THE SPARK SPECTRA OF ZINC

by

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ABSTRACT

The spark spectra of zinc have been photographed in the region between 990 Å and 2590 Å using a condensed spark in helium as source. Exposures were taken using a Hilger large quartz prism spectrograph and a 3 meter normal incidence vacuum grating spectrograph of local design. Of 1000 lines measured, some 228 were classified in the spectra Zn I, Zn II, and Zn III on the basis of square arrays constructed using energy levels from Moore's "Atomic Energy Levels," volume II (1952). Also, 67 lines were classified in the third spark spectrum of zinc, Zn IV, enabling assignment of relative energies to 8 even levels belonging to the configuration $3d^8 4s$ and to 27 odd levels belonging to the configuration $3d^8 4p$. In addition, use was made of 25 lines measured by Bloch and Bloch (1936) in the region below 500 Å in determination of the ground state $3d^9\,{}^2D$.

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INTRODUCTION

A recent review of spectroscopy in the vacuum ultraviolet by Tousey (16) pointed out the renewed interest in the subject since 1945. This rejuvenated interest was attributed to technical advances, such as those in vacuum technology, and to the new fields where the extreme ultraviolet is of importance, such as high temperature plasmas, rocketry, solid state studies, and space astronomy. It should be kept in mind, however, that there is a vast amount of work yet to be done in the field, and that many spectra have not been investigated during the past twenty years. One such spectrum is the third spark spectrum of zinc, Zn IV.

Subbaraya (15) published nine terms and 48 classified lines in the region from 1029 Å to 1443 Å. Bloch and Bloch (1) published 32 classified lines in the region from 466 Å to 1449 Å, but did not assign term values. An almost complete lack of agreement between the two analyses led Mrs. Moore-Sitterly, in "Atomic Energy Levels," volume II (9), to report the spectrum as not having been analysed. Although there has been no subsequent work reported on this spectrum, there has been a signigicant amount of work done on lower members of the Co I isoelectronic sequence; notably that of Russell, King, and Moore (11) on Co I, and of Shenstone and Wilets (14) on Cu III.

The present work represents for the most part an extrapolation of relative term values in the Co I isoelectronic sequence using the regular and irregular doublet laws. Two extrapolations have generally been taken: one a linear extrapolation based on Ni II and Cu III, the other a quadratic extrapolation which includes Co I. Although begun without reference to either of the two previous works, use was made of Bloch and Bloch's wavelengths below 500 Å in order to determine the value of the ground state $3d^{9}\,{}^{2}D$.

EXPERIMENTAL

Three spectrograms were taken, all using as source a condensed spark in helium. The essentials of the source tube and electrical circuit are shown in figures 1 and 2 respectively. In all cases, Ilford type Q-2 plates were used.

Exposure 1 was taken on a Hilger large quartz prism spectrograph set to cover the region from 2100 Å to 2600 Å on a ten inch plate. The source was run for fifteen minutes in a pressure ofone atomsphere of helium using a slit width of five microns. With the diaphram closed to four millimeters, a ten second copper arc exposure was taken to provide standards. The plate was developed for one and one-half minutes in Kodak D 19 developer.

Exposures 2 and 3 were taken on a 3 meter normal incidence vacuum spectrograph of local design. The grating was produced by Bausch and Lomb (catalogue number 33-52-5471, serial number 2257 Al,) and was ruled with 1200 lines per millimeter and a blaze angle of $4^{\circ}7'$ on a circular blank of diameter 127 millimeters with a ruled area of height 69 millimeters and width 104 millimeters. The design allowed an angle of incidence of $9^{\circ}40'$ and a plate holder of length 30 inches to hold plates of width two inches. A slit of one centimeter length was used, with the slit width set at five microns (see figure 3.) Half the slit was covered with a lithium fluoride window to sort out second order lines. A gate valve between slit and grating enabled the main chamber of the fifty cubic foot spectrograph to be evacuated prior to the source tube being put in place. Evacuation was accomplished by using a Consolidated Electrodynamics Corporation MC 500-B diffusion pump with BW60 baffle backed by Balzers DUO 5 and Kinney KS - 27 pumps. A cold trap with liquid nitrogen was placed in the pumping exit. Pressure was measured on a Philips type PHG - 09 gauge.

The range of the spectrograph was found from the grating equation (Sawyer, 12):

$$n\lambda = d(\sin\alpha + \sin\beta)$$

where n is the order number, d the separation of the grating rulings, α the angle of incidence and β the angle of diffraction. Since the grating radius was 2998.3 millimeters, the value of β at the ends of the 30 inch plate holder was $\pm 6.742°$. For first order, this leads to:

$$\lambda = (10^{7}\ \text{Å/mm})(1200\ \text{lines/mm})(\sin 9°40' \pm \sin 6.742°)$$

giving a range from 416 Å to 2385 Å.

Sawyer also gives the reciprocal dispersion as:

$$d\lambda/dx = \frac{d \cos\beta}{n r}$$

where r is the radius. At the center of the plate holder;

$$d\lambda/dx = (8333.3\ \text{Å})/(2998.3\ \text{mm})$$

$$= 2.7793\ \text{Å / mm}$$

for first order. This value decreases symmetrically about the center as $\cos\beta$, giving the reciprocal dispersion at the ends of the plate holder as:

$$d\lambda/dx = 2.7793\ (\cos 6.742°)$$

$$= 2.7598\ \text{Å/mm}$$

For exposure 2, a lithium fluoride window was used to isolate the source from the slit. The gate valve was kept closed until the pressure had dropped to 0.5 microns. With the source kept at one atmosphere pressure of helium, the gate valve was opened, and the pressure rose to 50 microns, which held during the exposure time of twenty minutes. An 18" and a 10" plate were set to the red end of the plate holder. Developing time was two minutes using Johnson Azol developer.

Exposure 3 was taken with the lithium fluoride window removed. The source tube was connected to a Cenco-Hyvac pump, and maintained at a pressure of 7 centimeters as measured on a mercury manometer. The helium entrance and exit tubes were shaped (see diagram 1) in an attempt to minimize the amount of contamination reaching the slit. With the gate valve closed, a pressure of 0.6 microns was attained in the main chamber. When the gate valve was opened, a pressure of 0.6 millimeters was maintained during the exposure time of thirty minutes. An 18" and a 10" plate were set to the red end of the plate holder. Developing time was two minutes using Johnson Azol developer.

RESULTS

Spectrograms.

All plates displayed good "pole effect," thus enabling an estimation of the excitation of the spectral lines in most but the weakest cases.

Plate 1 contained lines from 2099 Å (air) to 2586 Å (air) with a general minimum of intensity occuring below 2200 Å.

Plates 2 contained lines from 1133 Å to 2384 Å with weak intensity below 1150 Å.

Plates 3 contained two regions of strong lines; one from 1580 Å to 2318 Å, the other from 988 Å to 1350 Å. In between, a few weak lines were present. Below 988 Å, three lines occured at approximately 677 Å, 717 Å, and 755 Å. This, together with a strong smell of oil upon opening the spectrograph, indicated a pump oil leak resulting in absorption in the regions indicated.

Wavelengths.

Measurements were taken on a Zeiss-Abbe comparitor, modified by the maker to enable measurement of 18" x 2" plates. Wavelengths were determined from the comparitor readings by use of the Hartmann dispersion formula

$$\lambda = \lambda_o + \frac{c}{d_o - d}$$

where the constants λ_o, C, $\bar{d}o$ were calculated by the method described by Sawyer (12). For plate 1, the constants were determined from measurements of the copper standards, whereas for the other plates well known zinc lines were used as standards.

The wavelengths expressed to thousanths of A are considered accurate to 0.01 Å ; those expressed to hundredths to 0.05 Å.

Intensities.

Intensities of spectral lines were measured on a Jarrell-Ash 23-100 recording microphotometer with Bristol dynamatic recorder. This actually provided a measure of the density on the spectrogram. From the characteristic curve of a photographic plate (Kodak 8) the density is found to be a linear function of the logarithm of the exposure. Since the exposure is proportional to the intensity, the density is therefore proportional to the logarithm of the intensity. For each exposure, the intensity of the line 2138.56 Å (air) was chosen to be 500. Hence, for each exposure, a logarithmic scale was drawn with which the height of the microphotometer density trace could be converted into an intensity for the spectral line.

Tabulation.

Wavelengths of lines measured, together with corresponding vacuum wavenumbers have been listed in tables X(a) and X(b). Table X(a) contains lines with λ greater than 2000 Å, and expressed in air wavelengths. Table X(b) contains lines with λ less than 2000 Å, and expressed in vacuum wavelengths. Conversions were based on tables by Edlén (3). Intensities on all plates are listed, together with intensities from the literature (see the legend at the beginning of each table.)

ANALYSIS OF RESULTS

Zn I, Zn II, and Zn III.

On the basis of relative term values given by Moore (9), square arrays were drawn up for the arc spectrum and the first and second spark spectra of zinc. By fitting vacuum wavenumbers into these arrays, 26 lines were classified in Zn I, 44 in Zn II, and 158 in Zn III.

Zn IV.

Due to the lack of consistent data regarding the energy levels of Zn IV, the analysis was begun without reference to previous work. As the wavelengths available did not include any below 500 Å, no initial attempt was made to establish the ground state a^2D. Instead, an arbitrary zero of energy was assigned to the level $a^4F_{4\frac{1}{2}}$. Using as data the energy levels in "Atomic Energy Levels," the relative term values for the levels belonging to the configurations $3d^8 4s$ and $3d^8 4p$ were calculated for Co I, Ni II, and Cu III. The relative term value for the lowest level in each mutiplet of Zn IV was then estimated by linear and quadratic extrapolations using the irregular doublet law. Similarly, extrapolated values of the LS interval factors using the regular doublet law, together with extrapolated estimates of the interval ratios within the multiplets, led to estimations of the multiplet intervals. The details of this analysis, together with the observed values, have been grouped under "even levels" and "odd levels."

The Even Levels.

The relative term values of $a^2F_{3\frac{1}{2}}$ and $b^2D_{2\frac{1}{2}}$ are shown in table I. Energies are given in reciprocal centimeters.

TABLE I

RELATIVE TERM VALUES OF $a^2F_{3\frac{1}{2}}$ AND $b^2D_{2\frac{1}{2}}$

	Co I (cm^{-1})	Ni II (cm^{-1})	Cu III (cm^{-1})	Zn IV Linear (cm^{-1})	Zn IV Quadratic (cm^{-1})	Zn IV Observed (cm^{-1})
$a^2F_{3\frac{1}{2}}$	3959.6	5156.2	6211.7	7267.2	7126.1	7221.9
$b^2D_{2\frac{1}{2}}$	16778.2	14714.0	17162.7	19611.4	24124.2	19779.7

Condon and Shortley (1935) give the theoretical LS interval factor, Γ, for $3d^8(^3F)4s\ a^4F$ as $\Gamma = -\frac{1}{3}\zeta_{3d}$, where ζ_{3d} is the spin-orbital interaction constant for a 3d electron. From the regular doublet law (Pauling and Goudsmit, 10):

$$\zeta_{3d} = \frac{R\alpha^2 (z-s)^4}{n^3 \ell (\ell+1)}$$

Using the value of ζ_{3d} from the data, and knowing the values of the Rydberg constant R, the fine structure constant α, the quantum numbers n and ℓ, and the nuclear charge z, the value of the screening constant s was extrapolated to give ζ_{3d} and Γ for Zn IV. Table II (a) gives this extrapolation, table II (b) gives the estimated interval ratio, and table II (c) combines these to give estimations of the intervals within a^4F, together with the observed intervals.

TABLE II (a)

EXTRAPOLATION OF Γ IN a^4F

	Co I (cm^{-1})	Ni II (cm^{-1})	Cu III (cm^{-1})	Zn IV (cm^{-1})
Γ	-151.7	-216.2	-293.5	-388
ζ_{3d}	455.2	648.6	880.4	1163
$(z-s)^4$	12,618	17,981	24,407	32,242
$(z-s)$	10.60	11.58	12.50	13.40
s	16.40	16.42	16.50	16.60

TABLE II (b)

ESTIMATED INTERVAL RATIO IN a^4F

	Co I	Ni II	Cu III	Zn IV
$a^4F_{4\frac{1}{2}}$ – $^4F_{3\frac{1}{2}}$	4.35	4.33	4.29	4.25
$^4F_{3\frac{1}{2}}$ – $^4F_{2\frac{1}{2}}$	3.61	3.63	3.67	3.72
$^4F_{2\frac{1}{2}}$ – $^4F_{1\frac{1}{2}}$	2.54	2.54	2.53	2.53

TABLE II (c)

MULTIPLET INTERVALS IN a^4F

	Zn IV (predicted) (cm^{-1})	Zn IV (observed) (cm^{-1})
$a^4F_{4\frac{1}{2}}$ – $^4F_{3\frac{1}{2}}$	-1645	-1635.9
$^4F_{3\frac{1}{2}}$ – $^4F_{2\frac{1}{2}}$	-1440	-1438.6
$^4F_{2\frac{1}{2}}$ – $^4F_{1\frac{1}{2}}$	-979	-974.0

For a^2F, $\Gamma = -\frac{2}{3}\zeta_{3d}$, so the predicted interval was found to be -2585 cm^{-1} as compared to an observed value of -2528.0 cm^{-1}.

The theoretical LS interval for b^2D is zero. However, a linear extrapolation of the interval in Ni II and Cu III gave an estimate of -936 cm^{-1}. The observed value was -939.8 cm^{-1}.

The Odd Levels.

The relative term values of the lowest level in each odd multiplet are shown in table III.

TABLE III

RELATIVE TERM VALUES OF THE ODD LEVELS

	Co I (cm^{-1})	Ni II (cm^{-1})	Cu III (cm^{-1})	Zn IV linear (cm^{-1})	Zn IV quadratic (cm^{-1})	Zn IV observed (cm^{-1})
$z\,^4D^\circ_{3\frac{1}{2}}$	28543.7	43164.0	58059.4	72955	73230	72588.3
$z\,^4G^\circ_{4\frac{1}{2}}$	28981.9	44911.1	60532.3	76094	75666	75716.3
$z\,^4F^\circ_{4\frac{1}{2}}$	29359.3	46163.2	62745.0	79327	79105	79006.2
$z\,^2G^\circ_{4\frac{1}{2}}$	29956.9	46905.9	63637.6	80369	80152	80240.8
$z\,^2F^\circ_{3\frac{1}{2}}$	31967.8	48686.2	66024.5	83363	83983	83095.1
$z\,^2D^\circ_{2\frac{1}{2}}$	32609.6	49025.6	66087.0	83148	83794	82840.8
$z\,^4P^\circ_{2\frac{1}{2}}$	40997.3	58176.8	75802.4	93428	93874	93025
$y\,^2F^\circ_{2\frac{1}{2}}$	43646.1	59300.1	77279.1	95258	97583	94883
$y\,^2D^\circ_{1\frac{1}{2}}$	40428.5	59760.0	78183.2	96606	95698	96274
$z\,^2P^\circ_{1\frac{1}{2}}$	40054.9	60571.4	79396.0	98221	96529	97964
$x\,^2F^\circ_{3\frac{1}{2}}$	47095.9	67523.2	87001.0	106479	105529	106074

Goudsmit and Humphreys (4) have shown that the value of Γ may be determined from ζ' and ζ_e, the spin-orbital interaction constants for the atomic core and the electron, by the equation:

$$\Gamma = \zeta' \frac{l(l+1) + l_1(l_1+1) - l_2(l_2+1)}{2l(l+1)} \cdot \frac{s(s+1) + s_1(s_1+1) - s_2(s_2+1)}{2s(s+1)}$$

$$+ \zeta_e \frac{l(l+1) + l_2(l_2+1) - l_1(l_1+1)}{2l(l+1)} \cdot \frac{s(s+1) + s_2(s_2+1) - s_1(s_1+1)}{2s(s+1)}$$

where l_1, and s , l_2 and s_2, l and s, are the quantum numbers of the core, the electron, and the resultant configuration. For $z\,^4D^\circ$ and $z\,^4F^\circ$, this gives:

$$\Gamma_{^4D^\circ} = -\frac{4}{9}\zeta_{3d} - \frac{1}{9}\zeta_{4p}$$

$$\Gamma_{^4F^\circ} = -\frac{11}{36}\zeta_{3d} - \frac{1}{36}\zeta_{4p}$$

Solving:

$$\zeta_{3d} = -\frac{3}{5}\left(\Gamma_{^4D^\circ} - 4\,\Gamma_{^4F^\circ}\right)$$

$$\zeta_{4p} = -\frac{3}{5}\left(11\,\Gamma_{^4D^\circ} - 16\,\Gamma_{^4F^\circ}\right)$$

Table IV (a) gives linear and quadratic extrapolations of ζ_{3d} and ζ_{4p} with corresponding $\Gamma_{^4D^\circ}$ and $\Gamma_{^4F^\circ}$. Table IV (b) gives the estimated interval ratios, and table IV (c) combines these to give estimates of the intervals, together with the observed intervals.

