Extension of the First Spark Spectrum of Caesium (Cs II)

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With an electrodeless discharge in caesium vapor as a light source, the spark spectrum of caesium has been completely rephotographed in the region λ2300–λ10,000 in the first order of 21 ft. concave grating and with a Hilger E1 quartz spectrograph. The observations of Sommer in the region λ3268–λ7280 were confirmed and extended and many new lines were photographed outside Sommer's range. These data were used to extend the classifications of Laporte, Miller and Sawyer, based on Sommer's data supplemented by vacuum spectrograph measurements, in which practically only terms belonging to the $5p^5\ ^2P_{1\frac{1}{2}}$ limit were identified. In the present work most of the terms of the $5p^5\ (^2P_{\frac{1}{2}})$ $5d$, $6d$, $6s$, $7s$, and $6p$ configurations were located as well as a few new terms belonging to the $5p^5\ ^2P_{1\frac{1}{2}}$ limit, and about 100 additional lines were classified in the Cs II spectrum.

I. Introduction

In a recent publication Laporte, Miller[1] and Sawyer presented an interpretation of the first spark spectrum of caesium on the basis of the material of Sommer[2] who photographed the caesium spark spectrum in the region λλ3267–7280 and arranged 51 lines in a scheme involving transitions between a middle group of five terms and an upper and a lower group of eight and five terms, respectively. Sommer pointed out the similarity to the neon spectrum but was unable to correlate the two spectra unambiguously. Laporte, Miller and Sawyer photographed the caesium spectrum from a hollow cathode discharge in helium with a 1 meter vacuum spectrograph and discovered eight new lines in the region between 962A and 612A. Identification of these ultraviolet lines as transitions between the lowest term $5p^6\ ^1S_0$, and terms of the configurations $5p^5$ ($6s$, $7s$, $5d$, $6d$) having $j=1$, made possible the interpretation of Sommer's scheme since five of the eight ultraviolet lines proved to involve terms in Sommer's scheme.

It was found that Sommer's middle set of terms belonged to the $5p^5\ 6p$ configuration and his upper and lower sets, respectively, to a blend of $5p^5\ 5d$ and $6s$, and $5p^5\ 6d$ and $7s$. However, from the table of electron configurations and expected terms in a rare gas spectrum given in Table I, it may be seen that these three term groups should contain respectively 10, 16 and 16 terms, divided in each case for (jj) coupling, into two sets having as limits, one $5p^5\ ^2P_{1\frac{1}{2}}$ and the other $5p^5\ ^2P_{\frac{1}{2}}$ of the Cs II spectrum. The two sets will be completely and widely separated in Cs II as indeed they are for the preceding spectrum of Xe I. Sommer's terms were shown to belong entirely to lower series limit $^2P_{1\frac{1}{2}}$, while the remaining three resonance lines which did not fit into his scheme were believed to arise from configurations built upon $^2P_{\frac{1}{2}}$.

[1] Laporte, Miller, Sawyer, Phys. Rev. **39**, 458 (1932).
[2] Sommer, Ann. d. Physik **75**, 163 (1924).

TABLE I. *Electron configurations and theoretical terms of the Cs II spectrum.*

Electron configuration	Russell-Saunders	(*jj*)		Number of levels
$5p^5$	^2P	$^2P_{1\frac{1}{2}}$	$^2P_{\frac{1}{2}}$	(2)
$5p^6$	$^1S_0$	0		(1)
$5p^5\,6s$, $5p^5\,7s$, $5p^5\,8s$ . . .	$^1P_1$ $^3P_{210}$	21	10	(4)
$5p^5\,6p$, $5p^5\,7p$, $5p^5\,8p$ . . .	$^1S_0\,^1P_1\,^1D_2\,^3S_1\,^3P_{210}\,^3D_{321}$	12 0123	01 12	(10)
$5p^5\,5d$, $5p^5\,6d$, $5p^5\,7d$ . . .	$^1P_1\,^1D_2\,^1F_3\,^3P_{210}\,^3D_{321}\,^3F_{432}$	0123 1234	12 23	(12)
$5p^5\,4f$, $5p^5\,5f$, $5p^5\,6f$ . . .	$^1D_2\,^1F_3\,^1S_4\,^3D_{321}\,^3F_{432}\,^3G_{543}$	1234 2345	23 34	(12)

An attempt was made in the previous work to locate more terms built on the $^2P_{\frac{1}{2}}$ limit but except for a tentative group of three terms, which combined with the three terms indicated by the three resonance lines mentioned above, none were found. The data of Sommer seemed insufficient in range for the purpose. The present study has been undertaken to extend the experimental data on the spark spectrum of caesium with the hope of locating more terms and especially those based on the $^2P_{\frac{1}{2}}$ limit.

II. Experimental

In the work of Laporte, Miller and Sawyer, the light source used was a hollow cathode discharge in helium. Since, however, the available excitation which can be given to caesium ions by metastable helium atoms is about 163,000 cm^{-1} and the ionization potential of Cs II was determined to be about 189,000, this source is not suitable for the excitation of the complete Cs II spectrum.[3] The electrodeless discharge was chosen for the present work because of its economy of material and easily controllable conditions.

The discharge tube was a Corex bulb about 4 cm in diameter and 15 cm long, and was originally blown with a side arm in which several seal-off constrictions separated small bulbs, as well as with a side arm for evacuating. In an atmosphere of nitrogen in a manipulation box, a small fraction of a gram of caesium was washed in anhydrous ether and placed in the side arm. The bulb was evacuated by a mercury vapor pump, the first side arm sealed off and the caesium distilled by stages through the small bulbs into the main bulb and the main bulb, after thorough heating while still on the pumps to drive off adsorbed gases and vapors, was sealed off while still hot. The bulb was suspended inside the exciting coil of eight turns of hollow copper tubing wound in a solenoid about 10 cm in diameter and 8 cm long and the whole

[3] Cf. for example, Sawyer, Phys. Rev. **36**, 44 (1930).

