

SERIES SPECTRA OF POTASSIUM AND CALCIUM

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ABSTRACT

Several of the strongest extreme ultra-violet lines in the  $K_{III}$ ,  $K_{IV}$ ,  $Ca_{IV}$ , and  $Ca_{IV}$  spectra are given their series designation. In  $K_{II}$  several lines are identified in addition to those found by DeBruin. The absolute value of the terms of  $K_{II}$  are determined thus fixing the ionization potential at 31.7 volts. 137 lines are classified in  $Ca_{III}$  and the term values of the levels involved are calculated. These correspond to an ionization potential of 51.0 volts.

I. *Six-Electron Systems.* Hopfield and Dieke<sup>1</sup> have called attention to a triplet  $PP'$  group which they traced from  $S_I$  to  $K_{IV}$ . Since this group follows the irregular doublet law it can be definitely identified as the  $PP'$

TABLE I  
Triplet  $PP'$  groups in six-electron systems.

Ion	Int.	$\lambda$ I.A. Vac.	$\nu$	$\Delta\nu$	Series designation
$S_I$			72380.	21348.9	$aP_2-bP_1$
			72174.		$aP_1-bP_0$
			72019.		$aP_2-bP_2$
			71985.		$aP_1-bP_1$
			71805.		$aP_0-bP_1$
			71625.		$aP_1-bP_2$
$Cl_{II}$	4	1063.77	94005.3	20426.1	$aP_2-bP_1$
	4	1067.95	93637.4		$aP_1-bP_0$
	5	1071.03	93367.9		$aP_2-bP_2$
	3	1071.77	93304.0		$aP_1-bP_1$
	4	1075.22	93003.9		$aP_0-bP_1$
	3	1079.07	92672.7		$aP_1-bP_2$
$A_{III}$		871.11	114796.	20387.	$aP_2-bP_1$
		875.56	114213.		$aP_1-bP_0$
		878.78	113794.		$aP_2-bP_2$
		879.62	113685.		$aP_1-bP_1$
		883.22	113222.		$aP_0-bP_1$
		887.45	112682.		$aP_1-bP_2$
$K_{IV}$	4	737.15	135658.	20497.	$aP_2-bP_1$
	4	741.94	134782.		$aP_1-bP_0$
	4	745.26	134181.		$aP_2-bP_2$
	3	746.39	133978.		$aP_1-bP_1$
	4	750.00	133333.		$aP_0-bP_1$
	4	754.66	132510.		$aP_1-bP_2$
$Ca_{IV}$	4	637.89	156766.	20497.	$aP_2-bP_1$
	3	643.10	155497.		$aP_1-bP_0$
	5	646.51	154678.		$aP_2-bP_2$
	3	647.82	154364.		$aP_1-bP_1$
	4	651.49	153495.		$aP_0-bP_1$
	3	656.71	152275.		$aP_1-bP_2$

<sup>1</sup> Hopfield and Dieke, Phys. Rev. 27, 638 (1926).

group to be expected on the return of a  $3s$  electron that had been excited to a  $3p$  orbit. The wave-lengths and frequencies of these groups along with the corresponding group in  $\text{Ca}_V$  are given in Table I. The frequencies for  $\text{S}_I$  were given by Hopfield and Dieke<sup>1</sup> while those for  $\text{A}_{III}$  were determined by Dorgelo and Abbink.<sup>2</sup> The data for  $\text{Cl}_{II}$ ,  $\text{K}_{IV}$  and  $\text{Ca}_V$  represent new determinations.

II. *Seven-Electron Systems.* Turner<sup>3</sup> has given the wave-lengths of six lines in the extreme ultra-violet spectrum of  $\text{Cl}_I$ . Four of these can be arranged in a doublet  $PP'$  group, the position and separations of which are approximately those to be expected for the combination between the  $4k^2P$  term of the  $s^2p^4 \cdot s$  configuration and the  $a^2P$  term of the  $s^2p^5$  configuration. A corresponding  $PP'$  group is found in the table of the "blue" argon spectrum in the extreme ultra-violet given by Dorgelo and Abbink. In this case the

TABLE II  
Doublet lines in seven-electron systems.

