THIRD SPECTRUM OF XENON

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ABSTRACT

The third spectrum of xenon (Xe III) characteristic of doubly ionized xenon atoms (Xe^{++}) appears along with the second spectrum when a Geissler tube containing the gas is operated by an alternating current transformer with condensers and spark gap in the discharge circuit. The partial or complete suppression of lines originating in ions of higher stage than the first by the insertion of varying amounts of inductance in the discharge circuit has been used to distinguish the lines of Xe III from those of the other xenon spectra. Wave-length measurements of xenon spark spectra based mainly on observations with the Rowland grating at the National Bureau of Standards extend from 2200 to 8900 A. The majority of the Xe III lines are in the near ultraviolet region. About 300 lines have been classified arising from 84 levels of Xe III.

The low states of Xe^{++} are ^{3}P, ^{1}D, and ^{1}S, due to the $5s^25p^4$ configuration. The higher excited states are built upon the ^{4}S, ^{2}D, and ^{2}P states of Xe^{+++} by the addition of an ns, np, or nd electron to the normal $5s^25p^3$ configuration. Complete quantum number designations are given for about two-thirds of the levels. A sufficient number of levels are available to account for nearly all the terms belonging to the low and first excited states. Numerous instances of mutual perturbations between terms causing a sharing of combining properties makes an unambiguous assignment of quantum numbers difficult or impossible in such cases. These perturbations apparently are also responsible for frequent and intense intersystem combinations as well as combinations between terms converging to different limits. The fact that all groups of terms are tied together permits an accurate calculation of their relative values. In all cases permitted by the rules governing quantum transitions, the levels of first excited states combine with the low levels giving lines in the extreme ultraviolet region observed by J. C. Boyce. The absolute term values are arrived at from an estimation of the limit of the $5s^25p^3(^4S)nd^5D°$ series. The lowest $4s^24p^{4\,3}P_2$ level comes out accordingly 259,089 cm^{-1}, equivalent to an ionization potential of 32.0 volts for Xe^{++}.

CONTENTS

I. INTRODUCTION

The third spectrum or second spark spectrum of an element is characteristic of the doubly ionized atom, as distinguished from the second spectrum or first spark spectrum due to the singly ionized atom,

and the first spectrum or arc spectrum of the neutral atom. These successive spectra are designated by a roman numeral following the chemical symbol which refers to the spectrum and not to the ion. Although the upper limit of excitation may be fixed by controlling the conditions of operation of the light source, it is not possible generally to prevent the simultaneous appearance of spectra from atoms of lower stages of ionization along with those of maximum excitation. For this reason the preliminary sorting of the observed lines so that each is associated with its respective ion source is an essential prerequisite to a term analysis of any spectrum of an element higher than the first.

A discussion of the methods which have been employed successfully to accomplish this selection as well as an account of the early observations of xenon spectra is given in previous publications. [1] [2] [3] [4]

II. EXPERIMENTAL

A complete description of the spark spectra of xenon has been prepared at the National Bureau of Standards over the wave length range 2200 to 8900 A. The spectra were obtained from Geissler tubes operated by a-c transformers in a circuit containing a spark gap and condensers. Except for the region beyond 2575 A in the ultraviolet, the entire spectrum was observed with the 20000 line per inch Rowland grating. One set of observations was made with the 35-ft radius, 30000-line grating at the Massachusetts Institute of Technology. Agreement of various sets of observations indicates that the wave lengths are correct to within 0.01 A for most sharp lines in the range covered by grating observations. The complete list contains about 2000 lines. Probably three-fourths of these are lines of the second spectrum, Xe II, a partial analysis of which has been reported. [5] A list of about 500 lines has been selected which appear to belong to Xe III or spectra still higher, although nearly all are believed to be Xe III. The basis of the selection is the partial or complete suppression of lines originating in ions of higher stage than the first when small amounts of inductance are placed in the circuit. This is the method which was used in the separation of the krypton spectra. [6]

For the xenon tubes used in this investigation a very small amount of inductance was sufficient to suppress the Xe III lines, from 0.00005 to 0.00018 henry being used for most exposures. A comparison was made also with the selection of xenon lines given by L. Bloch, E. Bloch, and G. Déjardin, [7] who observed that there was a radial distribution of ions in an electrodeless discharge tube so that when the slit was illuminated end on, first spark lines appeared as short lines originating in the center of the tube, whereas higher spark lines were long lines whose emitters had greater population near the walls. Comparison of the two methods indicates generally satisfactory agreement, almost perfect in the case of the second spectra of the rare gases. The lines which the Blochs indicate as belonging to the fourth spectrum, however, seem more probably to originate in high energy states of the third.

[1] Wm. F. Meggers, T. L. deBruin, and C. J. Humphreys, BS J. Research **3**, 731 (1929), RP115.
[2] C. J. Humphreys, T. L. deBruin, and W. F. Meggers, BS J. Research **6** ,287 (1931), RP275.
[3] T. L. deBruin, C. J. Humphreys, and Wm. F. Meggers, BS J. Research **11** ,409 (1933), RP599.
[4] C. J. Humphreys, Phys. Rev. **47**, 712 (1935).
[5] C. J. Humphreys, T. L. deBruin, and W. F. Meggers, BS J. Research **6**, 287 (1931), RP275.
[6] C. J. Humphreys, Phys. Rev. **47**, 712 (1935).
[7] L. Bloch, E. Bloch, and G. Déjardin, Ann. Phys. **10**, p. 461 (1924.)

The extreme ultraviolet spectra of xenon, hitherto limited to the description published by Abbink and Dorgelo in 1928,[8] have been observed recently by J. C. Boyce, who includes a list of 128 classified lines of Xe III in a paper just published.[9] These observations were made with the 2-meter vacuum spectrograph of the Carnegie Institution of Washington now set up in the spectroscopy laboratory of the Massachusetts Institute of Technology. Dr. Boyce very generously made these data available to the author previous to publication, and his cooperation while the analysis was in progress is gratefully acknowledged. The connection of the extreme ultraviolet lines with the rest of the observed spectrum will be discussed in connection with the details of the analysis.

III. ANALYSIS OF THE Xe III SPECTRUM

1. CLASSIFIED LINES

Classifications have been obtained for about 300 of the lines ascribed to Xe III. These are assembled in table 1, which gives estimated intensity, wave length in air, wave number in vacuum, and the levels involved in the transition. The intensities are comparable only over short ranges. A letter h following the intensity estimate indicates that the line is hazy. Lines marked 1- are very faint, just barely measurable.

