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New Vacuum Ultraviolet Wavelengths and Revised Energy Levels in the Second Spectrum of Zinc (Zn II)

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Spectra from sliding spark discharges between zinc electrodes and from a hollow-cathode source were photographed in the range 2105–1400 Å with the NBS 10.7 m vacuum spectrograph. New measurements of 130 Zn II lines in this region, combined in some cases with previous measurements in the air region, were used to derive revised positions for the known levels. Wavelengths calculated from these levels are given for 267 lines in the region 2570–730 Å. The line list also includes unclassified Zn II lines below 2570 Å, based on the most complete description of this spectrum [A. M. Crooker and K. A. Dick, Can. J. Phys. **46**, 1241 (1968)]. A few additions to the line list of Crooker and Dick above 2700 Å are given. The line and level lists take into account recent work at the National Bureau of Standards on the Zn II analysis.

Key words: Atomic energy levels of Zn II; ionized zinc; spectral wavelengths of Zn II.

1. Introduction

An improved description of the Zn II spectrum has recently been given by Crooker and Dick [1],[1] who also extended and revised the earlier analyses [2, 3]. From a combination array made in connection with a theoretical fitting of some Zn II levels [4, 5], we decided that a resolution of several blends in the vacuum ultraviolet spectrum was needed. It appeared likely that the resolution available in this laboratory was sufficiently greater than that obtained by Crooker and Dick to make worthwhile a reobservation of Zn II in the indicated region. The resulting new wavelengths are reported here, together with a list of revised energy levels partially based on them.

2. Observations

The spectra were photographed with the NBS 10.7 m Eagle-mounting vacuum spectrograph. A 1200 grooves/mm grating used in the first order gave a plate factor of 0.78 Å/mm. One source was a sliding spark between zinc electrodes, in series with an auxiliary rotating spark gap and appropriate inductance, resistance, and capacitance charged to 500 V [6]. Three different exposures were made:[2]

S_1, hot spark	2105–1714 Å
S_2, mild spark	2105–1714 Å
S_3, mild spark	2105–1400 Å.

The hot spark gave the stronger lines of Zn IV and Zn III and also gave our most complete Zn II spectrum. The mild sparks showed no Zn IV lines, and were strong sources of Zn I and of Zn II lines having low or medium excitation energies. Spectra for standard wavelengths (C I, N I, and Ge I [7]) were photographed only on the S_3 spectrograms. Zinc wavelengths obtained from this exposure were the principal standards for reducing the other two exposures.

We also obtained measurements of spectra from a water-cooled aluminum hollow-cathode source that contained zinc (as an impurity in the aluminum) and copper, silicon, and germanium (for standard wavelengths [7]). The discharge current was 0.8 A through a carrier gas of helium at about 2 torr. Each of five different exposures (3 to 30 min) covered the range 2105–1400 Å.

[1] Figures in brackets indicate the literature references at the end of this paper.

[2] Typical circuit parameters for hot and mild sparks are given in [6]. We used peak currents varying from several hundred amperes (S_1) to a few amperes (S_2).

3. Line List and Level Values

Table 1 contains more than 300 Zn II lines in the range 2570–730 Å. Crooker and Dick [1] have obtained by far the most complete spectrum in this region, and the observed wavelengths for about two-thirds of these lines are taken from their list. The observed wavelengths for 130 lines are from our measurements (2105–1400 Å, with a number 1–4 in the first column). We derived most of the level values in table 2 using these new measurements combined with a few previous measurements at longer wavelengths where this appeared consistent or was necessary. The calculated wavelengths given for the 267 classified lines in table 1 were obtained from the revised levels. They are recommended as the most accurate wavelengths now available for Zn II in this region. An "X" in the calculated-wavelength column indicates that the corresponding level separation was based entirely on the observed wavelength for this transition.

The resulting wavelengths are categorized as follows (numbers correspond to those in the first column of Table 1):

1. The observed wavelength is from the hollow-cathode source. Most of these lines were measured in each of two to five different exposures. The estimated uncertainty of the calculated wavelength is ±0.002 Å. (The different measurements for a single line usually agreed to within ±0.001 Å, but this precision was not maintained in the accuracy as indicated by the Ritz principle.)

2. All the above applies except that the observed wavelength is based on a single measurement of a weak line. The observed wavelength still usually agrees with the (preferred) calculated value to within 0.003 Å.

3. This indicates a line of the (2) type except that the corresponding energy level difference is based on this one measurement. The wavelength is probably accurate to ±0.003 Å.

4. The observed wavelength is from our sliding spark sources. The Ritz-principle consistency of these lines is considerably poorer than for the hollow-cathode wavelength (see below). The observed and calculated wavelengths for unblended lines are different by about 0.005 Å on the average, and by more than 0.015 Å for a few lines. Most of the calculated wavelengths should be in error by less than 0.01 Å.

No number in the first column. The observed wavelength is from [1] or [9]. The calculated wavelengths for most of these lines are based on level differences derived from our sliding-spark measurements; the corresponding probable error is less than 0.01 Å.

The rms deviation of the standard wavelengths (from smooth reduction curves) for the spark spectrograms was about 0.002 Å. The much larger error for the resulting zinc measurements (type 4 lines, above) is not too surprising, since we had only one independent measurement of the spark spectrum against well-known reference wavelengths. The accuracy for some Zn II lines was also reduced by their width or diffuseness. More accurate wavelength measurements for some Zn II lines from a spark source would probably not be justified, because of sensitivity to Stark shifts. The $6f\,^2F^\circ$ levels, for example, are depressed by about 1 cm^{-1} in the sliding-spark discharge. This accounts for most of the disagreement between the calculated and observed wavelengths for the line at 1430.27 Å.

Except for the even levels above the limit, most of the level values in table 2 are consistent with the best observations to ±0.2 cm^{-1}. Values are given to two decimal places for some levels that appeared consistent to within ±0.1 cm^{-1}. Most of the levels above the limit are probably in error by less than 0.5 cm^{-1}.

The revised levels give improved agreement between the calculated and the more accurately measured wavelengths over the entire spectrum. Disagreements between calculated and observed wavenumbers are much reduced (from ~ 2 cm^{-1} in [1]) for several accurately measured air-region lines connecting $3d^{10}f$ and $3d^{10}d$ levels. The new wavelengths in the region 2000–2103 Å, which contains the basic $3d^{10}4s-3d^{10}4p$ transitions and also the $3d^{10}4p-3d^{10}4d$ multiplet, are systematically longer than the values in [1] by more than 0.03 Å. Thus the revised values for the $4p\,^2P^\circ$ and $4d\,^2D$ levels are less than the values in [1] by about 0.7 cm^{-1} and 1.7 cm^{-1}, respectively. This accounts for a systematic difference (between the two lists) for all excited levels except those of the $3d^{10}f$ and $3d^{10}g$ configurations. The systematic difference that exists between our levels and the values of Shenstone and Gibson [2, 3] is smaller and in the opposite direction.

Estimated relative intensities [3] and line characteristics from several different sources are given in table 1, since they often help confirm the analysis. Comparing intensities of Zn II lines from the hot spark (S_1) and the mild sparks (S_2, S_3), we find in S_1 an enhancement of lines from levels above the ionization limit. Some of the weaker lines that appeared only in S_1 were clearly broadened relative to other lines, and the classifications indicate that this width arises from autoionization. We note especially that transitions from the four $3d^94s(^3D)5s$ levels having $J=1\frac{1}{2}$ or $2\frac{1}{2}$ are always wide, analogous to the Cu I spectrum [8]. These same autoionizing transitions are quite strong in Dick's source E_1 and very weak or not observed in E_2.[4]

An example of the usefulness of these excitation characteristics is the classification of the line at 1833.573 Å. We began this work mainly to attempt a resolution of this $4p'\,^4F^\circ_{4\frac{1}{2}}-5s'\,^4D_{3\frac{1}{2}}$ transition from the $4s^2\,^2D_{2\frac{1}{2}}-4f\,^2F^\circ$ line. The relative intensities of 1833.573 Å in S_1 and S_2, S_3 (as compared, for example, with the now resolved transition from $4f\,^2F^\circ$) show that it arises from a level above the limit. However, the level is not observably autoionization-broadened. These characteristics are consistent with a transition

[3] The relative intensities of 42 lines observed in the hollow-cathode spectrum were similar to those in the mildest spark (S_2) spectrum, and are not given in table 1.

[4] In the region above 2385 Å, E_1 and E_2 in the table are Dick's [9] intensities I_4 and I_5, respectively; below 2385 Å, E_1 and E_2 are his intensities I_1 and I_2, respectively. Our statements about relative intensities refer to I_1 and I_2. Three autoionizing lines with apparently comparable intensities in these two sources are probably blends (see notes to table 1).

TABLE 1. Zn II *spectrum below 2570 Å*

Sources of the observed wavelengths and accuracies of the calculated wavelengths are indicated by numbers in the first column, as explained in the text. New classifications are indicated by an asterisk (*). The letters refer to footnotes, where it is explained that a few lines of Zn III or of doubtful ionization stage are also listed. Relative intensity estimates: E_1 and E_2 are from different exposures of electrodeless discharge sources, as given by Dick [9], and the other three exposures are described in the text. Numbers under the heading "S_2, S_3" are approximate geometric means of the relative intensities from these two sources. Self-reversed lines are indicated by "R" and haziness (in [9]) by "H". Lines with intensities followed by "W" were so diffuse (on our plates) as to suggest autoionization broadening.

