An Extension of the Pd I-Like Isoelectronic Sequence to Antimony VI and Tellurium VII*

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With a vacuum spectrograph in the region 784 to 1331A some of the lines arising from the transition d^9p to d^9s electronic configurations of Sb VI and Te VII have been found. The wave-lengths and frequencies of the stronger lines are given along with the values for the sixteen terms $^3P^0D^0F^0$, $^1P^0D^0F^0(4d^95p)$ and ^3D, $^1D(4d^95s)$. Extrapolations were made from a Moseley diagram for the value of $^1S_0$, as the shorter wave-lengths (below 300A) for the $^1P_1{}^0$, $^3P_1{}^0$, and $^3D_1{}^0$ into $^1S_0$ were not obtained. Centroidal and fan type diagrams are also given.

THE terms and related wave-lengths and frequencies arising from the electronic configurations d^{10}, d^9s, d^9p have been previously identified for Pd I[1] and Ag II[2] by Shenstone, and for Cd III by McLennan, McLay and Crawford.[3] Cd III was also worked out by Gibbs and White,[4] who extended the isoelectronic sequence to In IV[4] and Sn V.[5] The present paper continues the extension to include Sb VI and Te VII.

The three strongest lines of the triplets $D-F^0$, $D-D^0$, $D-P^0$ are shown in Fig. 1. The transitions $^1P_1{}^0$, $^3P_1{}^0$, and $^3D_1{}^0$ $(4d^95p)$ into $^1S_0$ $(4d^{10})$ should be at 289, 296, and 284A for Sb VI and at 240, 245, and 236A for Te VII, following extrapolations from the Moseley diagram, Fig. 2. As the spectrograph did not give satisfactory measurements below 300A these transitions were not obtained.

In 1928, having only the first members of any series, Gibbs and White made extrapolations from the known values of Ag I for Pd I by use of the relations for the elements in the first long

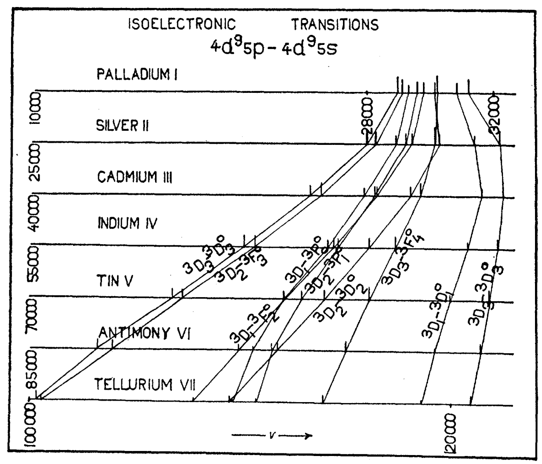

FIG. 1. Displacement of multiplets.

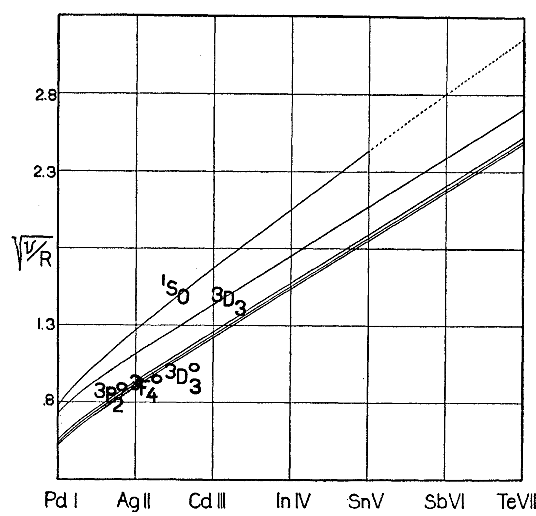

FIG. 2. Moseley diagram.

* Presented at the April, 1932, meeting of the American Physical Society in Washington.

[1] Pd I. Shenstone, Phys. Rev. **36**, 670 (1930).

[2] Ag II. Shenstone, Phys. Rev. **31**, 321 (1928). See also McLennan and Smith, Proc. Roy. Soc. Canada **20**, 110 (1926).

[3] Cd III. McLennan, McLay and Crawford, Trans. Roy. Soc. Canada **22**, 45 (1928).

[4] Cd III and In IV. Gibbs and White, Phys. Rev. **31**, 776 (1928).

[5] Sn V. Gibbs and White, Proc. Nat. Acad. Sci. **14**, 345 (1928).

TABLE I. *Values of* $(\nu/R)^{\frac{1}{2}}$.