TABLE 1.—*Classified lines of* Xe III

Intensity	Wave length (air)	Wave number (vac)	Transition	Intensity	Wave length (air)	Wave number (vac)	Transition
1 h	2235.35	44721.79	$(^2D)6s\,^3D_1^\circ - (^2P)6p\,^3D_2$	3	2658.26	37607.41	$(^4S)5d\,^5D_0^\circ - (^4S)6p\,^3P_1$
1	2303.73	43394.48	$(^4S)5d\,^5D_2^\circ - (^2D)6p\,^3P_1$	1	2661.00	37568.70	$(^4S)5d\,^3D_2^\circ - (^2D)6p\,^3F_2$
1-	2312.29	43233.85	$5s5p^5\,^1P_1^\circ - (^2D)6p\,^3F_2$	10	2669.00	37456.10	$(^4S)5d\,^5D_3^\circ - (^4S)6p\,^5P_3$
1	2403.76	41588.82	$(^2D)5d\,^1P_1^\circ - (^2P)6p\,^3D_2$	1	2678.54	37322.70	$(^2D)6s\,^3D_2^\circ - (^2D)6p\,^1D_2$
1	2414.52	41403.50	$(^2D)5d\,^3S_1^\circ - 28_1$	2	2685.58	37224.86	$(^2D)5d\,^3S_1^\circ - (^2P)6p\,^3D_2$
4	2416.73	41365.65	$(^4S)5d\,^5D_3^\circ - (^2D)6p\,^3D_3$	5	2687.03	37204.78	$(^4S)5d\,^3D_2^\circ - (^4S)6p\,^5P_3$
5	2436.48	41030.36	$(^4S)5d\,^5D_3^\circ - (^2D)6p\,^3F_2$	8	2696.50	37074.13	$(^4S)5d\,^3D_1^\circ - (^2D)6p\,^3D_1$
1	2447.64	40843.30	$5s5p^5\,^3P_0^\circ - (^4S)6p\,^3P_1$	4	2727.22	36656.54	$(^2D)5d\,^1F_3^\circ - 2_2$
3	2452.62	40760.38	$(^2D)5d\,^3F_3^\circ - 12_1$	4	2728.22	36643.11	$(^2D)6s\,^3S_1^\circ - (^2D)6p\,^3F_1$
1	2463.02	40588.28	$(^2D)5d\,^1D_2^\circ - 36$	12	2740.80	36474.93	$(^2D)5d\,^3F_3^\circ - (^2D)6p\,^3D_3$
3	2471.28	40452.63	$(^4S)5d\,^5D_0^\circ - (^4S)6p\,^3P_2$	8	2747.88	36380.95	$(^2D)5d\,^3G_3^\circ - (^2D)6p\,^3F_3$
1	2472.34	40435.28	$(^2D)5d\,^3F_3^\circ - (^2D)6p\,^3F_3$	6	2760.76	36211.23	$13_1^\circ - 32_1$
1	2483.43	40254.73	$(^2D)5d\,^\circ F_3^\circ - 8_2$	12	2761.60	36200.22 {	$(^2D)5d\,^3G_3^\circ - 8_2$ / $15_2^\circ - 34_1$
3	2486.69	40201.97	$(^4S)5d\,^5D_2^\circ - (^4S)6p\,^3P_2$	1	2763.00	36181.88	$(^2D)5d\,^5G_3^\circ - (^2D)6p\,^1F_3$
4	2501.04	39971.32	$5s5p^5\,^1P_1^\circ - (^2D)6p\,^3D_1$	5	2766.20	36140.02	$(^2D)5d\,^3F_3^\circ - (^2D)6p\,^3F_2$
3	2510.52	39820.39	$(^4S)5d\,^3D_3^\circ - (^2D)6p\,^1P_1$	10	2772.41	36059.08	$(^4S)6p\,^5P_1 - (^4S)6d\,^5D_0^\circ$
1	2515.14	39747.26	$(^4S)5d\,^3D_2^\circ - 2_2$	10	2776.96	36000.00	$(^4S)5d\,^3D_2^\circ - (^2D)6p\,^3D_2$
1	2524.09	39606.33	$(^4S)5d\,^5D_1^\circ - (^4S)6p\,^3P_2$	5	2779.64	35965.29 {	$(^2D)5d\,^3D_2^\circ - 26_1$ / $(^4S)6p\,^3P_2 - (^4S)7s\,^3S_1^\circ$
2	2533.31	39462.19	$(^4S)5d\,^3D_3^\circ - (^2D)6p\,^3D_2$	12	2783.37	35917.08	$(^2D)6p\,^3D_2 - 37^\circ$
1	2570.26	38894.92	$(^4S)6s\,^3S_1^\circ - (^2D)6p\,^1P_1$	20	2794.86	35769.44	$(^4S)6p\,^5P_1 - (^4S)6d\,^5D_1^\circ$
1 h	2572.30	38864.08	$(^2D)5d\,^1P_1^\circ - (^2P)6p\,^3D_1$	20	2800.22	35700.98	$(^4S)6p\,^5P_1 - (^4S)6d\,^5D_2^\circ$
5	2578.36	38772.74	$(^2D)5d\,^1F_3^\circ - (^2D)6p\,^3F_3$	2	2805.08	35639.13	$15_2^\circ - 32_1$
2	2578.62	38768.83	$(^4S)5d\,^3D_1^\circ - (^2D)6p\,^3D_2$	3	2806.39	35622.49	$(^2D)5d\,^1P_1^\circ - (^2D)6p\,^1D_2$
2	2590.45	38591.80	$(^2D)5d\,^1F_3^\circ - 8_2$	10	2807.25	35611.58	$2_2 - 39_1^\circ$
4	2591.69	38573.34	$(^2D)5d\,^1D_2^\circ - (^2D)6p\,^1F_3$	8	2809.07	35588.51	$(^4S)6p\,^5P_2 - (^4S)6d\,^5D_1^\circ$
6	2608.90	38318.90	$(^2D)5d\,^3F_3^\circ - 2_2$	1	2810.52	35570.15	$(^2D)6p\,^3D_2 - 33^\circ$
1	2624.52	38090.85	$13_1^\circ - 36$	8	2811.67	35555.60	$(^4S)6p\,^5P_1 - (^4S)7s\,^3S_2^\circ$
3	2637.54	37902.83	$(^4S)5d\,^5D_1^\circ - (^2D)6p\,^3D_3$	30	2814.47	35520.23	$(^4S)6p\,^5P_2 - (^4S)6d\,^5D_3^\circ$
5	2641.12	37851.46	$(^4S)5d\,^5D_1^\circ - (^4S)6p\,^3P_1$	40	2815.94	35501.69	$(^4S)6p\,^5P_2 - (^4S)6d\,^5D_2^\circ$
1	2650.20	37721.78	$(^4S)6p\,^3P_1 - (^4S)7s\,^3S_1^\circ$	20	2826.05	35374.69	$(^4S)6p\,^5P_2 - (^4S)7s\,^3S_2^\circ$

[8] J. H. Abbink and H. B. Dorgelo, Z. Phys. **47**, 221 (1928).

[9] J. C. Boyce, Phys. Rev. **49**, 730 (1936).