Notes	λ(air), Å		Intensity				σ, cm⁻¹	Classification
	obs.	calc.	E_1	E_2			obs.	
	2567.975	.976	50	30			38929.5	$4d\ ^2\mathrm{D}_{2\frac{1}{2}}-7f\ ^2\mathrm{F}^\circ_{3\frac{1}{2}}$
a	2567.795	.798	50	10			38932.3	$4d\ ^2\mathrm{D}_{2\frac{1}{2}}-7f\ ^2\mathrm{F}^\circ_{2\frac{1}{2}}$
	2564.456	.461	30	30			38982.9	$4d\ ^2\mathrm{D}_{1\frac{1}{2}}-7f\ ^2\mathrm{F}^\circ_{2\frac{1}{2}}$
	2557.947	.948	1000	1000			39082.13	$4p\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}-5s\ ^2\mathrm{S}_{\frac{1}{2}}$
*	2545.0	.00	5				39281.	$7p\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}-5s''\ ^2\mathrm{D}_{2\frac{1}{2}}$
b*	2527.96	8.01?	50	15			39545.8	$4d\ ^2\mathrm{D}_{2\frac{1}{2}}-9p\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}$?
	2506.69	.70	10	5			39881.2	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^4\mathrm{P}^\circ_{1\frac{1}{2}}$
	2501.990	.990	1000	1000			39956.14	$4p\ ^2\mathrm{P}^\circ_{\frac{1}{2}}-5s\ ^2\mathrm{S}_{\frac{1}{2}}$
	2439.5	.53	15				40979.6	$4s^2\ ^2\mathrm{D}_{2\frac{1}{2}}-4p'\ ^4\mathrm{P}^\circ_{2\frac{1}{2}}$
	2435.76	.79	15	10			41042.5	$4d\ ^2\mathrm{D}_{2\frac{1}{2}}-8f\ ^2\mathrm{F}^\circ$
	2433.131	.11	5	1			41086.8	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^4\mathrm{P}^\circ_{\frac{1}{2}}$
	2432.74	.73	10	5			41093.4	$4d\ ^2\mathrm{D}_{1\frac{1}{2}}-8f\ ^2\mathrm{F}^\circ_{2\frac{1}{2}}$
	2390.078	×	20	30			41826.9	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^4\mathrm{F}^\circ_{2\frac{1}{2}}$
	2383.923	.949	30	15			41934.9	$5s\ ^2\mathrm{S}_{\frac{1}{2}}-4p''\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}$
	2346.685	.68	20	12			42600.3	$4s^2\ ^2\mathrm{D}_{2\frac{1}{2}}-4p'\ ^4\mathrm{P}^\circ_{1\frac{1}{2}}$
	2336.493	.48	2	0H			42786.1	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^4\mathrm{F}^\circ_{1\frac{1}{2}}$
*	2273.150	.175	50	10			43978.2	$5s\ ^2\mathrm{S}_{\frac{1}{2}}-8p\ ^2\mathrm{P}^\circ_{\frac{1}{2}}$
*	2212.402	.437	3	1			45185.7	$5s\ ^2\mathrm{S}_{\frac{1}{2}}-8p\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}$
	2210.176	.201	60	15			45231.2	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^2\mathrm{F}^\circ_{2\frac{1}{2}}$
	2203.511	.453	15	5			45368.0	$5s\ ^2\mathrm{S}_{\frac{1}{2}}-4p''\ ^2\mathrm{P}^\circ_{\frac{1}{2}}$
	2163.475	.511	6	8			46207.4	$5s\ ^2\mathrm{S}_{\frac{1}{2}}-4p''\ ^2\mathrm{D}^\circ_{1\frac{1}{2}}$
	2159.060	.085	2	2			46301.9	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^4\mathrm{D}^\circ_{2\frac{1}{2}}$
	2150.539	.58	10	6			46485.3	$4p'\ ^2\mathrm{D}^\circ_{2\frac{1}{2}}-5s'\ ^4\mathrm{D}_{3\frac{1}{2}}$
b	2147.419	.43	75	20R			46552.9	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^4\mathrm{D}^\circ_{1\frac{1}{2}}$
	2122.741	.775	75	12			47094.0	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^4\mathrm{D}^\circ_{\frac{1}{2}}$
c	2116.318	.35	5	10			47236.9	$4p'\ ^2\mathrm{D}^\circ_{2\frac{1}{2}}-5s'\ ^4\mathrm{D}_{2\frac{1}{2}}$
	λ(vac), Å		Intensity					
	obs.	calc.	E_1	E_2	S_1	S_2, S_3		
1	2102.844	.842	200	200R	400	400	47554.65	$4p\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}-4d\ ^2\mathrm{D}_{1\frac{1}{2}}$
1	2100.604	×	300	300R	700	700	47605.36	$4p\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}-4d\ ^2\mathrm{D}_{2\frac{1}{2}}$
3	2085.511	×	30	15	2	2	47949.88	$4s^2\ ^2\mathrm{D}_{2\frac{1}{2}}-4p'\ ^2\mathrm{F}^\circ_{2\frac{1}{2}}$
	2082.191	.246	4				48026.3	$4p'\ ^2\mathrm{D}^\circ_{1\frac{1}{2}}-5s'\ ^4\mathrm{D}_{2\frac{1}{2}}$
4	2081.115	.111	25	18	3	3	48051.2	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^2\mathrm{P}^\circ_{\frac{1}{2}}$
4b	2080.596	.600	50	20	8W		48063.2	$4p'\ ^2\mathrm{D}^\circ_{2\frac{1}{2}}-5s'\ ^4\mathrm{D}_{1\frac{1}{2}}$
3	2077.070	×	20	15		1	48144.74	$4s^2\ ^2\mathrm{D}_{2\frac{1}{2}}-4p'\ ^4\mathrm{D}^\circ_{3\frac{1}{2}}$
1	2064.887	.890	200	300R	600	600	48428.80	$4p\ ^2\mathrm{P}^\circ_{\frac{1}{2}}-4d\ ^2\mathrm{D}_{1\frac{1}{2}}$
1	2062.662	.664	300	500R	1200R	1200R	48481.04	$4s\ ^2\mathrm{S}_{\frac{1}{2}}-4p\ ^2\mathrm{P}^\circ_{\frac{1}{2}}$
1	2057.471	.470		25R	80	80	48603.36	$4s^2\ ^2\mathrm{D}_{1\frac{1}{2}}-4p'\ ^2\mathrm{D}^\circ_{1\frac{1}{2}}$
	2045.594		5	3			48885.6	
	2044.588	.626	30	12			48909.6	$4p'\ ^2\mathrm{F}^\circ_{3\frac{1}{2}}-5s'\ ^4\mathrm{D}_{3\frac{1}{2}}$
1	2039.962	×	60	25R	50	50	49020.52	$4s^2\ ^2\mathrm{D}_{2\frac{1}{2}}-4p'\ ^4\mathrm{D}^\circ_{2\frac{1}{2}}$
	2037.479		8	8			49080.3	
	2029.543	.556	35	12			49272.2	$4s^2\ ^2\mathrm{D}_{2\frac{1}{2}}-4p'\ ^4\mathrm{D}^\circ_{1\frac{1}{2}}$
1	2026.137	.136	300	500R	1500R	1500R	49355.00	$4s\ ^2\mathrm{S}_{\frac{1}{2}}-4p\ ^2\mathrm{P}^\circ_{1\frac{1}{2}}$
	2017.099	.129	25	15			49576.1	$4p'\ ^4\mathrm{D}^\circ_{2\frac{1}{2}}-5s'\ ^4\mathrm{D}_{3\frac{1}{2}}$
4b	2013.616	.677	15	15	2W		49661.9	$4p'\ ^2\mathrm{F}^\circ_{3\frac{1}{2}}-5s'\ ^4\mathrm{D}_{2\frac{1}{2}}$