Ion	Int.	$\lambda$ , A. Vac.	$\nu$	$\Delta\nu$	Series designation
$\text{Cl}_I$	2	1335.8	74863.	884.	$aP_2-4kP_1$
	5	1347.2	74225.		$aP_2-4kP_2$
	3	1351.7	73979.	883.	$aP_1-4kP_1$
	5	1363.5	73342.		$aP_1-4kP_2$
$\text{A}_{II}$		718.05	139266.	1436.	$aP_2-4kP_1$
		723.35	138246.		$aP_2-4kP_2$
		725.53	137830.	1430.	$aP_1-4kP_1$
		730.91	136816.		$aP_1-4kP_2$
$\text{K}_{III}$	2	466.78	214234.	2163.	$aP_2-4kP_1$
	3	470.08	212730.		$aP_2-4kP_2$
	2	471.54	212071.	2168.	$aP_1-4kP_1$
	2	474.92	210562.		$aP_1-4kP_2$
$\text{Ca}_{IV}$	2	335.36	298189.	3134.	$aP_2-4kP_2$
	2	338.92	295055.		$aP_1-4kP_2$
$\text{A}_{II}$		919.79	108720.	1431.	$aP_2-bS$
		932.06	107289.		$aP_1-bS$
$\text{K}_{III}$	5	765.65	130608.	21157.	$aP_2-bS$
	4	778.54	128446.		$aP_1-bS$
$\text{Ca}_{IV}$	6	665.96	152448.	20875.	$aP_2-bS$
	5	669.70	149321.		3127.

identification is confirmed by the fact that the separation of the  $a^2P$  term is within 8 frequency units of the value predicted by Meissner<sup>4</sup> from the difference in the limits of the series of lines in  $\text{A}_I$  that are based on these

<sup>2</sup> Dorgelo and Abbink, *Zeits. f. Physik* **41**, 753 (1927).

<sup>3</sup> Turner, *Phys. Rev.* **27**, 397 (1926).

<sup>4</sup> Meissner, *Zeits. f. Physik* **39**, 172 (1926); **40**, 839 (1927).

two terms in the  $A_{II}$  ion. Assuming the identification of these two groups it is possible to predict the position and separations of the corresponding lines in  $K_{III}$  and  $Ca_{IV}$ . In  $K_{III}$  a strong  $PP'$  group is observed as predicted and in  $Ca_{IV}$  part of the group is found, the remainder being obscured by other strong lines.

Another group of lines that should be emitted by a seven-electron system is the combination of the  $a^2P$  term of the  $s^2p^5$  configuration with the  $b^2S$  term of the  $sp^6$  configuration. These pairs, having the same separation as that found in the  $PP'$  groups and following the irregular doublet law, have been traced from  $A_{II}$  to  $Ca_{IV}$ . These lines are among the strongest lines in the spectrum as would be expected from the fact that they are the resonance lines of these ions. The lines identified in these seven-electron systems are collected in Table II.

III. *Eight-Electron Systems.* Meissner<sup>4</sup> has made a very complete analysis of the  $A_I$  spectrum and DeBruin<sup>5</sup> has classified a large number of lines of the spark spectrum of potassium as due to jumps between various terms of  $K_{II}$ . More recently DeBruin<sup>6</sup> has been able to correlate about one-half of these terms with the corresponding terms of argon, as analyzed by the Meissner. On plates recently taken at this laboratory it has been possible to identify several very strong extreme ultra-violet lines as transitions between DeBruin's terms and the single ground term of the  $s^2p^6$  configuration. These lines are given in Table III.

TABLE III  
Series lines in  $K_{II}$

Int.	$\lambda$ , A. Vac.	$\nu$	Series designation
5	600.75	166459.	$3p-4s_2$
5	607.90	164501.	$3p-3d_5$
4	612.61	163236.	$3p-4s_4$
2	615.40	162496.	$3p-4s_6$ ?