Similar estimates and observed values for multiplet intervals in other odd terms are given in table V.

TABLE IV (a)

EXTRAPOLATION OF Γ IN z^4D°, z^4F°

	Co I (cm^{-1})	Ni II (cm^{-1})	Cu III (cm^{-1})	Zn IV Linear (cm^{-1})	Zn IV Quadratic (cm^{-1})
ζ_{3d}	423.4	636.2	803.5	970.8	925.3
ζ_{4p}	13.0	597.2	1314.1	2031.0	2163.7
$\Gamma_{^4D^\circ}$				-657.2	-651.6
$\Gamma_{^4F^\circ}$				-240.2	-222.6

TABLE IV (b)

ESTIMATED INTERVAL RATIOS IN z^4D°, Z^4F°

	Co I	Ni II	Cu III	Zn IV
$z^4D^\circ_{3½}$				
	3.31	3.38	3.41	3.42
$^4D^\circ_{2½}$				
	2.62	2.57	2.56	2.55
$^4D^\circ_{1½}$				
	1.57	1.56	1.54	1.53
$^4D^\circ_{½}$				

TABLE IV (b) (continued)

	Co I	Ni II	Cu III	Zn IV
$z^4F^\circ_{4\frac{1}{2}}$ – $^4F^\circ_{3\frac{1}{2}}$	4.84	4.84	4.82	4.80
$^4F^\circ_{3\frac{1}{2}}$ – $^4F^\circ_{2\frac{1}{2}}$	3.71	3.70	3.94	4.00
$^4F^\circ_{2\frac{1}{2}}$ – $^4F^\circ_{1\frac{1}{2}}$	1.94	1.97	1.76	1.70

TABLE IV (c)

MULTIPLET INTERVALS IN z D , z F

	Zn IV (linear) (cm^{-1})	Zn IV (quadratic) (cm^{-1})	Zn IV (observed) (cm^{-1})
$z^4D^\circ_{3\frac{1}{2}}$ – $^4D^\circ_{2\frac{1}{2}}$	-2247.6	-2284.7	-2269.9
$^4D^\circ_{2\frac{1}{2}}$ – $^4D^\circ_{1\frac{1}{2}}$	-1675.9	-1661.6	-1608.6
$^4D^\circ_{1\frac{1}{2}}$ – $^4D^\circ_{\frac{1}{2}}$	-1005.5	- 996.9	-1002.6
$z^4F^\circ_{4\frac{1}{2}}$ – $^4F^\circ_{3\frac{1}{2}}$	-1153.0	-1068.5	-1186.6
$^4F^\circ_{3\frac{1}{2}}$ – $^4F^\circ_{2\frac{1}{2}}$	- 960.8	- 890.4	- 978.6
$^4F^\circ_{2\frac{1}{2}}$ – $^4F^\circ_{1\frac{1}{2}}$	- 408.3	- 378.4	- 287.8

TABLE V

MULTIPLET INTERVALS IN THE ODD MULTIPLETS

	linear (cm^{-1})	quadratic (cm^{-1})	observed (cm^{-1})
z $^4G^\circ_{5\frac{1}{2}}$ – $^4G^\circ_{4\frac{1}{2}}$	673.3	633.2	611.9
$^4G^\circ_{4\frac{1}{2}}$ – $^4G^\circ_{3\frac{1}{2}}$	-1436.0	-1439.1	-1544.3
$^4G^\circ_{3\frac{1}{2}}$ – $^4G^\circ_{2\frac{1}{2}}$	-1116.8	-1119.3	-1187.9
z $^2G^\circ_{4\frac{1}{2}}$ – $^2G^\circ_{3\frac{1}{2}}$	-2232.0	-2434.0	-2218.2
z $^2F^\circ_{3\frac{1}{2}}$ – $^2F^\circ_{2\frac{1}{2}}$	-2287.6	-2191.7	-2343.8
z $^2D^\circ_{2\frac{1}{2}}$ – $^2D^\circ_{1\frac{1}{2}}$	-1800.8	-1555.5	-1910.7
z $^4P^\circ_{1\frac{1}{2}}$ – $^4P^\circ_{2\frac{1}{2}}$	257.5	221.0	316
y $^2F^\circ_{2\frac{1}{2}}$ – $^2F^\circ_{3\frac{1}{2}}$	1359.2	1479.8	1428
y $^2D^\circ_{1\frac{1}{2}}$ – $^2D^\circ_{2\frac{1}{2}}$	955.8	572.4	1046
x $^2F^\circ_{3\frac{1}{2}}$ – $^2F^\circ_{2\frac{1}{2}}$	-1741.8	-2788.1	-1318

Intensities.

With the estimates of relative term values and multiplet intervals as a guide, a search was made of the wavelengths listed in order to classify the strongest lines of the Zn IV spectrum. As a further guide, a square array of Cu III was constructed from the data of Shenstone and Wilets (14). Table VII shows a modified square array with energy level designations and intensities of the classified lines, the intensity of each line being chosen from the exposure with the best intensity in that region. Shown in brackets are the intensities of Cu III.

The Ground State.

In order to establish the ground state a^2D, use was made of Bloch and Bloch's wavelengths below 500 Å. It was found that their classification of lines in this region was consistent with the above classification, with the minor condition that their lines resulting from the transitions between $a^2D_{2\frac{1}{2}}$ and the odd levels $z^2G^\circ_{3\frac{1}{2}}$ and $z^2F^\circ_{3\frac{1}{2}}$ were interchanged. This led to an a^2D interval of 2765 cm^{-1} and a term value of $a^4F_{4\frac{1}{2}}$ relative to $a^2D_{2\frac{1}{2}}$ of 128,735.5 cm^{-1}. Further of their lines were then classified. Table X (c) contains those lines classified, an asterisk denoting the ones classified by Bloch and Bloch.

A further verification was found by considering the ratio of ζ_{3d} in a^2D and a^4F, using $\Gamma = -\zeta_{3d}$ for a^2D. The results are shown in table VI.

TABLE VI

INTERVAL IN a^2D

	Co I	Ni II	Cu III	Zn IV Predicted	Zn IV Observed
ζ_{3d} $(a^4F)(cm^{-1})$	455.4	648.6	880.4	1156.7	
ζ_{3d} $(a^2D)(cm^{-1})$	389.4	602.8	828.7	1102	1106
Ratio	1.169	1.076	1.062	1.05	

Summary.

Wavelengths are included in tables X (a), (b), (c). An energy level table is given as table IX, and includes intervals. That the analysis is consistent may be seen from table VII, where the classified lines of Zn IV are listed separately, showing the difference between the observed wavenumbers and the wavenumbers calculated from the energy levels. It may also be seen from table VII to account for all the equivalent major lines in the same region for Cu III as observed by Shenstone and Wilets (14).

SUGGESTIONS FOR FURTHER WORK

That there are still many lines of Zn IV to be classified may be seen from tables X (a) and X (b). From table VII, it is evident that there are also many combinations to which these lines may be assigned. The two limiting factors in this work have been the lower limit of wavelengths obtained and the relatively low intensity of the lines in the regions of interest. Several further possible classifications have been investigated, but lack of substantiation has made such classifications suspect. For example, the classification:

1363.947 Å	73316.6 cm^{-1}	$a\,^2G_{4\frac{1}{2}} - x\,^2F^{\circ}_{3\frac{1}{2}}$
1340.192 Å	74616.2 cm^{-1}	$a\,^2G_{3\frac{1}{2}} - x\,^2F^{\circ}_{2\frac{1}{2}}$

would lead to energy levels:

$a\,^2G_{4\frac{1}{2}}$	161,493 cm^{-1}	-19 cm^{-1}
$a\,^2G_{3\frac{1}{2}}$	161,512 cm^{-1}	

which is consistent with an extrapolated value of 161,056 cm^{-1} for $a\,^2G_{4\frac{1}{2}}$, and an interval of -33 cm^{-1}.

Verification of such classifications may be possible through the use of a source more suited to higher excitation, such as the electrodeless discharge. The use of a grazing incidence vacuum grating spectrograph could also improve wavelengths in the region below 500 Å.

With spectrograms of greater intensity, it may also be possible to classify lines of Zn III which arise from transitions involving levels belonging to the configuration $3d^8 4s^2$. Extrapolation of Ni I isoelectronic sequence data should aid such an investigation, particularly in view of Shenstone's (13) practically complete analysis of Cu II.

FIGURE 1.

THE SOURCE TUBE.

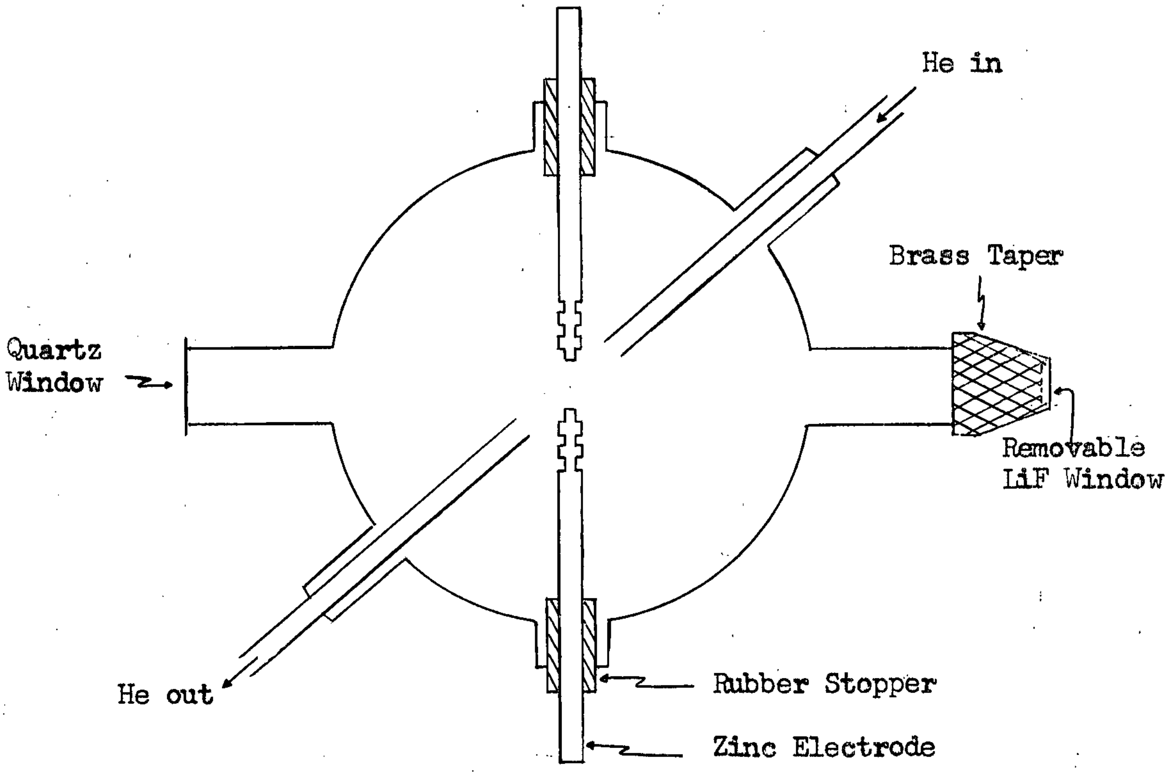


FIGURE 2.

THE ELECTRICAL CIRCUIT.

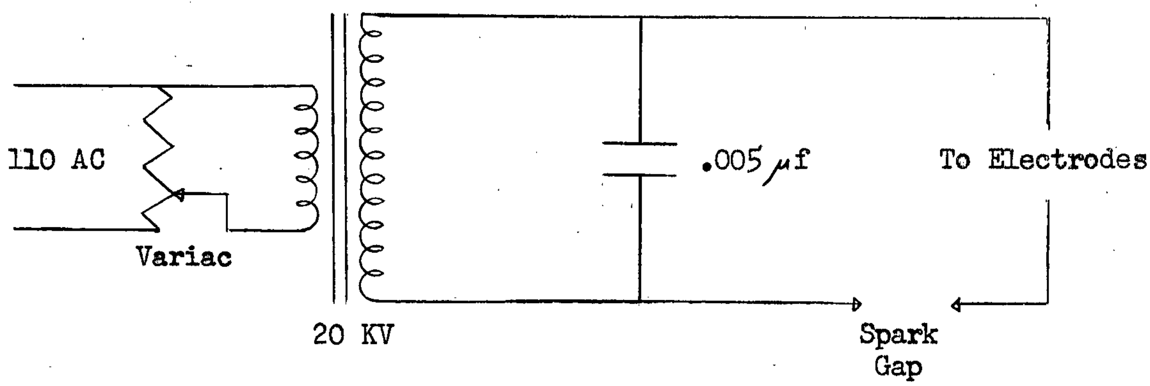
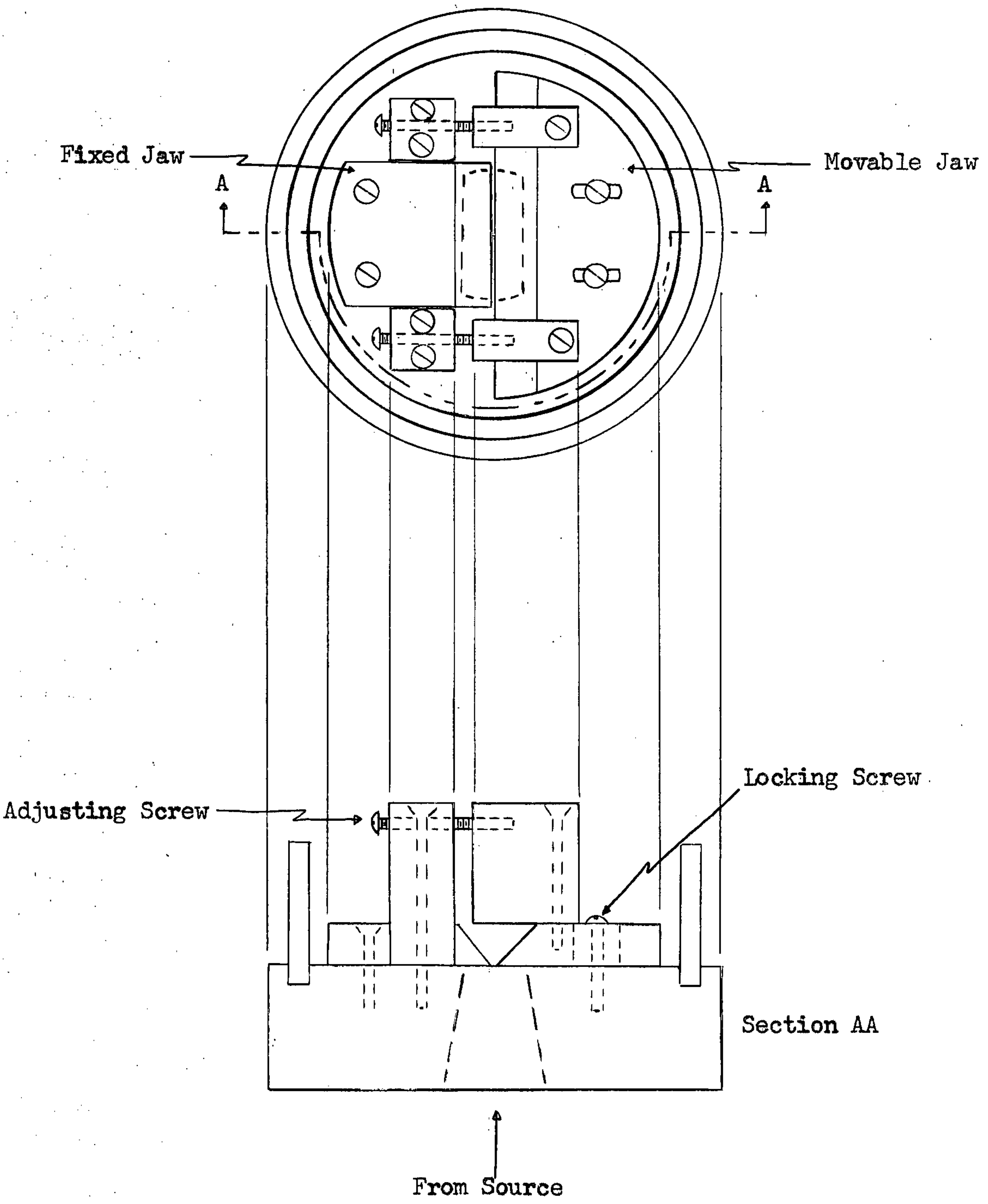


FIGURE 3.