TABLE 1.—*Classified lines of Xe III*—Continued

Intensity	Wave length (air)	Wave number (vac)	Transition	Intensity	Wave length (air)	Wave number (vac)	Transition
30	2827.45	35357.18	$(^4S)5d^5D_3^\circ - (^4S)6p^5P_2$	10	3246.84	30790.32	$(^2D)5d^3D_3^\circ - (^2P)6p^3D_3$
6	2832.95	35288.54	$(^2D)6s^3D_3^\circ - (^2P)6p^3D_3$	80	3268.96	30581.99	$(^4S)6s^5S_2^\circ - (^4S)6p^3P_2$
6	2833.18	35285.67	$(^2D)6p^3D_2 - 31\tfrac12$	8	3276.39	30512.63	$(^2D)5d^1P_1^\circ - 12_2$
3	2838.85	35215.20	$(^4S)6p^3P_0 - (^4S)7s^3S_1^\circ$	8	3278.48	30493.18	$(^4S)6p^3P_2 - (^4S)6d^5D_1^\circ$
2	2839.57	35206.27	$(^2D)6p^3D_2 - 29\tfrac12$	3 h	3284.70	30435.44	$(^2D)5d^3G_4^\circ - (^2D)6p^3D_3$
40	2847.66	35106.26	$(^4S)5d^5D_2^\circ - (^4S)6p^5P_2$	10 h	3285.89	30424.42	$(^4S)6p^3P_2 - (^4S)6d^5D_2^\circ$
2	2850.25	35074.36	$(^4S)6s^3S_1^\circ - (^2D)6p^3D_2$	30	3287.92	30405.64	$(^4S)6p^3P_2 - (^4S)6d^5D_3^\circ$
1	2857.81	34981.58	$(^2D)6s^1D_2^\circ - 26_1$	20	3301.60	30279.66	$(^4S)6p^3P_2 - (^4S)7s^5S_2^\circ$
30	2862.41	34925.36	$(^4S)5d^5D_2^\circ - (^4S)6p^5P_1$	10	3306.80	30232.04	$13_1^\circ - 26_1$
1	2863.86	34907.68	$(^2D)6s^1D_2^\circ - (^2P)6p^3D_2$	1	3314.30	30163.63	$8_2 - 35^\circ$
1	2868.42	34852.19	$(^2D)6s^3D_1^\circ - (^2D)6p^3P_1$	10	3314.87	30158.45	$13_1^\circ - (^2P)6p^3D_2$
30	2871.68	34812.63	$(^2D)5d^1F_3^\circ - (^2D)6p^3D_3$	2	3317.44	30135.08	$(^4S)5d^3D_1^\circ - (^4S)6p^3P_2$
2	2872.73	34799.91	$(^2D)5d^2D_3^\circ - (^2P)6p^3D_2$	2	3319.53	30116.11	$(^2P)6s^3P_2^\circ - 32_1$
25	2891.71	34571.50	$(^2D)5d^3F_3^\circ - (^2D)6p^3D_2$	40	3331.65	30006.16	$(^2D)5d^1P_1^\circ - 8_2$
30	2896.63	34512.79	$(^4S)5d^5D_1^\circ - (^4S)6p^5P_2$	1 h	3334.26	29983.07	$(^2D)6p^3F_3 - 35^\circ$
2	2897.69	34500.16	$(^2D)5d^3S_1^\circ - (^2P)6p^3D_1$	25	3338.98	29940.69	$(^2D)5d^3D_1^\circ - (^2D)6p^3P_1$
1	2899.57	34477.80	$(^2D)5d^1F_3^\circ - (^2D)6p^3F_2$	10	3340.06	29931.00	$\begin{cases}(^2D)5d^1F_3^\circ - (^2D)6p^3D_1\\(^2P)6s^3P_1^\circ - 34_1\end{cases}$
50	2906.56	34394.88	$(^2D)5d^3G_4^\circ - (^2D)6p^3F_3$	4 h	3344.97	29887.07	$8_2 - 33^\circ$
2	2911.47	34336.88	$13_1^\circ - 28_1$	12	3349.76	29844.34	$(^2D)6s^3D_2^\circ - (^2D)6p^1P_1$
40	2911.90	34331.81	$(^4S)5d^5D_1^\circ - (^4S)6p^5P_1$	30	3357.98	29771.28	$(^2D)6s^3D_2^\circ - 2_2$
20	2914.12	34305.66	$(^4S)5d^3D_2^\circ - (^2D)6p^3D_1$	3 h	3362.81	29728.52	$12_2 - 37^\circ$
20	2917.59	34264.86	$(^2D)5d^3G_3^\circ - 2_2$	4	3370.65	29659.38	$15\tfrac12 - 26_1$
25	2923.51	34195.48	$(^2D)5d^1G_4^\circ - (^2D)6p^1F_3$	2 h	3377.09	29602.82	$8_2 - 31\tfrac12$
20	2930.29	34116.36	$(^2D)5d^1G_4^\circ - (^2D)6p^3F_3$	5	3379.02	29585.91	$15\tfrac12 - (^2P)6p^3D_2$
25	2932.74	34087.86	$(^4S)5d^5D_0^\circ - (^4S)6p^5P_1$	8	3403.89	29369.75	$(^2P)6s^1P_1^\circ - 32_1$
10	2939.13	34013.75	$(^2D)6p^3D_3 - 37^\circ$	4 h	3435.78	29097.16	$12_2 - 31\tfrac12$
40	2940.22	34001.15	$(^2D)6p^3F_3 - 33^\circ$	60	3444.23	29025.78	$(^2D)6s^3D_1^\circ - (^2D)6p^3F_2$
60	2945.25	33943.08	$(^2D)6p^3D_3 - 35^\circ$	25	3454.25	28941.58	$(^2D)6s^1D_2^\circ - (^2D)6p^1D_2$
40	2947.53	33916.82	$(^2D)5d^1G_4^\circ - (^2D)6p^1F_3$	25	3467.20	28833.49	$(^2D)5d^3D_2^\circ - (^2D)6p^1D_2$
40	2948.06	33910.73	$(^2D)5d^3F_3^\circ - (^2D)6p^3F_2$	40	3468.19	28825.26	$(^4S)6s^5S_2^\circ - (^4S)6p^3P_1$
15	2964.98	33717.22	$(^2D)6p^3F_2 - 31\tfrac12$	1	3479.11	28734.79	$(^2D)5d^3D_1^\circ - 12_2$
10	2966.97	33694.60	$(^2D)6p^1F_3 - 39\tfrac12$	4	3497.89	28580.52	$(^2P)6s^1P_1^\circ - (^2D)6p^3P_0$