The series of  $s_2$  and  $s_3$  levels (Meissner's notation) in  $K_{II}$  are based on the  $a^2P_1$  term of  $K_{III}$  while the  $s_4$  and  $s_5$  terms are based on the  $a^2P_2$  term. Consequently for the higher members of these series the  $s_2, s_3$  levels are separated from the corresponding  $s_4, s_5$  levels by a frequency difference approximately equal to  $a^2P_2 - a^2P_1$ . The identification, in Section II, of certain lines in the  $K_{III}$  spectrum fixes the separation in this  $a^2P$  term and therefore makes possible the approximate prediction of the separation between the  $5s_2, 5s_3$  terms and the  $5s_4, 5s_5$  terms. When this is done it is evident from the agreement in this separation as well as in the inner quantum numbers and position that DeBruin's  $Y_2, Y_3, Y_4$  and  $Y_5$  terms should be identified with these  $5s_5, 5s_4, 5s_3$  and  $5s_2$  terms respectively. Since DeBruin has already identified the  $4s$  terms this fixes two successive members of a series from which the absolute term values can be calculated by the use of the Rydberg formula.

<sup>5</sup> DeBruin, Proc. R. S. Amsterdam, 29, 713 (1926).

<sup>6</sup> DeBruin, Dissertation, Amsterdam, 1927.

Table IV gives the classification of 137 lines in the Ca<sub>III</sub> spectrum. The wave-lengths above 2250Å are taken from Anderson<sup>7</sup> while the remainder represent new determinations. The notation used in the present article follows that of Meissner for the *s* and *p* terms except that the preceding numeral is changed, in conformity with recent usage, to agree with the total quantum number of the excited electron. The correlation of the terms in