TABLE II.

$5p^5(^2P_{1\frac{1}{2}})5d, 6s$			$5p^6$	$5p^5(^2P_{1\frac{1}{2}})6p$		
			$^1S_0$	1_1	2_2	3_3
	J		0	1	2	3
		Relative term value	00.00	*126,518.54	*128,089.83	*129,107.65
4_3^0	3	105,949.74			22,139.77 (2) 0.32	23,157.78 (0) 0.13
5_1^0	1	106,222.77		20,295.73 (1) 0.04	21,867.31 (3) −0.25	
$^3P_2^0$	2	*107,392.33		*19,126.12 (8) 0.09	*20,697.48 (6) 0.02	*21,715.33 (10) −0.01
6_2^0	2	107,563.14		18,955.52 (4) −0.08		21,544.16 (1) 0.35
$^3P_1^0$	1	*107,905.01	*107,905 (20) 0.01	*18,613.42 (6) 0.11	*20,184.84 (6) −0.02	
7_0^0	0	108,245.86				
1_1^0	1	*110,945.18	*110,946 (20) −0.72	*15,573.14 (2) 0.18	*17,144.51 (6) 0.10	
2_2^0	2	*112,795.08			*15,294.63 (4) 0.12	*16,312.38 (4) 0.19
3_3^0	3	*113,716.01			*14,373.12 (4) 0.10	*15,390.96 (3) 0.08
$5p^5(^2P_{\frac{1}{2}})5d, 6s$						
1_0^0	0	119,465.28				
2_2^0	2	119,665.41				
3_2^0	2	120,404.87				
4_1^0	1	122,866.03	*122,872 (20) −5.97			
5_1^0	1	123,636.44	*123,645 (20) −8.56			
$5p^5(^2P_{1\frac{1}{2}})6d, 7s$						
$^3P_2^0$	2	*149,212.25		*22,693.82 (7) −0.11	*21,122.47 (4) −0.05	*20,104.64 (5) −0.04
$^3P_1^0$	1	*149,605.33	*149,604 (12)	*23,086.95 (4) −0.16	*21,515.53 (5) −0.03	
1_1^0	1	*152,172.11	*152,172 (5) 0.11	*25,653.67 (7) −0.10	*24,082.27 (4) 0.01	
2_2^0	2	*152,791.49		*26,273.12 (6) −0.17	*24,701.59 (4) 0.07	*23,683.75 (3) 0.09
3_2^0	2	*153,302.27		*26,783.83 (2) −0.10	*25,212.38 (6) 0.06	*24,194.54 (2) 0.08
4_3^0	3	*153,556.54			*25,466.74 (6) −0.03	
5_3^0	3	*153,678.17			*25,588.30 (4) 0.04	*24,570.52 (6) −0.04
6_1^0	1	*156,399.31	*156,392 (12) 7.31		*28,309.51 (0) −0.03	
$5p^5(^2P_{1\frac{1}{2}})7d, 8s; 5p^5(^2P_{\frac{1}{2}})\ 6d, 7s$						
1_2^0	2	158,717.91			30,628.61 (1) −0.53	29,610.16 (0) 0.10
2_0^0	0	162,352.92		35,834.32 (3*p*) 0.06		
3_3^0	3	162,388.96			34,299.37 (3) −0.24	
4_1^0	1	163,180.20	*163,180 (7) 0.20	36,662.16 (0*p*) −0.50	35,090.18 (1*p*) 0.09	
5_2^0	2	164,444.88		37,926.67 (0*p*) −0.33	36,355.02 (1*p*) 0.03	35,337.24 (2) −0.01
6_1^0	1	164,656.77	*164,655(3) 1.77		36,567.26 (2*p*) −0.32	
	1	165,813.70				
	2 or 1	165,899.95		39,371.06 (2*p*) 0.35		
9^0	2 or 1	166,131.11			38,041.11 (2*p*) 0.17	
10_3^0	3	166,600.74			38,510.97 (1*p*) −0.06	37,493.20 (0*p*) −0.11

* Terms and transitions discovered by Laporte, Miller and Sawyer.

TABLE II. (*Continued*).