10	2968.56	33676.55	$8_2 - 39\tfrac12$	80	3522.83	28378.18	$(^4S)5d^3D_1^\circ - (^4S)6p^3P_1$
4	2969.45	33666.47	$(^2D)6p^3D_3 - 33^\circ$	20	3539.96	28240.87	$(^2P)6s^3P_2^\circ - 28_1$
8	2971.24	33646.19	$(^2D)6s^3D_1^\circ - 12_2$	50	3542.33	28221.97	$(^2D)6s^3D_2^\circ - 12_2$
15	2984.63	33495.25	$(^2D)6p^3F_3 - 39\tfrac12$	50	3552.13	28144.11	$(^2D)5d^1D_2^\circ - (^2D)6p^1P_1$
10	2991.25	33421.12	$(^4S)6p^3P_3 - (^4S)6d^5D_2^\circ$	40	3561.38	28071.01	$(^2D)5d^1P_1^\circ - 2_2$
8	2991.45	33418.89	$(^2D)6s^3D_2^\circ - (^2D)6p^3P_1$	100	3579.69	27927.44	$(^2D)6s^3D_2^\circ - (^2D)6p^3D_3$
40	2992.91	33402.58	$(^4S)6p^3P_3 - (^4S)6d^5D_3^\circ$	80	3583.64	27896.65	$(^2D)6s^3D_3^\circ - (^2D)6p^3F_3$
8	2994.69	33382.73	$(^2D)6p^3D_3 - 31\tfrac12$	5	3592.00	27831.73	$(^4S)5d^3D_3^\circ - (^4S)6p^5P_2$
10	3001.85	33303.11	$(^2D)6p^3D_3 - 29\tfrac12$	6	3601.89	27755.31	$5s5p^5\,^1P_1^\circ - (^4S)6p^5P_1$
30	3004.32	33275.73	$(^4S)6p^5P_2 - (^4S)7s^5S_2^\circ$	40	3607.01	27715.91	$(^2D)6s^3D_3^\circ - 8_2$
6	3014.18	33166.88	$(^2D)5d^3D_2^\circ - (^2P)6p^3D_1$	20	3609.44	27697.26	$(^2D)6s^3D_2^\circ - (^2D)6p^1F_3$
100	3023.80	33061.37	$\begin{cases}(^4S)6p^3P_3 - (^4S)6d^5D_4^\circ\\(^2D)6s^3D_2^\circ - (^2D)6p^3P_0\end{cases}$	4	3618.90	27624.86	$19\tfrac12 - 26_1$
8	3026.52	33031.66	$5s5p^5\,^1P_1^\circ - (^4S)6p^3P_2$	40	3623.13	27592.61	$(^2D)6s^3D_2^\circ - (^2D)6p^3F_2$
15	3054.49	32729.20	$(^2D)5d^1D_2^\circ - 26_1$	600	3624.05	27585.60	$(^4S)6s^5S_2^\circ - (^4S)6p^5P_3$
10	3073.49	32526.58	$(^2D)6s^3D_1^\circ - 32_1$	3	3628.57	27551.24	$19\tfrac12 - (^2P)6p^3D_2$
40	3083.54	32420.87	$(^2D)5d^3G_3^\circ - (^2D)6p^3D_3$	20	3632.14	27524.16	$(^2P)6s^3P_0^\circ - 26_1$
50	3091.06	32342.00	$(^2D)5d^3F_2^\circ - (^2D)6p^3D_2$	3	3636.03	27494.72	$(^2P)6s^1P_1^\circ - 28_1$
8	3099.91	32249.67	$(^4S)6p^3P_1 - (^4S)6d^5D_1^\circ$	15	3641.00	27457.19	$(^2D)6s^3D_2^\circ - (^2D)6p^3D_2$
3	3103.47	32212.68	$(^2D)6s^3D_3^\circ - 12_2$	5	3644.14	27433.53	$13_1^\circ - (^2P)6p^3D_1$
30	3106.33	32183.02	$(^2D)6s^1D_2^\circ - (^2P)6p^3D_1$	3	3653.12	27366.09	$(^4S)5d^3D_2^\circ - (^4S)6p^3P_2$
12	3114.46	32099.01	$2_2 - 35^\circ$	20	3654.63	27354.79	$(^2D)5d^1D_2^\circ - (^2D)6p^3P_1$
1	3124.61	31994.75	$(^2P)6s^3P_2^\circ - 36$	50	3676.63	27191.10	$(^4S)6s^3S_1^\circ - (^4S)6p^3P_0$
20	3150.69	31729.92	$19\tfrac12 - 28_1$	4	3708.15	26959.98	$23\tfrac12 - 36$
10	3151.82	31718.54	$(^2D)5d^1P_1^\circ - (^2D)6p^3P_1$	25	3745.72	26689.58	$(^2D)5d^1P_1^\circ - (^2D)6p^1D_2$
8	3152.98	31706.88	$(^2D)6s^3D_2^\circ - 8_2$	10	3765.85	26546.91	$(^2P)6s^3P_2^\circ - 26_1$
2 h	3160.70	31629.44	$(^2P)6s^3P_0^\circ - 28_1$	20	3772.53	26499.91	$25_1^\circ - 36$
5 h	3169.82	31538.44	$2_2 - 31\tfrac12$	40	3776.30	26473.45	$(^2P)6s^3P_2^\circ - (^2P)6p^3D_2$
5 h	3177.19	31465.28	$(^2D)6p^1P_1^\circ - 31\tfrac12$	300	3780.98	26440.69	$(^4S)6s^3S_1^\circ - (^4S)6p^3P_2$
40	3185.24	31385.76	$(^2D)6p^1P_1 - 29\tfrac12$	12	3791.67	26366.14	$(^2D)5d^3S_1^\circ - (^2D)6p^1P_1$
25	3196.51	31275.11	$5s5p^5\,^1P_1^\circ - (^4S)6p^3P_1$	20	3829.77	26103.85	$(^2P)6p^3D_3 - 39\tfrac12$
4	3199.22	31248.62	$(^2D)6p^1P_1^\circ - 36$	20	3841.52	26024.01	$(^2D)6s^3D_2^\circ - (^2D)6p^3D_2$
25	3236.84	30885.44	$(^4S)5d^3D_1^\circ - (^4S)6p^3P_0$	20	3841.88	26021.57	$(^2D)5d^3D_2^\circ - (^2D)6p^3P_1$
100	3242.86	30828.11	$(^2D)5d^3F_3^\circ - (^4S)6p^3P_2$	10	3854.30	25937.72	$(^2D)5d^3F_3^\circ - (^4S)6p^3P_2$