Terms (Limit $4d^9$)		Pd I	Diff.	Ag II	Diff.	Cd III	Diff.	In IV	Diff.	Sn V	Diff.	Sb VI	Diff.	Te VII
$4d^{10}$	$^1S_0$	0.783	0.488	1.271	0.405	1.676	0.390	2.066	0.376	2.442	0.363	(2.805)	0.351	(3.156)
$4d^95s$	$^3D_3$	.731	.390	1.121	.320	1.441	.318	1.759	.315	2.074	.313	2.387	.310	2.697
$4d^95p$	$^3F_4{}^0$	.534	.389	0.923	.319	1.242	.318	1.560	.315	1.875	.313	2.188	.311	2.499
	$^3D_3{}^0$	.521	.388	.909	.319	1.228	.318	1.546	.316	1.862	.313	2.175	.312	2.487
	$^3P_2{}^0$	.550	.390	.940	.321	1.261	.320	1.581	.317	1.898	.313	2.212	.312	2.524

TABLE II. *Absolute values for lowest terms.*

	$4d^{10}\ (^2D_{2\frac{1}{2}})\ ^1S_0$	Ionization potential
Pd I	67,236 cm^{-1}	8.3 volts
Ag II	177,164	21.8
Cd III	308,318	38.0
In IV	468,214	57.8
Sn V	654,527	80.7
Sb VI	(863,413)	(106)
Te VII	(1,093,017)	(135)

TABLE III. *Classified lines of Sb VI.*

λ (A)	ν (cm^{-1})	Int.	Designation	λ (A)	ν (cm^{-1})	Int.	Designation
? 883.45	113193	00	$^3D_2-{}^1D_2{}^0$	1035.85	96539.1	10	$^3D_2-{}^3P_1{}^0$
892.21	112081	3	$^3D_3-{}^1F_3{}^0$	1046.10	95593.2	2	$^3D_1-{}^3P_0{}^0$
? 897.35	111439	00	$^3D_2-{}^3D_1{}^0$	1051.39	95112.2	12	$^1D_2-{}^1P_1{}^0$
914.86	109306	5	$^3D_2-{}^1F_3{}^0$	1053.24	94945.1	20	$^3D_1-{}^3F_2{}^0$
940.26	106354	30	$^3D_3-{}^3D_3{}^0$	1072.94	93201.8	15	$^1D_2-{}^3D_3{}^0$
943.71	105964	5	$^3D_1-{}^1D_2{}^0$	1089.42	91791.8	00	$^1D_2-{}^3F_2{}^0$
952.96	104936	0	$^3D_3-{}^3F_2{}^0$	1090.36	91712.8	5	$^3D_3-{}^3F_3{}^0$
959.57	104213	5	$^3D_1-{}^3D_1{}^0$	1116.22	89588.1	3	$^3D_1-{}^3D_2{}^0$
972.66	102811	1	$^1D_2-{}^1D_2{}^0$	1119.63	89315.2	8	$^3D_1-{}^3P_1{}^0$
978.79	102167	5	$^3D_2-{}^3F_2{}^0$	1124.34	88941.1	25	$^3D_2-{}^3F_3{}^0$
? 989.52	101059	00	$^1D_2-{}^3D_1{}^0$	1133.20	88245.7	15	$^3D_3-{}^3P_2{}^0$
999.70	100030	35	$^3D_3-{}^3F_4{}^0$	1156.94	86434.9	10	$^1D_2-{}^3D_2{}^0$
1004.18	99583.7	5	$^3D_3-{}^3D_2{}^0$	1169.94	85474.5	5	$^3D_2-{}^3P_2{}^0$
1010.82	98929.6	2	$^1D_2-{}^1F_3{}^0$	1272.79	78567.6	20	$^1D_2-{}^3F_3{}^0$
1017.65	98265.6	5	$^3D_1-{}^1P_1{}^0$	1331.59	75098.2	1	$^1D_2-{}^3P_2{}^0$
1032.93	96812.0	20	$^3D_2-{}^3D_2{}^0$				