$5p^5(^2P_{1\frac{1}{2}})6p$			$5p^5(^2P_{\frac{1}{2}})6p$			
4_1	5_2	6_0	1_1	2_1	3_2	4_0
1	2	0	1	1	2	0
*129,989.72	*130,766.00	*133,153.54	141,555.59	143,352.12	143,394.19	144,523.45
	24,816.59 (0) −0.33				37,444.50 (1) −0.05	
	24,542.83 (1) 0.40		35,332.52 (2p) 0.30		37,171.83 (2p) −0.41	38,300.69 (0p) −0.01
*22,597.42 (2) −0.03	*23,373.78 (9) −0.11		34,163.16 (0) −0.10	35,959.78 (1) 0.01		
22,426.92 (3) −0.34			33,992.66 (7) −0.21	35,789.21 (2) −0.23		
*22,084.85 (7) −0.14	*22,861.10 (6) −0.11	*25,248.63 (5) −0.10	33,650.61 (5) −0.03	35,447.19 (2p) −0.08	35,489.04 (4p) 0.14	36,618.32 (1p) 0.12
21,744.06 (2) −0.20			33,309.52 (2) 0.21	35,106.30 (0p) −0.04		
*19,044.61 (6) −0.11	*19,820.81 (6) −0.03	*22,208.49 (7) −0.17	30,610.40 (7) −0.01	32,406.84 (1) 0.10	32,448.92 (2) 0.09	33,578.17 (1) 0.10
*17,194.57 (3) 0.07	*17,970.87 (7) 0.05		28,760.70 (0) −0.19	30,557.09 (5) −0.05	30,599.05 (7) 0.06	
	*17,049.36 (1) 0.03				29,677.65 (7) −0.07	
			22,090.41 (0) −0.10	23,886.73 (1) 0.11		
			21,890.25 (3) −0.07	23,686.83 (0) −0.12	23,728.67 (6) 0.11	
			21,150.58 (1) 0.14	22,947.39 (0) −0.14	22,989.36 (0) −0.14	
			*18,689.34 (3) 0.22	20,486.32 (0) −0.23	*20,528.06 (6) 0.10	*21,657.19 (3) 0.23
			*17,919.29 (0) −0.14	19,715.72 (0) −0.04	*19,757.88 (3) −0.13	*20,886.87 (3) 0.14
	*18,446.14 (5) 0.11					
*19,615.46 (4) 0.15	*18,839.20 (3) 0.13	*16,451.65 (2) 0.14				
*22,182.32 (2) 0.07	*21,406.02 (4) 0.09	19,018.53 (0) 0.04				
*22,801.61 (5) 0.16	*22,025.41 (6) 0.08					
*23,312.46 (7) 0.09	*22,536.21 (0) 0.06					
	*22,790.50 (0) 0.04					
	*22,912.15 (9) 0.02					
*26,409.65 (5) −0.06	*25,633.22 (0) 0.09	*23,245.86 (6) −0.09				
	27,951.81 (0) 0.10			15,365.59 (1) 0.20		
32,363.01 (1) 0.19			20,797.53 (1) −0.20			
	31,623.10 (0p) −0.14				18,994.53 (0) 0.24	
33,190.44 (2) 0.04		30,026.58 (2) 0.08	*21,624.51 (4) 0.10	19,828.56 (1) 0.48	*19,785.91 (3) 0.10	*18,656.65 (0) 0.10
	33,678.55 (2) 0.33			21,092.66 (5) 0.10	21,050.61 (2) 0.10	
34,666.98 (2) 0.07	33,890.73 (5) 0.04	31,503.30 (1) −0.07	23,101.13 (2) 0.05	21,304.73 (1) −0.08	21,262.55 (5) 0.03	
	35,047.74 (0) −0.04	32,659.85 (1) 0.31	24,257.90 (4) 0.21	22,461.66 (1) 0.08	22,419.35 (3) 0.16	21,290.55 (1) −0.30
35,900.36 (1p) −0.13	35,124.31 (4) −0.36		24,334.53 (0) −0.17	22,538.01 (4) −0.18	22,495.94 (2) −0.18	
36,141.39 (2p) 0.00	35,365.28 (0p) −0.17		24,575.44 (6) 0.08	22,779.08 (2) −0.09	22,736.88 (3) 0.04	
					23,206.44 (1) 23,206.44 (1) 0.11	

* Terms and transitions discovered by Laporte, Miller and Sawyer.

placed in a transite box or oven provided with nichrome heating wires on its inner walls and with a quartz window for end-on observation of the tube. The exciting current was provided by a large commercial induction furnace of quenched gap type operating on 220-volt a.c. The exciting coil was cooled when in operation by water circulation. To attain the requisite vapor pressure of caesium it was necessary to heat the bulb by the oven to a temperature in the range 120°–200°C. Once the discharge had started, the heat from the exciting coil in the luminous vapor and especially from the dielectric losses in the glass was sufficient so that no auxiliary heating was needed. In fact the dielectric loss in the glass heated it to so great an extent that it was found safe to operate the discharge only 15 seconds in each minute. The discharge was bluish-white in color, filling the entire bulb apparently uniformly, and of tremendous brilliancy.

The discharge was photographed in the region λ2300–λ3300A with a Hilger E1 quartz spectrograph and from λ2300–λ10,000A in the first order of a 21 ft, 15,000 line grating. Exposure times, i.e., actual operation of the discharge, varied from 45 sec. with contrast plates on the quartz spectrograph in the region near λ3000 to as long as $1\frac{1}{2}$ hours on some of the grating exposures in the less sensitive regions. Few lines were measured on the grating below λ2700. The longest wave-length measured was λ8194 and the shortest λ2315. The short wave-length limit was doubtless due to the absorption of the Corex glass. All wave-lengths were measured against standards from an iron arc and determinations are believed to be accurate in most cases to ±0.01 or 0.02A. Practically all the lines given by Sommer (about 380) were verified and 200 additional lines were measured in his region. The coarse hyperfine structure reported by Sommer for most of the strong lines was not observed. About 300 new lines were found below Sommer's limit in the ultraviolet and a few in the red.