TABLE 1. Zn II *spectrum below 2570 Å* — Continued

Notes	λ(vac), Å obs.	λ(vac), Å calc.	Intensity E_1	Intensity E_2	Intensity S_1	Intensity S_2, S_3	σ, cm⁻¹ obs.	Classification
1	2012.590	×	100	35R	80	80	49687.22	$4s^2\ ^2D_{2\frac{1}{2}}-4p'\ ^2F^\circ_{3\frac{1}{2}}$
b	1998.977	.998	25				50025.6	$4p'\ ^2D^\circ_{1\frac{1}{2}}-5s'\ ^4D_{\frac{1}{2}}$
	1996.922	.973	50				50077.1	$4p'\ ^4D^\circ_{1\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
*	1993.367	.424	50				50166.4	$4p'\ ^2D^\circ_{2\frac{1}{2}}-5s'\ ^2D_{2\frac{1}{2}}$
4	1986.988	7.001	100	1	3W		50327.4	$4p'\ ^4D^\circ_{\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
	1985.608	.620	70				50362.4	$4p'\ ^4D^\circ_{\frac{1}{2}}-5s'\ ^4D_{1\frac{1}{2}}$
4	1982.426	.430	10		4		50443.2	$4p'\ ^2D^\circ_{2\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
4	1982.111	.113	100	20	50	12	50451.3	$4p'\ ^4D^\circ_{3\frac{1}{2}}-5s'\ ^4D_{3\frac{1}{2}}$
	1977.494	.422?	5	10			50569.1	$4p'\ ^2P^\circ_{1\frac{1}{2}}-5s'\ ^4D_{\frac{1}{2}}$?
	1977.159	.175	25				50577.6	$4p'\ ^2P^\circ_{\frac{1}{2}}-5s'\ ^4D_{\frac{1}{2}}$
	1974.467	.485	12	8			50646.6	$4p'\ ^2F^\circ_{2\frac{1}{2}}-5s'\ ^4D_{3\frac{1}{2}}$
1	1969.404	.405	100	35R	80	80	50776.78	$4s^2\ ^2D_{2\frac{1}{2}}-4p'\ ^2P^\circ_{1\frac{1}{2}}$
4	1964.538	.532	80		3W		50902.6	$4p'\ ^4D^\circ_{1\frac{1}{2}}-5s'\ ^4D_{1\frac{1}{2}}$
	1954.872	.881	75				51154.2	$4p'\ ^4D^\circ_{2\frac{1}{2}}-5s'\ ^4D_{1\frac{1}{2}}$
4	1952.999	3.014	80		3W		51203.3	$4p'\ ^4D^\circ_{3\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
	1951.911	.902	60				51231.8	$4p'\ ^2D^\circ_{1\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
2	1948.459	.460	30	15	1		51322.61	$4s^2\ ^2D_{2\frac{1}{2}}-4p'\ ^2D^\circ_{1\frac{1}{2}}$
	1945.583	.608	60				51398.5	$4p'\ ^2F^\circ_{2\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
	1940.413	.421	40				51535.4	$4p'\ ^4D^\circ_{\frac{1}{2}}-5s'\ ^4D_{\frac{1}{2}}$
	1931.073	.091	40				51784.7	$4p'\ ^2P^\circ_{\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
III	1929.774		} 100	40R	{ 80		51819.5	
3	1929.670	.669			3	3	51822.33	$4s^2\ ^2D_{1\frac{1}{2}}-4f\ ^2F^\circ_{2\frac{1}{2}}$
4	1920.271	.278	70	5H	2		52076.0	$4p'\ ^4D^\circ_{1\frac{1}{2}}-5s'\ ^4D_{\frac{1}{2}}$
III	1919.068		} 100	{ 20	120		52108.6	
1	1918.962	×		50R	100	100	52111.51	$4s^2\ ^2D_{2\frac{1}{2}}-4p'\ ^2D^\circ_{2\frac{1}{2}}$
	1914.806	.803	60				52224.6	$4p'\ ^2F^\circ_{2\frac{1}{2}}-5s'\ ^4D_{1\frac{1}{2}}$
*	1901.523	.531	60				52589.4	$4p'\ ^2F^\circ_{3\frac{1}{2}}-5s'\ ^2D_{2\frac{1}{2}}$
	1896.056	.015	2				52741.1	$4p'\ ^4D^\circ_{\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
*	1894.259	.282	75	8			52791.1	$4p'\ ^2D^\circ_{2\frac{1}{2}}-5s''\ ^2D_{2\frac{1}{2}}$
4	1872.128		100		10W		53415.2	
	1867.994	.968	40				53533.4	$4p'\ ^4D^\circ_{2\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
*	1866.366	.390	10				53580.1	$4p'\ ^2D^\circ_{1\frac{1}{2}}-5s''\ ^2D_{2\frac{1}{2}}$
4	1866.077		100	1	7WW		53588.	
4	1864.117		100		15WW		53644.7	
	1857.274	.279	5				53842.4	$4p'\ ^4F^\circ_{1\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
	1850.140	.146	10	6			54050.0	$4p'\ ^4F^\circ_{2\frac{1}{2}}-5s'\ ^4D_{3\frac{1}{2}}$
*	1847.562	.568	75	5			54125.4	$4p'\ ^2P^\circ_{1\frac{1}{2}}-5s''\ ^2D_{2\frac{1}{2}}$
1	1836.654	.653	75	15	4	30	54446.84	$4s^2\ ^2D_{1\frac{1}{2}}-6p\ ^2P^\circ_{\frac{1}{2}}$
4	1836.007	.008	70	15	40	2	54466.0	$4p'\ ^4F^\circ_{3\frac{1}{2}}-5s'\ ^4D_{3\frac{1}{2}}$
2	1834.268	.267	40	12	1	1	54517.66	$4s^2\ ^2D_{1\frac{1}{2}}-6p\ ^2P^\circ_{1\frac{1}{2}}$
4 *	1833.573	.567	}		{ 150	50	54538.3	$4p'\ ^4F^\circ_{4\frac{1}{2}}-5s'\ ^4D_{3\frac{1}{2}}$
3	1833.481	{ .485 .465	100	25R	25	40	54541.06	{ $4s^2\ ^2D_{2\frac{1}{2}}-4f\ ^2F^\circ_{3\frac{1}{2}}$ $4s^2\ ^2D_{2\frac{1}{2}}-4f\ ^2F^\circ_{2\frac{1}{2}}$
	1831.376	.341	80				54603.8	$4p'\ ^2F^\circ_{2\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
4	1816.479		80		1W		55051.6	
	1813.170	.159	1				55152.0	$4p'\ ^2D^\circ_{2\frac{1}{2}}-4_{2\frac{1}{2}}$
4 *	1811.105	.112			15W		55214.9	$4p'\ ^2F^\circ_{3\frac{1}{2}}-5s''\ ^2D_{2\frac{1}{2}}$
4	1811.008	.014			80W		55217.9	$4p'\ ^4F^\circ_{3\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
4	1797.643	.643	100		20W		55628.4	$4p'\ ^4F^\circ_{2\frac{1}{2}}-5s'\ ^4D_{1\frac{1}{2}}$
	1796.701		15	5			55657.6	
	1795.160		5				55705.3	
4	1790.759	.760	80	1H	15		55842.2	$4p'\ ^4F^\circ_{1\frac{1}{2}}-5s'\ ^4D_{\frac{1}{2}}$
*	1789.509	.504	8				55881.3	$4p'\ ^4D^\circ_{2\frac{1}{2}}-5s''\ ^2D_{2\frac{1}{2}}$
	1787.384	.358	00				55947.7	$4p'\ ^2P^\circ_{1\frac{1}{2}}-3_{2\frac{1}{2}}$
	1775.024	.012	3	1H			56337.3	$4p'\ ^2D^\circ_{2\frac{1}{2}}-6_{2\frac{1}{2}}$
	1774.040	.050	75				56368.5	$4p'\ ^4P^\circ_{\frac{1}{2}}-5s'\ ^4D_{1\frac{1}{2}}$
	1762.395	.400	25	5			56741.0	$4p'\ ^2F^\circ_{3\frac{1}{2}}-1_{3\frac{1}{2}}$