THE SLIT.



Scale 2:1

TABLE VII

SQUARE ARRAY OF ZN IV

	$z^4D^o_{3½}$	$z^4D^o_{2½}$	$z^4G^o_{4½}$	$z^4G^o_{5½}$	$z^4D^o_{1½}$	$z^4G^o_{3½}$	$z^4D^o_{½}$	$z^4G^o_{2½}$	$z^4F^o_{4½}$	$z^4F^o_{3½}$	$z^2G^o_{4½}$	$z^4F^o_{2½}$	$z^4F^o_{1½}$	$z^2G^o_{3½}$	$z^2D^o_{2½}$	$z^2F^o_{3½}$	$z^2D^o_{1½}$	$z^2F^o_{2½}$	$z^4P^o_{1½}$
$a^2D_{2½}$		(5)				(0)		(0)		4 (150)		2 (100)	0 (2)	2 (100)	6 (400)	5 (300)	1 (50)	6 (200)	0 (5)
$^2D_{1½}$													2 (20)		2 (200)		6 (300)	2 (200)	1 (30)
$a^4F_{4½}$	40 (1000)		25 (300)	25 (2000)		(1)			30 (1000)	0 (2)	0 (1)			2		0			
$^4F_{3½}$	4 (10)	20 (700)	30 (600)			25 (300)		(1)	6 (200)	20 (500)	20 (400)	7 (15)		6 (3)	8 (2)	3 (2)		(0)	
$^4F_{2½}$		25 (30)			20 (500)	20 (500)		20 (200)		15 (300)		20 (300)	5 (10)	1 (3)	5 (2)	12 (30)	5 (1)	2	
$^4F_{1½}$		(0)			1 (10)		15 (400)	25 (400)				15 (200)	20 (300)				8 (10)	10	
$a^2F_{3½}$	7 (2)		25 (200)			2		2	25 (200)	6 (30)	25 (500)	8 (5)		15 (300)	25 (500)	30 (500)		4 (3)	
$^2F_{2½}$						15 (50)		7		2 (5)		6 (2)	10 (20)	20 (500)	6 (5)	15 (200)	15 (300)	25 (500)	
$b^2D_{2½}$	(25)	(40)			(4)										(5)				10 (200)
$^2D_{1½}$		(10)			(8)		(2)						(0)		(2)				0 (5)
$a^4P_{1½}$		(30)			(20)		(10)										(0)		(5)
$^4P_{½}$					(15)		(20)												(20)
$^4P_{2½}$	(50)	(20)								(5)									(1)
$a^2P_{1½}$															(4)		(0)	(5)	
$^2P_{½}$																	(8)		
$a^2G_{4½}$										(5)	(1)		(6)			(40)			
$^2G_{3½}$													(3)		(8)			(25)	

	$z^4P^o_{2½}$	$z^4P^o_{½}$	$y^2F^o_{2½}$	$y^2D^o_{1½}$	$y^2F^o_{3½}$	$z^2P^o_{½}$	$y^2D^o_{2½}$	$z^2P^o_{1½}$	$y^4D^o_{2½}$	$y^4D^o_{1½}$	$y^4D^o_{½}$	$y^4D^o_{3½}$	$x^2D^o_{2½}$	$x^2D^o_{1½}$	$y^2P^o_{1½}$	$z^2H^o_{4½}$	$y^2P^o_{½}$	$z^2H^o_{5½}$	$z^2S^o_{½}$	$x^2F^o_{3½}$	$z^4S^o_{1½}$	$x^2F^o_{2½}$	$y^2G^o_{3½}$	$y^2G^o_{4½}$
$a^2D_{2½}$	3 (100)				5 (150)		7 (200)	0 (10)	(20)	(15)		(20)	(50)	(75)	(100)					8 (300)		0 (50)		
$^2D_{1½}$	0 (20)		3 (100)	5 (150)		(2)	(10)	0 (20)	(15)	(5)	(3)		(15)	(150)	(20)		(100)		(15)			7 (200)		
$a^4F_{4½}$												(5)												
$^4F_{3½}$							1		(10)			(1)												
$^4F_{2½}$					(2)					(10)														
$^4F_{1½}$										(2)	(5)													
$a^2F_{3½}$			(5)		(5)		4 (3)						(0)							(3)				
$^2F_{2½}$				(5)				(1)														(3)		
$b^2D_{2½}$	10 (300)				20 (300)		(5)	(10)				(40)			(5)					(3)	(10)			
$^2D_{1½}$		(10)	8 (300)	(30)		(10)	(10)	(50)	(3)	(0)					(1)							(3)		
$a^4P_{1½}$	(20)	(30)		(10)		(15)	(10)		(100)	(100)			(5)								(20)			
$^4P_{½}$		(2)		(5)		(0)				(75)	(50)										(15)			
$^4P_{2½}$	(5)		(30)	(30)	(30)		(200)	(15)	(15)			(300)			(2)					(10)	(25)			
$a^2P_{1½}$								(10)	(20)				(300)	(30)	(10)		(1)		(100)					
$^2P_{½}$						(2)				(1)	(2)			(50)	(100)		(15)		(1)					
$a^2G_{4½}$												(1)				(10)		(400)		(400)				(500)
$^2G_{3½}$																(300)						(200)	(300)	(2)

TABLE VIII

CLASSIFIED LINES OF ZN IV

Wavelength λ (Å)	Wavenumber ν (cm^{-1})	ν (obs.) - ν (calc) $\Delta\nu$ (cm^{-1})	classification
1529.839	65366.4	0.0	$a\,^2F_{3\frac{1}{2}} - z\,^4D^{\circ}_{3\frac{1}{2}}$
1481.22	67512	1.2	$a\,^2F_{2\frac{1}{2}} - z\,^4G^{\circ}_{3\frac{1}{2}}$
1459.968	68494.7	0.3	$a\,^2F_{3\frac{1}{2}} - z\,^4G^{\circ}_{4\frac{1}{2}}$
1455.634	68698.6	0.0	$a\,^2F_{2\frac{1}{2}} - z\,^4G^{\circ}_{2\frac{1}{2}}$
1427.783	70038.7	0.0	$a\,^2F_{3\frac{1}{2}} - z\,^4G^{\circ}_{3\frac{1}{2}}$
1419.584	70443.2	0.3	$a\,^2F_{2\frac{1}{2}} - z\,^4F^{\circ}_{3\frac{1}{2}}$
1409.392	70952.6	0.2	$a\,^4F_{3\frac{1}{2}} - z\,^4D^{\circ}_{3\frac{1}{2}}$
1403.980	71226.1	-0.5	$a\,^2F_{3\frac{1}{2}} - z\,^4G^{\circ}_{2\frac{1}{2}}$
1400.136	71421.6	0.1	$a\,^2F_{2\frac{1}{2}} - z\,^4F^{\circ}_{2\frac{1}{2}}$
1394.522	71709.2	-0.1	$a\,^2F_{2\frac{1}{2}} - z\,^4F^{\circ}_{1\frac{1}{2}}$
1393.070	71783.9	(0.2	$a\,^4F_{2\frac{1}{2}} - z\,^4D^{\circ}_{2\frac{1}{2}}$
		(-0.4	$a\,^2F_{3\frac{1}{2}} - z\,^4F^{\circ}_{4\frac{1}{2}}$
1389.078	71990.2	0.2	$b\,^2D_{1\frac{1}{2}} - z\,^4P^{\circ}_{1\frac{1}{2}}$
1380.870	72418.1	-0.2	$a\,^4F_{1\frac{1}{2}} - z\,^4D^{\circ}_{1\frac{1}{2}}$
1377.637	72588.1	-0.2	$a\,^4F_{4\frac{1}{2}} - z\,^4D^{\circ}_{3\frac{1}{2}}$
1375.306	72711.1	0.0	$a\,^2F_{2\frac{1}{2}} - z\,^2G^{\circ}_{3\frac{1}{2}}$
1371.185	72929.6	-0.2	$b\,^2D_{2\frac{1}{2}} - z\,^4P^{\circ}_{1\frac{1}{2}}$
1370.411	72970.8	-0.1	$a\,^2F_{3\frac{1}{2}} - z\,^4F^{\circ}_{3\frac{1}{2}}$
1369.506	73019.0	0.1	$a\,^2F_{3\frac{1}{2}} - z\,^2G^{\circ}_{4\frac{1}{2}}$
1368.166	73090.6	-0.3	$a\,^2F_{2\frac{1}{2}} - z\,^2D^{\circ}_{2\frac{1}{2}}$
1365.702	73222.4	0.1	$a\,^4F_{3\frac{1}{2}} - z\,^4D^{\circ}_{2\frac{1}{2}}$
1365.262	73246.0	0.2	$b\,^2D_{2\frac{1}{2}} - z\,^4P^{\circ}_{2\frac{1}{2}}$
1363.444	73343.7	-1.5	$a\,^2F_{2\frac{1}{2}} - z\,^2F^{\circ}_{3\frac{1}{2}}$
1362.535	73392.6	0.3	$a\,^4F_{2\frac{1}{2}} - z\,^4D^{\circ}_{1\frac{1}{2}}$
1362.010	73420.9	0.0	$a\,^4F_{1\frac{1}{2}} - z\,^4D^{\circ}_{1\frac{1}{2}}$
1352.270	73949.7	0.2	$a\,^2F_{3\frac{1}{2}} - z\,^4F^{\circ}_{2\frac{1}{2}}$
1349.882	74080.6	0.2	$a\,^4F_{3\frac{1}{2}} - z\,^4G^{\circ}_{4\frac{1}{2}}$
1348.351	74164.7	0.7	$b\,^2D_{1\frac{1}{2}} - y\,^2F^{\circ}_{2\frac{1}{2}}$
1347.949	74186.8	0.7	$a\,^4F_{2\frac{1}{2}} - z\,^4G^{\circ}_{3\frac{1}{2}}$
1344.079	74400.4	0.4	$a\,^4F_{1\frac{1}{2}} - z\,^4G^{\circ}_{2\frac{1}{2}}$
1333.310	75001.3	-0.3	$a\,^2F_{2\frac{1}{2}} - z\,^2D^{\circ}_{1\frac{1}{2}}$
1329.103	75238.7	-0.4	$a\,^2F_{3\frac{1}{2}} - z\,^2G^{\circ}_{3\frac{1}{2}}$
1326.719	75373.9	-0.1	$a\,^4F_{2\frac{1}{2}} - z\,^4G^{\circ}_{2\frac{1}{2}}$
1322.437	75618.0	-0.9	$a\,^2F_{3\frac{1}{2}} - z\,^2D^{\circ}_{2\frac{1}{2}}$
1322.336	75623.8	-0.9	$a\,^4F_{3\frac{1}{2}} - z\,^4G^{\circ}_{3\frac{1}{2}}$

TABLE VIII (continued)

1321.194	75689.1	0.1	$a^2F_{2\frac{1}{2}} - z^2F^\circ_{2\frac{1}{2}}$
1320.729	75715.8	-0.5	$a^4F_{4\frac{1}{2}} - z^4G^\circ_{4\frac{1}{2}}$
1317.982	75873.6	0.4	$a^2F_{3\frac{1}{2}} - z^2F^\circ_{3\frac{1}{2}}$
1310.132	76328.2	0.0	$a^4F_{4\frac{1}{2}} - z^4G^\circ_{5\frac{1}{2}}$
1306.649	76531.6	-0.2	$b^2D_{2\frac{1}{2}} - y^2F^\circ_{3\frac{1}{2}}$
1296.736	77116.7	-1.6	$a^4F_{2\frac{1}{2}} - z^4F^\circ_{3\frac{1}{2}}$
1296.630	77123.0	0.1	$a^4F_{1\frac{1}{2}} - z^4F^\circ_{2\frac{1}{2}}$
1292.475	77370.9	0.6	$a^4F_{3\frac{1}{2}} - z^4F^\circ_{4\frac{1}{2}}$
1291.804	77411.1	0.4	$a^4F_{1\frac{1}{2}} - z^4F^\circ_{1\frac{1}{2}}$
1280.467	78096.5	-0.4	$a^4F_{2\frac{1}{2}} - z^4F^\circ_{2\frac{1}{2}}$
1278.497	78216.8	-0.2	$a^2F_{3\frac{1}{2}} - z^2F^\circ_{2\frac{1}{2}}$
1275.767	78384.2	-0.5	$a^4F_{2\frac{1}{2}} - z^4F^\circ_{1\frac{1}{2}}$
1272.956	78557.3	0.4	$a^4F_{3\frac{1}{2}} - z^4F^\circ_{3\frac{1}{2}}$
1272.199	78604.1	-0.8	$a^4F_{3\frac{1}{2}} - z^4G^\circ_{4\frac{1}{2}}$
1265.732	79005.7	-0.5	$a^4F_{4\frac{1}{2}} - z^4F^\circ_{4\frac{1}{2}}$
1259.651	79387.1	0.6	$a^4F_{2\frac{1}{2}} - z^2G^\circ_{3\frac{1}{2}}$
1257.305	79535.2	-0.3	$a^4F_{3\frac{1}{2}} - z^4F^\circ_{2\frac{1}{2}}$
1253.653	79766.9	0.6	$a^4F_{2\frac{1}{2}} - z^2D^\circ_{2\frac{1}{2}}$
1249.681	80020.4	-0.2	$a^4F_{2\frac{1}{2}} - z^2F^\circ_{3\frac{1}{2}}$
1246.993	80192.9	0.1	$a^4F_{4\frac{1}{2}} - z^4F^\circ_{3\frac{1}{2}}$
1246.244	80241.1	0.3	$a^4F_{4\frac{1}{2}} - z^2G^\circ_{4\frac{1}{2}}$
1239.120	80702.4	-0.6	$a^4F_{1\frac{1}{2}} - z^2D^\circ_{1\frac{1}{2}}$
1237.247	80824.6	-0.5	$a^4F_{3\frac{1}{2}} - z^2G^\circ_{3\frac{1}{2}}$
1231.448	81205.2	0.3	$a^4F_{3\frac{1}{2}} - z^2D^\circ_{2\frac{1}{2}}$
1228.652	81390.0	-0.4	$a^4F_{1\frac{1}{2}} - z^2F^\circ_{2\frac{1}{2}}$
1227.610	81459.1	-0.1	$a^4F_{3\frac{1}{2}} - z^2F^\circ_{3\frac{1}{2}}$
1224.328	81677.5	0.5	$a^4F_{2\frac{1}{2}} - z^4D^\circ_{1\frac{1}{2}}$
1214.118	82364.3	-0.1	$a^4F_{2\frac{1}{2}} - z^2F^\circ_{2\frac{1}{2}}$
1212.700	82460.6	-0.4	$a^4F_{4\frac{1}{2}} - z^2G^\circ_{3\frac{1}{2}}$
1203.427	83096.0	0.9	$a^4F_{4\frac{1}{2}} - z^2F^\circ_{3\frac{1}{2}}$
1109.926	90096.1	-12	$a^2F_{3\frac{1}{2}} - y^2D^\circ_{2\frac{1}{2}}$
1045.081	95686.4	- 8	$a^4F_{3\frac{1}{2}} - y^2D^\circ_{2\frac{1}{2}}$
482.10	207426	-4	$a^2D_{1\frac{1}{2}} - z^4F^\circ_{1\frac{1}{2}}$
478.92	208803	-8	$a^2D_{1\frac{1}{2}} - z^2D^\circ_{2\frac{1}{2}}$
478.62	208934	5	$a^2D_{2\frac{1}{2}} - z^4F^\circ_{3\frac{1}{2}}$
476.40	209908	1	$a^2D_{2\frac{1}{2}} - z^4F^\circ_{2\frac{1}{2}}$
475.75	210194	0	$a^2D_{2\frac{1}{2}} - z^4F^\circ_{1\frac{1}{2}}$
474.54	210730	8	$a^2D_{1\frac{1}{2}} - z^2D^\circ_{1\frac{1}{2}}$
473.49	211198	1	$a^2D_{2\frac{1}{2}} - z^2G^\circ_{3\frac{1}{2}}$
473.00	211416	7	$a^2D_{1\frac{1}{2}} - z^2F^\circ_{2\frac{1}{2}}$
472.65	211576	4	$a^2D_{2\frac{1}{2}} - z^2D^\circ_{2\frac{1}{2}}$
472.08	211828	-2	$a^2D_{2\frac{1}{2}} - z^2F^\circ_{3\frac{1}{2}}$