III. Analysis of Data

In Table II are given the results of the classification of the spectrum of Cs II. In the first column are given the electronic configurations of the odd terms and spectroscopic notations of the levels where known. Numbers have

Table III. *Wave-length list of Cs II lines classified.*

Int.		λ in air	ν (vac)	Classification
3	vac.	607.31	164,655	$5p^6\,{}^1S_0-({}^2P_{1\frac{1}{2}}\,7d, 8s; {}^2P_{\frac{1}{2}}\,6d, 7s)6_1^0$
7	"	612.82	163,180	$5p^6\,{}^1S_0-({}^2P_{\frac{1}{2}}\,6d, 7s)4_1^0$
12	"	639.42	156,392	$5p^6\,{}^1S_0-({}^2P_{1\frac{1}{2}}\,6d)6_1^0$
5	"	657.15	152,172	$5p^6\,{}^1S_0-({}^2P_{1\frac{1}{2}}\,6d)1_1^0$
12	"	668.43	149,604	$5p^6\,{}^1S_0-({}^2P_{1\frac{1}{2}}\,7s\,{}^3P_1^0$
20	"	808.77	123,645	$5p^6\,{}^1S_0-({}^2P_{1\frac{1}{2}}\,5d, 6s)5_1^0$
20	"	813.85	122,872	$5p^6\,{}^1S_0-({}^2P_{\frac{1}{2}}\,5d, 6s)4_1^0$
20	"	901.34	110,946	$5p^6\,{}^1S_0-({}^2P_{1\frac{1}{2}}\,5d)1_1^0$
20	"	926.75	107,905	$5p^6\,{}^1S_0-({}^2P_{1\frac{1}{2}}\,6s)\,{}^3P_1^0$
$2p$		2539.174	39,371.06	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,7d, 8s; {}^2P_{\frac{1}{2}}\,6d, 7s)8^0$
$1p$		2595.886	38,510.97	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,7d, 8s; {}^2P_{\frac{1}{2}}\,6d, 7s)10_3^0$
$0p$		2610.140	38,300.69	$({}^2P_{\frac{1}{2}}\,6p)4_0-({}^2P_{1\frac{1}{2}}\,5d, 6s)5_1^0$
$2p$		2627.952	38,041.11	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,7d, 8s; {}^2P_{\frac{1}{2}}\,6d, 7s)9^0$
$0p$		2635.882	37,926.67	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,7d, 8s; {}^2P_{\frac{1}{2}}\,6d, 7s)5_2^0$
$0p$		2666.358	37,493.20	$({}^2P_{1\frac{1}{2}}\,6p)3_3-({}^2P_{1\frac{1}{2}}\,7d, 8s; {}^2P_{\frac{1}{2}}\,6d, 7s)10_3^0$

TABLE III. (*Continued*).