TABLE 1. Zn II *spectrum below 2570 Å* — Continued

Notes	λ(vac), Å obs.	λ(vac), Å calc.	Intensity E_1	Intensity E_2	Intensity S_1	Intensity S_2, S_3	σ, cm⁻¹ obs.	Classification
4	1762.243				10	1	56745.9	
4d	1762.223				10		56746.5	
4	1762.191	.195	80	2H	10		56747.5	$4p'\ ^4P^\circ_{1\frac{1}{2}} - 5s'\ ^4D_{2\frac{1}{2}}$
4	1762.151				20	2	56748.8	
	1756.665		2	3			56926.1	
*	1755.847	.862	10				56952.6	$4p'\ ^2F^\circ_{2\frac{1}{2}} - 5s''\ ^2D_{2\frac{1}{2}}$
	1752.358	.373	3	0			57066.0	$4p'\ ^2D^\circ_{1\frac{1}{2}} - 5_{\frac{1}{2}}$
	1751.806			5			57083.9	
1	1747.124	.125	75	25R	80	80	57236.92	$4s^2\ ^2D_{2\frac{1}{2}} - 6p\ ^2P^\circ_{1\frac{1}{2}}$
	1742.285		20	5			57395.9	
	1741.930	.933	18	12			57407.6	$4p'\ ^4D^\circ_{2\frac{1}{2}} - 1_{3\frac{1}{2}}$
4	1737.895	.882	50	3	40		57540.9	$4p'\ ^4P^\circ_{\frac{1}{2}} - 5s'\ ^4D_{\frac{1}{2}}$
	1736.889	.886	60				57574.2	$4p'\ ^4P^\circ_{1\frac{1}{2}} - 5s'\ ^4D_{1\frac{1}{2}}$
	1736.825	.817		0H			57576.3	$4p'\ ^2F^\circ_{3\frac{1}{2}} - 4_{2\frac{1}{2}}$
4	1735.607	{ .605 .581	} 80	20R	80	40	57616.7	{ $4p'\ ^4P^\circ_{2\frac{1}{2}} - 5s'\ ^4D_{3\frac{1}{2}}$ $4p'\ ^2P^\circ_{\frac{1}{2}} - 5_{\frac{1}{2}}$
	1732.953	.961	25				57705.0	$4p'\ ^4D^\circ_{2\frac{1}{2}} - 3_{2\frac{1}{2}}$
	1730.619	.626	2	0H			57782.8	$4p'\ ^2D^\circ_{1\frac{1}{2}} - 8_{1\frac{1}{2}}$
	1724.364	.376	2				57992.4	$4p'\ ^4D^\circ_{1\frac{1}{2}} - 4_{2\frac{1}{2}}$
	1723.901	.885	2				58008.0	$4p'\ ^4F^\circ_{2\frac{1}{2}} - 5s'\ ^2D_{1\frac{1}{2}}$
	1719.136	.124	2				58168.8	$4p'\ ^2D^\circ_{2\frac{1}{2}} - 12_{3\frac{1}{2}}$
	1718.182	.173	1				58201.1	$4p'\ ^2D^\circ_{2\frac{1}{2}} - 13_{2\frac{1}{2}}$
	1716.935	.936	1				58243.3	$4p'\ ^4D^\circ_{2\frac{1}{2}} - 4_{2\frac{1}{2}}$
			E_1	E_2	S_3			
4	1715.760	.757	60	12	5		58283.2	$4p'\ ^4D^\circ_{3\frac{1}{2}} - 1_{3\frac{1}{2}}$
	1715.388	.370	1	0			58295.8	$4p'\ ^2D^\circ_{1\frac{1}{2}} - 11_{2\frac{1}{2}}$
	1714.457	.431	15	1H			58327.5	$4p'\ ^2P^\circ_{1\frac{1}{2}} - 8_{1\frac{1}{2}}$
	1714.270	.246		0			58333.9	$4p'\ ^2P^\circ_{\frac{1}{2}} - 8_{1\frac{1}{2}}$
	1713.251	.253	50	00			58368.6	$4p'\ ^4P^\circ_{2\frac{1}{2}} - 5s'\ ^4D_{2\frac{1}{2}}$
b	1710.052	.039	10	1			58477.8	$4p'\ ^2F^\circ_{2\frac{1}{2}} - 1_{3\frac{1}{2}}$
	1709.243	.231		0			58505.4	$4p'\ ^2D^\circ_{2\frac{1}{2}} - 14_{2\frac{1}{2}}$
b	1707.191	.195	20				58575.8	$4p'\ ^4D^\circ_{\frac{1}{2}} - 5_{\frac{1}{2}}$
	1704.577	.550	00				58665.6	$4p'\ ^2P^\circ_{1\frac{1}{2}} - 9_{2\frac{1}{2}}$
e*	1702.836	.820?	2	00			58725.6	$4p'\ ^2D^\circ_{2\frac{1}{2}} - 20_{2\frac{1}{2}}$?
b	1702.210	{ .203 .177	} 10				58747.2	{ $4p'\ ^4P^\circ_{1\frac{1}{2}} - 5s'\ ^4D_{\frac{1}{2}}$ $4p'\ ^4P^\circ_{\frac{1}{2}} - 5s'\ ^2D_{1\frac{1}{2}}$
	1701.766	.783	12	0			58762.5	$4p'\ ^2F^\circ_{3\frac{1}{2}} - 6_{2\frac{1}{2}}$
	1701.398	.392	4				58775.2	$4p'\ ^2F^\circ_{2\frac{1}{2}} - 3_{2\frac{1}{2}}$
	1699.471	.458	3				58841.8	$4p'\ ^2P^\circ_{1\frac{1}{2}} - 11_{2\frac{1}{2}}$
	1691.592	.584	1				59115.9	$4p'\ ^4D^\circ_{1\frac{1}{2}} - 5_{\frac{1}{2}}$
	1691.470	.501	1				59120.2	$4p'\ ^4D^\circ_{3\frac{1}{2}} - 4_{2\frac{1}{2}}$
b	1689.818	.837	25	2			59178.0	$4p'\ ^4D^\circ_{1\frac{1}{2}} - 6_{2\frac{1}{2}}$
b	1688.240	.240	15	5			59233.3	$4p'\ ^2F^\circ_{3\frac{1}{2}} - 7_{3\frac{1}{2}}$
	1686.502	.489	25				59294.3	$4p'\ ^2D^\circ_{1\frac{1}{2}} - 14_{2\frac{1}{2}}$
	1685.942	.943	5				59314.0	$4p'\ ^2F^\circ_{2\frac{1}{2}} - 4_{2\frac{1}{2}}$

Notes	λ(vac), Å		Intensity				σ, cm^{-1}	Classification
	obs.	calc.	E_1	E_2	S_3	---	obs.	
	1682.698	.692	5				59428.4	$4p'\ ^2D^\circ_{2\frac{1}{2}}-6_{2\frac{1}{2}}$
	1679.667	.653	5	1			59535.6	$4p'\ ^2P^\circ_{1\frac{1}{2}}-13_{2\frac{1}{2}}$
	1671.313	.310	20				59833.2	$4p'\ ^4D^\circ_{1\frac{1}{2}}-8_{1\frac{1}{2}}$
	1669.453	.449	2				59899.9	$4p'\ ^4D^\circ_{2\frac{1}{2}}-7_{3\frac{1}{2}}$
	1668.585	.563	1				59931.0	$4p'\ ^2F^\circ_{3\frac{1}{2}}-11_{2\frac{1}{2}}$
	1667.911	.934	5	00			59955.2	$4p'\ ^4P^\circ_{1\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
f	1664.326	.320					60084.4	$4p'\ ^4D^\circ_{2\frac{1}{2}}-8_{1\frac{1}{2}}$
4	1658.251	.254	60		4		60304.5	$4p'\ ^4D^\circ_{3\frac{1}{2}}-6_{2\frac{1}{2}}$
	1655.020	.007	30				60422.2	$4p'\ ^4D^\circ_{2\frac{1}{2}}-9_{2\frac{1}{2}}$
f	1652.931	.912					60498.6	$4p'\ ^2F^\circ_{2\frac{1}{2}}-6_{2\frac{1}{2}}$
4	1650.208	.206	20		6		60598.4	$4p'\ ^4D^\circ_{2\frac{1}{2}}-11_{2\frac{1}{2}}$
4	1645.386	.392	50		60		60776.0	$4p'\ ^4D^\circ_{3\frac{1}{2}}-7_{3\frac{1}{2}}$
	1641.257	.225	2				60928.9	$4p'\ ^2F^\circ_{3\frac{1}{2}}-14_{2\frac{1}{2}}$
4	1638.242	.243	20		3		61041.0	$4p'\ ^4D^\circ_{1\frac{1}{2}}-13_{2\frac{1}{2}}$
*	1635.277	.264	20				61151.7	$4p'\ ^2F^\circ_{3\frac{1}{2}}-21_{4\frac{1}{2}}$
	1635.180	.181	20	3			61155.3	$4p'\ ^2F^\circ_{2\frac{1}{2}}-8_{1\frac{1}{2}}$
	1632.390	.384	15				61259.9	$4p'\ ^4D^\circ_{2\frac{1}{2}}-12_{3\frac{1}{2}}$
4	1631.534	.526	12	3	8		61292.0	$4p'\ ^4D^\circ_{2\frac{1}{2}}-13_{2\frac{1}{2}}$
	1631.364	{ .393 { .361	} 20				61298.4	{ $4p'\ ^4P^\circ_{2\frac{1}{2}}-5s'\ ^2D_{2\frac{1}{2}}$ { $4p'\ ^4D^\circ_{3\frac{1}{2}}-9_{2\frac{1}{2}}$
4	1630.114	.111	25		5		61345.4	$4p'\ ^4D^\circ_{1\frac{1}{2}}-14_{2\frac{1}{2}}$
	1626.200	.191	3				61493.1	$4p'\ ^2F^\circ_{2\frac{1}{2}}-9_{2\frac{1}{2}}$
	1624.020	.022	30				61575.6	$4p'\ ^4P^\circ_{2\frac{1}{2}}-5s'\ ^2D_{1\frac{1}{2}}$
	1623.479	.461	40	1			61596.1	$4p'\ ^4D^\circ_{2\frac{1}{2}}-14_{2\frac{1}{2}}$
	1621.552	.555	40				61669.3	$4p'\ ^2F^\circ_{2\frac{1}{2}}-11_{2\frac{1}{2}}$
3	1618.968	.968	40	1	15		61767.74	$4s^2\ ^2D_{1\frac{1}{2}}-5f\ ^2F^\circ_{2\frac{1}{2}}$
4e *	1617.675	.675?	60		40		61817.1	$4p'\ ^4D^\circ_{2\frac{1}{2}}-20_{2\frac{1}{2}}$?
	1615.949	.981	3	1			61883.1	$4p'\ ^4F^\circ_{2\frac{1}{2}}-1_{3\frac{1}{2}}$
4d	1614.364		40	1	10		61943.9	
4	1611.866		50	8R	25		62039.9	
	1609.390	.376	25	5R			62135.3	$4p'\ ^4D^\circ_{3\frac{1}{2}}-12_{3\frac{1}{2}}$
4	1608.819		40	15R	70		62157.4	
	1608.555	.542	10				62167.6	$4p'\ ^4D^\circ_{3\frac{1}{2}}-13_{2\frac{1}{2}}$
4	1606.082		25	12R	60		62263.3	
	1605.196	.185	8	5R			62297.7	$4p'\ ^4F^\circ_{3\frac{1}{2}}-1_{3\frac{1}{2}}$
	1604.347	.343	15				62330.7	$4p'\ ^2F^\circ_{2\frac{1}{2}}-12_{3\frac{1}{2}}$
4	1603.508	.515	30	0	3		62363.3	$4p'\ ^2F^\circ_{2\frac{1}{2}}-13_{2\frac{1}{2}}$
4 *	1603.315	.320	30	15R	100		62370.8	$4p'\ ^4F^\circ_{4\frac{1}{2}}-1_{3\frac{1}{2}}$
g *	1597.801	.859?	40	5R	5		62586.0	$4p''\ ^2F^\circ_{3\frac{1}{2}}-6s'\ ^2D_{2\frac{1}{2}}$?
4	1597.556	.564	50	5R	15W		62595.6	$4p'\ ^4F^\circ_{3\frac{1}{2}}-3_{2\frac{1}{2}}$
	1596.076		10				62653.7	
4	1595.732	.723	30	8R	20		62667.2	$4p'\ ^2F^\circ_{2\frac{1}{2}}-14_{2\frac{1}{2}}$
4 *	1595.027	.031	40	10R	100		62694.9	$4p'\ ^4D^\circ_{3\frac{1}{2}}-21_{4\frac{1}{2}}$
f	1594.448	.446					62717.6	$4p'\ ^4F^\circ_{2\frac{1}{1}}-4_{2\frac{1}{2}}$
4 *	1590.133	.134?	25	10R	25		62887.8	$4p'\ ^2F^\circ_{2\frac{1}{2}}-20_{2\frac{1}{2}}$?
2	1589.777	.780	30	10R	50		62901.90	$4s^2\ ^2D_{1\frac{1}{2}}-7p\ ^2P^\circ_{1\frac{1}{2}}$
	1588.754	.721		3R			62942.4	$4p'\ ^4F^\circ_{1\frac{1}{2}}-6_{2\frac{1}{2}}$
3	1585.368	×	25	15R	100		63076.84	$4s^2\ ^2D_{1\frac{1}{2}}-7p\ ^2P^\circ_{\frac{1}{2}}$
	1583.933	.935	15				63134.0	$4p'\ ^4F^\circ_{3\frac{1}{2}}-4_{2\frac{1}{2}}$
	1575.810		10				63459.4	
4	1572.991		90	8R	40WW		63573.2	
*	1564.369	.387	6	3			63923.5	$4p'\ ^4P^\circ_{2\frac{1}{2}}-5s''\ ^2D_{2\frac{1}{2}}$
4	1559.466	.454	20	2R	10W		64124.5	$4p'\ ^4P^\circ_{1\frac{1}{2}}-3_{2\frac{1}{2}}$
3	1555.764		25	12R	100		64277.10	
4	1554.740	.746	20		6		64319.4	$4p'\ ^4F^\circ_{3\frac{1}{2}}-6_{2\frac{1}{2}}$
4	1554.225		15	1	6		64340.7	