TABLE VIII (continued)

468.42	213484	-3	$a^2D_{2\frac{1}{2}} - z^2D^{\circ}_{1\frac{1}{2}}$
466.91	214174	0	$a^2D_{2\frac{1}{2}} - z^2F^{\circ}_{2\frac{1}{2}}$
457.29	218680	0	$a^2D_{1\frac{1}{2}} - z^4P^{\circ}_{1\frac{1}{2}}$
456.64	218991	-5	$a^2D_{1\frac{1}{2}} - z^4P^{\circ}_{2\frac{1}{2}}$
452.79	220853	-1	$a^2D_{1\frac{1}{2}} - y^2F^{\circ}_{2\frac{1}{2}}$
451.58	221445	0	$a^2D_{2\frac{1}{2}} - z^4P^{\circ}_{1\frac{1}{2}}$
450.93	221764	3	$a^2D_{2\frac{1}{2}} - z^4P^{\circ}_{2\frac{1}{2}}$
449.95	222247	2	$a^2D_{1\frac{1}{2}} - y^2D^{\circ}_{1\frac{1}{2}}$
446.55	223939	4	$a^2D_{1\frac{1}{2}} - z^2P^{\circ}_{1\frac{1}{2}}$
444.36	225043	-4	$a^2D_{2\frac{1}{2}} - y^2F^{\circ}_{3\frac{1}{2}}$
442.35	226065	9	$a^2D_{2\frac{1}{2}} - y^2D^{\circ}_{2\frac{1}{2}}$
441.11	226701	1	$a^2D_{2\frac{1}{2}} - z^2P^{\circ}_{1\frac{1}{2}}$
428.53	233356	-7	$a^2D_{1\frac{1}{2}} - x^2F^{\circ}_{2\frac{1}{2}}$
425.88	234808	-2	$a^2D_{2\frac{1}{2}} - x^2F^{\circ}_{3\frac{1}{2}}$
423.49	236133	5	$a^2D_{2\frac{1}{2}} - x^2F^{\circ}_{2\frac{1}{2}}$

TABLE IX

ENERGY LEVELS OF ZN IV

Configuration	Designation	J	Level (cm^{-1})	Interval (cm^{-1})
$3d^9$	a^2D	$2\frac{1}{2}$	0.0	-2765
		$1\frac{1}{2}$	2765	
$3d^8(^3F)4s$	a^4F	$4\frac{1}{2}$	128735.5	-1635.9
		$3\frac{1}{2}$	130371.4	-1438.6
		$2\frac{1}{2}$	131810.0	- 974.0
		$1\frac{1}{2}$	132784.0	
$3d^8(^3F)4s$	a^2F	$3\frac{1}{2}$	135957.4	-2528.0
		$2\frac{1}{2}$	138485.4	
$3d^8(^1D)4s$	b^2D	$2\frac{1}{2}$	148515.2	- 939.8
		$1\frac{1}{2}$	149455.0	
$3d^8(^3F)4p$	z^4D°	$3\frac{1}{2}$	201323.8	-2269.9
		$2\frac{1}{2}$	203593.7	-1608.6
		$1\frac{1}{2}$	205202.3	-1002.6
		$\frac{1}{2}$	206204.9	
$3d^8(^3F)4p$	z^4G°	$5\frac{1}{2}$	205063.7	611.9
		$4\frac{1}{2}$	204451.8	-1544.3
		$3\frac{1}{2}$	205996.1	-1187.9
		$2\frac{1}{2}$	207184.0	
$3d^8(^3F)4p$	z^4F°	$4\frac{1}{2}$	207741.7	-1186.6
		$3\frac{1}{2}$	208928.3	- 978.6
		$2\frac{1}{2}$	209906.9	- 287.8
		$1\frac{1}{2}$	210194.7	
$3d^8(^3F)4p$	z^2G°	$4\frac{1}{2}$	208976.3	-2218.2
		$3\frac{1}{2}$	211196.5	

TABLE IX (continued)

Configuration	Designation	J	Level	Interval
$3d^8(^3F)4p$	$z\,^2F°$	$3\frac{1}{2}$	211830.6	-2343.8
		$2\frac{1}{2}$	214174.4	
$3d^8(^3F)4p$	$z\,^2D°$	$2\frac{1}{2}$	211576.3	-1910.7
		$1\frac{1}{2}$	213487.0	
$3d^8(^3P)4p$	$z\,^4P°$	$2\frac{1}{2}$	221761	316
		$1\frac{1}{2}$	221445	
		$\frac{1}{2}$		
$3d^8(^1D)4p$	$y\,^2F°$	$2\frac{1}{2}$	223619	1428
		$3\frac{1}{2}$	225047	
$3d^8(^1D)4p$	$y\,^2D°$	$1\frac{1}{2}$	225010	1046
		$2\frac{1}{2}$	226056	
$3d^8(^1D)4p$	$z\,^2P°$	$\frac{1}{2}$		
		$1\frac{1}{2}$	226700	
$3d^8(^1G)4p$	$x\,^2F°$	$3\frac{1}{2}$	234810	-1318
		$2\frac{1}{2}$	236128	

TABLE X (a)

WAVELENGTHS ABOVE 2000 Å (AIR)

Legend:

- H: Intensities given by Kayser (6).
- M: Intensities given by Harrison (5).
  ( ) denote discharge tube intensities.
- P: Intensities from exposure 1.
- V: Intensities from exposure 3.
- L: Intensities from exposure 2.
- λ: Wavelengths (air) in Ångstroms.
- ν: Wavenumbers (vacuum) in reciprocal centimeters.

H	M	P	V	L	λ	ν		Classification
8		1			2586.01	38659	I	
	300	6			2582.57	38709	I	$4p\,^3P_1^\circ$ - $6d\,^3D$
		1			2577.32	38788	I	
		6h			2576.00	38808	III	
7		5h			2575.56	38815	III	
		2			2573.06	38853	I	
		0			2571.61	38874	I	
	10	5			2570.72	38888	II	$4s^2\,^2D_{2\frac{1}{2}}$ - $5p\,^2P^\circ_{1\frac{1}{2}}$
6		7			2569.94	38900	I	$4p\,^3P_0^\circ$ - $6d\,^3D_1$
4		1			2567.80	38932	I	$4p\,^3P_2^\circ$ - $8s\,^3S_1$
	10h				2562.58	39011	I	
20	300	1000			2557.97	39082	II	$4p\,^2P^\circ_{1\frac{1}{2}}$ - $5s\,^2S_{\frac{1}{2}}$
		2			2554.36	39137	III	
		2			2552.55	39165	II	
		0			2547.67	39240	III	
		0			2546.51	39258	I	
		00			2545.6	39272	III	
3	40h	1			2542.33	39322	I	$4p\,^3P_1^\circ$ - $8s\,^3S_1$
		1			2539.44	39367	II	
		00			2536.48	39413	I	
		3			2535.94	39421	II	
		2			2534.72	39440	II	
		4			2533.67	39461	II	
		1			2532.18	39480	II	
	10	1			2530.09	39512	I	$4p\,^3P_0^\circ$ - $8s\,^3S_1$

TABLE X(a)(continued)

H	M	P	V	L	λ	ν		Classification
		1			2528.46	39553	I	
		2h			2527.91	39559	III	
5		10			2527.08	39560	III	
		1			2524.10	39606	I	
5		10			2522.09	39638	III	
		2h			2520.33	39665	III	
		0			2519.15	39684	I	
		2			2516.06	39733	I	
6	150	10			2515.80	39737	I	$4p\,{}^3P^{\circ}_2$ - $7d\,{}^3D$
		3h			2515.07	39748	III	
		1			2514.26	39761	I	
		2			2512.00	39797	I	
7		8			2509.07	39843	III	
		3			2508.05	39860	III	
		1			2506.90	39878	I	
		0			2506.65	39882	II	$4s^2\,{}^2D_{1\frac{1}{2}}$ - $4p\,{}^4P^{\circ}_{1\frac{1}{2}}$
6	400	800			2501.97	39956	II	$4p\,{}^2P^{\circ}_{\frac{1}{2}}$ - $5s\,{}^2S_{\frac{1}{2}}$
		2h			2497.87	40022	III	
		2h			2497.16	40033	III	
		3h			2496.11	40050	II	
		0h			2495.69	40057	I	
3	25	0h			2493.38	40094	I	$4p\,{}^3P^{\circ}_2$ - $9s\,{}^3S_1$
		10h			2492.08	40115	III	
	100	8h			2491.52	40124	I	$4p\,{}^3P^{\circ}_1$ - $7d\,{}^3D$
		6h			2491.22	40129	II	
		8h			2490.79	40136	III	
5		12h			2486.93	40198	III	
		10h			2486.18	40210	III	
		8h			2484.57	40236	III	
		0			2483.38	40256	I	
		2h			2480.24	40306	III	
3	30	4h			2479.81	40314	I	$4p\,{}^3P^{\circ}_0$ - $7d\,{}^3D$
		1			2476.39	40369	I	
	8	12			2473.37	40418	III	
		8			2472.70	40429	III	
	12	0			2469.51	40482	I	$4p\,{}^3P^{\circ}_1$ - $9s\,{}^3S_1$
		4h			2468.97	40491	III	
7		12			2467.16	40520	III	
		2h			2463.75	40576	III	
3	20	6			2463.53	40580	I	$4p\,{}^3P^{\circ}_2$ - $8d\,{}^3D$

TABLE X (a)(continued)

H	M	P	V	L	λ	ν		Classification
		8h			2462.14	40603	III	
		5h			2460.45	40631	II	
		1			2455.98	40705	II	
		2h			2451.30	40782	III	
		15			2450.39	40797	III	
		00			2448.20	40834	III	
		7			2445.04	40887	III	
7		20			2442.14	40935	III	
3	(3)	1			2440.19	40968	I	$4p\,^3P_1^\circ$ - $8d\,^3D$
		8h			2438.30	41000	III	
		6h			2437.61	41011	III	
		8h			2434.40	41065	III	
	8	0h			2430.91	41124	I	$4p\,^3P_2^\circ$ - $9d\,^3D$
		3			2429.54	41178	I	
	(10)	0			2428.93	41159	I	$4p\,^3P_0^\circ$ - $8d\,^3D$
10		30h			2427.06	41190	III	
6		25h			2423.45	41251	III	
		2			2421.73	41280	I	$4p\,^3P_2^\circ$ - $11s\,^3S_1$
		5h			2420.85	41295	III	
10		25h			2418.86	41329	III	
		7			2414.74	41400	II	
		0h			2410.53	41472	I	
6		15			2408.55	41506	III	
	5	0h			2408.13	41513	I	$4p\,^3P_1^\circ$ - $9d\,^3D$
		12h			2405.32	41562	III	
		1			2404.88	41569	I	
		2h			2401.58	41627	III	
	3	1			2399.23	41667	I	$4p\,^3P_1^\circ$ - $11s\,^3S_1$
		3			2398.88	41673	III	
		2			2396.63	41713	III	
		1			2395.63	41730	I	
	15h	0			2393.80	41762	I	$4p\,^3P_2^\circ$ - $11d\,^3D$
		7			2393.11	41774	III	
5	(5)	3			2390.18	41825	II	$4s^2\,^2D_{1\frac{1}{2}}$ - $4p'\,^4F_{2\frac{1}{2}}$
		00			2388.62	41852	I	$4p\,^3P_0^\circ$ - $11s\,^3S_1$
	(2)	2		5h	2383.98	41934	II	$5s\,^2S_{\frac{1}{2}}$ - $4p''\,^2P_{1\frac{1}{2}}^\circ$
	4	1		1	2382.00	41969	I	$4p\,^3P_2^\circ$ - $12d\,^3D$
		4		8	2371.31	42158	III	
		0			2368.15	42214	I	
		2		3h	2366.46	42244	III	

TABLE X (a)(continued)

H	M	P	V	L	λ	ν		Classification
	2	0		1h	2361.11	42340	I	$4p\,^3P^\circ_0 - 11d\,^3D$
		2			2354.78	42454	I	
		10		15	2348.30	42571	III	
		00			2348.25	42572	I	
		6		8	2347.67	42582	III	
		2		3	2346.62	42602	II	$4s\,^2D_{2\frac{1}{2}} - 4p'\,^4P_{1\frac{1}{2}}$
		0		1h	2343.47	42659	I	
		0			2334.78	42818	I	
		00			2332.77	42854	I	
		3			2321.03	43071	I	
		4h	15	10	2317.66	43134	IV	
	(3)	1		2h	2317.16	43143	I	
			00		2314.20	43198		
6		10h	15	30	2313.64	43209	III	
			2	1h	2308.76	43300	III	
		10h	25	15	2307.60	43322	III	
			3		2307.03	43332	III	
			1h		2306.40	43344	IV	
			1	1h	2300.32	43459	III	
			00		2299.24	43479		
		20	25	25	2296.82	43525	III	
			0		2293.29	43592	III	
			3	1h	2292.67	43604	III	
			1		2291.65	43623	III	
		15			2287.96	43694	I	
			0		2286.58	43720	III	
		1	10	3h	2286.00	43731	III	
		2	0h		2276.48	43914	I	
			00		2276.23	43919	I	
			2h		2273.20	43977	II	
			00		2271.72	44006	IV	
		1			2268.88	44061	I	
			00	00	2268.05	44077	I	
			00	00	2267.65	44085	II	
10	(10)	8	15	20	2265.25	44132	II	
		40	3	3	2264.94	44137	III	$4d\,^3F_2 - 4p'\,^3G^\circ_3$
	(10)	12	25	20	2252.82	44375	III	
		3	4	3	2246.95	44491	I	
		1			2246.02	44510	I	
		2	2	2	2242.58	44578	I	

TABLE X (a)(continued)