TABLE 1.—*Classified lines of* Xe III—Continued

Intensity	Wave length (air)	Wave number (vac)	Transition
10	3861.05	25892.37	$(^2D)5d\,^1P_1^\circ - (^2P)6p\,^3F_2$
200	3877.80	25780.54	$(^2D)6s\,^3D_3^\circ - 2_2$
60	3880.46	25762.86	$(^2D)6s\,^3D_1^\circ - (^2D)6p\,^2D_1$
4	3903.70	25609.49	$(^4S)5d\,^3D_2^\circ - (^4S)6p\,^3P_1$
4h	3915.30	25533.62	$17_3^\circ - (^2P)6p\,^3D_3$
500	3922.53	25486.56	$(^4S)6s\,^5S_2^\circ - (^4S)6p\,^5P_3$
300	3950.56	25305.73	$(^4S)6s\,^5S_2^\circ - (^4S)6p\,^5P_1$
4	3969.91	25182.39	$25_1^\circ - 34_1$
8	3985.96	25080.99	$23_2^\circ - 32_1$
20	3992.85	25037.71	$(^2D)6s\,^1D_2^\circ - (^2D)6p\,^3P_1$
4	4021.62	24858.60	$(^4S)5d\,^3D_1^\circ - (^4S)6p\,^4P_1$
10	4028.58	24815.65	$(^2D)5d\,^3D_2^\circ - 12_1$
20	4043.21	24725.86	$(^2P)6s\,^3P_0^\circ - (^2D)6p\,^3D_1$
200	4050.05	24684.10	$(^4S)6s\,^3S_1^\circ - (^4S)6p\,^3P_1$
60	4060.43	24621.00	$25_1^\circ - 32_1$
2	4060.88	24618.28	$(^2D)6p\,^1D_2 - 37^0$
100	4109.07	24329.56	$(^2D)6s\,^3D_3^\circ - (^2D)6p\,^3D_1$
10	4110.06	24323.70	$(^2D)5d\,^1P_1^\circ - (^2D)6p\,^3D_2$
1−	4112.34	24310.22	$(^2D)5d\,^3D_2^\circ - 8_2$
3h	4132.42	24192.10	$13_1^\circ - (^2D)6p\,^1D_2$
10	4142.01	24136.08	$(^2P)6s\,^3P_2^\circ - 26_1$
100	4145.73	24114.43	$(^2D)5d\,^2D_1^\circ - (^2D)6p\,^3F_2$
5	4152.03	24077.84	$27_3^\circ - 36$
2	4154.65	24062.65	$(^2P)6s\,^3P_2^\circ - (^2P)6p\,^3D_2$
1	4167.66	23987.54	$(^2D)6p\,^1D_2 - 31_3^\circ$
20	4176.53	23936.60	$(^2D)6s\,^3D_3^\circ - (^2D)6p\,^3D_3$
5	4194.88	23831.89	$\{(^2D)6s\,^1D_2^\circ - 12_2$ $\quad 25_1^\circ - (^2P)6p\,^3P_0$
10	4203.92	23780.65	$(^2D)5d\,^3S_1^\circ - (^2D)6p\,^1P_1$
10	4209.62	23748.45	$(^2P)6s\,^3P_1^\circ - (^2P)6p\,^3D_1$
20	4214.04	23723.54	$(^2D)5d\,^3D_2^\circ - 12_2$
10	4216.75	23708.29	$(^2D)5d\,^3F_2^\circ - (^4S)6p\,^3P_2$
1−	4232.66	23619.18	$15_2^\circ - (^2D)6p\,^1D_2$
1	4235.82	23601.56	$(^2D)6s\,^3D_2^\circ - (^2D)6p\,^3F_2$
10	4240.24	23576.95	$17_3^\circ - (^2D)6p\,^1D_3$
20	4272.60	23398.39	$(^2D)5d\,^2D_2^\circ - (^2D)6p\,^3F_3$
1	4274.13	23390.01	$(^2P)6s\,^1P_1^\circ - (^2D)6p\,^1D_2$
30	4285.89	23325.84	$(^2D)6s\,^1D_2^\circ - 8_2$
2	4305.86	23217.66	$(^2D)5d\,^3D_2^\circ - 8_2$
10	4308.00	23206.12	$23_2^\circ - 28_1$
6	4309.33	23198.96	$(^2D)5d\,^3D_3^\circ - (^2D)6p\,^1F_3$
1−	4357.66	22941.67	$(^2D)5d\,^3F_3^\circ - (^4S)6p\,^5P_3$
4h	4387.52	22785.54	$(^2D)5d\,^1D_2^\circ - (^2D)6p\,^3P_1$
4	4395.12	22746.14	$25_1^\circ - 28_1$
1−	4417.81	22629.32	$(^2D)5d\,^1P_1^\circ - (^2D)6p\,^3D_1$
1−	4425.25	22591.27	$(^2P)6p\,^3D_3 - 35^0$
50	4434.16	22545.88	$(^2D)5d\,^2D_1^\circ - (^2D)6p\,^3D_2$
8	4453.61	22447.41	$(^2D)5d\,^3D_2^\circ - (^2D)6p\,^1P_1$
1	4468.15	22374.37	$(^2D)5d\,^3D_2^\circ - 2_2$
2h	4488.81	22271.39	$(^4S)5d\,^3D_2^\circ - (^4S)6p\,^5P_2$
10	4503.46	22198.94	$27_2^\circ - 32_1$
1h	4525.67	22090.00	$(^4S)5d\,^3D_2^\circ - (^4S)6p\,^5P_1$
30	4537.33	22033.24	$(^2D)6s\,^3D_2^\circ - (^2D)6p\,^3D_2$
2	4631.50	21585.25	$19_2^\circ - (^2D)6p\,^1D_2$
2	4632.68	21579.75	$(^2D)5d\,^1D_2^\circ - 12_2$
1−	4643.63	21528.87	$(^2D)5d\,^3S_1^\circ - (^2D)6p\,^3F_2$
9	4657.78	21463.46	$(^2D)6s\,^1D_2^\circ - (^2D)6p\,^1P_1$
30	4673.66	21390.54	$(^2D)6s\,^1D_2^\circ - 2_2$
60	4683.53	21345.46	$(^4S)6s\,^3S_1^\circ - (^4S)6p\,^3P_2$
1	4685.17	21337.99	$(^2P)6s\,^3P_2^\circ - (^2P)6p\,^3D_1$
2	4697.49	21282.03	$(^2D)5d\,^3D_2^\circ - 2_2$
30	4723.57	21164.53	$(^4S)6s\,^3S_1^\circ - (^4S)6p\,^5P_1$
4	4743.89	21073.87	$(^2D)5d\,^1D_2^\circ - 8_2$
12	4794.48	20851.51	$(^2D)5d\,^3D_1^\circ - (^2D)6p\,^3D_1$
40	4869.47	20530.40	$(^2D)5d\,^2D_2^\circ - (^2D)6p\,^3D_3$
3	4927.53	20288.50	$13_1^\circ - (^2D)6p\,^3P_1$
10	5008.55	19960.31	$(^2D)5d\,^3S_1^\circ - (^2D)6p\,^3D_2$
1h	5070.53	19716.32	$15_2^\circ - (^2D)6p\,^3P_1$
20	5107.38	19574.07	$(^2D)6s\,^1D_2^\circ - (^2D)6p\,^3P_0$
1	5114.57	19546.55	$(^2D)6s\,^1D_2^\circ - (^2D)6p\,^3D_3$
4	5143.03	19438.39	$(^2D)5d\,^2D_2^\circ - (^2D)6p\,^3D_3$
20	5223.66	19138.35	$(^2D)5d\,^1D_2^\circ - 2_2$
3	5233.16	19103.61	$(^2D)5d\,^3D_3^\circ - (^2D)6p\,^3F_2$
60	5238.95	19082.50	$13_1^\circ - 12_2$
6	5310.99	18823.66	$(^2D)6s\,^3D_1^\circ - (^4S)6p\,^3P_2$
30	5367.06	18627.01	$(^2D)5d\,^3D_2^\circ - (^2D)6p\,^3D_2$
1	5371.09	18613.03	$(^2D)5d\,^3F_2^\circ - (^4S)6p\,^5P_2$
2	5384.17	18567.81	$25_1^\circ - (^2P)6p\,^3D_2$
50	5401.04	18509.32	$15_2^\circ - 12_2$
12	5413.56	18467.01	$17_3^\circ - 12_2$
1	5454.30	18329.08	$(^2D)6p\,^1P_1 - (^4S)6d\,^5D_0^\circ$
1	5510.55	18141.97	$17_3^\circ - (^2D)6p\,^3F_2$
40	5524.39	18096.53	$(^2P)6s\,^3P_2^\circ - (^2D)6p\,^1D_2$
12	5552.83	18003.85	$15_2^\circ - 8_2$
2	5566.02	17961.18	$17_3^\circ - 8_2$
1	5666.46	17642.82	$(^2D)6s\,^1D_2^\circ - (^2D)6p\,^2D_2$
6	5701.31	17534.98	$(^2D)5d\,^3D_3^\circ - (^2D)6p\,^2D_2$
12	5748.71	17390.39	$(^2D)6s\,^3D_3^\circ - (^4S)6p\,^3P_2$
2h	5761.96	17350.40	$(^2P)6s\,^1P_1^\circ - (^2D)6p\,^1D_2$
2	5780.55	17294.61	$(^2D)5d\,^1D_2^\circ - (^2D)6p\,^2D_3$
10	5857.61	17067.09	$(^2D)6s\,^3D_1^\circ - (^4S)6p\,^3P_1$
25	6221.66	16068.45	$15_2^\circ - 2_2$
60	6238.24	16025.74	$17_3^\circ - 2_2$
2	6260.16	15969.63	$19_2^\circ - 8_2$
2h	6268.30	15948.89	$(^2D)5d\,^3D_3^\circ - (^2D)6p\,^3D_1$
1	6371.65	15690.19	$(^2D)5d\,^1P_1^\circ - (^4S)6p\,^3P_2$
1	6818.12	14662.76	$(^2D)5d\,^3D_1^\circ - (^4S)6p\,^3P_0$
4h	7043.94	14192.69	$(^2P)6s\,^3P_2^\circ - (^2D)6p\,^3P_1$
2h	7049.34	14181.82	$17_3^\circ - (^2D)6p\,^3D_3$
2h	7174.90	13933.64	$(^2D)5d\,^1P_1^\circ - (^4S)6p\,^3P_1$
2h	7185.92	13912.27	$(^2D)5d\,^3D_1^\circ - (^4S)6p\,^3P_3$
1−	7298.93	13696.87	$(^2D)5d\,^1D_2^\circ - (^2D)6p\,^3D_1$
1	7448.9	13421.11	$27_2^\circ - (^2P)6p\,^3D_1$
5h	7460.82	13399.66	$(^2D)6s\,^3D_3^\circ - (^4S)6p\,^3P_2$
1	7653.8	13061.82	$(^2D)6p\,^1D_2$