TABLE 1. Zn II *spectrum below 2570 Å* — Continued

Notes	λ(vac), Å obs.	λ(vac), Å calc.	Intensity E_1	Intensity E_2	Intensity S_3	---	σ, cm⁻¹ obs.	Classification
3	1550.936	.937	25	10R	80		64477.19	$4s^2\,{}^2D_{2\frac{1}{2}}-5f\,{}^2F^\circ_{3\frac{1}{2}}$
4	1548.957	.971	15		3W		64559.6	$4p'\,{}^4F^\circ_{2\frac{1}{2}}-8_{1\frac{1}{2}}$
4	1548.434	.426	20	5R	20		64581.4	$4p'\,{}^4P^\circ_{\frac{1}{2}}-5_{\frac{1}{2}}$
4	1547.800		20	5R	20		64607.8	
4	1546.650		25	12R	100		64655.9	
4	1546.460	.465	20	10R	10		64663.8	$4p'\,{}^4P^\circ_{1\frac{1}{2}}-4_{2\frac{1}{2}}$
4	1545.087		20	8R	2		64721.3	
4	1544.922		25	15R	50		64728.2	
4	1543.428	.434	25	10R	40		64790.8	$4p'\,{}^4F^\circ_{3\frac{1}{2}}-7_{3\frac{1}{2}}$
4	1543.037	.034	25	10R	50		64807.3	$4p'\,{}^4F^\circ_{1\frac{1}{2}}-13_{2\frac{1}{2}}$
4	1542.531		20	10R	2WW		64828.5	
4 *	1541.707	.709	30	12R	40		64863.2	$4p'\,{}^4F^\circ_{4\frac{1}{2}}-7_{3\frac{1}{2}}$
4	1540.895	.901	35	15R	80		64897.3	$4p'\,{}^4F^\circ_{2\frac{1}{2}}-9_{2\frac{1}{2}}$
2	1540.120	.122	30	10R	50		64930.01	$4s^2\,{}^2D_{1\frac{1}{2}}-4p''\,{}^2P^\circ_{1\frac{1}{2}}$
4	1536.726	.738	25	10R	20		65073.4	$4p'\,{}^4F^\circ_{2\frac{1}{2}}-11_{2\frac{1}{2}}$
4	1535.823	.818	30	15R	30		65111.7	$4p'\,{}^4F^\circ_{1\frac{1}{2}}-14_{2\frac{1}{2}}$
1	1535.081	.085	40	40R	200		65143.14	$4p\,{}^2P^\circ_{1\frac{1}{2}}-6s\,{}^2S_{\frac{1}{2}}$
4	1531.394	.422	25	8R	3W		65300.0	$4p'\,{}^4P^\circ_{\frac{1}{2}}-8_{1\frac{1}{2}}$
4	1531.088	.082	30	8R	30		65313.0	$4p'\,{}^4F^\circ_{3\frac{1}{2}}-9_{2\frac{1}{2}}$
*	1530.620	.639?	25				65333.0	$4p'\,{}^4F^\circ_{1\frac{1}{2}}-20_{2\frac{1}{2}}$?
4	1528.759		25	5R	9		65412.5	
4	1528.550		30	10R	40		65421.5	
4	1527.915	.910	30	15R	100		65448.7	$4p'\,{}^4P^\circ_{2\frac{1}{2}}-1_{3\frac{1}{2}}$
	1527.236		20	10R			65477.8	
	1527.125		25	10R			65482.5	
4	1526.969	.972	30	10R	15		65489.2	$4p'\,{}^4F^\circ_{3\frac{1}{2}}-11_{2\frac{1}{2}}$
1	1523.903	.903	40	30R	150		65620.97	$4s^2\,{}^2D_{2\frac{1}{2}}-7p\,{}^2P^\circ_{1\frac{1}{2}}$
4	1521.276	.271	50	8R	40		65734.3	$4p'\,{}^4F^\circ_{2\frac{1}{2}}-12_{3\frac{1}{2}}$
4	1520.998	1.003	40	8R	15		65746.3	$4p'\,{}^4P^\circ_{2\frac{1}{2}}-3_{2\frac{1}{2}}$
4	1520.527	.526	40	10R	50		65766.7	$4p'\,{}^4F^\circ_{2\frac{1}{2}}-13_{2\frac{1}{2}}$
	1520.022	.039	25				65788.5	$4p'\,{}^4P^\circ_{1\frac{1}{2}}-5_{\frac{1}{2}}$
4	1518.631	.628	30		3		65848.8	$4p'\,{}^4P^\circ_{1\frac{1}{2}}-6_{2\frac{1}{2}}$
1	1514.763	.761	50	15R	120		66016.93	$4p\,{}^2P^\circ_{\frac{1}{2}}-6s\,{}^2S_{\frac{1}{2}}$
4	1514.479		30	8R	25		66029.3	
4	1513.522	.519	20	8R	20		66071.1	$4p'\,{}^4F^\circ_{2\frac{1}{2}}-14_{2\frac{1}{2}}$
4	1511.718		{ 30	8R	15		66149.9	
4	1511.694	.700			12		66151.0	$4p'\,{}^4F^\circ_{3\frac{1}{2}}-12_{3\frac{1}{2}}$
2	1510.363	.362	40	15R	150		66209.25	$4s^2\,{}^2D_{1\frac{1}{2}}-4p''\,{}^2D^\circ_{2\frac{1}{2}}$
*	1510.045	.045	5				66223.2	$4p'\,{}^4F^\circ_{4\frac{1}{2}}-12_{3\frac{1}{2}}$
4	1508.645	.644	40	8R	70		66284.6	$4p'\,{}^4P^\circ_{2\frac{1}{2}}-4_{2\frac{1}{2}}$
4	1504.034	.044	5		5		66487.9	$4p'\,{}^4F^\circ_{3\frac{1}{2}}-14_{2\frac{1}{2}}$
4	1503.653	.649	35	5R	25		66504.7	$4p'\,{}^4P^\circ_{1\frac{1}{2}}-8_{1\frac{1}{2}}$
4h	1503.109		30	5R	20		66528.8	
4e, i*	1499.077	.077?	{ 5		{ 20		66707.7	$4p'\,{}^4F^\circ_{3\frac{1}{2}}-20_{2\frac{1}{2}}$?
4i *	1499.052	.037			20		66708.8	$4p'\,{}^4F^\circ_{3\frac{1}{2}}-21_{4\frac{1}{2}}$
4 *	1497.410	.410	40	8R	80		66782.0	$4p'\,{}^4F^\circ_{4\frac{1}{2}}-21_{4\frac{1}{2}}$
	1496.001	.043	5	1			66844.9	$4p'\,{}^4P^\circ_{1\frac{1}{2}}-9_{2\frac{1}{2}}$
1 *	1493.133	×	40	25R	300		66973.27	$4s^2\,{}^2D_{1\frac{1}{2}}-8p\,{}^2P^\circ_{\frac{1}{2}}$
4	1492.121	.119	25		30		67018.7	$4p'\,{}^4P^\circ_{1\frac{1}{2}}-11_{2\frac{1}{2}}$
2	1488.926	.927	10	10R	120		67162.50	$4s^2\,{}^2D_{1\frac{1}{2}}-6f\,{}^2F^\circ_{2\frac{1}{2}}$
1	1486.065	×	40	40R	700		67291.81	$4s^2\,{}^2D_{2\frac{1}{2}}-4p''\,{}^2F^\circ_{3\frac{1}{2}}$
4	1482.139	.140	30	10R	80		67470.1	$4p'\,{}^4P^\circ_{2\frac{1}{2}}-6_{2\frac{1}{2}}$
1	1478.216	.216	50	30R	300		67649.11	$4s^2\,{}^2D_{2\frac{1}{2}}-4p''\,{}^2P^\circ_{1\frac{1}{2}}$
1	1477.016	.015	60	30R	400		67704.07	$4s^2\,{}^2D_{1\frac{1}{2}}-4p''\,{}^2F^\circ_{2\frac{1}{2}}$
4	1471.862	.857	30	8R	50		67941.2	$4p'\,{}^4P^\circ_{2\frac{1}{2}}-7_{3\frac{1}{2}}$