H	M	P	V	L	λ	ν		Classification
		10			2230.55	44818	I	
	(2)	4	25	15	2229.32	44843	III	
		1			2229.10	44847	IV	
		3			2228.14	44866	I	
			0		2219.46	45042	IV	
		1	2	1	2218.11	45070	II	
		2	8	8	2210.18	45231	II	
		30	0	1h	2203.51	45368	II	$5s\,^2S_{1/2} - 8p\,^2P^\circ$
		10			2194.54	45553	I	
			6h		2193.76	45570	III	
			3	1	2192.25	45601	II	
			5	3h	2190.10	45646	III	
			0	3	2189.64	45656	I	
			0		2184.70	45759	III	
			0		2184.40	45765	IV	
			10	8	2180.82	45840	III	
			0		2178.91	45880	IV	
			5	1	2175.46	45953	III	
			2	00	2173.80	45988	III	
			3	1h	2171.24	46042	III	
			2		2170.74	46053	IV	
			10	8h	2170.35	46061	III	
		0			2170.03	46068	I	
			00		2168.39	46103		
			0		2167.29	46126	III	$4d\,^3F_4 - 4p'\,^3D_3^\circ$
			0		2166.89	46135	III	
			00		2165.41	46166		
			00		2165.07	46173	III	$4d\,^3F_4 - 4p'\,^3F_3^\circ$
			2	0h	2163.46	46208	IV	
			4	0h	2162.52	46228	III	
			4	0h	2162.08	46237	III	
			00		2160.98	46261		
			8	3h	2156.80	46350	III	
			2		2155.30	46383	IV	
			3	1h	2153.25	46427	IV	
			3	1h	2152.98	46433	IV	
			1	1h	2150.64	46483	III	
			0	00	2148.96	46519	III	
			00		2148.50	46529		
			4	1h	2146.54	46572	III	

TABLE X (a)(continued)

H	M	P	V	L	λ	ν		Classification
		30	5	8	2144.41	46618	III	$4d'D_2 - 4p'\,{}^3G^\circ_3$
100	800	500	500	500	2138.56	46746	I	$4s^2\,{}^1S_0 - 4p\,{}^1P^\circ_1$
			3	6	2135.710	46808.1	III	
			5	6	2135.608	46810.3	IV	
			0	1	2129.302	46948.9	IV	
			0	2	2127.743	46983.3	II	
			0	1	2125.788	47026.5	I	
			0h	2	2123.872	47069.0	I	
			1	2	2122.764	47093.5	II	$4s^2\,{}^2D_{1\frac{1}{2}} - 4p'\,{}^4D^\circ_{\frac{1}{2}}$
			5	6	2122.546	47098.4	I	
			0h		2116.497	47232.9		
			0h		2115.301	47259.6		
			1	2	2111.877	47336.2		
			2h	1h	2109.442	47390.9	III	
7			25	25	2104.236	47508.1	II	
			15		2103.920	47515.2	II	
			10	5	2103.536	47523.9	III	
		600	100	300	2101.978	47559.1	II	$4p\,{}^2P^\circ_{1\frac{1}{2}} - 4d\,{}^2D_{1\frac{1}{2}}$
8		800	200	800	2099.733	47610.0	II	$4p\,{}^2P^\circ_{1\frac{1}{2}} - 4d\,{}^2D_{2\frac{1}{2}}$
			10	10	2097.800	47653.9	II	
	(2)			5	2097.614	47658.1	II	
5			25	25	2096.747	47677.8	II	
—			15h		2089.265	47848.5	III	
6			15	20	2087.166	47896.6	I	
			50h	100h	2086.710	47907.1	I	
			3	4	2084.642	47954.6	I	
				3	2080.93	48040	IV	
				3	2079.82	48066	II	$4s^2\,{}^2D_{1\frac{1}{2}} - 4p'\,{}^2P_{1\frac{1}{2}}$
6			15	25	2078.891	48087.2	III	
			2		2077.621	48116.6	II	
			2		2076.428	48144.3	II	
			2	2	2076.217	48149.2	II	
			15	10	2071.181	48266.2	III	
				50h	2069.79	48298.7	I	
				15h	2068.204	48335.7		
2			200	500	2064.095	48431.9	II	$4p\,{}^2P^\circ_{\frac{1}{2}} - 4d\,{}^2D_{1\frac{1}{2}}$
7	100		200	800	2061.906	48483.3	II	$4s\,{}^2S_{\frac{1}{2}} - 4p\,{}^2P^\circ_{\frac{1}{2}}$
			10		2059.975	48528.8	III	
15			20	25	2056.662	48606.9	II	
			2h	2	2054.96	48647	II	

TABLE X (a)(continued)

H	M	V	L	λ	ν		Classification
		1h		2053.275	48677.6	III	
		2h	2h	2052.62	48703		
		1h	3	2048.837	48792.5		
		2h	5	2048.293	48805.5		
			4	2047.573	48822.6	I	
			2	2047.307	48829.0	I	
		3		2043.844	48911.7	II	
		1		2043.637	48916.7	II	
		8h	15h	2040.655	48983.6	II	
		10	8	2039.483	49016.3	III	
10		6	10	2039.212	49022.8	II	$4s^2\,^2D_{2\frac{1}{2}} - 4p'\,^4D^\circ_{2\frac{1}{2}}$
		2h	1	2037.625	49061.0	III	
		1	0	2036.969	49076.8	IV	
			1	2036.768	49081.6	II	
		1	1	2035.716	49107.0	II	
		2h		2033.518	49160.1	II	
		10h	10h	2029.414	49259.5	II	
8	200	300	1000	2025.375	49357.7	II	$4s\,^2S_{\frac{1}{2}} - 4p\,^2P^\circ_{1\frac{1}{2}}$
		1h		2019.998	49489.0	III	$4d\,^3G_4 - 4p'\,^3F^\circ_4$
			10h	2019.343	49505.1	II	
		4	8	2016.399	49577.4	III	
10		12	15	2011.854	49689.4	II	
		6	10	2011.62	49695	IV	

TABLE X (b)

WAVELENGTHS IN THE REGION FROM 2000 Å TO 987 Å (VACUUM)

Legend:

H: Intensities given by Kayser (6).

K: Intensities given by Kelly (7).

P: Intensities from exposure 1.

V: Intensities from exposure 3.

L: Intensities from exposure 2.

λ: Wavelengths (vacuum) in Ångstroms.

ν: Wavenumbers (vacuum) in reciprocal centimeters.

H	K	V	L	λ	ν		Classification
		3	4	1998.957	50026.1	III	
		2		1997.47	50063	III	
		5	10	1996.891	50077.8	III	
		3h	8h	1993.420	50165.0	I	
		1	1h	1990.486	50239.0	II	
		1		1989.09	50274	IV	
			1	1988.125	50298.6	IV	
		3	3	1987.846	50305.7	IV	
		10	25	1986.970	50327.9	II	
		5h	8	1985.578	50363.2	II	
		1h		1984.878	50380.9	IV	
		0		1983.111	50425.8	IV	
		1h		1982.377	50444.5	IV	
	2	15	30	1982.143	50450.4	II	
		1h		1979.560	50516.3	IV	
		0h		1978.123	50553.0		
		4	4	1977.157	50577.7		
		0		1976.887	50584.6	IV	
	0	2		1974.875	50636.1	IV	
		3	1	1974.430	50647.5	II	
			2	1974.27	50652	III	$4d\,{}^1F_3 - 4p'\,{}^3D^\circ_2$
		0		1973.000	50684.2	I	
	4	15	25	1969.376	50777.5	II	$4s^2\,{}^2D_{2\frac{1}{2}} - 4p'\,{}^2P^\circ_{1\frac{1}{2}}$
	0		3	1968.960	50788.2	IV	
		15h	20h	1964.495	50903.7	I	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
		5h	8	1963.100	50939.8	IV	
		2h	2h	1957.204	51093.3	I	
		12h	15h	1954.894	51153.7	III	
		15	20	1953.004	51203.2	II	
		10h	12h	1951.933	51231.3	II	
			1h	1950.103	51279.4	IV	
	3	1	2	1948.437	51323.2	II	$4s^2\,{}^2D_{2\frac{1}{2}}$ – $4p'\,{}^2D^\circ_{1\frac{1}{2}}$
		5	12	1945.594	51398.2	II	
		2	1	1944.140	51436.6	III	
	3		2	1942.253	51486.6	II	$4s^2\,{}^2D_{2\frac{1}{2}}$ – $4p'\,{}^2F^\circ_{3\frac{1}{2}}$
		5	10	1940.410	51535.5	I	
		1h		1930.51	51800	I	
		12	8	1929.78	51819	III	
	4	2	4	1929.70	51822	II	$4s^2\,{}^2D_{1\frac{1}{2}}$ – $4f\,{}^2F^\circ_{2\frac{1}{2}}$
	1	2h	1	1921.05	52055	II	
		5	7	1920.277	52075.8	II	
		10		1919.085	52108.2	III	
	5	25	40	1919.025	52109.8	II	$4s^2\,{}^2D_{2\frac{1}{2}}$ – $4p'\,{}^2D^\circ_{2\frac{1}{2}}$
		1h		1917.625	52147.8	III	$5s\,{}^1D_2$ – $4p'\,{}^3D^\circ_2$
		1h		1917.161	52160.5	III	
		1h		1915.113	52216.2		
		3h	4	1914.809	52224.5	II	
		10	7	1907.158	52434.0	IV	
		8h	3h	1901.511	52589.8		
	1		1h	1898.90	52662.1	II	
		2h		1895.07	52768		
		10h	4	1894.269	52790.8	I	
		10h	2h	1892.819	52831.3	I	
		3h		1890.704	52890.4		
		1h		1889.08	52936		
		1h		1888.443	52953.7		
		4		1885.28	53043	IV	
		4		1885.04	53049	IV	
		12	10	1881.848	53139.3	IV	
		0	1	1878.473	53234.7	I	
		5	3	1877.962	53249.2	IV	
			1	1877.425	53264.4	I	
		3hh	3hh	1875.2	53327		
		10	12	1872.099	53416.0	III	
		3h	3h	1867.977	53533.8	II	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification	
		10	8	1866.059	53588.0	III	$4d\,{}^3D_2$ –	$4p'\,{}^3F^\circ_2$
			1	1865.6	53602	I		
		20	20	1864.083	53645.7	II		
		3	2	1862.773	53683.4	I		
		0	0	1856.782	53856.6			
		4	3	1854.700	53917.1	III		
			0	1853.66	53947			
		2h	1	1850.734	54032.6	I		
		0h	0	1850.10	54051	I		
	0	5	4	1849.767	54060.9	IV		
		1h		1848.47	54099	IV		
		3h	4	1847.541	54126.0	I		
	0	5	5	1844.879	54204.1	III		
		1		1843.91	54233			
4	5	25	40	1839.295	54368.7	III	$4s\,{}^1D_2$ –	$4p\,{}^3P^\circ_2$
8	5	4	4	1836.638	54447.3	II	$4s^2\,{}^2D_{1\frac{1}{2}}$ –	$6p\,{}^2P^\circ_{\frac{1}{2}}$
		6	12	1836.008	54466.0	III	$5s\,{}^3D_1$ –	$4p'\,{}^3F^\circ_2$
		5	3	1835.096	54493.1	IV		
		5	2	1834.922	54498.2	IV		
		2h	2	1834.234	54518.7	II	$4s^2\,{}^2D_{1\frac{1}{2}}$ –	$6p\,{}^2P^\circ_{1\frac{1}{2}}$
3	4	25	40	1833.540	54539.3	II	$4s^2\,{}^2D_{2\frac{1}{2}}$ –	$4f\,{}^2F^\circ_{3\frac{1}{2}}$
		15h	6h	1831.348	54604.7	II		
			1	1830.280	54636.4	I		
		8h	5h	1829.185	54669.2	I		
			2	1826.199	54758.6	I		
		15	10	1824.737	54802.4	III	$4d\,{}^1F_3$ –	$4p''\,{}^3G^\circ_4$
		1		1821.653	54895.2	IV		
			1	1821.09	54912			
			1	1820.79	54921			
		1	1	1820.318	54935.5	I		
		12h	8	1816.457	55052.2	I		
		10	6	1814.192	55121.0	IV		
	2	25	20	1811.048	55216.6	II		
		3		1808.915	55281.8	II		
		1h		1802.43	55481			
	0	1h		1801.96	55495			
		5	4	1801.681	55503.7	IV		
		2	1	1800.082	55553.0	IV		
		15	15	1797.651	55628.2	II		
	2	2	2	1796.657	55658.9	II		

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
		1	1	1795.115	55706.7	II	
		10		1790.763	55842.1	II	
		3h	1h	1789.572	55879.3		
		4	2	1777.212	56267.9	II	
		5	4	1774.000	56369.8	II	
			0	1771.990	56433.7	III	$4d\,^3F_3 - 4p''\,^3D^\circ_3$
			0	1769.666	56507.8		
7	4	30	50	1767.692	56571.0	III	$4s\,^1D_2 - 4p\,^3P^\circ_1$
		2h	1	1763.035	56720.4		
		10	15	1762.195	56747.4	I	
			1	1756.633	56927.1		
		20	35	1753.811	57018.7	III	$4s\,^3D_1 - 4p\,^2P^\circ_2$
		1	8	1751.816	57083.6	II	
9	6	50	80	1749.630	57154.9	III	$4s\,^3D_2 - 4p\,^3F^\circ_3$
		10	1	1747.80	57215	IV	
			4	1742.290	57395.7	III	$4d\,^1F_3 - 4p''\,^1F^\circ_3$
			2	1741.919	57408.0	II	
		3	4	1737.865	57541.9	I	
		2	3	1736.044	57602.2	I	
	2	20	35	1735.618	57616.4	II	
		2	2	1732.950	57705.1	II	
		0		1724.967	57972.1	III	$4d\,^1F_3 - 4p''\,^3F^\circ_3$
		1	1	1721.671	58083.1	III	$4d\,^3D_3 - 4p''\,^3D^\circ_3$
		4	4	1715.758	58283.3	II	
		1	1	1714.464	58327.3		
		2	3	1713.247	58368.7	II	
6	6	40	80	1706.648	58594.4	III	$4s\,^3D_2 - 4p\,^3P^\circ_2$
	3	25	40	1695.386	58983.6	III	$4s\,^1D_2 - 4p\,^3F^\circ_2$
			0	1691.962	59103.0		
			1h	1690.93	59139		
7	6	40	50	1688.494	59224.4	III	$4s\,^3D_1 - 4p\,^3P^\circ_1$
		1	3	1686.480	59295.1	II	
		1	1	1683.483	59400.7	II	
		0	1	1682.638	59430.5	IV	
9	7	50	100	1673.052	59771.0	III	$4s\,^3D_2 - 4p\,^3P^\circ_2$
			4	1670.770	59852.6	I	
			2	1670.563	59860.1	IV	
			10	1666.745	59997.2	III	
			2	1665.046	60058.4	III	
		2	8	1664.311	60084.9	II	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification	
			1	1663.330	60120.4	III		
			2	1662.746	60141.5	III	$4d\,^1G_4$ -	$4p''\,^3G^\circ_3$
			2	1660.773	60212.9			
			4	1655.024	60422.1	III	$4d\,^1D_2$ -	$4p''\,^3F^\circ_3$
			4	1653.375	60482.4	III		
			1	1653.024	60495.2	II		
			2	1652.931	60498.3	II		
			1	1652.58	60512	II		
8	6	30	50	1651.748	60541.9	III	$4s\,^3D_1$ -	$4p\,^3P^\circ_0$
		4	12	1650.217	60598.1	II		
			1	1649.925	60608.8	II		
		0	3	1649.054	60640.8	III		
			1	1648.412	60664.4	III		
			δ 2,1	1647.512	60697.6			
			3	1645.875	60758.0			
		6	30	1645.404	60775.4	III		
10	6	30	80	1644.817	60797.2	III	$4s\,^3D_2$ -	$4p\,^3P^\circ_1$
			10	1640.443	60959.2	III		
10	6	30	100	1639.335	61000.4	III	$4s\,^1D_2$ -	$4p\,^3D^\circ_3$
		0	4	1638.244	61041.0			
			1	1635.63	61139	IV		
		0h	8	1635.242	61153.0	III		
			1	1633.49	61219	IV		
			2	1632.609	61251.7	II		
			8	1631.527	61292.3	II		
			8	1631.366	61298.3	III	$4d\,^3P_1$ -	$4p''\,^3D^\circ_1$
		2	10	1630.119	61345.2	II		
10	7	30	100	1629.201	61379.8	III	$4s\,^3D_2$ -	$4p\,^3F^\circ_3$
		3h	20	1628.470	61407.3	III		
			1	1626.203	61492.9			
			2	1625.747	61510.2	III		
			2	1624.103	61572.4	III		
			2	1623.448	61597.3	II		
5	6		80	1622.500	61633.3	III	$4s\,^3D_1$ -	$4p\,^3F^\circ_2$
			2	1621.959	61653.8	II		
			2	1621.570	61668.6	III	$4d\,^3D_2$ -	$4p''\,^3D^\circ_1$
8	5	20	50	1619.604	61743.5	III	$4s\,^1D_2$ -	$4p\,^3D^\circ_2$
		2	20	1617.684	61816.8	II		
			1	1616.107	61877.1			
			1	1615.993	61881.5			