2. THEORETICAL TERMS

The doubly ionized xenon atom has the same outer electronic structure as neutral oxygen or the neutral atoms of homologous elements in the sixth column of the periodic table. It is isoelectronic with neutral tellurium, singly ionized iodine, or trebly ionized cesium. The Hund [10] theory, predicts for Xe III, the spectrum characteristic of Xe^{++}, an array of terms with the same designations as those belonging to the spectra of the elements mentioned. The most probable electron configurations and resulting spectral terms of Xe^{++} are shown in table 2. The low states of Xe^{++} are ^3P, ^1D, and ^1S due to the $5s^2 5p^4$ configuration. $5s5p^5$ gives $^3P°$ and $^1P°$. The higher

[10] F. Hund, Linienspektren und periodisches System der Elemente (Julius Springer, Berlin, 1927).

excited states are built upon the ^{4}S, ^{2}D, and ^{2}P states of Xe^{+++} by the addition of an ns, np, or nd electron to the normal $5s^25p^3$ configuration. All the identified levels are explained on the basis of these configurations, but further analysis of this spectrum may require other configurations to account for the remaining uninterpreted levels and unclassified lines.

TABLE 2.—*Electron configurations and spectral terms for* Xe III

Electron configuration			
$5s^25p^4$	^{3}P	^{1}D	^{1}S
$5s5p^5$	^{1}P^0 ^{3}P^0		
	Term limit	*Term limit*	*Term limit*
	$5s^25p3$ ^{4}S$^\circ$	$5s^25p3$ ^{2}D$^\circ$	$5s^25p3$ ^{2}P$^\circ$
$5s^25p^36s$	^{3}S$^\circ$ ^{5}S$^\circ$	^{1}D$^\circ$ ^{3}D$^\circ$	^{1}P$^\circ$ ^{3}P$^\circ$
$5s^25p^36p$	^{3}P ^{5}P	^{1}P ^{1}D ^{1}F	^{1}S ^{1}P ^{1}D
		^{3}P ^{3}D ^{3}F	^{3}S ^{3}P ^{3}D
$5s^25p^35d$	^{3}D$^\circ$ ^{5}D$^\circ$	^{1}S$^\circ$ ^{1}P$^\circ$ ^{1}D$^\circ$ ^{1}F$^\circ$ ^{1}G$^\circ$	^{1}P$^\circ$ ^{1}D$^\circ$ ^{1}F$^\circ$
		^{3}S$^\circ$ ^{3}P$^\circ$ ^{3}D$^\circ$ ^{3}F$^\circ$ ^{3}G$^\circ$	^{3}P$^\circ$ ^{3}D$^\circ$ ^{3}F$^\circ$
$5s^25p^37s$	^{3}S$^\circ$ ^{5}S$^\circ$	^{1}D$^\circ$ ^{3}D$^\circ$	^{1}P$^\circ$ ^{3}P$^\circ$
$5s^25p^36d$	^{3}D ^{5}D$^\circ$	^{1}S$^\circ$ ^{1}P$^\circ$ ^{1}D$^\circ$ ^{1}F$^\circ$ ^{1}G$^\circ$	^{1}P$^\circ$ ^{1}D$^\circ$ ^{1}F$^\circ$
		^{3}S$^\circ$ ^{3}P$^\circ$ ^{3}D$^\circ$ ^{3}F$^\circ$ ^{3}G$^\circ$	^{3}P$^\circ$ ^{3}D$^\circ$ ^{3}F$^\circ$

3. GENERAL FEATURES OF THE XeI III SPECTRUM

The position of xenon in the periodic system leads us to expect a closer approach to jj coupling for its spectra than in the case of any of the elements of smaller atomic number which have the same electron configurations. There is no conformity to multiplet interval rules. The intervals are large compared to the term separations so that there is an overlapping in several instances. The intensities are fairly regular for the multiplets of the (^{4}S) family other than those involving ^{3}D$^\circ$, but very irregular for most of the higher terms converging to (^{2}D) and (^{2}P). It is thus indicated that there may be a progressive change in the coupling scheme as one goes to higher terms.