TABLE IV  
Series lines in Ca<sub>III</sub>

Int.	λI. A. Vac.	$\nu$	Series designation	Int.	λI. A. Vac.	$\nu$	Series designation
5	403.734	247688.	3 <i>p</i> -4 <i>s</i> <sub>2</sub>	0*	1905.98	52466.4	3 <i>D</i> <sub>5</sub> -4 <i>p</i> <sub>9</sub>
5	409.948	243933.	3 <i>p</i> -4 <i>s</i> <sub>4</sub>	2	1907.46	52425.7	4 <i>p</i> <sub>7</sub> -5 <i>s</i> <sub>3</sub>
2	490.56	203851.	3 <i>p</i> -3 <i>D</i> <sub>1</sub>	4	1910.17	52351.4	3 <i>D</i> <sub>7</sub> -4 <i>p</i> <sub>8</sub>
2 <i>d</i>	1270.54	78706.7	3 <i>D</i> <sub>1</sub> -4 <i>p</i> <sub>2</sub>	3*	1935.79	51658.5	4 <i>p</i> <sub>6</sub> -5 <i>s</i> <sub>2</sub>
2	1278.38	78224.0	3 <i>D</i> <sub>1</sub> -4 <i>p</i> <sub>6</sub>	4	1939.72	51553.8	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>8</sub>
2	1281.50	78033.6	3 <i>D</i> <sub>1</sub> -4 <i>p</i> <sub>3</sub>	6	1943.12	51463.6	4 <i>p</i> <sub>10</sub> -4 <i>D</i> <sub>2</sub>
3	1297.96	77044.0	3 <i>D</i> <sub>2</sub> -4 <i>p</i> <sub>3</sub>	5	1948.31	51326.5	3 <i>D</i> <sub>8</sub> -4 <i>p</i> <sub>6</sub>
1	1310.58	76302.1	3 <i>D</i> <sub>2</sub> -4 <i>p</i> <sub>4</sub>	3	1952.16	51225.3	3 <i>D</i> <sub>7</sub> -4 <i>p</i> <sub>7</sub>
2	1317.60	75895.6	3 <i>D</i> <sub>1</sub> -4 <i>p</i> <sub>6</sub>	4	1953.06	51201.74	<i>p</i> , -5 <i>s</i> <sub>4</sub> , 3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>9</sub>
3	1334.94	74909.7	3 <i>D</i> <sub>2</sub> -4 <i>p</i> <sub>6</sub>	2	1958.18	51067.8	4 <i>p</i> <sub>9</sub> -4 <i>D</i> <sub>4</sub>
1	1355.37	73780.6	3 <i>D</i> <sub>2</sub> -4 <i>p</i> <sub>7</sub>	5	1964.70	50898.4	4 <i>p</i> <sub>9</sub> -5 <i>s</i> <sub>5</sub>
1	1359.81	73539.7	3 <i>D</i> <sub>1</sub> -4 <i>p</i> <sub>8</sub>	5	1968.03	50812.2	4 <i>p</i> <sub>10</sub> -4 <i>D</i> <sub>1</sub>
2	1385.39	72181.8	3 <i>D</i> <sub>2</sub> -4 <i>p</i> <sub>9</sub>	1	1972.01	50709.7	4 <i>p</i> <sub>8</sub> -4 <i>D</i> <sub>4</sub>
3	1459.87	68499.2	3 <i>D</i> <sub>3</sub> -4 <i>p</i> <sub>3</sub>	3	1978.63	50540.0	4 <i>p</i> <sub>8</sub> -5 <i>s</i> <sub>5</sub>
4	1463.41	68333.5	3 <i>D</i> <sub>1</sub> -4 <i>p</i> <sub>10</sub>	2	1989.61	50261.1	4 <i>p</i> <sub>4</sub> -5 <i>s</i> <sub>2</sub>
2	1480.55	67542.5	3 <i>D</i> <sub>4</sub> -4 <i>p</i> <sub>3</sub>	4	2000.44	49989.0	3 <i>D</i> <sub>7</sub> -4 <i>p</i> <sub>8</sub>
4	1484.92	67343.7	3 <i>D</i> <sub>2</sub> -4 <i>p</i> <sub>10</sub>	4	2001.61	49959.8	4 <i>p</i> <sub>7</sub> -5 <i>s</i> <sub>4</sub>
2	1496.92	66803.8	3 <i>D</i> <sub>4</sub> -4 <i>p</i> <sub>4</sub>	3	2003.74	49906.7	4 <i>p</i> <sub>4</sub> -5 <i>s</i> <sub>3</sub>
3	1506.94	66359.6	3 <i>D</i> <sub>3</sub> -4 <i>p</i> <sub>6</sub>	1	2010.55	49737.6	3 <i>D</i> <sub>9</sub> -4 <i>p</i> <sub>2</sub>
0	1528.89	65406.9	3 <i>D</i> <sub>4</sub> -4 <i>p</i> <sub>8</sub>	3	2014.75	49633.9	3 <i>D</i> <sub>7</sub> -4 <i>p</i> <sub>9</sub>
4	1555.48	64288.8	3 <i>D</i> <sub>4</sub> -4 <i>p</i> <sub>7</sub>	4 <i>d</i>	2019.42	49519.2	4 <i>p</i> <sub>8</sub> -5 <i>s</i> <sub>2</sub>
6	1562.50	64000.0	3 <i>D</i> <sub>3</sub> -4 <i>p</i> <sub>8</sub>	3	2021.48	49468.7	4 <i>p</i> <sub>7</sub> -4 <i>D</i> <sub>4</sub>
5	1571.31	63641.2	3 <i>D</i> <sub>3</sub> -4 <i>p</i> <sub>9</sub>	2	2027.34	49325.7	4 <i>p</i> <sub>6</sub> -5 <i>s</i> <sub>2</sub>
0*	1584.82	63098.6	4 <i>p</i> <sub>10</sub> -4 <i>D</i> <sub>5</sub>	2	2028.38	49300.4	4 <i>p</i> <sub>7</sub> -5 <i>s</i> <sub>5</sub>
