THE SPARK SPECTRA OF SILVER AND PALLADIUM (AG II AND PD II)—AN EXTENSION

By H. A. Blair
Palmer Physical Laboratory, Princeton, N. J.

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Abstract

An attempt was made to excite the $4f$ electron spectrum of Ag II in the Schüler tube with helium. Failure is discussed assuming the excitation process Ag normal atom $+He^+$. Some little extension was made to the lower spectrum. The Schüler tube was also used to extend the $4d^86s$ and $5d$ configurations of Pd II. About forty terms were added. A complete list of lines arising from high levels is given.

Ag II

An attempt was made, using the Schüler tube, to excite the spectrum connected with the $4f$ electron in Ag II. By Hund theory this should consist of the set of terms $^{3\text{ and }1}P$, D, F, G, H in combination with the terms associated with the $5d$ electron. From analogy with other spectra the lines should lie in the lower half of the visible spectrum. Some fifty lines were measured in this region which could be allotted to the Ag II spectrum with reasonable certainty, but comparatively few were strong. About one quarter of these correspond to lines given in Kayser's Handbuch without displacement of wave-length. This lack of displacement further identifies these lines as being due to transitions from the $4f$ state for the following reason:—As is well known the lines due to transitions from high levels, which are diffuse when excited in the electric spark, are sharp when excited in the Schüler tube and besides have greater wave numbers by about two units. This means that the levels from which they arise are displaced by that amount toward their series limits. Since, however, the $4f$ levels will likely have a displacement similar to that known in the $5d$ it is to be expected that the lines due to transitions between them will not be displaced.

Among the lines observed some of the $5d$ differences were found, but it was not possible to identify any of the $4f$ terms with certainty on account of the fewness of the combinations. It appears that the Schüler tube is not well adapted to the excitation of this spectrum. This will be considered later in connection with the results in Pd II as well.

The spectral region from 2000 to 3000A which contains the lines of existing classifications of the silver spark, the most recent of which is due to Shenstone,[1] was also measured from Schüler tube plates. Shenstone's classification included all the predicted terms arising from the structures d^95s, $6s$, and $5d$, but the terms $5d\,^3P_0$ and $5d\,^1S_0$ were doubtful. The present measures gave about twenty new lines, some of which permitted these terms to be determined more reasonably, although the $^1S_0$ is much higher than expected

[1] Shenstone, Phys. Rev. **31**, 317 (1928).

TABLE I. *Ag II terms.*

$d^9 5d^3P_0$	89366.9	$d^9 5d^1S_0$	95287.5

These new terms are given in Table I. To correspond with the other terms as previously given by Shenstone about 2 cm^{-1} should be subtracted.

In Table II are given the new lines as well as the few old ones whose allocations have been changed. In each case the wave number and wave-length are from Schüler tube measurements. From each of these also should 2 cm^{-1} be subtracted that they may fit Shenstone's terms. In the case of the old lines the authors and intensities are given.

TABLE II. *Ag II lines.*

Wave-length	Author	I	I	Wave number	Designation
3329.71	F	3*u*	10	30023.9	$5p^1D_2{}^0-6s^3D_2$
3146.10	B		8	31776.2	$5p^1F_3{}^0-6s^3D_2$
2801.93	B		4	35679.2	$5p^1P_1{}^0-5d^3S_1$
2752.19	B		4	36324.0	$5p^1D_2{}^0-5d^3D_3$
2743.78	B		15	36435.3	$5p^3D_1{}^0-5d^3P_1$
2728.73	B		3	36636.3	$5p^1D_2{}^0-5d^3D_2$
2656.59	E	10*u*	10	37631.0	$5p^1F_3{}^0-5d^3P_2$
2617.01	B		12	38200.1	$5p^3D_1{}^0-5d^3P_0$
2587.24	B		3	38639.7	$5p^1P_1{}^0-5d^3P_0$
2435.07	B		2	39434.8	$5p^3P_0{}^0-5d^3S_1$
2506.91	B		1	39877.8	$5p^3F_3{}^0-5d^3P_2$
2454.20	B		4	40734.2	$5p^3P_2{}^0-6s^3D_2$
2411.59	B		20	41453.8	$5p^3D_1{}^0-5d^1D_2$
2317.26	B		1	43141.1	$5p^3P_1{}^0-5d^3P_2$
2265.85	B		3	44120.5	$5p^3D_1{}^0-5d^1S_0$
2243.44	S	9*U*	40	44560.6	$5p^1P_1{}^0-5d^1S_0$
2240.47	B		3	44619.6	$5p^3F_2{}^0-5d^3D_1$
2226.02	S	10*U*	15	44909.2	$5p^3P_1{}^0-5d^3P_0$
2210.32	B		4	45228.2	$5p^3P_2{}^0-6s^1D_2$
2120.81	B		2	47136.9	$5p^3P_1{}^0-5d^1P_1$