Intersystem combinations are abundant and include several instances of singlet-quintet combinations. Transitions between levels which belong to groups converging to different ion limits are also of frequent occurrence and permit precise calculation of the relative values of all terms. The transitions seem to require only that combining terms be of opposite parity, and conformity to the j-selection rule. These facts all indicate that perturbations between terms occur frequently. Further evidence for such perturbations is the occurrence of pairs of terms having the same combining properties. Specific instances will be considered.

Up to the past year no reliable work on the analysis of Xe III had been published. Analysis of the doubly ionized rare-gas spectra by Deb and Dutt[11] is completely wrong. The most intense lines of the (^{4}S) family have been classified by deBruin.[12] He identified the $6s^5$S$^\circ$$-6p^5$P and $6s^3$S$^\circ$$-6p^3$P combinations by extrapolation from Te I[13] and I II[14] and confirmed the identifications by C. J. Bakker's unpublished Zeeman effects. DeBruin also found the (^{4}S)$6d^5$D$^\circ$ levels, which are the second members of the series. With

[11] S. C. Deb and A. K. Dutt, Z. Phys. **67**, 138 (1931).
[12] T. L. deBruin, Zeeman Verhandelingen, p. 413 (1935).
[13] Bartelt, Z. Phys. **88**, 522 (1934).
[14] Lacroute, Ann. phys. **3**, 1 (1935).

the exception of one and possibly a second level of this quintet, this analysis is in agreement with deBruin's work.

4. TABLE OF TERMS

All the known terms of Xe III are assembled in table 3. It was suggested by Dr. Boyce that the complete set including the low levels be placed in this paper to avoid the necessity of duplication in printing. For this reason a uniform notation has been adopted. Levels without certain interpretation are given a number, even for even levels, odd for odd levels, the subscript being the probable j value. If the number is followed by a quantum designation, the latter is suggested but not regarded as certain. The table now contains 84 levels. Levels designated 30 and 34 are regarded as of doubtful reality, because some of the combination lines are otherwise classified.

TABLE 3.—Xe III *terms*

Electron configuration						
$5s^25p^4$	$^3P_2$	259089	$^1D_2$	241989	$^1S_0$	221691
	$^3P_1$	249294				
	$^3P_0$	250958				
$5s5p^5$	$^3P_2$	160826				
	$^3P_1$	155520				
	$^3P_0$	149630				
	$^1P_1$	140062.72				
	Term limit $5s^2\,5p^3\,^4S^\circ$		Term limit $5s^2\,5p^3\,^2D^\circ$		Term limit $5s^2\,5p^3\,^2P^\circ$	
$5s^25p^36s$	$^5S_2$	137613.00	$^3D_1$	125854.72	$^3P_0$	108583.55
			$^3D_2$	124421.51	$^3P_1$	107606.40
	$^3S_1$	133471.80	$^3D_3$	120430.72	$^3P_2$	105195.59
			$^1D_2$	116040.63	$^1P_1$	104449.39
$5s^25p^36p$	$^5P_1$	112307.29	$^3D_1$	100091.90	$^3D_3$	85142.20
	$^5P_2$	112126.40	$^3D_2$	98397.50	$20_1\ ^3D_1$	83857.65
	$^5P_3$	110027.40	$^3D_3$	96494.07	$22_2\ ^3D_2$	81132.93
			$^3F_2$	96828.90		
	$^3P_0$	106280.64	2_2	94650.20	26_1	81059.42
	$^3P_1$	108787.71	$4_1\ ^1P_1$	94577.18	28_1	76954.59
	$^3P_2$	107031.06				
			$^3P_0$	92793.33	$30_0\ ^3P_0$	75868.85
			$6_3\ ^1F_3$	92733.48	32_1	75079.63
			8_2	92714.78	34_1	74518.40
			$10_3\ ^3F_3$	92534.05	36_1 or $_2$	73200.80
			12_2	92208.79		
			$14_1\ ^3P_1$	91002.85		
			$^1D_2$	87099.00		
$5s^25p^35d$	$^5D_4$		$1_3\ ^3F_3$	132968.93	13_1	111291.36
	$^5D_3$	147483.54	$3_3\ ^1F_3$	131306.71	15_2	110718.72
	$^5D_2$	147232.66	$5_2\ ^3F_2$	130739.49	17_3	110675.91
	$^5D_1$	146639.15	$7_3\ ^3G_3$	128915.00	19_2	108684.32
	$^5D_0$	146395.14	$9_4\ ^3G_4$	126928.94	23_2	100160.71
			$11_3\ ^1G_3$	126650.41	25_1	99700.71
	$^3D_3$	137859.15	$^1P_1$	122721.35	27_2	97278.61
	$^3D_2$	134397.28	$^3S_1$	118357.77		
	$^3D_1$	137165.97				
			$^3D_1$	120943.39		
			$^3D_2$	117024.51		
			$^3D_3$	115932.46		
			$^1D_2$	113788.61		
$5s^25p^37s$	$^5S_2$	76751.69				
	$^3S_1$	71065.72				
$5s^25p^36d$	$^5D_4$	76966.03				
	$^5D_3$	76624.76				
	$^5D_2$	76606.25				
	$^5D_1$	76537.87				
	$^5D_0$	76248.21				
$5s^25p^36d$ or $7s$			29_2	63191.42		
			31_2	63111.70		
			33_2 or $_3$	62827.70		
			35_2 or $_3$	62551.10		
			37_2 or $_3$	62480.33		
			39_2	59038.63		

5. THE (^{4}S) FAMILY OF TERMS; IONIZATION POTENTIAL

The terms of the (^{4}S) family due to first excited states have all been found with the exception of $5d^5D_2^o$. The level is hard to find at best because it is expected to yield only one strong combination. DeBruin's $6d^5D_4^o$ may, therefore, be regarded as doubtful. There is better reason for believing that the line at $\nu 33061.37$ is $(^2D)6s^3D_1^o -$ $(^2D)6p^3P_0$ rather than $(^4S)6p^5P_3 - (^4S)6d^5D_4^o$. The $^5D^o$ levels are partially inverted in I II, so that $^5D_4^o$ is between $^5D_3^o$ and $^5D_2^o$. The level was not found in Te I. The second series members of the terms of the (^{4}S) family have also been found with the exception of $6d^3D^o$. Three series are thus made available on which to base an estimation of the absolute term values and the ionization potential for Xe^{++}. The $^5D^o$ series was actually chosen. The values of the limit of the $^5D_2^o$ series arrived at directly and from the limits of $^3S^o$ and $^5S^o$ and known separation of levels are as follows:

$$
\begin{array}{ll}
^5D_2^o & 147{,}232 \text{ cm}^{-1} \\
^3S_1^o + (^5D_2^o - ^3S_1^o) & 147{,}717 \text{ cm}^{-1} \\
^5S_2^o + (^5D_2^o - ^5S_2^o) & 141{,}798 \text{ cm}^{-1}
\end{array}
$$

The value of $^5D_2^o$ obtained through the $^5S^o$ series differs from the directly computed limit by 6,000 units. A discrepancy in the same sense and of about the same magnitude was found in Kr III[15], in which spectrum the other series limits were in good agreement.