4	1586.19	63044.1	3 <i>D</i> <sub>4</sub> -4 <i>p</i> <sub>8</sub>	1	2030.67	49244.8	3 <i>D</i> <sub>9</sub> -4 <i>p</i> <sub>5</sub>
1	1595.24	62686.5	3 <i>D</i> <sub>4</sub> -4 <i>p</i> <sub>9</sub>	4	2034.12	49161.3	4 <i>p</i> <sub>9</sub> -4 <i>D</i> <sub>3</sub>
1	1688.81	59213.3	4 <i>p</i> <sub>10</sub> -5 <i>s</i> <sub>2</sub>	3	2039.01	49043.4	3 <i>D</i> <sub>9</sub> -4 <i>p</i> <sub>3</sub>
1	1698.95	58859.9	4 <i>p</i> <sub>10</sub> -5 <i>s</i> <sub>3</sub>	4	2042.27	48965.1	3 <i>D</i> <sub>8</sub> -4 <i>p</i> <sub>8</sub>
1	1716.23	58267.2	4 <i>p</i> <sub>9</sub> -4 <i>D</i> <sub>5</sub>	4	2047.31	48844.6	4 <i>p</i> <sub>6</sub> -5 <i>s</i> <sub>4</sub>
1*	1726.88	57907.9	4 <i>p</i> <sub>8</sub> -4 <i>D</i> <sub>5</sub>	3	2047.80	48832.9	4 <i>p</i> <sub>2</sub> -5 <i>s</i> <sub>2</sub>
3	1738.56	57518.9	3 <i>D</i> <sub>5</sub> -4 <i>p</i> <sub>6</sub>	3	2049.02	48803.8	4 <i>p</i> <sub>8</sub> -4 <i>D</i> <sub>3</sub>
3	1744.61	57319.4	3 <i>D</i> <sub>5</sub> -4 <i>p</i> <sub>3</sub>	3	2057.30	48607.4	3 <i>D</i> <sub>8</sub> -4 <i>p</i> <sub>9</sub>
3	1762.14	56749.2	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>2</sub>	3*	2062.83	48477.1	4 <i>p</i> <sub>2</sub> -5 <i>s</i> <sub>3</sub> †
3	1773.29	56392.4	4 <i>p</i> <sub>10</sub> -5 <i>s</i> <sub>4</sub>	2	2068.30	48348.9	4 <i>p</i> <sub>6</sub> -4 <i>D</i> <sub>4</sub>
0	1777.93	56245.2	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>5</sub>	2	2070.21	48304.3	3 <i>D</i> <sub>9</sub> -4 <i>p</i> <sub>4</sub>
4	1783.92	56056.3	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>3</sub>	2	2075.55	48180.0	4 <i>p</i> <sub>6</sub> -5 <i>s</i> <sub>5</sub>
4	1794.31	55731.7	4 <i>p</i> <sub>10</sub> -5 <i>s</i> <sub>5</sub>	5	2099.23	47636.5	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>10</sub>
4	1800.24	55548.1	4 <i>p</i> <sub>6</sub> -4 <i>D</i> <sub>5</sub>	6	2129.88	46951.0	4 <i>p</i> <sub>4</sub> -4 <i>D</i> <sub>4</sub>
5	1807.91	55312.5	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>4</sub>	3*	2132.17	46900.6	3 <i>D</i> <sub>9</sub> -4 <i>p</i> <sub>6</sub>
5	1812.17	55182.5	3 <i>D</i> <sub>5</sub> -4 <i>p</i> <sub>8</sub> , 3 <i>D</i> <sub>7</sub> -4 <i>p</i> <sub>2</sub>	6	2141.07	46705.6	4 <i>p</i> <sub>8</sub> -5 <i>s</i> <sub>4</sub>
1	1828.43	54691.7	3 <i>D</i> <sub>7</sub> -4 <i>p</i> <sub>5</sub>	1	2144.47	46631.6	4 <i>p</i> <sub>9</sub> -4 <i>D</i> <sub>2</sub>
2	1849.51	54068.4	3 <i>D</i> <sub>5</sub> -4 <i>p</i> <sub>7</sub>	6	2153.15	46443.6	4 <i>p</i> <sub>6</sub> -4 <i>D</i> <sub>3</sub>
6*	1854.72	53916.5	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>5</sub>	2	2161.07	46273.4	4 <i>p</i> <sub>8</sub> -4 <i>D</i> <sub>2</sub>
3	1860.50	53749.0	3 <i>D</i> <sub>7</sub> -4 <i>p</i> <sub>4</sub>	4	2164.18	46206.9	4 <i>p</i> <sub>8</sub> -4 <i>D</i> <sub>4</sub>
6	1870.28	53467.9	3 <i>D</i> <sub>8</sub> -4 <i>p</i> <sub>3</sub>	5	2172.27	46034.8	4 <i>p</i> <sub>8</sub> -5 <i>s</i> <sub>5</sub>
5	1872.39	53407.7	4 <i>p</i> <sub>3</sub> -4 <i>D</i> <sub>5</sub>	3	2183.98	45788.0	3 <i>D</i> <sub>9</sub> -4 <i>p</i> <sub>7</sub>
1*	1892.92	52828.4	3 <i>D</i> <sub>5</sub> -4 <i>p</i> <sub>8</sub>	2	2191.95	45621.5	4 <i>p</i> <sub>8</sub> -4 <i>D</i> <sub>1</sub>
3	1894.17	52793.6	3 <i>D</i> <sub>6</sub> -4 <i>p</i> <sub>7</sub>	3	2205.08	45349.8	4 <i>p</i> <sub>2</sub> -5 <i>s</i> <sub>5</sub>
0	1896.94	52716.5	4 <i>p</i> <sub>2</sub> -4 <i>D</i> <sub>5</sub>	2	2219.91	45046.9	4 <i>p</i> <sub>4</sub> -4 <i>D</i> <sub>3</sub>