Int.	λ in air	ν (vac)	Classification
1*p*	2669.792	37,444.50	$(^2P_{\frac{1}{2}}\,6p)3_2-(^2P_{1\frac{1}{2}}\,5d,\,6s)4_3^0$
2*p*	2689.412	37,171.83	$(^2P_{\frac{1}{2}}\,6p)3_2-(^2P_{1\frac{1}{2}}\,5d)5_1^0$
0*p*	2726.802	36,662.16	$(^2P_{1\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)4_1^0$
1*p*	2730.065	36,618.32	$(^2P_{\frac{1}{2}}\,6p)4_0-(^2P_{\frac{1}{2}}\,6s)^3P_1^0$
2*p*	2733.879	36,567.26	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)6_1^0$
1*p*	2749.839	36,355.02	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)5_2^0$
2*p*	2766.095	36,141.39	$(^2P_{1\frac{1}{2}}\,6p)4_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)9^0$
1*p*	2780.065	35,959.78	$(^2P_{\frac{1}{2}}\,6p)2_1-(^2P_{1\frac{1}{2}}\,6s)^2P_2^0$
1*p*	2784.666	35,900.36	$(^2P_{1\frac{1}{2}}\,6p)4_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,(^2P_{\frac{1}{2}}\,6d,\,7s)8^0$
3*p*	2789.797	35,834.32	$(^2P_{1\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)2_0^0$
2*p*	2793.316	35,789.21	$(^2P_{\frac{1}{2}}\,6p)2_1-(^2P_{1\frac{1}{2}}\,5d,\,6s)6_2^0$
4*p*	2816.943	35,489.04	$(^2P_{\frac{1}{2}}\,6p)3_2-(^2P_{1\frac{1}{2}}\,6s)^3P_1^0$
2*p*	2820.268	35,447.19	$(^2P_{\frac{1}{2}}\,6p)2_1-(^2P_{1\frac{1}{2}}\,6s)^3P_1^0$
0*p*	2826.802	35,365.28	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,(^2P_{\frac{1}{2}}\,6d,\,7s)9^0$
2	2829.045	35,337.24	$(^2P_{1\frac{1}{2}}\,6p)3_3-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)5_2^0$
2*p*	2829.423	35,332.52	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,5d)5_1^0$
5	2846.193	35,124.31	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)8^0$
0*p*	2847.655	35,106.30	$(^2P_{\frac{1}{2}}\,6p)2_1-(^2P_{1\frac{1}{2}}\,5d)7_0^0$
1*p*	2848.955	35,090.18	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)4_1^0$
0	2852.415	35,047.74	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)7_1^0$
2	2883.745	34,666.98	$(^2P_{1\frac{1}{2}}\,6p)4_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)6_1^0$
3	2914.652	34,299.37	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,(^2P_{\frac{1}{2}}\,6d,\,7s)3_3^0$
0	2926.274	34,163.16	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,6s)^3P_2^0$
7	2940.953	33,992.66	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,5d)\,6_2^0$
5	2949.800	33,890.73	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^3P_{\frac{1}{2}}\,6d,\,7s)6_1^0$
2	2968.383	33,678.55	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)5_2^0$
5	2970.851	33,650.61	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,6s)^3P_1^0$
1	2977.258	33,578.17	$(^2P_{\frac{1}{2}}\,6p)4_0-(^2P_{1\frac{1}{2}}\,5d)1_1^0$
2	3001.271	33,309.52	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,5d)7_0^0$
2*p*	3012.041	33,190.44	$(^2P_{1\frac{1}{2}}\,6p)4_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)4_1^0$
1	3060.976	32,659.85	$(^2P_{1\frac{1}{2}}\,6p)6_0-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)7_1^0$
2	3080.874	32,448.92	$(^2P_{\frac{1}{2}}\,6p)3_2-(^2P_{1\frac{1}{2}}\,5d)1_1^0$
1	3084.875	32,406.84	$(^2P_{\frac{1}{2}}\,6p)2_1-(^2P_{1\frac{1}{2}}\,5d)1_1^0$
1*p*	3089.053	32,363.01	$(^2P_{1\frac{1}{2}}\,6p)4_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)2_0^0$
0*p*	3161.333	31,623.10	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)3_3^0$
1	3173.355	31,503.30	$(^2P_{1\frac{1}{2}}\,6p)6_0-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)6_1^0$
1	3263.982	30,628.61	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)1_2^0$
7	3265.924	30,610.40	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,5d)1_1^0$
7	3267.135	30,599.05	$(^2P_{\frac{1}{2}}\,6p)3_2-(^2P_{1\frac{1}{2}}\,5d)2_2^0$
5	3271.626	30,557.09	$(^2P_{\frac{1}{2}}\,6p)2_1-(^2P_{1\frac{1}{2}}\,5d)2_2^0$
2	3329.428	30,026.58	$(^2P_{1\frac{1}{2}}\,6p)6_0-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,(^2P_{\frac{1}{2}}\,6d,\,7s)4_1^0$
7	3368.575	29,677.65	$(^2P_{\frac{1}{2}}\,6p)3_2-(^2P_{1\frac{1}{2}}\,5d)3_3^0$
0	3376.261	29,610.16	$(^2P_{1\frac{1}{2}}\,6p)3_3-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)1_2^0$
0	3475.973	28,760.70	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,5d)2_2^0$
0	3531.376	28,309.51	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,6d)6_1^0$
0	3576.570	27,951.81	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)1_2^0$
2	3732.539	26,783.83	$(^2P_{1\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,6d)\,3_2^0$
5	3785.424	26,409.65	$(^2P_{1\frac{1}{2}}\,6p)4_1-(^2P_{1\frac{1}{2}}\,6d)6_1^0$
6	3805.096	26,273.12	$(^2P_{1\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,6d)2_2^0$
7	3896.978	25,653.67	$(^2P_{1\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,6d)1_1^0$
0	3900.09	25,633.22	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,6d)6_1^0$
4	3906.939	25,588.30	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,6d)5_3^0$
6	3925.583	25,466.74	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,6d)4_3^0$
5	3959.495	25,248.63	$(^2P_{1\frac{1}{2}}\,6p)6_0-(^2P_{1\frac{1}{2}}\,6s)^3P_1^0$
6	3965.187	25,212.38	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,6d)3_2^0$
0	4028.43	24,816.59	$(^2P_{1\frac{1}{2}}\,6p)5_2-(^2P_{1\frac{1}{2}}\,5d)4_3^0$
4	4047.184	24,701.59	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,6d)2_2^0$
6	4067.958	24,575.44	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)9^0$
6	4068.773	24,570.52	$(^2P_{1\frac{1}{2}}\,6p)3_3-(^2P_{1\frac{1}{2}}\,6d)5_3^0$
1	4073.364	24,542.83	$(^2P_{1\frac{1}{2}}6p)5_2-(^2P_{1\frac{1}{2}}\,5d)5_1^0$
0	4108.232	24,334.53	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)8^0$
4	4121.210	24,257.90	$(^2P_{\frac{1}{2}}\,6p)1_1-(^2P_{1\frac{1}{2}}\,7d,\,8s;\,^2P_{\frac{1}{2}}\,6d,\,7s)7_1^0$
2	4132.003	24,194.54	$(^2P_{1\frac{1}{2}}\,6p)3_3-(^2P_{1\frac{1}{2}}\,6d)3_2^0$
4	4151.267	24,082.27	$(^2P_{1\frac{1}{2}}\,6p)2_2-(^2P_{1\frac{1}{2}}\,6d)1_1^0$

TABLE III. (*Continued*).