The choice of 147,232 for the value of the term $5d^5D_2^o$ places $^5S_2^o$ at 137,613, which was arbitrarily given a whole-number value. All other terms were fixed by their experimentally known relative positions. The value of the lowest $s^2p^4\ ^3P_2$ level was calculated through its ultraviolet combinations as $259{,}089$ cm^{-1} giving an ionization potential of 32.0 volts for Xe^{++}. Tate and Smith[16] reported an experimental value of 32.2 ± 0.3 volt. Referring again to the peculiar behavior of the $^5S^o$ series, it may be noted that $6s^5S^o$ is located between $5d^3D_1^o$ and $^3D_3^o$ and that $^3D_2^o$ is lower. A perturbation of $^5S_2^o$ by $^3D_2^o$ may be responsible for this state of affairs. The $^3D^o$ term is somewhat irregular in all analogous spectra, usually being partially inverted. In Te I it overlaps $^5D^o$ and in I II it is lower.

The Moseley diagram for all the terms of the (^{4}S) family except $^3D^o$ is shown in figure 1. It is regular in every way. The curves are nearly straight lines, a fact which favors the choice of $^5D^o$ for the calculation of the absolute term values rather than $^5S^o$ since the latter choice would have increased the curvature. The slopes of the curves are seen to decrease with increasing total quantum number and those related to the same total quantum number are parallel. All this indicates that the terms of the (^{4}S) family are correctly interpreted in all of these iso-electronic spectra. Such a diagram could have been used to predict the terms in Xe III. This was not actually done, since the other evidence was sufficient.

6. DISCUSSION

In the spectra of all the doubly ionized rare gases a very intense multiplet array appears in the extreme ultraviolet owing to the combination of the lowest $s^2p^4\ ^3P$ and ^1D terms with $sp^5\ ^3P^o$ and $^1P^o$. The

15 C. J. Humphreys, Phys. Rev. 47, 712 (1835).
16 J. T. Tate and P. T. Smith, Phys. Rev. 46, 773 (1934).

discovery of this array immediately establishes the intervals between the low terms. When the ultraviolet data are combed with these intervals, the odd levels are found from the s^2p^35d and s^2p^36s configurations which combine not only with the low terms but with the even terms of the first excited states, that is those due to s^2p^36p. For this reason a complete set of data in both the extreme ultraviolet and ordinary optical regions is essential to a satisfactory analysis. In the work on this spectrum, Dr. Boyce had obtained the relative values of most of the odd levels. This was the starting point of the present analysis, which was carried forward by applying the "constant differences" of these odd levels to find the s^2p^36p terms. Complete quantum numbers have been assigned or suggested in all cases where the evidence appears sufficient.

The strongest multiplet of the (^2D) family is the combination $6s^3D^0 - 6p^3D$, which shows fairly regular intensities. The level designated $6p^3F_2$ behaves similarly to $^3D_2$ so that there is not much basis for a distinction. The designation $^1P_1$ is suggested for the term listed in the table as 4_1, mainly because of its location just above ^3D, where this term is found in analogous spectra, Se I and Kr III. Similarly the highest term in

FIGURE 1.—*Moseley diagram for 52 electron-system spectra.*

this group 87099.00 is called ^1D. It is similarly located in Se I, Kr III, and I II. There is additional evidence here from the combinations with $(^2D)6s^1D^\circ$ and $(^2D)5d^1D^\circ$. The levels designated 2_2 and 8_2 show identical combining properties and are evidently perturbing each other. Each combines with $(^2D)5d^1P_1^\circ$, but with no other levels of j-value less than 2. Three levels 6_3, 10_3, and $(^2P)6p^3D_3$ show almost identical combining properties but do not combine with levels having j less than three. On the basis of the electron configurations assumed, only one level of j value 4, $(^2D)6p^3F_4$, is predicted. We believe it to be missing since in similar spectra it shows only a few combinations, and there may not be enough combinations here to locate it by "constant differences." The interpretations $^1F_3$ and $^3F_3$ are suggested for 6_3 and 10_3, respectively, although it is doubtful if quantum numbers can be assigned unambiguously.

Among levels of the (^2P) family, the evidence for positive identifications is insufficient to justify anything more than the assignment of
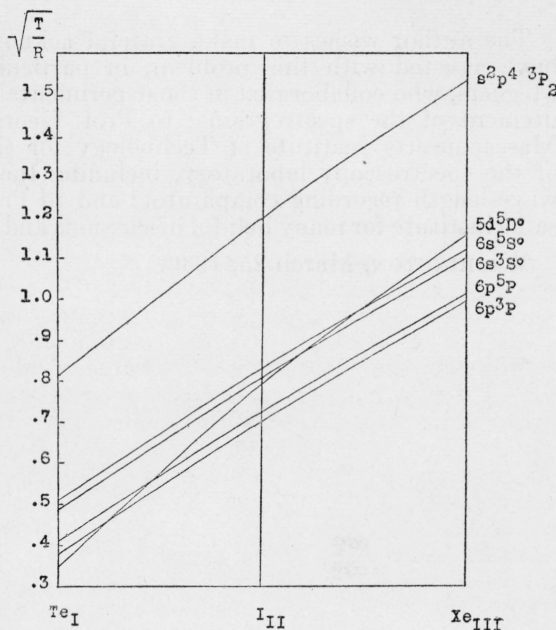
j values except for the $(^2P)6s\,^3P^\circ$ and $^1P^\circ$ terms. $^3P^\circ$ is a regular term, occurs in the expected position, and gives strong combinations. The identification of $^1P^\circ$ is justified both by its combination with the low ^1D and ^1S terms and strong visible combinations. A few levels have been found which appear to be second series members of odd levels converging to (^2D).

Most of the intense lines of Xe III both classified and unclassified are in the region between 3500 and 4000 A. In the further study of this spectrum, Zeeman effect observations are desirable. It is hoped that such an analysis for both Xe II and Xe III can be undertaken in the near future.

Washington, March 25, 1936.