\* May be blend with impurity or high order line.

† Anderson, *Astrophys. J.* **59**, 76 (1924).

TABLE IV continued

Inf. $\lambda$ , A. Vac.	$\nu$	Series designation	Int. $\lambda$ , A. Air	$\nu$	Series designation
1	2220.56	4 <i>p</i> <sub>7</sub> -4 <i>D</i> <sub>2</sub>	6	2704.87	4 <i>s</i> <sub>3</sub> -4 <i>p</i> <sub>2</sub>
2	2245.01	3 <i>D</i> <sub>9</sub> -4 <i>p</i> <sub>8</sub>	4	2771.27	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>7</sub>
	I. A. Air		6	2791.63	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>6</sub>
2	2252.65	4 <i>p</i> <sub>7</sub> -4 <i>D</i> <sub>1</sub>	7	2813.88	4 <i>s</i> <sub>3</sub> -4 <i>p</i> <sub>4</sub>
0	2256.33	4 <i>p</i> <sub>3</sub> -4 <i>D</i> <sub>3</sub>	7	2866.57	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>2</sub>
2	2276.54	4 <i>p</i> <sub>6</sub> -4 <i>D</i> <sub>2</sub>	7	2869.95	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>8</sub>
0	2310.87	4 <i>p</i> <sub>6</sub> -4 <i>D</i> <sub>1</sub>	7	2881.80	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>7</sub>
1	2351.40	4 <i>p</i> <sub>4</sub> -4 <i>D</i> <sub>2</sub>	9	2899.78	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>9</sub>
3	2393.20	4 <i>p</i> <sub>3</sub> -4 <i>D</i> <sub>2</sub>	2	2907.90	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>5</sub>
1	2431.08	4 <i>p</i> <sub>3</sub> -4 <i>D</i> <sub>1</sub>	8	2924.33	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>3</sub>
1	2442.54	4 <i>p</i> <sub>5</sub> -4 <i>D</i> <sub>1</sub>	7	2988.61	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>3</sub>
1	2472.52	4 <i>p</i> <sub>2</sub> -4 <i>D</i> <sub>1</sub>	6	2989.30	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>4</sub>
5	2497.67	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>2</sub>	6	3028.66	4 <i>s</i> <sub>3</sub> -4 <i>p</i> <sub>7</sub>
6	2541.49	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>3</sub>	8	3119.66	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>6</sub>
3	2587.09	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>2</sub>	4	3233.02	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>7</sub>
2	2590.34	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>4</sub>	5	3367.81	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>8</sub>
6	2620.82	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>5</sub>	8	3372.68	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>10</sub>
6	2634.17	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>3</sub>	7	3537.75	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>10</sub>
3	2686.73	4 <i>s</i> <sub>4</sub> -4 <i>p</i> <sub>4</sub>	6	3761.62	4 <i>s</i> <sub>3</sub> -4 <i>p</i> <sub>10</sub>
8	2687.78	4 <i>s</i> <sub>5</sub> -4 <i>p</i> <sub>6</sub>	5	4081.74	4 <i>s</i> <sub>2</sub> -4 <i>p</i> <sub>10</sub>

