					0.0129
3s ² S-3p ² P ^o	[1663]	[1550]			0.152
3s ² S-4p ² P ^o					0.387
3s ² S-5p ² P ^o					0.103
3s ² S-6p ² P ^o					0.046
3s ² S-7p ² P ^o					0.0244
3p ² P ^o -4s ² S					0.044
3p ² P ^o -5s ² S					0.0098
3p ² P ^o -6s ² S					0.0041
3p ² P ^o -7s ² S					0.0020
3p ² P ^o -3d ² D		[3967]	[4797]	[4153]	0.0248
3p ² P ^o -4d ² D					0.58
3p ² P ^o -5d ² D					0.137
3p ² P ^o -6d ² D					0.0556
3p ² P ^o -7d ² D					0.0289
4s ² S-4p ² P ^o					0.222
4s ² S-5p ² P ^o					0.440
4s ² S-6p ² P ^o					0.123
4s ² S-7p ² P ^o					0.054
4p ² P ^o -5s ² S					0.071
4p ² P ^o -6s ² S					0.0159
4p ² P ^o -7s ² S					0.0065
4p ² P ^o -4d ² D					0.049
4p ² P ^o -5d ² D					0.570
4p ² P ^o -6d ² D					0.140
4p ² P ^o -7d ² D					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)				Multiplet <i>f</i> -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 ² S-4p ² P°		20.13			0.096
2s ² S-5p ² P°		18.13			0.0397
2s ² S-6p ² P°		17.25			0.0208
2s ² S-7p ² P°					0.0122
2p ² P°-3s ² S	28.93	29.09			0.0191
2p ² P°-4s ² S		21.41			0.0040
2p ² P°-5s ² S					0.0019
2p ² P°-6s ² S					9.2 (-4) ^d
2p ² P°-7s ² S					5.3 (-4)
2p ² P°-3d ² D		28.27		28.42	0.68
2p ² P°-4d ² D		21.10		21.18	0.12
2p ² P°-5d ² D				18.99 ^c	0.0455
2p ² P°-6d ² D				17.96 ^c	0.0222
2p ² P°-7d ² D				17.46 ^c	0.0128
3s ² S-3p ² P°	[1498]	[1378]			0.143
3s ² S-4p ² P°					0.393
3s ² S-5p ² P°					0.104
3s ² S-6p ² P°					0.046
3s ² S-7p ² P°					0.0245
3p ² P°-4s ² S					0.043
3p ² P°-5s ² S					0.0096
3p ² P°-6s ² S					0.0040
3p ² P°-7s ² S					0.0020
3p ² P°-3d ² D		[3313]	[4105]	[3820]	0.0231
3p ² P°-4d ² D					0.58
3p ² P°-5d ² D					0.137
3p ² P°-6d ² D					0.0556
3p ² P°-7d ² D					0.0289
4s ² S-4p ² P°					0.212
4s ² S-5p ² P°					0.447
4s ² S-6p ² P°					0.124
4s ² S-7p ² P°					0.054
4p ² P°-5s ² S					0.070
4p ² P°-6s ² S					0.0156
4p ² P°-7s ² S					0.0064
4p ² P°-4d ² D					0.046
4p ² P°-5d ² D					0.573
4p ² P°-6d ² D					0.140
4p ² P°-7d ² D					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 <i>f</i> -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 ² S-4p ² P ^o					0.097
2s ² S-5p ² P ^o					0.0398
2s ² S-6p ² P ^o					0.0208
2s ² S-7p ² P ^o					0.0122
2p ² P ^o -3s ² S	[25.53]	[25.70]			0.0187
2p ² P ^o -4s ² S					0.0039
2p ² P ^o -5s ² S					0.0018
2p ² P ^o -6s ² S					9.1 (-4) ^c
2p ² P ^o -7s ² S					5.2 (-4)
2p ² P ^o -3d ² D		[24.86]	[25.02]	[25.01]	0.68
2p ² P ^o -4d ² D					0.12
2p ² P ^o -5d ² D					0.0454
2p ² P ^o -6d ² D					0.0221
2p ² P ^o -7d ² D					0.0128
3s ² S-3p ² P ^o	[1401]	[1268]			0.134
3s ² S-4p ² P ^o					0.396
3s ² S-5p ² P ^o					0.104
3s ² S-6p ² P ^o					0.046
3s ² S-7p ² P ^o					0.0246
3p ² P ^o -4s ² S					0.042
3p ² P ^o -5s ² S					0.0095
3p ² P ^o -6s ² S					0.0040
3p ² P ^o -7s ² S					0.0020
3p ² P ^o -3d ² D		[2975]	[3831]	[3514]	0.0216
3p ² P ^o -4d ² D					0.58
3p ² P ^o -5d ² D					0.137
3p ² P ^o -6d ² D					0.0557
3p ² P ^o -7d ² D					0.0289
4s ² S-4p ² P ^o					0.203
4s ² S-5p ² P ^o					0.450
4s ² S-6p ² P ^o					0.124
4s ² S-7p ² P ^o					0.054
4p ² P ^o -5s ² S					0.069
4p ² P ^o -6s ² S					0.0154
4p ² P ^o -7s ² S					0.0063
4p ² P ^o -4d ² D					0.044
4p ² P ^o -5d ² D					0.574
4p ² P ^o -6d ² D					0.140
4p ² P ^o -7d ² D					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 (\AA)				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 <i>f</i> -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 ² S-4p ² P°		14.082			0.098
2s ² S-5p ² P°		12.636			0.0400
2s ² S-6p ² P°					0.0210
2s ² S-7p ² P°					0.0123
2p ² P°-3s ² S	20.052	20.220			0.0181
2p ² P°-4s ² S					0.0038
2p ² P°-5s ² S					0.0018
2p ² P°-6s ² S					8.8 (-4) ^c
2p ² P°-7s ² S					5.0 (-4)
2p ² P°-3d ² D		19.642	[19.80]	19.789	0.68
2p ² P°-4d ² D		14.658	[14.75]	14.738	0.12
2p ² P°-5d ² D		13.118		13.191	0.0452
2p ² P°-6d ² D				12.478	0.0220
2p ² P°-7d ² D					0.0127
3s ² S-4p ² P°					0.41
3s ² S-5p ² P°					0.105
3s ² S-6p ² P°					0.046
3s ² S-7p ² P°					0.0247
3p ² P°-4s ² S					0.041
3p ² P°-5s ² S					0.0092
3p ² P°-6s ² S					0.0039
3p ² P°-7s ² S					0.0019
3p ² P°-4d ² D					0.59
3p ² P°-5d ² D					0.137
3p ² P°-6d ² D					0.0557
3p ² P°-7d ² D					0.0289
4s ² S-5p ² P°					0.459
4s ² S-6p ² P°					0.126
4s ² S-7p ² P°					0.055
4p ² P°-5s ² S					0.067
4p ² P°-6s ² S					0.0150
4p ² P°-7s ² S					0.0061
4p ² P°-5d ² D					0.578
4p ² P°-6d ² D					0.140
4p ² P°-7d ² D					0.0615