Int.	λ in air	ν (vac)	Classification
1	4186.249	23,886.73	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)1_0^0$
6	4213.129	23,728.67	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{\frac{1}{2}}\,5d,\,6s)2_2^0$
0	4220.571	23,686.83	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)2_2^0$
3	4221.119	23,683.75	$({}^2P_{1\frac{1}{2}}\,6p)3_3-({}^2P_{1\frac{1}{2}}\,6d)2_2^0$
9	4227.100	23,373.78	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,6s)^3P_2^0$
7	4228.350	23,312.46	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,6d)3_2^0$
1	4307.942	23,206.44	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)10_3^0$
6	4330.636	23,245.86	$({}^2P_{1\frac{1}{2}}\,6p)6_0-({}^2P_{1\frac{1}{2}}\,6d)6_1^0$
0	4316.992	23,157.78	$({}^2P_{1\frac{1}{2}}\,6p)3_3-({}^2P_{1\frac{1}{2}}\,5d)4_3^0$
2	4327.580	23,101.13	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)6_1^0$
4	4330.239	23,086.95	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,7s)^3P_1^0$
0	4348.620	22,989.36	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{\frac{1}{2}}5d,\,6s)3_2^0$
0	4356.575	22,947.39	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)3_2^0$
9	4363.375	22,912.15	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,6d)5_3^0$
6	4373.018	22,861.10	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,6s)^3P_1^0$
5	4384.428	22,801.61	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,6d)2_2^0$
0	4386.566	22,790.50	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,6d)4_3^0$
2	4388.764	22,779.08	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)9^0$
3	4396.909	22,736.88	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)9^0$
7	4405.253	22,693.82	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,7s)^3P_2^0$
2	4424.046	22,597.42	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,6s)^3P_2^0$
4	4435.708	22,538.01	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)8^0$
0	4436.06	22,536.21	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,6d)3_2^0$
2	4444.004	22,495.94	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)8^0$
1	4450.785	22,461.66	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,({}^2P_{\frac{1}{2}}\,6d,\,7s)7_1^0$
3	4457.680	22,426.92	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,5d)6_2^0$
3	3459.185	22,419.35	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}6d,\,7s)7_1^0$
7	4501.525	22,208.49	$({}^2P_{1\frac{1}{2}}\,6p)6_0-({}^2P_{1\frac{1}{2}}\,5d)1_1^0$
2	4506.834	22,182.32	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,6d)1_1^0$
2	4515.495	22,139.77	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,5d)4_3^0$
0	4525.59	22,090.41	$({}^2P_{\frac{1}{2}}\,6p)1_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)\;1_0^0$
7	4526.725	22,084.85	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,6s)^3P_1^0$
6	4538.942	22,025.41	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,6d)2_2^0$
3	4566.983	21,890.25	$({}^2P_{\frac{1}{2}}\,6p)1_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)2_2^0$
3	4571.786	21,867.31	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,5d)5_1^0$
2	4497.673	21,744.06	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,6d)7_0^0$
10	4603.755	21,715.33	$({}^2P_{\frac{1}{2}}\,6p)3_3-({}^2P_{1\frac{1}{2}}\,6s)^3P_2^0$
3	4616.13	21,657.19	$({}^2P_{\frac{1}{2}}\,6p)4_0-({}^2P_{\frac{1}{2}}\,5d,\,6s)4_1^0$
4	4623.091	21,624.51	$({}^2P_{\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,({}^2P_{\frac{1}{2}}\,5d,\,7s)4_1^0$
1	4640.333	21,544.16	$({}^2P_{1\frac{1}{2}}\,6p)3_3-({}^2P_{1\frac{1}{2}}\,5d)6_2^0$
5	4646.508	21,515.53	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,7s)^3P_1^0$
4	4670.280	21,406.02	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,6d)1_1^0$
1	4692.482	21,304.73	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s\,{}^2P_{\frac{1}{2}}\,6d,\,7s)6_1^0$
1	4695.610	21,290.55	$({}^2P_{\frac{1}{2}}\,6p)4_0-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,({}^2P_{\frac{1}{2}}\,6d,\,7s)7_1^0$
5	4701.793	21,262.55	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{\frac{1}{2}}\,7d,\,8s;\,({}^2P_{\frac{1}{2}}\,6d,\,7s)6_1^0$
1	4726.684	21,150.58	$({}^2P_{\frac{1}{2}}\,6p)1_1-({}^2P_{\frac{1}{2}}\,6d,\,6s)3_2^0$
4	4732.975	21,122.47	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,7s)^3P_2^0$
5	4739.665	21,092.66	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)5_2^0$
2	4749.132	21,050.61	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)5_2^0$
3	4786.363	20,886.87	$({}^2P_{\frac{1}{2}}\,6p)4_0-({}^2P_{\frac{1}{2}}\,5d,\,6s)5_1^0$
1	4806.924	20,797.53	$({}^2P_{\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)2_0^0$
6	4830.161	20,697.48	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,6s)^3P_2^0$
6	4870.024	20,528.06	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{\frac{1}{2}}\,5d,\,6s)4_1^0$
0	4879.95	20,486.32	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)4_1^0$
1	4925.744	20,295.73	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\text{-}5d)5_1^0$
6	4952.835	20,184.84	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,6s)^3P_1^0$
5	4972.593	20,104.64	$({}^2P_{1\frac{1}{2}}\,6p)3_3-({}^2P\,{}_{1\frac{1}{2}}\,7s)^3P_2^0$
1	5041.828	19,828.56	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)4_1^0$
6	5043.800	19,820.81	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,5d)1_1^0$
3	5052.696	19,785.91	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)4_1^0$
3	5059.866	19,757.88	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{\frac{1}{2}}\,5d,\,6s)5_1^0$
0	5070.684	19,715.72	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)5_1^0$
4	5096.604	19,615.46	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,7s)^3P_1^0$
8	5227.002	19,126.12	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,6s)^3P_2^0$

TABLE III. (*Continued*).