calcium arising from an excited *d* electron with the corresponding terms in argon is, in many cases, doubtful and therefore all of these terms are labeled with a *D* with subscripts numbered in the order of their term values.

The terms that have been identified in Ca<sub>III</sub> are listed in the first column of Table V. The inner quantum number of the term, *J*, is given in the second column and the value of the term  $\nu$  in the third column. In the fifth column the corresponding terms of K<sub>II</sub> are listed using DeBruin's notation. The

TABLE V  
Term values in eight-electron systems.

Ca <sub>III</sub>				K <sub>II</sub>			Al
Term	<i>J</i>	Term value	$\Delta\nu$	DeBruin's Notation	Term value	$\Delta\nu$	Meissner's Notation
4 <i>s</i> <sub>5</sub>	2	170583.5		X <sub>2</sub>	94130.0		1 <i>s</i> <sub>5</sub>
4 <i>s</i> <sub>4</sub>	1	169200.0	1383.5	X <sub>3</sub>	93400.0	730.0	1 <i>s</i> <sub>4</sub>
4 <i>s</i> <sub>3</sub>	0	167518.6	1681.4	X <sub>7</sub>	91487.5	1912.5	1 <i>s</i> <sub>3</sub>
4 <i>s</i> <sub>2</sub>	1	165433.6	2085.0	X <sub>8</sub>	90175.5	1312.0	1 <i>s</i> <sub>2</sub>
5 <i>s</i> <sub>5</sub>	2	85210.0		Y <sub>2</sub>	44061.5		2 <i>s</i> <sub>5</sub>
5 <i>s</i> <sub>4</sub>	1	84546.6	663.4	Y <sub>3</sub>	43644.1	417.4	2 <i>s</i> <sub>4</sub>
5 <i>s</i> <sub>3</sub>	0	82084.3	2462.3	Y <sub>4</sub>	41910.0	1734.1	2 <i>s</i> <sub>3</sub>
5 <i>s</i> <sub>2</sub>	1	81728.4	355.9	Y <sub>5</sub>	41618.2	291.8	2 <i>s</i> <sub>2</sub>
3 <i>p</i>	0	413127.			256637.		1 <i>p</i> <sub>0</sub>
4 <i>p</i> <sub>10</sub>	1	140941.6		P <sub>1</sub>	73428.6		2 <i>p</i> <sub>10</sub>
			4833.4			3180.1	

TABLE V (continued)