TABLE X (b) (continued)

H	K	V	L	λ	ν		Classification
			2	1615.308	61907.7		
			8	1614.409	61942.2		
		1	5	1613.918	61961.0	II	
			1	1613.119	61991.7	III	
		1	20	1611.880	62039.4	II	
			1	1611.491	62054.3		
			2	1610.946	62075.3	II	
			0	1610.22	62103		
			6	1609.390	62135.3	II	
		2	25	1608.827	62157.1	II	
			1	1607.246	62218.2	III	
			4	1606.882	62232.3	IV	
		1	20	1606.079	62263.4	II	
			0	1605.53	62285	IV	
			1	1605.36	62291	IV	
			3	1604.464	62326.1	IV	
			5	1604.345	62330.7	II	
		1	8	1603.490	62364.0	III	$5s\,{}^{1}D_{2}$ - $4p''\,{}^{3}D^{\circ}_{1}$
	0		15	1603.318	62370.7	II	
			1	1602.444	62404.7	III	
			1	1602.22	62414	IV	
	1		5	1601.695	62433.9	III	
9	5	40	30	1600.871	62466.0	III	$4s\,{}^{1}D_{2}$ - $4p\,{}^{1}F^{\circ}_{3}$
8	5	35	30	1598.524	62557.7	III	$4s\,{}^{3}D_{3}$ - $4p\,{}^{3}F^{\circ}_{3}$
			1	1597.835	62584.7		
			2	1596.913	62620.8	III	$5s\,{}^{3}D_{2}$ - $4p''\,{}^{3}F^{\circ}_{2}$
			15	1595.734	62667.1	II	
	0		15	1595.298	62684.2	IV	
		1	20	1595.032	62694.7	III	
			1	1593.717	62746.4		
	2		6	1592.423	62797.4	III	
			0	1592.118	62809.4	III	
			15	1590.131	62887.9	I	
10	5	1	25h	1589.548	62911.0	I	$4s^{2}\,{}^{1}S_{0}$ - $5p\,{}^{1}P^{\circ}_{1}$
			1	1588.381	62957.2	III	
			3	1587.840	62978.6	III	$4d\,{}^{1}G_{4}$ - $4p''\,{}^{3}F^{\circ}_{4}$
			8	1586.436	63034.4	IV	
			4	1585.223	63082.6	III	$5s\,{}^{3}D_{3}$ - $4p''\,{}^{3}F^{\circ}_{2}$
			2	1584.669	63104.7	III	
			3	1583.938	63133.8	II	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
			3	1583.092	63167.5	III	
10	4	25	30	1582.048	63209.2	III	$4s\,^3D_2 - 4p\,^3F^\circ_2$
15	15	35	50	1581.515	63230.5	III	$4s\,^3D_3 - 4p\,^3F^\circ_4$
			2	1579.930	63293.9	III	
			2	1578.856	63337.0	III	
			4h	1578.344	63357.6	III	$5s\,^3D_3 - 4p''\,^3D^\circ_2$
			4	1577.528	63390.3	IV	
			2	1577.304	63399.3	II	
			5	1576.750	63421.6	III	
			2	1575.849	63457.9	II	
			0	1575.710	63463.5	III	
			1h	1574.868	63497.4		
			1h	1574.124	63527.4		
			2	1573.803	63540.4	II	
			20h	1573.016	63572.2	II	
			4	1572.437	63595.6	III	
			4	1571.380	63638.3	II	
			2	1570.852	63659.7	III	
			2	1570.107	63689.9	II	
			10	1569.351	63720.6	IV	
			8	1568.890	63739.3	III	
			8	1567.900	63779.6	IV	
			4	1567.308	63803.7	III	
			0	1567.028	63815.1	III	
			4	1566.801	63824.3	IV	
			2	1566.179	63849.7	IV	
			2	1565.672	63870.3	III	$4d\,^3S_1 - 4p''\,^3D^\circ_2$
			2	1564.945	63900.0	IV	
			3	1564.112	63934.0	III	
			8	1563.900	63942.7		
9	4	6	20	1562.535	63998.6	III	$4s\,^1D_2 - 4p\,^1P^\circ_1$
			2	1561.90	64025	IV	
			6	1559.731	64113.6	IV	
			8	1559.441	64125.6	III	
			10	1559.047	64141.8	III	
			1	1558.904	64147.6	IV	
			3	1557.673	64198.3	III	
			2	1556.181	64259.9	III	
			4	1556.050	64265.3	III	
	0		15	1555.787	64276.2	II	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
			6	1555.238	64298.8	III	
			5	1554.735	64319.6	II	
			3	1554.177	64342.7	II	
			5	1553.809	64358.0	III	
			15	1553.572	64367.8	II	
7	3		10	1553.098	64387.4	III	$4s\,^3D_2$ – $4p\,^3F^\circ_2$
	5	3	30	1552.933	64394.3	III	$4s\,^3D_1$ – $4p\,^3D^\circ_2$
7	7	6	30	1552.291	64420.9	III	$4s\,^1D_2$ – $4p\,^1D^\circ_2$
			1	1551.031	64473.2	II	$4s^2\,^2D_{2\frac{1}{2}}$ – $5f\,^2F^\circ_{3\frac{1}{2}}$
			15	1550.747	64485.1	IV	
			2	1549.838	64522.9	III	
			7	1548.972	64559.0	II	
			5	1548.426	64581.7	II	
			10	1547.800	64607.8	II	
			15	1547.001	64641.2	II	
	2		25	1546.655	64655.7	II	
			1	1546.452	64664.2	II	
			4	1546.071	64680.1	III	
			10	1545.094	64721.0	II	
			20	1544.925	64728.1	II	
			6	1543.919	64770.2	IV	
			15	1543.428	64790.9	II	
			20	1543.039	64807.2	II	
			8	1542.515	64829.2	II	
			1	1542.236	64840.9	III	
	1		20	1541.708	64863.1	III	$5s\,^3D_2$ – $4p''\,^3D^\circ_1$
			25	1540.904	64897.0	II	
			12	1540.143	64929.0	II	$4s^2\,^2D_{1\frac{1}{2}}$ – $4p''\,^2P^\circ_{1\frac{1}{2}}$
			12	1539.834	64942.1	II	
			4	1539.369	64961.7	IV	
			7	1539.069	64974.4	IV	
			15	1536.727	65073.4	II	
			20	1535.809	65112.3	II	
20	10		25	1535.107	65142.0	II	$4p\,^2P^\circ_{\frac{1}{2}}$ – $6s\,^2S_{\frac{1}{2}}$
			6	1533.682	65202.6	IV	
10	3		4	1533.086	65227.9	III	$4s\,^3D_2$ – $4p\,^3D^\circ_2$
			3	1532.918	65235.1	III	
			2	1532.160	65267.3	III	
			6	1532.025	65273.1	II	
			10	1531.382	65300.5	II	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
			20	1531.074	65313.6	II	
			12	1530.608	65333.5	II	
	0		7	1529.839	65366.4	IV	$a\,^2F_{3\frac{1}{2}}$ – $z\,^4D^o_{3\frac{1}{2}}$
			5	1528.752	65412.8	III	
			15	1528.554	65421.3	II	
	3		25	1527.902	65449.2	II	
			5	1526.943	65490.3	III	
	2		20	1526.854	65494.2	III	
			4	1525.56	65550	IV	
	4		30	1523.873	65622.3	II	$4s^2\,^2D_{2\frac{1}{2}}$ – $7p\,^2P^o_{1\frac{1}{2}}$
	3		2	1522.95	65662	III	
			25	1521.289	65733.7	II	
			15	1520.985	65746.9	II	
			10	1520.740	65757.5	III	
			20	1520.520	65767.0	II	
			5	1520.017	65788.7	III	
			6	1519.442	65813.6	III	
			6	1518.634	65848.7	II	
8	7		50	1515.844	65969.8	III	$4s\,^3D_2$ – $4p\,^3D^o_2$
10	5		25	1514.787	66015.9	II	$4p\,^2P^o_{\frac{1}{2}}$ – $6s\,^2S_{\frac{1}{2}}$
			15	1514.478	66029.4	II	
			15	1513.505	66071.8	II	
			1	1511.886	66142.6	III	
			15	1511.708	66150.4	II	
	2		30	1510.355	66209.6	II	$4s^2\,^2D_{1\frac{1}{2}}$ – $4p''\,^2D_{1\frac{1}{2}}$
	2		25	1508.647	66284.6	II	
			5	1507.869	66318.8	II	
8	8		50	1505.900	66405.5	III	$4s\,^3D_3$ – $4p\,^3D^o_3$
			1	1504.07	66486	II	
			15	1503.649	66504.9	II	
			15	1503.100	66529.2	II	
6	5		40	1500.419	66648.0	III	$4s\,^3D_1$ – $4p\,'P^o_1$
6	5		40	1499.400	66693.4	III	$4s\,^3D_2$ – $4p\,'F^o_3$
			2	1499.074	66707.8	II	
5	5		30	1498.770	66721.4	III	$4s\,^3D_1$ – $4p\,^3D^o_1$
			25	1497.387	66783.0	II	
	3		50h	1493.193	66970.6	II	
	2		8	1492.128	67018.4	II	
7	1		50	1490.939	67071.8	III	$4s\,^3D_1$ – $4p\,'D^o_2$
	3		50	1486.064	67291.9	II	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification	
	0		6	1483.282	67418.1	III	$4p\,^1D^\circ_2$ –	$5s\,^3D_2$
	2		20	1482.145	67469.8	II		
			15	1481.836	67483.9	IV		
			15	1481.22	67512	IV	$a\,^2F_{2\frac{1}{2}}$ –	$z\,^4G^\circ_{3\frac{1}{2}}$
	3		50	1478.255	67647.3	II	$4s^2\,^2D_{2\frac{1}{2}}$ –	$4p'\,^2P^\circ_{1\frac{1}{2}}$
	3		50	1477.003	67704.7	I		
	0		25	1475.599	67769.1	III	$4p\,^3D^\circ_1$ –	$5s\,^3D_2$
8	7		40	1473.409	67869.8	III	$4s\,^3D_3$ –	$4p\,^1F^\circ_3$
			1	1472.33	67920	III		
	1		20	1471.891	67939.8	I		
	1		4	1471.232	67970.2	III	$4p\,^1P^\circ_1$ –	$4d\,^1S_0$
			1	1470.462	68005.8	III		
			0	1470.048	68025.0	III		
			0	1468.978	68074.5	I	$4s^2\,^1S_0$ –	$6p\,^3P^\circ_1$
			4	1467.858	68126.5	II		
			5	1467.486	68143.8	III		
			1	1466.655	68182.4			
4	3		30	1465.748	68224.6	III	$4s\,^3D_2$ –	$4p\,^1P^\circ_1$
			2	1465.43	68239	IV		
5	4		30	1464.188	68297.2	III	$4s\,^3D_2$ –	$4p\,^3D^\circ_1$
	1		15h	1462.708	68366.4	II	$4s^2\,^2D_{1\frac{1}{2}}$ –	$8p\,^2P^\circ$
			2	1460.623	68463.9	II		
	3		25	1459.968	68494.7	IV	$a\,^2F_{3\frac{1}{2}}$ –	$z\,^4G^\circ_{4\frac{1}{2}}$
			3	1459.004	68539.9	II		
	4		10	1457.537	68608.9	I	$4s^2\,^1S_0$ –	$6p\,^1P^\circ_1$
10	7		25	1457.410	68614.9	II	$4s\,^2P^\circ_{1\frac{1}{2}}$ –	$5d\,^2D_{1\frac{1}{2}}$
50	8		40	1456.923	68637.8	II	$4p\,^2P^\circ_{1\frac{1}{2}}$ –	$5d\,^2D_{2\frac{1}{2}}$
8			50	1456.716	68647.6	III	$4s\,^3D_2$ –	$4p\,^1D^\circ_2$
			7	1455.634	68698.6	IV	$a\,^2F_{2\frac{1}{2}}$ –	$z\,^4G^\circ_{2\frac{1}{2}}$
			7	1454.480	68748.4			
	4		15	1451.160	68910.4	III	$4p\,^1F^\circ_3$ –	$5s\,^3D_3$
	4		30	1450.770	68928.9	II	$4s^2\,^2D_{2\frac{1}{2}}$ –	$4p''\,^2D^\circ_{1\frac{1}{2}}$
			3	1449.850	68972.7	III	$4p\,^1D^\circ_2$ –	$4d\,^1D_2$
	0		15	1449.524	68988.2	IV		
	0		3	1446.932	69111.8	III	$4p\,^3D^\circ_2$ –	$4d\,^3S_1$
	2		6	1446.103	69151.4	III	$4p\,^1D^\circ_2$ –	$4d\,^3G_3$
	2		30	1445.072	69200.7	II		
	2		25	1442.522	69323.0	III	$4p\,^3D^\circ_1$ –	$4d\,^1D_2$
	0		15	1441.499	69372.2	III	$4p\,^1F^\circ_3$ –	$5s\,^3D_1$
30	8		30	1439.078	69488.9	II	$4p\,^2P^\circ_{\frac{1}{2}}$ –	$5d\,^2D_{1\frac{1}{2}}$

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
			0	1437.140	69582.6		
			0	1437.017	69588.6		
	1		20	1436.582	69610.6	IV	
	0		3	1436.121	69632.0	III	$4p\,{}^3D^\circ_2 - 5s\,{}^3D_3$
			20	1433.888	69740.5	III	$4p\,{}^1D^\circ_2 - 5s\,{}^3D_1$
5	5		30	1432.129	69826.1	III	$4s\,{}^3D^\circ_3 - 4p\,{}^1D_2$
			6	1431.51	69856	III	
			2h	1431.16	69873	I	
			30	1430.121	69924.2	III	$4p\,{}^1D^\circ_2 - 5s\,{}^1D_2$
			20	1427.905	70032.7	III	
			2	1427.783	70038.7	IV	$a\,{}^2F_{3\frac{1}{2}} - z\,{}^4G^\circ_{3\frac{1}{2}}$
	2		25	1426.624	70095.6	III	$4p\,{}^3D^\circ_2 - 5s\,{}^3D_2$
			25	1425.241	70163.6	III	$4p\,{}^1P^\circ_1 - 5s\,{}^3D_1$
			5	1425.030	70174.0	III	
			25	1422.992	70274.5	III	$4p\,{}^3D^\circ_1 - 5s\,{}^1D_2$
			12	1421.525	70347.0	III	$4p\,{}^1P^\circ_1 - 5s\,{}^1D_2$
			25	1420.941	70375.9	III	$4p\,{}^3D^\circ_3 - 5s\,{}^3D_3$
	0		30	1419.977	70423.7	I	
			2	1419.584	70443.2	IV	$a\,{}^2F_{2\frac{1}{2}} - z\,{}^4F^\circ_{3\frac{1}{2}}$
			25	1418.696	70487.3	IV	
			5	1417.893	70527.2	III	
	0		1	1416.066	70618.2	III	$4p\,{}^1D^\circ_2 - 4d\,{}^3D_2$
			8	1413.898	70726.5	IV	
			1	1413.011	70770.9	I	
			0	1412.762	70783.3	I	
	0		12	1411.679	70837.6	III	$4p\,{}^3D^\circ_3 - 5s\,{}^3D_2$
			1	1411.312	70856.1	III	
	2		15	1411.049	70869.3	IV	
			4h	1410.360	70903.9	I	
	00		6	1409.887	70927.7	III	$4p\,{}^1F^\circ_3 - 4d\,{}^1D_2$
			4	1409.392	70952.6	IV	$a\,{}^4F_{3\frac{1}{2}} - z\,{}^4D^\circ_{3\frac{1}{2}}$
	1		25	1408.703	70987.3	III	$4p\,{}^1D^\circ_2 - 4p\,{}^3P_1$
			2	1407.189	71063.7	I	
	2		30	1406.348	71106.2	III	$4p\,{}^1F^\circ_3 - 4d\,{}^3G_3$
4			2	1404.107	71219.6	I	$4s^2\,{}^1S_0 - 7p\,{}^1P^\circ_1$
			2	1403.980	71226.1	IV	$a\,{}^2F_{3\frac{1}{2}} - z\,{}^4G^\circ_{2\frac{1}{2}}$
	3		1	1402.766	71287.7	IV	
			6	1402.519	71300.3	IV	
	1		30	1401.792	71337.3	III	$4p\,{}^3D^\circ_1 - 4d\,{}^3P_1$
	0		6	1400.136	71421.6	IV	$a\,{}^2F_{2\frac{1}{2}} - z\,{}^4F^\circ_{2\frac{1}{2}}$