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TABLE 1. Zn II *spectrum below 2570 Å*—Continued

Notes	λ(vac), Å obs.	λ(vac), Å calc.	Intensity E_1	Intensity E_2	Intensity S_3	Intensity ---	σ, cm^{-1} obs.	Classification
	1470.222	.218	2				68016.9	$4p'\ {}^{4}P^{\circ}_{1\frac{1}{2}} - 14_{2\frac{1}{2}}$
4	1467.867	.868	25		4		68126.1	$4p'\ {}^{4}P^{\circ}_{2\frac{1}{2}} - 8_{1\frac{1}{2}}$
4 *	1466.697	.696	30	5R	15		68180.4	$4s^2\ {}^{2}D_{1\frac{1}{2}} - 8p\ {}^{2}P^{\circ}_{1\frac{1}{2}}$
1	1462.743	×	50	15R	150		68364.71	$4s^2\ {}^{2}D_{1\frac{1}{2}} - 4p''\ {}^{2}P^{\circ}_{\frac{1}{2}}$
	1460.616	.620	12				68464.3	$4p'\ {}^{4}P^{\circ}_{2\frac{1}{2}} - 9_{2\frac{1}{2}}$
1	1457.422	.423	40	8R	100		68614.31	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 5d\ {}^{2}D_{1\frac{1}{2}}$
1	1456.907	×	50	10R	500		68638.56	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 5d\ {}^{2}D_{2\frac{1}{2}}$
1	1450.778	.779	50	30R	700		68928.53	$4s^2\ {}^{2}D_{2\frac{1}{2}} - 4P''\ {}^{2}D^{\circ}_{2\frac{1}{2}}$
1	1445.042	×	60	30R	700		69202.14	$4s^2\ {}^{2}D_{1\frac{1}{2}} - 4p''\ {}^{2}D^{\circ}_{1\frac{1}{2}}$
	1442.962	.970	5				69301.9	$4p'\ {}^{4}P^{\circ}_{2\frac{1}{2}} - 12_{3\frac{1}{2}}$
1	1439.091	.091	60	30R	500		69488.31	$4p\ {}^{2}P^{\circ}_{\frac{1}{2}} - 5d\ {}^{2}D_{1\frac{1}{2}}$
1	1430.992	.991	50	25R	150		69881.59	$4s^2\ {}^{2}D_{2\frac{1}{2}} - 6f\ {}^{2}F^{\circ}_{2\frac{1}{2}}$
4	1430.285	.268	10		15		69916.1	$4s^2\ {}^{2}D_{2\frac{1}{2}} - 6f\ {}^{2}F^{\circ}_{3\frac{1}{2}}$
2	1419.982	.984	50	25R	200		70423.43	$4s^2\ {}^{2}D_{2\frac{1}{2}} - 4p''\ {}^{2}F^{\circ}_{2\frac{1}{2}}$
*	1419.416	.427	3	3R			70451.5	$4s^2\ {}^{2}D_{1\frac{1}{2}} - 7f\ {}^{2}F^{\circ}_{2\frac{1}{2}}$
3 *	1410.443	×	60	15R	100		70899.71	$4s^2\ {}^{2}D_{2\frac{1}{2}} - 8p\ {}^{2}P^{\circ}_{1\frac{1}{2}}$
4j *	1407.259				7		71060.1	
4j	1407.215		{50}	{5R}	3		71062.3	
4j *	1407.189	×			2		71063.7	$4s^2\ {}^{2}D_{1\frac{1}{2}} - 9p\ {}^{2}P^{\circ}_{1\frac{1}{2}}$?
	1390.372	.408	40	5R			71923.2	$4s^2\ {}^{2}D_{2\frac{1}{2}} - 4p''\ {}^{2}D^{\circ}_{1\frac{1}{2}}$
b	1366.682	{.728 .678}	{60}	20R			73169.9	{$4s^2\ {}^{2}D_{2\frac{1}{2}} - 7f\ {}^{2}F^{\circ}_{3\frac{1}{2}}$ $4s^2\ {}^{2}D_{2\frac{1}{2}} - 7f\ {}^{2}F^{\circ}_{2\frac{1}{2}}$}
*	1355.332	.328?	25				73782.7	$4s^2\ {}^{2}D_{2\frac{1}{2}} - 9p\ {}^{2}P^{\circ}_{1\frac{1}{2}}$?
	1323.909		30				75533.9	
	1309.521	.517		1			76363.8	$4p'\ {}^{2}D^{\circ}_{2\frac{1}{2}} - 6s'\ {}^{4}D_{3\frac{1}{2}}$
	1306.741	.763	5				76526.3	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 7s\ {}^{2}S_{\frac{1}{2}}$
	1277.523	.538	40	10R			78276.5	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 6d\ {}^{2}D_{1\frac{1}{2}}$
	1277.306	.324	60				78289.8	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 6d\ {}^{2}D_{2\frac{1}{2}}$
	1265.065						79047.3	
	1263.412	.430	40	15R			79150.7	$4p\ {}^{2}P^{\circ}_{\frac{1}{2}} - 6d\ {}^{2}D_{1\frac{1}{2}}$
	1258.581	.574	00				79454.6	$4p'\ {}^{4}D^{\circ}_{2\frac{1}{2}} - 6s'\ {}^{4}D_{3\frac{1}{2}}$
	1244.848	.852	2	3			80331.1	$4p'\ {}^{4}D^{\circ}_{3\frac{1}{2}} - 6s'\ {}^{4}D_{3\frac{1}{2}}$
	1241.874	.840		0			80523.5	$4p'\ {}^{2}F^{\circ}_{2\frac{1}{2}} - 6s'\ {}^{4}D_{3\frac{1}{2}}$
	1240.625	.638?	3				80604.5	$4p'\ {}^{4}D^{\circ}_{1\frac{1}{2}} - 6s'\ {}^{2}D_{2\frac{1}{2}}$?
	1211.841	.800	25	5R			82519.1	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 8s\ {}^{2}S_{\frac{1}{2}}$
	1206.525		30	15R			82882.6	
	1197.149	.126	40	10R			83531.8	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 7d\ {}^{2}D_{2\frac{1}{2}}$
	1193.231		60	20R			83806.1	
	1192.961						83825.0	
	1185.610	.598	1				84344.8	$4p'\ {}^{4}F^{\circ}_{3\frac{1}{2}} - 6s'\ {}^{4}D_{3\frac{1}{2}}$
	1184.858	.840	40				84398.3	$4p\ {}^{2}P^{\circ}_{\frac{1}{2}} - 7d\ {}^{2}D_{1\frac{1}{2}}$
*	1184.528	.580	8				84421.8	$4p'\ {}^{4}F^{\circ}_{4\frac{1}{2}} - 6s'\ {}^{4}D_{3\frac{1}{2}}$
	1183.488		2				84496.0	
	1171.943	.929?	1	5			85328.4	$4p'\ {}^{4}F^{\circ}_{2\frac{1}{2}} - 6s'\ {}^{2}D_{2\frac{1}{2}}$?
	1153.398	.379	25	5			86700.3	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 8d\ {}^{2}D_{2\frac{1}{2}}$
	1152.139		4	5			86795.1	
	1142.904	.904	1				87496.4	$4p'\ {}^{4}P^{\circ}_{2\frac{1}{2}} - 6s'\ {}^{4}D_{3\frac{1}{2}}$
	1141.955	.932	20	5H			87569.1	$4p\ {}^{2}P^{\circ}_{\frac{1}{2}} - 8d\ {}^{2}D_{1\frac{1}{2}}$
	1138.524						87833.0	
	1126.611	.602	8	2H			88761.8	$4p\ {}^{2}P^{\circ}_{1\frac{1}{2}} - 9d\ {}^{2}D_{2\frac{1}{2}}$
	1115.657	.660	15	8H			89633.3	$4p\ {}^{2}P^{\circ}_{\frac{1}{2}} - 9d\ {}^{2}D_{1\frac{1}{2}}$
	986.516	.525	12	8			101366.8	$4s\ {}^{2}S_{\frac{1}{2}} - 5p\ {}^{2}P^{\circ}_{\frac{1}{2}}$
	984.139	.142	20	10			101611.7	$4s\ {}^{2}S_{\frac{1}{2}} - 5p\ {}^{2}P^{\circ}_{1\frac{1}{2}}$
	971.699			2			102912.5	
	949.455	.462	5	10			105323.6	$4s\ {}^{2}S_{\frac{1}{2}} - 4p'\ {}^{4}P^{\circ}_{1\frac{1}{2}}$

TABLE 1. Zn II *spectrum below 2570 Å* – Continued

Notes	λ(vac), Å obs.	λ(vac), Å calc.	Intensity E_1	Intensity E_2	Intensity ---	σ, cm⁻¹ obs.	Classification
f	938.719	.713				106528.2	$4s\ ^2S_{1/2}-4p'\ ^4P^{\circ}_{1/2}$
f	923.969	.976				108228.7	$4s\ ^2S_{1/2}-4p'\ ^4F^{\circ}_{1 1/2}$
	892.914	.903	2	10		111992.9	$4s\ ^2S_{1/2}-4p'\ ^4D^{\circ}_{1 1/2}$
f	888.620	.613				112534.0	$4s\ ^2S_{1/2}-4p'\ ^4D^{\circ}_{1/2}$
	881.060	.064	1	15		113499.6	$4s\ ^2S_{1/2}-4p'\ ^2P^{\circ}_{1 1/2}$.
	833.600	.616		1H		119961.6	$4s\ ^2S_{1/2}-6p\ ^2P^{\circ}_{1 1/2}$
	779.163	.159	6	10		128342.9	$4s\ ^2S_{1/2}-7p\ ^2P^{\circ}_{1 1/2}$
	778.112	.098	2	5		128516.2	$4s\ ^2S_{1/2}-7p\ ^2P^{\circ}_{1/2}$
	767.050	.038	7	5		130369.6	$4s\ ^2S_{1/2}-4p''\ ^2P^{\circ}_{1 1/2}$
*	755.223	.202	4	5		132411.2	$4s\ ^2S_{1/2}-8p\ ^2P^{\circ}_{1/2}$
	747.358	.349	3	5		133804.7	$4s\ ^2S_{1/2}-4p''\ ^2P^{\circ}_{1/2}$
	742.720	.700	1	3		134640.2	$4s\ ^2S_{1/2}-4p''\ ^2D^{\circ}_{1 1/2}$
*	732.605	.572?	00	1		136499.2	$4s\ ^2S_{1/2}-9p\ ^2P^{\circ}_{1 1/2}$?