TABLE IV. *Classified lines of Te VII.*

λ (A)	ν (cm^{-1})	Int.	Designation	λ (A)	ν (cm^{-1})	Int.	Designation
784.09	127536	1	$^3D_3-{}^1F_3{}^0$	913.01	109528	20	$^3D_2-{}^3D_2{}^0$
803.56	124446	1	$^3D_2-{}^1F_3{}^0$	925.12	108094	0	$^1D_2-{}^1P_1{}^0$
827.06	120910	30	$^3D_3-{}^3D_3{}^0$	927.81	107781	7	$^3D_1-{}^3F_2{}^0$
829.84	120505	1	$^3D_1-{}^1D_2{}^0$	956.68	104528	0	$^1D_2-{}^3F_2{}^0$
843.21	118594	2	$^3D_1-{}^3D_1{}^0$	964.85	103643	0	$^3D_3-{}^3F_3{}^0$
852.87	117251	1	$^1D_2-{}^1D_2{}^0$	975.04	102505	8	$^3D_1-{}^3P_1{}^0$
? 861.60	116063	00	$^3D_2-{}^3F_2{}^0$	994.50	100553	10	$^3D_2-{}^3F_3{}^0$
866.99	115342	4	$^1D_2-{}^3D_1{}^0$	996.90	100311	25	$^3D_3-{}^3P_2{}^0$
877.59	113948	20	$^3D_3-{}^3F_4{}^0$	1007.54	99251.6	2	$^1D_2-{}^3P_1{}^0$
898.09	111347	1	$^3D_1-{}^1P_1{}^0$	1020.50	97991.2	0	$^1D_2-{}^3D_2{}^0$
902.63	110787	15	$^3D_2-{}^3P_1{}^0$	? 1028.61	97218.6	00	$^3D_2-{}^3P_2{}^0$
911.77	109677	1	$^3D_1-{}^3P_0{}^0$	1123.36	89018.6	15	$^1D_2-{}^3F_3{}^0$

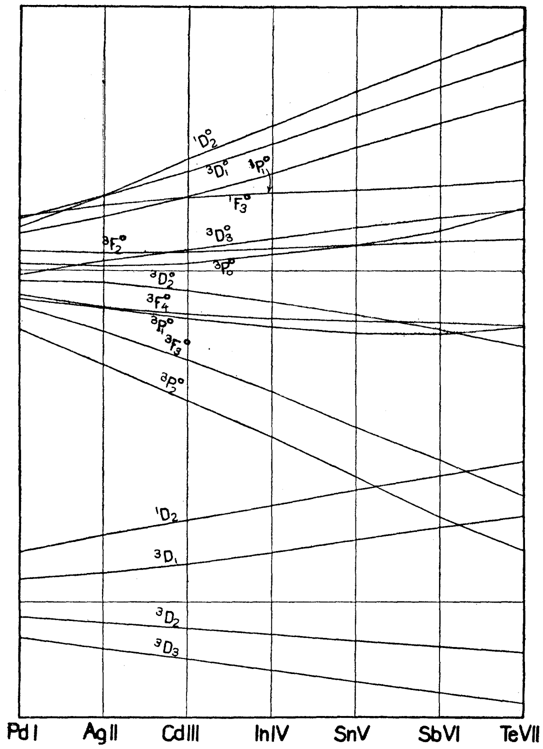

FIG. 3. Relative positions of the levels in each configuration.

period. Using the data for Pd I published in 1930 by Shenstone[1] and also the data for Ag II now available,[2] the author has remade the Moseley diagram of Gibbs and White and extended it to Sb VI and Te VII. In extrapolating the lines of this diagram beyond the first two elements, the term values have been so chosen as to make $\Delta(\nu/R)^{\frac{1}{2}}$ between terms that approach the same limit and arise from electronic configurations having the same total quantum number, remain constant. (See Table I.) The new absolute term values are about eight percent larger than those determined by the approximation by Gibbs and White. In Table II are given the absolute values of the lowest term with respect to $^2D_{2\frac{1}{2}}$, and the approximate ionization potentials. The smoothness of the curves in Fig. 1 and of the curves when the terms are plotted according to the centroids, Fig. 3, were of aid in selecting the proper lines.

TABLE V. *Term values.*

Designation		Sb VI	Te VII
$4d^95s$	$^3D_3$	0	0
	$^3D_2$	2,771	3,090
	$^3D_1$	9,994	11,372
	$^1D_2$	13,147	14,625
$4d^95p$	$^3P_2{}^0$	88,246	100.311
	$^3F_3{}^0$	91,713	103,643
	$^3P_1{}^0$	99,311	113,877
	$^3D_2{}^0$	99,583	112,617
	$^3F_4{}^0$	100,030	113,948
	$^3F_2{}^0$	104,939	119,153
	$^3P_0{}^0$	105,587	121,049
	$^3D_3{}^0$	106,354	120,910
	$^1P_1{}^0$	108,259	122,719
	$^1F_3{}^0$	112,077	127,536
	$^3D_1{}^0$	114,207	129,966
	$^1D_2{}^0$	115,954	131,877

The author wishes to thank Professor R. C. Gibbs, who suggested the extension of this iso-electronic sequence and who made possible the use of the vacuum spectrograph. An investigation recently completed extends a similar sequence ($5d^96p$) into ($5d^96s$) starting with Pt I to Bi VI, and the data for this sequence and for the sequence discussed in this paper were compared at the December, 1932, meeting of the American Physical Society in Atlantic City.