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
	1		20	1395.678	71649.8	III	$4p\,^3D^\circ_2$ - $4d\,^3D_2$
	3		25	1394.932	71688.1	III	$4p\,^1F^\circ_3$ - $4d\,^3P_2$
			10	1394.522	71709.2	IV	$a\,^2F_{2\frac{1}{2}}$ - $z\,^4F^\circ_{1\frac{1}{2}}$
	3		1	1393.761	71748.3	III	
			3	1393.491	71762.2	III	$4p\,^1D^\circ_2$ - $4d\,^3F_3$
	2		25	1393.070	71783.9	IV	($a\,^2F_{3\frac{1}{2}}$ - $z\,^4F^\circ_{4\frac{1}{2}}$
							($a\,^4F_{2\frac{1}{2}}$ - $z\,^4D^\circ_{2\frac{1}{2}}$
	0		1	1392.188	71829.4	III	$4p\,^3D^\circ_2$ - $4d\,^3G_3$
			2	1391.812	71848.8	III	
	2		25	1391.224	71879.2	III	$4p\,^1F^\circ_3$ - $5s\,^1D_2$
	1		10	1390.404	71921.6	I	
	2		35	1389.634	71961.4	III	$4p\,^3D^\circ_3$ - $4d\,^3G_4$
			0	1389.078	71990.2	IV	$b\,^2D_{1\frac{1}{2}}$ - $z\,^4P^\circ_{1\frac{1}{2}}$
	0		15	1388.290	72031.1	IV	
7	7		40	1387.715	72060.9	II	
			15	1387.465	72073.9	III	$4p\,^1F^\circ_3$ - $4d\,^3D_3$
			25	1387.250	72085.1	III	
			15	1387.072	72094.3	IV	
			1	1386.311	72133.9	I	
	00		8	1384.354	72235.9	IV	
	00		8	1383.720	72269.0	III	
			1	1382.054	72356.1		
	00		1	1381.348	72393.1	III	($4p\,^3D^\circ_3$ - $4d\,^1D_2$
							($4p\,^3F^\circ_2$ - $5s\,^3D_3$
	00		12	1381.023	72410.1	III	$4p\,^3D^\circ_2$ - $4d\,^3P_2$
	1		1	1380.870	72418.1	IV	$a\,^4F_{1\frac{1}{2}}$ - $z\,^4D^\circ_{1\frac{1}{2}}$
	2		30	1379.179	72506.9	III	
			15	1377.944	72571.9	III	$4p\,^1F^\circ_3$ - $4d\,^3D_2$
6	5		40	1377.637	72588.1	IV	$a\,^4F_{4\frac{1}{2}}$ - $z\,^4D^\circ_{3\frac{1}{2}}$
	2		12	1377.374	72601.9	III	$4p\,^3D^\circ_2$ - $5s\,^1D_2$
	00		12	1375.978	72675.6	IV	
	3		20	1375.306	72711.1	IV	$a\,^2F_{2\frac{1}{2}}$ - $z\,^2G^\circ_{3\frac{1}{2}}$
	1		15	1374.647	72746.0	III	
	1		25	1373.709	72795.6	III	$4p\,^3D^\circ_2$ - $4d\,^3D_3$
	0		10	1372.576	72855.7	III	$4p\,^3F^\circ_2$ - $5s\,^3D_2$
			1	1371.637	72905.6		
	1		10	1371.185	72929.6	IV	$b\,^2D_{1\frac{1}{2}}$ - $z\,^4P^\circ_{1\frac{1}{2}}$
			6	1370.550	72963.4	III	$4p\,^3P^\circ_0$ - $4d\,^3S_1$
			6	1370.411	72970.8	IV	$a\,^2F_{3\frac{1}{2}}$ - $z\,^4F^\circ_{3\frac{1}{2}}$
	5		25	1369.506	73019.0	IV	$a\,^2F_{3\frac{1}{2}}$ - $z\,^2G^\circ_{4\frac{1}{2}}$

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification	
			6	1368.166	73090.6	IV	$a^{2}F_{2\frac{1}{2}}$ -	$z^{2}D^{\circ}_{2\frac{1}{2}}$
	2		20	1368.068	73095.8	III	$4p\,^{3}D^{\circ}_{1}$ -	$4d\,^{3}F_{2}$
	2		12	1366.990	73153.4	III	$4p\,^{3}D^{\circ}_{3}$ -	$4d\,^{3}P_{2}$
	3		10	1366.691	73169.4	II	$(4s\,^{2}D_{2\frac{1}{2}}$ -	$7f\,^{2}F^{\circ}_{2\frac{1}{2}}$
							(-	$7f\,^{2}F^{\circ}_{3\frac{1}{2}}$
	3		20	1365.702	73222.4	IV	$a^{4}F_{3\frac{1}{2}}$ -	$z^{4}D^{\circ}_{2\frac{1}{2}}$
			10	1365.262	73246.0	IV	$b^{2}D_{2\frac{1}{2}}$ -	$z^{4}P^{\circ}_{2\frac{1}{2}}$
	4		15	1364.349	73295.0	III	$4p\,^{3}D^{\circ}_{2}$ -	$4d\,^{3}D_{2}$
	5		15	1363.947	73316.6	IV		
	1		15	1363.444	73343.7	IV	$a^{2}F_{2\frac{1}{2}}$ -	$z^{2}F^{\circ}_{3\frac{1}{2}}$
	2	0	20	1362.535	73392.6	IV	$a^{4}F_{2\frac{1}{2}}$ -	$z^{4}D^{\circ}_{1\frac{1}{2}}$
	4		15	1362.010	73420.9	(III	$4p\,^{1}D^{\circ}_{2}$ -	$4d\,^{3}D_{1}$
						(IV	$a^{4}F_{1\frac{1}{2}}$ -	$z^{4}D^{\circ}_{\frac{1}{2}}$
	0		12	1361.351	73456.4	IV		
	4	1	25	1359.820	73539.2	III	$4p\,^{3}D^{\circ}_{3}$ -	$4d\,^{3}D_{3}$
	3	0	15	1359.619	73550.0	III	$4p\,^{3}F^{\circ}_{4}$ -	$5s\,^{3}D_{3}$
		0	10	1359.480	73557.5	IV		
	1		6	1358.619	73604.2	IV		
	4	1	25	1357.817	73647.6	IV		
	0		8	1356.532	73717.4	III	$4p\,^{1}F^{\circ}_{3}$ -	$4d\,^{3}F_{3}$
	4		20	1356.189	73736.0	IV		
	3		10	1355.982	73747.3	IV		
			2h	1355.876	73753.1	III	$4p\,^{3}D^{\circ}_{1}$ -	$4d\,^{1}P_{1}$
	0		2	1355.546	73771.0	III	$4p\,^{3}D^{\circ}_{1}$ -	$4d\,^{3}D_{1}$
	3		1	1355.229	73788.3	III	$(4p\,^{3}D^{\circ}_{1}$ -	$4d\,^{3}P_{0}$
							$(4p\,^{3}F^{\circ}_{4}$ -	$4d\,^{1}G_{4}$
	1		25	1354.223	73843.1	III	$4p\,^{1}P^{\circ}_{1}$ -	$4d\,^{3}D_{1}$
	2		8	1353.969	73856.9	III	$4p\,^{1}P^{\circ}_{1}$ -	$4d\,^{3}P_{0}$
	5	1	30	1352.900	73915.3	IV		
			8	1352.270	73949.7	IV	$a^{2}F_{3\frac{1}{2}}$ -	$z^{4}F^{\circ}_{2\frac{1}{2}}$
	2		15	1350.655	74038.2	III	$4p\,^{3}D^{\circ}_{3}$ -	$4d\,^{3}D_{2}$
			12	1350.397	74052.3	III		
	5	4	30	1349.882	74080.6	IV	$a^{4}F_{3\frac{1}{2}}$ -	$z^{4}G^{\circ}_{4\frac{1}{2}}$
			0	1349.290	74113.1			
		1	8	1348.351	74164.7	IV	$b^{2}D_{1\frac{1}{2}}$ -	$y^{2}F^{\circ}_{2\frac{1}{2}}$
	5	10	20	1347.949	74186.8	IV	$a^{4}F_{2\frac{1}{2}}$ -	$z^{4}G^{\circ}_{3\frac{1}{2}}$
	2	3	8	1347.311	74221.9	III	$4p\,^{3}F^{\circ}_{3}$ -	$5s\,^{3}D_{3}$
			8	1347.226	74226.6	I		
	0	8	25	1346.152	74285.8	III	$4p\,^{3}P^{\circ}_{1}$ -	$4d\,^{3}S_{1}$
			2	1345.628	74314.8			

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
			0	1345.421	74326.2		
			0	1345.125	74342.5		
			0	1344.723	74364.8		
	1	20	25	1344.079	74400.4	IV	$a^4F_{1\frac{1}{2}}$ – $z^4G^\circ_{2\frac{1}{2}}$
	6	20	25	1343.816	74415.0	III	$4p^3F^\circ_2$ – $4d^1D_2$
	0	30	30	1343.370	74439.7	III	$4p^3D^\circ_2$ – $4d^3F_3$
	2	15	25	1342.750	74474.0	IV	
	3	15	30	1340.192	74616.2	IV	
	2	20	30	1338.975	74684.0	III	$4p^3F^\circ_3$ – $5s^3D_2$
			1	1337.601	74760.7	III	
		4	12	1336.924	74798.6	IV	
		4		1335.119	74899.7		
		15	15	1333.310	75001.3	IV	$a^2F_{2\frac{1}{2}}$ – $z^2D^\circ_{1\frac{1}{2}}$
	4	15	15	1333.192	75008.0	IV	
	2	20	25	1331.839	75084.2	III	
		5	12	1331.428	75107.3	IV	
	3	6	10	1330.921	75135.9	III	$4p^3F^\circ_4$ – $4d^3G_4$
	3	10	25	1330.312	75170.3	IV	
		20	25	1330.164	75178.7	III	$4p^3F^\circ_2$ – $5s^3D_1$
	00	12	25	1329.957	75190.4	III	
	2	10	15	1329.103	75238.7	IV	$a^2F_{3\frac{1}{2}}$ – $z^2G^\circ_{3\frac{1}{2}}$
			12	1328.828	75254.3	II	
	1	5	10	1328.574	75268.7	III	$4p^3P^\circ_1$ – $5s^3D_2$
	5	40	30	1328.377	75279.8	III	$4p^3F^\circ_4$ – $4d^3G_5$
		10	8	1326.935	75361.6	III	$4p^3F^\circ_2$ – $5s^1D_2$
	4	15	20	1326.719	75373.9	IV	$a^4F_{2\frac{1}{2}}$ – $z^4G^\circ_{2\frac{1}{2}}$
	0	5h		1326.178	75404.7	I	
	1	2h	3	1325.827	75424.6	III	$4p^3D^\circ_2$ – $4d^3F_2$
			1	1324.821	75481.9	I	
		2	3	1323.904	75534.2	II	
	2	30	35	1323.524	75555.9	III	$4p^3F^\circ_2$ – $4d^3D_3$
		15	25	1322.437	75618.0	IV	$a^2F_{3\frac{1}{2}}$ – $z^2D^\circ_{2\frac{1}{2}}$
	4	15	25	1322.336	75623.8	IV	$a^4F_{3\frac{1}{2}}$ – $z^4G^\circ_{3\frac{1}{2}}$
	3	25	10	1321.194	75689.1	IV	$a^2F_{2\frac{1}{2}}$ – $z^2F^\circ_{2\frac{1}{2}}$
	4	25	10	1320.729	75715.8	IV	$a^4F_{4\frac{1}{2}}$ – $z^4G^\circ_{4\frac{1}{2}}$
			5	1319.401	75792.0		
	4	40	30 δ	1319.128	75807.7	III	$4p^3F^\circ_3$ – $4d^3G_4$
		10		1318.82	75825	III	
	4	30	25	1317.982	75873.6	IV	$a^2F_{3\frac{1}{2}}$ – $z^2F^\circ_{3\frac{1}{2}}$
			0	1316.667	75949.4	I	

TABLE X (b) (continued)

H	K	V	L	λ	ν		Classification
		3h	0	1316.468	75960.8	III	
		1		1315.381	76023.6	IV	
	1	10	5	1314.823	76055.9	III	$4p\,^3F^\circ_2 - 4d\,^3D_2$
	00	25	25	1314.080	76098.9	III	$4p\,^3D^\circ_2 - 4d\,^3D_1$
	1	6	3	1312.913	76166.5	III	$4p\,^3D^\circ_3 - 4d\,^3F_3$
	1	15	20	1311.958	76222.0	IV	
	1		3	1311.143	76269.3	III	$4p\,^3P^\circ_0 - 5s\,^3D_1$
	1	25	20	1310.132	76328.2	IV	$a\,^4F_{4½} - z\,^4G^\circ_{5½}$
	00	20	12	1308.584	76418.5	III	$4p\,^3F^\circ_3 - 4d\,^3G_3$
	1	20	20	1307.388	76488.4	III	$4p\,^3P^\circ_2 - 4d\,^3S_1$
1			10	1306.783	76523.8	II	$4p\,^2P^\circ_{2½} - 7s\,^2S_{½}$
	6	20	20	1306.649	76531.6	IV	$b\,^2D_{2½} - y\,^2F^\circ_{3½}$
		8	10	1306.332	76550.2	II	
	2	20	30	1303.558	76713.1	III	$4p\,^3F^\circ_4 - 4d\,^3D_3$
		1		1302.82	76757	IV	
		10	10	1301.697	76822.8	III	$4p\,^3P^\circ_1 - 4d\,^1D_2$
		3		1301.390	76840.9	III	
	3	20δ	20δ	1301.179	76853.4	III & IV	: III $4p\,^3F^\circ_2 - 4d\,^1F_3$
	1	12	10	1298.688	77000.8	III	$4p\,^3F^\circ_3 - 4d\,^3P_2$
	1	15	15	1298.542	77009.4	III	$4p\,^3P^\circ_2 - 5s\,^3D_3$
		3	2	1297.438	77075.0		
		15	15	1296.736	77116.7	IV	$a\,^4F_{2½} - z\,^4F^\circ_{3½}$
		15	15	1296.630	77123.0	IV	$a\,^4F_{1½} - z\,^4F^\circ_{2½}$
		1		1295.507	77189.8	III	$4p\,^3F^\circ_3 - 5s\,^1D_2$
	2	30	30	1295.329	77200.5	III	$4p\,^3F^\circ_2 - 4d\,^3F_3$
		1	1	1294.11	77273		
	5		6	1292.475	77370.9	IV	$a\,^4F_{3½} - z\,^4F^\circ_{4½}$
	4	10	8	1292.234	77385.4	III	$4p\,^3F^\circ_3 - 4d\,^3D_3$
1		25	1	1292.019	77398.2	II	$4p\,^2P^\circ_{½} - 7s\,^2S_{½}$
	5	20	8	1291.804	77411.1	IV	$a\,^4F_{1½} - z\,^4F^\circ_{1½}$
	2	8	15	1290.434	77493.3	IV	
	2	8	10	1290.049	77516.4	III	$4p\,^3P^\circ_0 - 4d\,^3P_1$
		8	6	1289.973	77521.0	III	
		5	5	1288.888	77586.3	III	$4p\,^3P^\circ_1 - 4d\,^3P_2$
		5	5	1288.807	77591.1	III	$4p\,^3P^\circ_1 - 5s\,^3D_1$
			0	1286.042	77758.0		
		8	3	1285.775	77774.1	III	$4p\,^3P^\circ_1 - 5s\,^1D_2$
		12	20	1284.72	77838	IV	
	2	12	20	1284.385	77858.3	IV	
		5	4	1284.195	77869.8	IV	