Ca <sub>III</sub>		K <sub>II</sub>		A <sub>I</sub>			
Term	<i>J</i>	Term value	$\Delta\nu$	DeBruin's Notation	Term value	$\Delta\nu$	Meissner's Notation
4 <i>p</i> <sub>9</sub>	3	136108.2		<i>P</i> <sub>2</sub>	70248.5		2 <i>p</i> <sub>9</sub>
4 <i>p</i> <sub>8</sub>	2	135749.5	358.7	<i>P</i> <sub>3</sub>	69951.4	297.1	2 <i>p</i> <sub>8</sub>
4 <i>p</i> <sub>7</sub>	1	134510.3	1239.2	<i>P</i> <sub>4</sub>	69105.9	845.5	2 <i>p</i> <sub>7</sub>
4 <i>p</i> <sub>6</sub>	2	133388.8	1121.5	<i>P</i> <sub>5</sub>	68482.6	623.3	2 <i>p</i> <sub>6</sub>
4 <i>p</i> <sub>4</sub>	1	131990.7	1398.1	<i>P</i> <sub>6</sub>	67393.3	1089.3	2 <i>p</i> <sub>4</sub>
4 <i>p</i> <sub>3</sub>	2	131248.2	742.5	<i>P</i> <sub>7</sub>	66975.3	418.0	2 <i>p</i> <sub>3</sub>
4 <i>p</i> <sub>5</sub>	0	131055.0	193.2	<i>P</i> <sub>8</sub>	66865.0	110.3	2 <i>p</i> <sub>5</sub>
4 <i>p</i> <sub>2</sub>	1	130558.6	496.4	<i>P</i> <sub>9</sub>	66502.2	362.8	2 <i>p</i> <sub>2</sub>
				<i>P</i> <sub>10</sub>	61860.9	4641.3	2 <i>p</i> <sub>1</sub>
				<i>X</i> <sub>4</sub>	93200.7		3 <i>d</i> <sub>6</sub>
3 <i>D</i> <sub>1</sub>	1	209281.9		<i>X</i> <sub>5</sub>	92140.9	1059.8	3 <i>d</i> <sub>5</sub>
3 <i>D</i> <sub>2</sub>	2	208291.6	990.3	<i>X</i> <sub>6</sub>	91704.7	436.2	3 <i>d</i> <sub>3</sub>
3 <i>D</i> <sub>3</sub>	3	199748.7	8542.9	<i>X</i> <sub>9</sub>	85801.6	5903.1	3 <i>d</i> <sub>4</sub>
3 <i>D</i> <sub>4</sub>	2	198794.7	954.0	<i>X</i> <sub>10</sub>	85110.2	691.4	3 <i>d</i> <sub>1</sub> ''
3 <i>D</i> <sub>5</sub>	1	188574.6	10220.1				3 <i>d</i> <sub>2</sub>
3 <i>D</i> <sub>6</sub>	1-2	187303.8	1270.8				3 <i>s</i> <sub>1</sub> ''''
3 <i>D</i> <sub>7</sub>	2	185739.2	1564.6				3 <i>s</i> <sub>1</sub> ''
3 <i>D</i> <sub>8</sub>	3	184715.4	1023.8				3 <i>s</i> <sub>1</sub> '''
3 <i>D</i> <sub>9</sub>	1	180295.6	4419.8				3 <i>s</i> <sub>1</sub> '
4 <i>D</i> <sub>1</sub>	1	90128.1		<i>Y</i> <sub>6</sub>	41232.1		4 <i>d</i> <sub>5</sub>
4 <i>D</i> <sub>2</sub>	2	89476.4	651.7	<i>Y</i> <sub>7</sub>	40781.2	450.9	4 <i>d</i> <sub>3</sub>
			2531.4	<i>Y</i> <sub>8</sub>	39570.7	1210.5	
4 <i>D</i> <sub>3</sub>	3	86945.0		<i>Y</i> <sub>9</sub>	38910.6	660.1	4 <i>d</i> <sub>4</sub>
4 <i>D</i> <sub>4</sub>	2	85040.5	1904.5	<i>Y</i> <sub>10</sub>	37440.8	1469.8	4 <i>d</i> <sub>1</sub> ''
4 <i>D</i> <sub>5</sub>	3?	77841.1	7199.4			3921.9	4 <i>s</i> <sub>1</sub> '''
				<i>Y</i> <sub>11</sub>	33512.9		

sixth column gives the absolute value of these K<sub>II</sub> terms as fixed by the method mentioned above. In the last column the corresponding levels of A<sub>I</sub> are listed in Meissner's notation.

These term values fix the ionization potential of K<sub>II</sub> as 31.7 volts and of Ca<sub>III</sub> as 51.0 volts.

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