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

^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 (\AA)			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 (\AA)				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 (\AA)				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 <i>f</i> -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 ² S-4p ² P°	9.493				0.10
2s ² S-5p ² P°					0.040
2s ² S-6p ² P°					0.0212
2s ² S-7p ² P°					0.0124
2p ² P°-3d ² D		13.147		13.294	0.68
2p ² P°-4d ² D		9.809	9.865		0.12
2p ² P°-5d ² D					0.0450
2p ² P°-6d ² D					0.0220
2p ² P°-7d ² D					0.0126
3s ² S-4p ² P°					0.43
3s ² S-5p ² P°					0.107
3s ² S-6p ² P°					0.047
3s ² S-7p ² P°					0.0249
3p ² P°-7s ² S					0.0018
3p ² P°-4d ² D					0.59
3p ² P°-5d ² D					0.138
3p ² P°-6d ² D					0.0558
3p ² P°-7d ² D					0.0289
4s ² S-5p ² P°					0.473
4s ² S-6p ² P°					0.128
4s ² S-7p ² P°					0.056
4p ² P°-7s ² S					0.0060
4p ² P°-5d ² D					0.583
4p ² P°-6d ² D					0.141
4p ² P°-7d ² D					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 <i>f</i> -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 ² S-4p ² P°					0.10
2s ² S-5p ² P°					0.040
2s ² S-6p ² P°					0.0212
2s ² S-7p ² P°					0.0125
2p ² P°-3d ² D		[12.03]		12.158	0.68
2p ² P°-4d ² D					0.12
2p ² P°-5d ² D					0.0450
2p ² P°-6d ² D					0.0220
2p ² P°-7d ² D					0.0126