Int.	λ in air	ν (vac.)	Classification
6	5249.373	19,044.61	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,5d)1_1{}^0$
0	5256.572	19,018.53	$({}^2P_{1\frac{1}{2}}\,6p)6_0-({}^2P_{1\frac{1}{2}}\,6d)1_1{}^0$
0	5263.21	18,994.53	$({}^2P_{\frac{1}{2}}\,6p)3_2-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)3_3{}^0$
4	5274.044	18,955.52	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,5d)6_2{}^0$
3	5306.609	18,839.20	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,7s){}^3P_1{}^0$
3	5349.10	18,689.34	$({}^2P_{\frac{1}{2}}\,6p)1_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)4_1{}^0$
10	5358.53	18,656.65	$({}^2P_{\frac{1}{2}}\,6p)4_0-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)4_1{}^0$
6	5370.979	18,613.42	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,6s){}^3P_1{}^0$
5	5419.687	18,446.14	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,7s){}^3P_2{}^0$
7	5563.019	17,970.87	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,5d)2_2{}^0$
0	5579.033	17,919.29	$({}^2P_{\frac{1}{2}}\,6p)1_1-({}^2P_{\frac{1}{2}}\,5d,\,6s)5_1{}^0$
3	5814.181	17,194.57	$({}^2P_{1\frac{1}{2}}\,6p)4_1-({}^2P_{1\frac{1}{2}}\,5d)2_2{}^0$
5	5831.159	17,144.51	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,5d)1_1{}^0$
1	5863.701	17,049.36	$({}^2P_{1\frac{1}{2}}\,6p)5_2-({}^2P_{1\frac{1}{2}}\,5d)3_3{}^0$
2	6076.738	16,451.65	$({}^2P_{1\frac{1}{2}}\,6p)6_0-({}^2P_{1\frac{1}{2}}\,7s){}^3P_1{}^0$
4	6128.619	16,312.38	$({}^2P_{1\frac{1}{2}}\,6p)3_3-({}^2P_{1\frac{1}{2}}\,5d)2_2{}^0$
2	6419.541	15,573.14	$({}^2P_{1\frac{1}{2}}\,6p)1_1-({}^2P_{1\frac{1}{2}}\,5d)1_1{}^0$
3	6495.528	15,390.96	$({}^2P_{1\frac{1}{2}}\,6p)3_3-({}^2P_{\frac{1}{2}}\,5d,\,6s)3_3{}^0$
1	6506.254	15,365.59	$({}^2P_{\frac{1}{2}}\,6p)2_1-({}^2P_{1\frac{1}{2}}\,7d,\,8s;\,{}^2P_{\frac{1}{2}}\,6d,\,7s)1_2{}^0$
3	6536.440	15,294.63	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,5d)2_2{}^0$
4	6955.519	14,373.12	$({}^2P_{1\frac{1}{2}}\,6p)2_2-({}^2P_{1\frac{1}{2}}\,5d)3_3{}^0$

been assigned to those levels whose L and S values are not fixed. The second column contains the J values of the odd levels, and the third the relative term values referred to $5p^6\ {}^1S_0$. The headings of the remaining columns give the electron configurations, spectroscopic notations, J values, and relative term values of the even terms to which are assigned numbers in order of their magnitude in lieu of their undetermined L and S values. In the body of the table are the wave numbers of the classified lines, followed in the parenthesis by their intensities. Except in the case of intensities followed by p (prism) these intensities are from grating measurements. Below each wave number is the discrepancy (calculated value minus observed value) between the observed wave numbers and the wave number calculated from the values assigned to the terms. The terms and transitions established in the previous paper are preceded by asterisks. It will be observed that the only transitions in that work involving terms of the ${}^2P_{\frac{1}{2}}$ limit were fixed in relation to the rest of the system only by the three resonance lines $\nu\nu$122,872, 123,645 and 163,180 and were thus uncertain by as much as ± 5 cm^{-1} because of the limited accuracy of the extreme ultraviolet measures. In the present work the first attempt was to remove this uncertainty by finding intercombinations between the $5p^5\ ({}^2P_{\frac{1}{2}})\ 6p$ terms thus established and the terms of the ${}^2P_{1\frac{1}{2}}$ limit. The lack of precision in the values of the ${}^2P_{\frac{1}{2}}$ terms, however, made it more feasible to approach the task by searching in the region indicated by these approximate terms for lines having the accurately known differences of the established terms of the $5p^5\ ({}^2P_{1\frac{1}{2}})5d,\ 6s$ configuration. This procedure in fact not only located the three known terms of $5p^5({}^2P_{\frac{1}{2}})\ 6p$ with precision as 141,555.59, 143,394.19 and 144,523.45 cm^{-1}, but located also one new term of this configuration as 143,352.12 cm^{-1}. The ν differences thus established were used in looking for new odd terms. Sixteen such terms were definitely established, and in addition the three terms involving the three resonance lines discussed above were accurately fixed as $\nu\nu$122,866.03, 123,636.44 and 163,180.20. It will be noted that in the case of most of the new terms one or two expected transitions are missing. However, each terms seems established beyond doubt by several close coincidences and by expected positions. A few less definitely established terms have been omitted.

Table III contains a list of the Cs II lines classified both in this and in the preceding investigation. In the first column are the intensities from the present grating measurements or in a few cases, where the intensity is followed by p, from the prism measurement; in the second and third columns are the λ's in air, and the wave numbers in vacuum; the last column contains the classification, with $5p^5$ omitted from all configurations above the ground state.

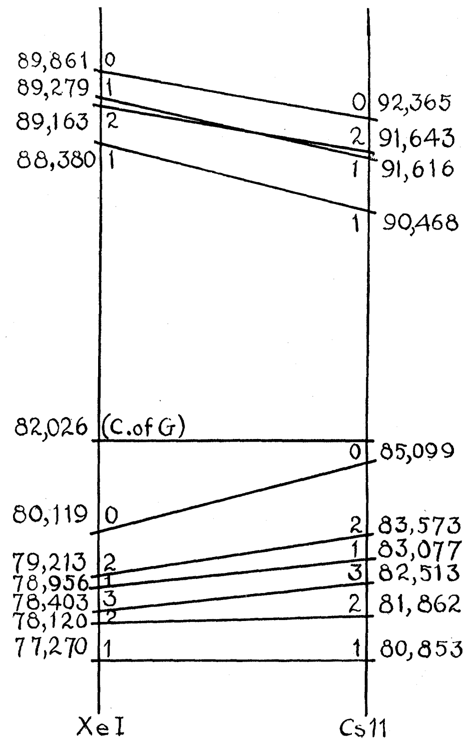

Fig. 1. The $5p^5\,6p$ terms of Xe I and Cs II referred to their centers of gravity and reduced in the case of Cs II by multiplying with 9,120/14,270, the ratio of the relativistic doublets $5p^5$.