[a] A Zn I line also at this position belongs to a multiplet having negligible intensity in E_1. (In the region above 2400 Å, E_1 corresponds to I_4 in [9].)
[b] Given in [1] or [9] as blend of Zn II and Zn III transitions. This explains an anomalously strong intensity in E_2 for three autoionizing Zn II lines.
[c] Either a blend or the classification is incorrect. The indicated Zn II transition should not be observed in E_2.
[III] Zn III line now resolved from nearby Zn II line.
[d] Line belongs to either Zn II or Zn III. The close group at 1762.2 Å has three resolved lines; our interpretation of measurements from three exposures (S_1, S_2, and S_3) is that the group comprises four different lines.
[e] Line assigned to Zn II only on the basis of a questionable classification.
[f] Weak line from spark exposure I_3 [9]. (Intensities from this source are not listed here.)
[g] Wavelength from [1]; line is blended with a ghost on S_3 plate.
[h] Line is given as blend of Zn IV and Zn II in [1]; the new wavelength is entirely due to an unclassified Zn II transition.
[i] The E_1 intensity appears to be too low.
[j] Interpretation of group not certain. There appear to be three lines, as given, with a possibility that the strongest (1407.259 Å) is either double or self-reversed.

TABLE 2. *Energy levels of* Zn II

All positions were redetermined in this investigation. The authorities for all except a few new levels are listed by Crooker and Dick [1], who also suggest that the numbered high even levels belong mainly to the $3d^94s4d$ configuration.

Configuration	Designation	J	Level (cm^{-1})
	Even levels		
$3d^{10}4s$	$4s\,^2S$	$\frac{1}{2}$	0.00
$3d^94s^2$	$4s^2\,^2D$	$2\frac{1}{2}$	62722.45
		$1\frac{1}{2}$	65441.64
$3d^{10}5s$	$5s\,^2S$	$\frac{1}{2}$	88437.15
$3d^{10}4d$	$4d\,^2D$	$1\frac{1}{2}$	96909.74
		$2\frac{1}{2}$	96960.40
$3d^{10}6s$	$6s\,^2S$	$\frac{1}{2}$	114498.02
$3d^{10}5d$	$5d\,^2D$	$1\frac{1}{2}$	117969.32
		$2\frac{1}{2}$	117993.61
$3d^{10}7s$	$7s\,^2S$	$\frac{1}{2}$	125880.0
$3d^{10}5g$	$5g\,^2G$	$4\frac{1}{2}$	127310.8
		$3\frac{1}{2}$	127310.9
$3d^{10}6d$	$6d\,^2D$	$1\frac{1}{2}$	127630.6
		$2\frac{1}{2}$	127643.7
$3d^{10}8s$	$8s\,^2S$	$\frac{1}{2}$	131876.9
$3d^{10}6g$	$6g\,^2G$	$3\frac{1}{2}, 4\frac{1}{2}$	132683.9
$3d^{10}7d$	$7d\,^2D$	$1\frac{1}{2}$	132880.6
		$2\frac{1}{2}$	132888.4
$3d^{10}9s$	$9s\,^2S$	$\frac{1}{2}$	135423.3
$3d^{10}7g$	$7g\,^2G$	$3\frac{1}{2}, 4\frac{1}{2}$	135923.8
$3d^{10}8d$	$8d\,^2D$	$1\frac{1}{2}$	136051.9
		$2\frac{1}{2}$	136056.8
$3d^{10}9d$	$9d\,^2D$	$1\frac{1}{2}$	138114.0
		$2\frac{1}{2}$	138117.5
Zn III $3d^{10}\,^1S_0$	Limit		144892.6
$3d^94s(^3D)5s$	$5s'\,^4D$	$3\frac{1}{2}$	161318.4
		$2\frac{1}{2}$	162070.3
		$1\frac{1}{2}$	162897.0
		$\frac{1}{2}$	164070.1
$3d^94s(^3D)5s$	$5s'\,^2D$	$2\frac{1}{2}$	[a] 164998.9
		$1\frac{1}{2}$	165277.1
$3d^94s(^1D)5s$	$5s''\,^2D$	$2\frac{1}{2}$	[a] 167624.4
	1	$3\frac{1}{2}$	[b] 169150.5
	3	$2\frac{1}{2}$	169447.7
	4	$2\frac{1}{2}$	169986.3
	5	$\frac{1}{2}$	171110.5
	6	$2\frac{1}{2}$	171171.6
	7	$3\frac{1}{2}$	[b] 171643.0
	8	$1\frac{1}{2}$	171827.6
	9	$2\frac{1}{2}$	172165.7
	11	$2\frac{1}{2}$	172341.5
	12	$3\frac{1}{2}$	173003.1
	13	$2\frac{1}{2}$	173035.3
	14	$2\frac{1}{2}$	173339.8
	20	$2\frac{1}{2}$?	[c] 173560.7?
	21	$4\frac{1}{2}$	[a] 173561.9

Configuration	Designation	J	Level (cm^{-1})
$3d^94s(^3D)6s$	$6s'\,^4D$	$3\frac{1}{2}$	191198.0
$3d^94s(^3D)6s$	$6s'\,^2D$	$2\frac{1}{2}$	[b] 192598. ?
	Odd levels		
$3d^{10}4p$	$4p\,^2P^\circ$	$\frac{1}{2}$	48481.00
		$1\frac{1}{2}$	49355.04
$3d^{10}5p$	$5p\,^2P^\circ$	$\frac{1}{2}$	101365.9
		$1\frac{1}{2}$	101611.4
$3d^9(^2D)4s4p(^3P^\circ)$	$4p'\,^4P^\circ$	$2\frac{1}{2}$	103701.6
	$4p'\,^4P^\circ$	$1\frac{1}{2}$	105322.7
	$4p'\,^4P^\circ$	$\frac{1}{2}$	106528.8
	$4p'\,^4F^\circ$	$4\frac{1}{2}$	[a] 106779.9
	$4p'\,^4F^\circ$	$3\frac{1}{2}$	106852.4
	$4p'\,^4F^\circ$	$2\frac{1}{2}$	107268.6
	$4p'\,^4F^\circ$	$1\frac{1}{2}$	108227.9
	$4p'\,^2F^\circ$	$2\frac{1}{2}$	110672.3
	$4p'\,^4D^\circ$	$3\frac{1}{2}$	110867.2
	$4p'\,^4D^\circ$	$2\frac{1}{2}$	111743.0
	$4p'\,^4D^\circ$	$1\frac{1}{2}$	111994.3
	$4p'\,^2F^\circ$	$3\frac{1}{2}$	112409.7
	$4p'\,^4D^\circ$	$\frac{1}{2}$	112534.9
	$4p'\,^2P^\circ$	$\frac{1}{2}$	[d] 113492.9
	$4p'\,^2P^\circ$	$1\frac{1}{2}$	113499.2
	$4p'\,^2D^\circ$	$1\frac{1}{2}$	114045.03
	$4p'\,^2D^\circ$	$2\frac{1}{2}$	114833.95
$3d^{10}4f$	$4f\,^2F^\circ$	$3\frac{1}{2}$	117263.4
		$2\frac{1}{2}$	117264.0
$3d^{10}6p$	$6p\,^2P^\circ$	$\frac{1}{2}$	119888.51
		$1\frac{1}{2}$	119959.34
$3d^{10}5f$	$5f\,^2F^\circ$	$3\frac{1}{2}$	127199.6
		$2\frac{1}{2}$	127209.4
$3d^{10}7p$	$7p\,^2P^\circ$	$1\frac{1}{2}$	128343.44
		$\frac{1}{2}$	128518.5
$3d^9(^2D)4s4p(^1P^\circ)$	$4p''\,^2F^\circ$	$3\frac{1}{2}$	130014.26
	$4p''\,^2P^\circ$	$1\frac{1}{2}$	130371.57
	$4p''\,^2D^\circ$	$2\frac{1}{2}$	131650.93
$3d^{10}8p$	$8p\,^2P^\circ$	$\frac{1}{2}$	[a] 132414.9
$3d^{10}6f$	$6f\,^2F^\circ$	$2\frac{1}{2}$	132604.09
		$3\frac{1}{2}$	132639.4
$3d^9(^2D)4s4p(^1P^\circ)$	$4p''\,^2F^\circ$	$2\frac{1}{2}$	133145.76
$3d^{10}8p$	$8p\,^2P^\circ$	$1\frac{1}{2}$	[a] 133622.1
$3d^9(^2D)4s4p(^1P^\circ)$	$4p''\,^2P^\circ$	$\frac{1}{2}$	133806.3
	$4p''\,^2D^\circ$	$1\frac{1}{2}$	134643.8
$3d^{10}7f$	$7f\,^2F^\circ$	$3\frac{1}{2}$	135889.9
		$2\frac{1}{2}$	135892.6
$3d^{10}9p$	$9p\,^2P^\circ$	$1\frac{1}{2}$	[c] 136505.3?
$3d^{10}8f$	$8f\,^2F^\circ$	$3\frac{1}{2}$	138002.1
		$2\frac{1}{2}$	138003.3

[a] New level from [4] or [5]. [b] J-value changed [5]. [c] Tentative new level. [d] This level was first located by Shenstone and Gibson [2, 3]. Its combinations were correctly listed in [1], although an erroneous position occurred in the level table.

from $5s'\ ^4D_{3\frac{1}{2}}$, and the new $4p'\ ^4F^\circ_{4\frac{1}{2}}$ level [4, 5] was confirmed by the resolution and character of its strongest combination.[5]

Thirty of the classifications in table 1 are due to work reported in [4] and [5]. A few other new classifications are also listed.