Mn XXIII ($Z = 25$)—Continued

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	
3s ² S-4p ² P°					0.44
3s ² S-5p ² P°					0.108
3s ² S-6p ² P°					0.047
3s ² S-7p ² P°					0.0249
3p ² P°-4d ² D					0.59
3p ² P°-5d ² D					0.138
3p ² P°-6d ² D					0.0558
3p ² P°-7d ² D					0.0289
4s ² S-5p ² P°					0.475
4s ² S-6p ² P°					0.128
4s ² S-7p ² P°					0.056
4p ² P°-5d ² D					0.584
4p ² P°-6d ² D					0.142
4p ² P°-7d ² D					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)				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 ² S-4p ² P°	7.990				0.10
2s ² S-5p ² P°					0.040
2s ² S-6p ² P°					0.0212
2s ² S-7p ² P°					0.0125
2p ² P°-3d ² D		11.02		11.17	0.68
2p ² P°-4d ² D		8.233		8.317	0.12
2p ² P°-5d ² D		7.36		7.41	0.0450
2p ² P°-6d ² D		6.97			0.0220
2p ² P°-7d ² D					0.0126
3s ² S-4p ² P°	[32.09]				0.45
3s ² S-5p ² P°					0.108
3s ² S-6p ² P°					0.048
3s ² S-7p ² P°					0.0250
3p ² P°-4d ² D		[31.77]	[32.18]	[32.01]	0.60
3p ² P°-5d ² D					0.138
3p ² P°-6d ² D					0.0558
3p ² P°-7d ² D					0.0289

Fe xxiv (Z = 26) — Continued

I.P. = [2023] eV

Transition	Component wavelengths (Å)				Multiplet <i>f</i> -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 ² S-5p ² P°					0.478
4s ² S-6p ² P°					0.128
4s ² S-7p ² P°					0.056
4p ² P°-5d ² D					0.585
4p ² P°-6d ² D					0.142
4p ² P°-7d ² D					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 <i>f</i> -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 ² S-4p ² P°					0.100
2s ² S-5p ² P°					0.040
2s ² S-6p ² P°					0.0213
2s ² S-7p ² P°					0.0125
2p ² P°-3d ² D		[10.17]	[10.32]	[10.31]	0.68
2p ² P°-4d ² D					0.12
2p ² P°-5d ² D					0.0450
2p ² P°-6d ² D					0.0220
2p ² P°-7d ² D					0.0126
3s ² S-4p ² P°					0.45
3s ² S-5p ² P°					0.108
3s ² S-6p ² P°					0.048
3s ² S-7p ² P°					0.0250
3p ² P°-4d ² D					0.60
3p ² P°-5d ² D					0.138
3p ² P°-6d ² D					0.0558
3p ² P°-7d ² D					0.0289
4s ² S-5p ² P°					0.481
4s ² S-6p ² P°					0.129
4s ² S-7p ² P°					0.056
4p ² P°-5d ² D					0.585
4p ² P°-6d ² D					0.142
4p ² P°-7d ² D					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)				Multiplet <i>f</i> -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 ² S-4p ² P°					0.101
2s ² S-5p ² P°					0.040
2s ² S-6p ² P°					0.0213
2s ² S-7p ² P°					0.0125
2p ² P°-3d ² D		[9.39]	[9.55]	[9.53]	0.68
2p ² P°-4d ² D					0.12
2p ² P°-5d ² D					0.0450
2p ² P°-6d ² D					0.0220
2p ² P°-7d ² D					0.0125
3s ² S-4p ² P°					0.45
3s ² S-5p ² P°					0.108
3s ² S-6p ² P°					0.048
3s ² S-7p ² P°					0.0250
3p ² P°-4d ² D					0.60
3p ² P°-5d ² D					0.138
3p ² P°-6d ² D					0.0558
3p ² P°-7d ² D					0.0289
4s ² S-5p ² P°					0.483
4s ² S-6p ² P°					0.129
4s ² S-7p ² P°					0.056
4p ² P°-5d ² D					0.586
4p ² P°-6d ² D					0.143
4p ² P°-7d ² D					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.