It is now of interest to compare the terms as found with those expected as shown in Table I and to consider them in relation to the terms of Xe I.[4] In Fig. 1 the relative term values of the ten p ($5p^5\,6p$) terms of Xe I are drawn referred to their center of gravity, and beside them the ten p terms of Cs II likewise referred to their center of gravity but reduced by multiplication with 9,120/14,270, the ratio of the relativistic doublets in the two cases. The correspondence is very good. The only crossing over is in two levels which

[4] Meggers, deBruin and Humphreys, Bureau Standards J. Research **3**, 731 (1929).

are very close together. The same crossing occurred in the Kr I–Rb II sequence.[5] The close correlation of the Xe I terms with those of Cs II is a convincing argument for the correctness of the Cs II analysis.

We may next consider the odd terms. Of the low group around 110,000 cm^{-1}, five terms come from Sommer's work. Four more terms were added in this work. The group was ascribed by Laporte, Miller and Sawyer to a mixture of $5p^5$ $(^2P_{1\frac{1}{2}})$ $5d$ and $6s$. Inspection of Table I shows that $6s$ should contribute two terms of $J=1, 2$; and $5d$, eight terms of $J=0, 1, 1, 2, 2, 3, 3, 4$. The group is then completely identified with the exception of the term with $J=4$, which it is impossible to locate since only one even term with $J=3$ is known with which this term could combine. In the previous work $\nu\nu$107,392, 107,905 were identified as $6s$ $^3P_2$ and $^3P_1$. The present work adds a new term with $J=2$ between these terms but the much greater intensities of the transitions to 107,392 make it almost certain that this assignment is correct. The remaining terms should arise from $5d$ and may be compared with the corresponding Xe I terms. Since two of the $5d$ terms in Xe I, and one $(J=3)$ in Cs II are unknown, a graphical representation as made for the p-terms in Fig. 1 is not useful. The most interesting anomaly is the term with $J=0$. In Xe I as in Ne I this term is the lowest of the $^2P_{1\frac{1}{2}}\,d$ group. In Rb II, however, it is the highest while in Cs II it is in the middle of the group. The remaining $5d$ and $6s$ terms, having $^2P_{\frac{1}{2}}$ as limit form a group of five terms near 120,000 cm^{-1}. As mentioned above two of these terms were located approximately in the work of Laporte, Miller and Sawyer by two extreme ultraviolet lines. They are now definitely fixed in position through the intercombinations of the $(^2P_{\frac{1}{2}})$ $6p$ group, with which they combine, with $(^2P_{1\frac{1}{2}})$ $6d$, $7s$. Except for the $J=0$ term which must belong to $6s$ it is not possible to assign these terms definitely to $6s$ or $5d$.

The remaining ten odd terms form a group near 160,000 cm^{-1}. These terms are probably a mixture of terms arising from $5p^5$ $(^2P_{\frac{1}{2}})$, $6d$, $7s$ and $5p^5(^2P_{1\frac{1}{2}})$ $7d$, $8s$. Laporte, Miller and Sawyer estimated $5p^6$ $^1S_0$ to be about 189,000 cm^{-1}. On this basis the assumption of a simple Rydberg formula would predict $5p^5(^2P_{1\frac{1}{2}})$ $7d$, $8s$, from the known positions of $5p^5(^2P_{1\frac{1}{2}})$ $5d$, $6s$ and $5p^5(^2P_{1\frac{1}{2}})$ $6d$, $7s$, as a group centered about approximately 165,000 cm^{-1}. Also, on the assumption that the group $5p^5(^2P_{\frac{1}{2}})$ $5d$, $6s$ centered about 120,000 cm^{-1} is the first member of a sequence which approaches a limit about 150,000 cm^{-1} (estimated from the relativistic doublet) higher than 189,000 cm^{-1}, the second member would center around approximately 162,000 cm^{-1}. The only basis upon which these terms could be assigned to one group or the other would be a careful determination of the relative intensities of transitions of each term with the $(^2P_{1\frac{1}{2}})$ $6p$ group and with the $(^2P_{\frac{1}{2}})$ $6p$ group. Transitions between terms having the same series limit should of course be stronger than between terms having different limits. On the basis of the present eye estimates of lines, which also for the two p-groups lie in quite different spectral regions, little can be said on this basis.

[5] Laporte, Miller and Sawyer, Phys. Rev. **38**, 843 (1931).

All the terms in this group around 160,000 cm^{-1} are new with the exception of 163,180.20 cm^{-1} which was fixed by a resonance line and three other transitions in the earlier paper. One of the new terms, 164,656.77 cm^{-1} is also confirmed by a vacuum spectrograph line, λ607.31, ν164,655, intensity 3, which was not previously reported.

Transitions involving terms arising from $5p^5nf$ configurations and also from higher members of the *s*, *p*, and *d* configurations might be expected in our data. Although the position of such terms can be predicted with a fair degree of approximation, no certain evidence of transitions involving them has as yet been obtained. The present extension of the Cs II spectrum, however, completes the essential outlines of a scheme analogous in all essentials to the Xe I spectrum, with the terms of each electron configuration divided into two completely separated groups having as series limits in the Cs II spectrum, $5p^5\ ^2P_{1\frac{1}{2}}$ and $5p^5\ ^2P_{\frac{1}{2}}$.