Some previous ambiguities as to the spectrum assignments of certain lines are now resolved. None of the lines in table 1 has any appreciable intensity due to Zn IV in our sources. It appears from Dick's ionization stage assignments [9] that the experimental behavior of the weaker lines classified by Zn II levels was consistent with the classifications but, in itself, was often not conclusive. For the stronger lines a good separation of Zn II and Zn III was obtained [9]. Our sources allow a separation of Zn II and Zn I in the region above 1715 Å for roughly this same group, and all the unclassified lines assigned to Zn II in this region are thus separated from both Zn III and Zn I. Below 1715 Å there is no definite separation of weaker Zn II lines from possible Zn I lines.

Most of the unclassified lines in table 1 were observed by Crooker and Dick in one of their electrodeless discharges and assigned to Zn II on the basis of excitation behavior. Wavelengths for some additional unclassified lines that had Zn II character in a spark source may be found in [1]. Most of the lines previously classified by levels regarded as tentative (or now rejected) are not included in table 1, since they were not assigned to Zn II on the basis of excitation characteristics alone. Conversely, the table includes some new assignments to Zn II made on the basis of classifications by new levels.

Table 3 gives some classified lines above 2700 Å that should be added to the list of Crooker and Dick [1] for completeness.

TABLE 3. *Some additions to the* Zn II *line list of Crooker and Dick* [*1*]

Unless otherwise noted, observations are from [9], with E and S corresponding to electrodeless-discharge and spark intensities, respectively, as in [1]. Diffuse lines are denoted by "D".

Note	λ(air), Å	E	S	σ, cm^{-1}	Classification
a	6842.32			14610.9	$5d\ ^2D_{2\frac{1}{2}}-6f\ ^2F^\circ_{2\frac{1}{2}}$
b	6396.98	1		15628.1	$5d\ ^2D_{2\frac{1}{2}}-8p\ ^2P^\circ_{1\frac{1}{2}}$?
a	5586.22	100	1	17896.2	$5d\ ^2D_{2\frac{1}{2}}-7f\ ^2F^\circ_{3\frac{1}{2}}$
a	5585.21			17899.5	$5d\ ^2D_{2\frac{1}{2}}-7f\ ^2F^\circ_{2\frac{1}{2}}$
c	5577.71	(50)		17923.5	$5d\ ^2D_{1\frac{1}{2}}-7f\ ^2F^\circ_{2\frac{1}{2}}$
b	3514.19	15		28448.0	$8p\ ^2P^\circ_{1\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$?
a	3304.80			30250.3	$4d\ ^2D_{2\frac{1}{2}}-5f\ ^2F^\circ_{2\frac{1}{2}}$
b	3279.72	10		30481.7	$8p\ ^2P^\circ_{\frac{1}{2}}-5s'\ ^4D_{1\frac{1}{2}}$?
d	3276.57	20		30511.0	$5p\ ^2P^\circ_{\frac{1}{2}}-8s\ ^2S_{\frac{1}{2}}$
e	3153.44	30D	2	31702.2	$4p''\ ^2P^\circ_{1\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
b	3138.7	30D		31851.	$4p''\ ^2F^\circ_{2\frac{1}{2}}-5s'\ ^2D_{2\frac{1}{2}}$
b	2997.8	50		33348.	$4p''\ ^2D^\circ_{2\frac{1}{2}}-5s'\ ^2D_{2\frac{1}{2}}$
e	2964.3	10D		33725.	$7p\ ^2P^\circ_{1\frac{1}{2}}-5s'\ ^4D_{2\frac{1}{2}}$
b	2857.59	50D	5	34984.3	$4p''\ ^2F^\circ_{3\frac{1}{2}}-5s'\ ^2D_{2\frac{1}{2}}$
f	2738.46	10		36506.1	$5p\ ^2P^\circ_{1\frac{1}{2}}-9d\ ^2D_{2\frac{1}{2}}$
f	2720.42			36748.1	$5p\ ^2P^\circ_{\frac{1}{2}}-9d\ ^2D_{1\frac{1}{2}}$

[a] Wavelength, classification from G. v. Salis, Ann. Physik [4] **76,** 145 (1925).

[b] Classification involves new level from [4] or [5]. Lines with questionable classifications may not belong to Zn II.

[c] Wavelength from Shenstone and Gibson [3]. Intensity is a guess for unblended Zn II line, as actual line was blended with a strong Zn III line in [9].

[d] Classified by v. Salis.

[e] Upper level found by Crooker and Dick [1].

[f] Both wavelengths are from [3], for consistency. The 2738 Å transition was listed in [1].

4. Comments on Levels

The $nf(^2F^\circ_{3\frac{1}{2}}-{}^2F^\circ_{2\frac{1}{2}})$ intervals obtained from the levels in table 2 are:[6]

$4f$	-0.6 cm^{-1}
$5f$	-9.8
$6f$	$+35.3$
$7f$	-2.7
$8f$	-1.2

Although f series with all or mostly negative intervals are frequently observed, this behavior has not been satisfactorily explained. It does seem clear that it is not generally due to interaction with known configurations. Such interactions can, in some cases, account for irregular variations of the intervals along the series. The $4p''\ ^2F^\circ$ levels in Zn II are so positioned that interaction with them probably explains the relatively large positive interval of the $6f\ ^2F^\circ$ term[7] and the increased negative interval of $5f\ ^2F^\circ$.

It seems best to rely entirely on the three-member g series for the ionization energy. The Ritz formula yields a value of 144892.6 cm^{-1} for Zn III $3d^{10}\ ^1S_0$ relative to the ground level of Zn II. An uncertainty of ± 2 cm^{-1} should take into account the effect of any errors in the levels.

All Zn II levels that appear to be well established are given in table 2. A few levels listed by Crooker and Dick [1] are omitted. Several of these were undesignated even levels (lying above the limit) given as questionable in [1]. (We have retained the originally assigned numbers as names for the remaining such levels.) The other deletions, and all except two of the new levels (both tentative), result from previously described work [4, 5].

5. References

[1] Crooker, A. M., and Dick, K. A., Can. J. Phys. **46,** 1241 (1968). This paper includes an account of previous investigations of Zn II.

[2] Moore, C. E., Atomic Energy Levels, Nat. Bur. Stand. (U.S.), Circ. 467, Vol. II, 259 pages (1952). References to publications on Zn II earlier than [1] are given.

[5] The line previously given for this transition, 1816.479 Å, [1] cannot arise from $5s'\ ^4D_{3\frac{1}{2}}$. Since this line is strong in E_1, does not appear in E_2, and is wide and weak (relative to E_1) in S_1, it arises from an (unknown) autoionization-broadened level.

[6] Some oversights regarding the $7f$ term in the level and line lists of [1] have been corrected. We also used data from references in table 3 to help determine some nf levels.

[7] The inference that $6f\ ^2F^\circ$ has the most perturbed of these intervals is consistent with its position nearest to a perturbing $3d^94s4p$ level, $4p''\ ^2F^\circ_{2\frac{1}{2}}$. The observed $3d^94s^2\ ^2D-3d^{10}nf\ ^2F^\circ$ multiplets (forbidden in the pure configuration approximation) probably arise mainly from the small interaction of the $3d^{10}nf$ series with $3d^94s4p$. Thus, on our spectrograms, the $4s^2\ ^2D_{2\frac{1}{2}}-6f\ ^2F^\circ_{2\frac{1}{2}}$ transition at 1430.992 Å is the strongest observed line belonging to any of these multiplets.

[3] Shenstone, A. G., and Gibson, L. E., unpublished material. (The main results of this analysis were given in [2].)
[4] Martin, W. C., and Sugar, J., J. Opt. Soc. Am. **59,** 1266 (1969). The present paper was given as the source of the experimental values for some levels and wavenumbers in Tables III, VI, and XII of this reference. These values were based on preliminary measurement of a zinc spark spectrogram. In some cases they differ by more than 1 cm^{-1} from the much more accurate values reported here.
[5] Martin, W. C., and Sugar, J., J. Res. Nat. Bur. Stand. (U.S.), **74A,** (Phys. and Chem) No. 1, 7 (Jan.–Feb. 1970).
[6] Sugar, J., J. Opt. Soc. Am. **53,** 831 (1963).
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[8] Shenstone, A. G., Phil. Trans. Roy. Soc. (London) [A] **241,** 297 (1948).
[9] Dick, K. A., The Spark Spectra of Zinc (Ph. D. Thesis, University of British Columbia, 1966).

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