TABLE X (b)(continued)

H	K	V	L	λ	ν		Classification
		12	6	1283.945	77885.0	III	$4p\,^3F^\circ_3 - 4d\,^3D_2$
	2	20	30	1283.510	77911.4	IV	
			1	1283.003	77942.2		
	1	15	20	1282.369	77980.7	IV	
		3	2	1282.014	78002.3	IV	
	1	20	20	1281.524	78032.1	III	$4p\,^3F^\circ_4 - 4d\,^3F_4$
		2	2	1281.300	78045.7	IV	
	4	20	3	1280.467	78096.5	IV	$a\,^4F_{2½} - z\,^4F^\circ_{2½}$
		3		1279.727	78141.7	IV	
	2	20	12	1279.043	78183.5	III	$4p\,^3F^\circ_2 - 4d\,^3F_2$
		4	1	1278.497	78216.8	IV	$a\,^2F_{3½} - z\,^2F^\circ_{2½}$
	3	25	20	1277.140	78300.0	IV	
	1	3	20	1276.232	78355.7	III	$4p\,^3F^\circ_4 - 4d\,^3F_3$
			5	1275.767	78384.2	IV	$a\,^4F_{2½} - Z\,^4F^\circ_{1½}$
	1	20	30	1274.393	78468.7	III	$4p\,^3P^\circ_1 - 4d\,^3D_2$
		7	5	1273.839	78502.9	IV	
	4	20	15	1272.956	78557.3	IV	$a\,^4F_{3½} - z\,^4F^\circ_{3½}$
		20	12	1272.199	78604.1	IV	$a\,^4F_{3½} - z\,^2G^\circ_{4½}$
	0	20	20	1272.056	78612.9	III	
	0	25	20	1270.581	78704.2	III	$4p\,^3F^\circ_3 - 4d\,^3F_4$
		1		1269.42	78776		
		1		1269.14	78794		
		1		1268.93	78807		
	0	15	12	1268.412	78838.7	III	$4p\,^3F^\circ_2 - 4d\,^1P_1$
	3	15	15	1268.075	78859.7	III	$4p\,^3P^\circ_1 - 4d\,^3P_1$
	0	12	15	1267.402	78901.6	III	
			0	1266.980	78927.8		
	5	20	30	1265.732	79005.7	IV	$a\,^4F_{4½} - z\,^4F^\circ_{4½}$
		15	12	1265.378	79027.8	III	($4p\,^3P^\circ_2 - 4d\,^1D_2$ ($4p\,^3F^\circ_3 - 4d\,^3F_3$
	2	8	3δ	1263.416	79150.5	II	$4p\,^2P^\circ_{½} - 6d\,^2D_{1½}$
	3	25	40	1262.542	79205.3	III	$4p\,^3P^\circ_2 - 4d\,^3G_3$
	000	1	2	1261.532	79268.7		
		0	1	1261.092	79296.4	I	
		2		1259.993	79365.5		
		1	0	1259.651	79387.1	IV	$a\,^4F_{2½} - z\,^2G^\circ_{3½}$
		7	2	1257.305	79535.2	IV	$a\,^4F_{3½} - z\,^4F^\circ_{2½}$
			0	1255.842	79627.9		
		2	0	1255.618	79642.1		
		2		1254.307	79725.3		

TABLE X (b)(continued)

K	V	L	λ	ν		Classification
	5	3	1253.653	79766.9	IV	$a^4F_{2\frac{1}{2}} - z^2D^\circ_{2\frac{1}{2}}$
2	30	30	1253.336	79787.1	III	$4p\,^3P^\circ_2 - 4d\,^3P_2$
2	8	5	1251.041	79933.4	III	$4p\,^3P^\circ_0 - 4d\,^1P_1$
	3	2	1250.470	79969.9	III	$4p\,^3P^\circ_0 - 4d\,^3P_0$
1	3	2	1250.378	79975.8	III	$4p\,^3P^\circ_2 - 5s\,^1D_2$
1	10	12	1249.681	80020.4	IV	$a^4F_{2\frac{1}{2}} - z^2F^\circ_{3\frac{1}{2}}$
	0	1	1249.385	80039.4	IV	
	0	0	1249.055	80060.5	IV	
	2	2	1248.180	80116.6	IV	
	1	2	1247.390	80167.4	III	$4p\,^3P^\circ_2 - 4d\,^3D_3$
	0	0	1246.993	80192.9	IV	$a^4F_{4\frac{1}{2}} - z^4F^\circ_{3\frac{1}{2}}$
		0	1246.244	80241.1	IV	$a^4F_{4\frac{1}{2}} - z^2G^\circ_{4\frac{1}{2}}$
		0	1244.888	80328.5		
		0	1243.827	80397.0	III	
		25	1243.151	80440.8	III	
1	1	2	1242.420	80488.1	III	
0	15	1	1240.772	80595.0	III	$4p\,^3P^\circ_1 - 4d\,^3F_2$
1	6	1	1239.592	80671.7	III	$4p\,^3P^\circ_2 - 4d\,^3D_2$
	0		1239.465	80680.0	IV	
1	8	2	1239.120	80702.4	IV	$a^4F_{1\frac{1}{2}} - z^2D^\circ_{1\frac{1}{2}}$
	5	1	1238.769	80725.3	IV	
00	6	1	1237.247	80824.6	IV	$a^4F_{3\frac{1}{2}} - z^2G^\circ_{3\frac{1}{2}}$
	5	2	1234.868	80980.3	IV	
2	10	5	1233.938	81041.4	III	$4p\,^3P^\circ_2 - 4d\,^3P_1$
	2	0	1233.811	81049.7	IV	
	8	2	1231.448	81205.2	IV	$a^4F_{3\frac{1}{2}} - z^2D^\circ_{2\frac{1}{2}}$
		0	1230.934	81239.1	III	
1	4	2	1230.430	81272.4	III	$4p\,^3P^\circ_1 - 4d\,^3D_1$
	3	1	1229.378	81342.0	IV	
	3		1229.044	81364.1	IV	
	10	2	1228.652	81390.0	IV	$a^4F_{1\frac{1}{2}} - z^2F^\circ_{2\frac{1}{2}}$
4	20	30	1228.474	81401.8	IV	
	3	1	1227.610	81459.1	IV	$a^4F_{3\frac{1}{2}} - z^2F^\circ_{3\frac{1}{2}}$
	1	0	1227.258	81482.5		
	2	1	1226.319	81544.9		
	8	2	1225.557	81595.6	III	
	8		1224.740	81650.0	IV	
	5	2	1224.328	81677.5	IV	$a^4F_{2\frac{1}{2}} - z^2D^\circ_{1\frac{1}{2}}$
4	8	8	1224.045	81696.4	IV	
	6	2	1223.660	81722.0	IV	

TABLE X (b)(continued)

K	V	L	λ	ν		Classification
4	20	15	1223.160	81755.5	IV	
		0	1221.915	81838.8		
		0	1220.698	81920.4		
	1		1219.890	81974.6		
	2		1214.118	82364.3	IV	$a^4F_{2\frac{1}{2}}$ – $z^2F^\circ_{2\frac{1}{2}}$
	2		1212.700	82460.6	IV	$a^4F_{4\frac{1}{2}}$ – $z^2G^\circ_{3\frac{1}{2}}$
	4		1212.484	82475.3	IV	
	6		1212.250	82491.2	IV	
	1h		1211.887	82516.0	II	$4p\,^2P^\circ_{1\frac{1}{2}}$ – $8s\,^2S_{\frac{1}{2}}$
	0		1203.427	83096.0	IV	$a^4F_{4\frac{1}{2}}$ – $z^2F^\circ_{3\frac{1}{2}}$
1	1		1201.492	83229.9	IV	
	0		1201.298	83243.3	IV	
0	15		1200.828	83275.9	III	$4p\,^3P^\circ_2$ – $4d\,^1F_3$
	0		1197.448	83510.9		
	0		1197.098	83535.4	II	$4p\,^2P^\circ_{1\frac{1}{2}}$ – $7d\,^2D_{2\frac{1}{2}}$
	1		1196.090	83605.8		
1	20	8	1195.369	83656.2	III	
0	15	5	1193.235	83805.8	III	
	5h		1191.913	83898.8	III	
00	6	2	1190.409	84004.8	IV	
	8		1189.592	84062.4	III	
	6	2	1187.69	84197	IV	
	8	2	1187.413	84216.7	IV	
	12		1184.810	84401.7	II	$4p\,^2P^\circ_{\frac{1}{2}}$ – $7d\,^2D_{1\frac{1}{2}}$
0	12	5	1182.021	84600.9	IV	
	1		1181.552	84634.4		
	3	1	1180.010	84745.0		
	2		1179.816	84759.0		
0	10	6	1179.503	84781.5	IV	
	12 δ	4 δ	1178.891	84825.5	IV	
	1		1178.404	84860.6		
	0		1178.087	84883.4		
00	8	5	1177.505	84925.3	IV	
0	1		1174.348	85153.6		
	2	2	1173.858	85189.2		
	1	1	1172.316	85301.2	IV	
	6	3h	1170.157	85458.6	III	
	6 δ	3h	1169.105	85535.5	III	
	5	1	1167.753	85634.6	III	
	2h		1166.790	85705.2		

TABLE X (b)(contined)

K	V	L	λ	ν		Classification
00	12	5	1165.860	85773.6	III	
	10	1	1165.720	85783.9	III	
	3	1	1165.548	85796.6	III	
		2	1165.311	85814.0		
	4	2	1158.741	86300.6	IV	
	4h		1157.322	86406.4	III	
00	6	4	1155.843	86517.0	IV	
	12	5	1155.510	86541.9	III	
	0		1155.05	86576	IV	
	0	1	1154.423	86623.4	IV	
		0	1152.979	86731.8	IV	
00	1	0	1150.478	86920.4		
	1	0	1149.852	86967.7		
	3	1h	1149.633	86984.3		
	2	1	1147.039	87181.0		
	15		1146.190	87245.6	III	
	1		1144.20	87397		
	2	1	1142.933	87494.2		
	1		1141.910	87572.6	II	$4p\,^2P^\circ_{1/2}$ – $8d\,^2D_{1\frac{1}{2}}$
	1		1140.837	87655.0	IV	
	0		1138.248	87854.3		
00	1		1136.423	87995.4	IV	
	1		1133.749	88203.0	IV	
	3	1	1133.060	88256.6		
	0		1132.680	88286.2		
	0		1132.271	88318.1		
	0		1118.077	89439.3		
0	2		1116.870	89535.9	IV	
1	4		1109.926	90096.1	IV	$a\,^2F_{3\frac{1}{2}}$ – $y\,^2D^\circ_{2\frac{1}{2}}$
	0		1109.064	90166.1		
	0		1094.458	91369.4		
	0		1094.129	91396.9		
	2		1070.708	93396.2	III	
	1		1069.745	93480.2		
	3δ		1068.69	93572		
	2δ		1067.38	93687		
	1		1046.880	95521.9	IV	
	1		1045.081	95686.4	IV	$a\,^4F_{3\frac{1}{2}}$ – $y\,^2D^\circ_{2\frac{1}{2}}$
	1		1044.524	95737.4	IV	
	0		1044.334	95754.8	IV	

TABLE X (b)(continued)

K	V	L	λ	ν		Classification
	0		1043.908	95793.9	IV	
	1		1043.599	95822.2	IV	
	1		1043.000	95877.3	IV	
	1		1039.315	96217.2	IV	
	0		1035.886	96536.7		
	0		1035.565	96565.6		
	1		1030.186	97069.8		
	0		1018.50	98184		
	1		1018.14	98218		
	1		1017.49	98281		
	6		990.48	100961		
	2		988.78	101134		

TABLE X (c)

WAVELENGTHS BELOW 500 Å

Legend:

B: Intensities given by Bloch and Bloch (1).

λ: Wavelengths (vacuum) in Ångstroms.

ν: Wavenumbers (vacuum) in reciprocal centimeters.

*: Lines classified by Bloch and Bloch.

B	λ	ν	Classification	
2	482.10	207426	$a^2D_{1\frac{1}{2}} - z^4F^{\circ}_{1\frac{1}{2}}$	
2	478.92	208803	$a^2D_{1\frac{1}{2}} - z^2D^{\circ}_{2\frac{1}{2}}$	*
4	478.62	208934	$a^2D_{2\frac{1}{2}} - z^4F^{\circ}_{3\frac{1}{2}}$	
2	476.40	209908	$a^2D_{2\frac{1}{2}} - z^4F^{\circ}_{2\frac{1}{2}}$	
0	475.75	210194	$a^2D_{2\frac{1}{2}} - z^4F^{\circ}_{1\frac{1}{2}}$	
6	474.54	210730	$a^2D_{1\frac{1}{2}} - z^2D^{\circ}_{1\frac{1}{2}}$	*
2	473.49	211198	$a^2D_{2\frac{1}{2}} - z^2G^{\circ}_{3\frac{1}{2}}$	*
2	473.00	211416	$a^2D_{1\frac{1}{2}} - z^2F^{\circ}_{2\frac{1}{2}}$	*
6	472.65	211573	$a^2D_{2\frac{1}{2}} - z^2D^{\circ}_{2\frac{1}{2}}$	*
5	472.08	211828	$a^2D_{2\frac{1}{2}} - z^2F^{\circ}_{3\frac{1}{2}}$	*
1	468.42	213484	$a^2D_{2\frac{1}{2}} - z^2D^{\circ}_{1\frac{1}{2}}$	*
6	466.91	214174	$a^2D_{2\frac{1}{2}} - z^2F^{\circ}_{2\frac{1}{2}}$	*
1	457.29	218680	$a^2D_{1\frac{1}{2}} - z^4P^{\circ}_{1\frac{1}{2}}$	
0	456.64	218991	$a^2D_{1\frac{1}{2}} - z^4P^{\circ}_{2\frac{1}{2}}$	
3	452.79	220853	$a^2D_{1\frac{1}{2}} - y^2F^{\circ}_{2\frac{1}{2}}$	
0	451.58	221445	$a^2D_{2\frac{1}{2}} - z^4P^{\circ}_{1\frac{1}{2}}$	
3	450.93	221764	$a^2D_{2\frac{1}{2}} - z^4P^{\circ}_{2\frac{1}{2}}$	
5	449.95	222247	$a^2D_{1\frac{1}{2}} - y^2D^{\circ}_{1\frac{1}{2}}$	
0	446.55	223939	$a^2D_{1\frac{1}{2}} - z^2P^{\circ}_{1\frac{1}{2}}$	
5	444.36	225043	$a^2D_{2\frac{1}{2}} - y^2F^{\circ}_{3\frac{1}{2}}$	
7	442.35	226065	$a^2D_{2\frac{1}{2}} - y^2D^{\circ}_{2\frac{1}{2}}$	
0	441.11	226701	$a^2D_{2\frac{1}{2}} - z^2P^{\circ}_{1\frac{1}{2}}$	
7	428.53	233356	$a^2D_{1\frac{1}{2}} - x^2F^{\circ}_{2\frac{1}{2}}$	
8	425.88	234808	$a^2D_{2\frac{1}{2}} - x^2F^{\circ}_{3\frac{1}{2}}$	
0	423.49	236133	$a^2D_{2\frac{1}{2}} - x^2F^{\circ}_{2\frac{1}{2}}$	

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