S—Shenstone F—Frings. E—Exner & Haschek. B—Author.

Some of the previously classified lines were greatly enhanced with the Schüler tube. These are λ3372 from 1 to 50, λ3269, 1 to 40, λ3223, 3 to 40, λ3184, 1*u* to 50, λ3129, 1*u* to 20. No reason can be given for these marked changes of intensity. The remainder of the lines in the group to which they belong, the 6*s*, although in most cases stronger, were not greatly different.

Pd II

The spectrum arising from the electron configurations $4d^9$, $4d^8\ 5s$ and $5p$ of Pd II has been very completely analyzed by Shenstone.[2] He was also able to classify a considerable number of the diffuse lines giving several of the $4d^86s$ and $5d$ terms. The present work is an extension of the analysis of the lines arising from the latter configurations.

Method of excitation. As with the silver, the Schüler tube was used for the excitation of the spectrum. The cathode used in each case was cylindrical, open at both ends, and measured 0.5 inches in diameter, and 1.5 inches in

[2] Shenstone. Phys. Rev. **32**, 1 (1928).

length. Helium was used to carry the current. It was purified by continuous circulation through a Misch metal discharge, and through chabazite cooled with liquid air. All gaseous impurities but hydrogen were soon removed by this method. A current of about 200 m.a. was used, the line voltage being 750 d.c. The gas pressure was kept between 3 and 4 mm, a much lower pressure, i.e., about 2 mm being found, as usual, to give the spark spectrum weakly compared with the arc. The photographs were made with the Hilger E1 quartz spectrograph. The extent of excitation is discussed later.

The data. In Table III is given a list of all the lines obtained, both classified and unclassified. The unassigned lines were included since the accuracy of measurement is probably sufficient to render a repetition of the

TABLE III. *Pd II lines.*

Wave-length	Author	I_1	I_2	Wave number	Designation
3382.57	S	1	10	29554.8	$ap^2F_{2\frac{1}{2}}{}^0-6s^4F_{3\frac{1}{2}}$
3377.35	B		2	29600.5	
3371.69	B		3	29650.2	
3365.99	B		2	29700.4	
3355.93	B		5	29789.5	
3352.19	B		3	29822.7	
3348.46	B		1	29855.9	$ap^2D_{2\frac{1}{2}}{}^0-ed^4F_{2\frac{1}{2}}$
3348.11	B		1	29859.0	
3315.64	B		1	30151.4	
3282.96	B		1	30451.6	$kp^2H_{4\frac{1}{2}}{}^0-ed^2F_{3\frac{1}{2}}$
3280.65	B		4	30473.0	
3278.05	B		3	30497.2	$cp^2F_{3\frac{1}{2}}{}^0-ed^4D_{3\frac{1}{2}}$
3276.24	B		1	30514.0	
3274.96	B		3	30525.9	
3261.72	B		2	30649.9	
3241.79	B		3	30838.3	
3237.44	B		1	30879.7	$ep^2P_{\frac{1}{2}}{}^0-6s^4P_{\frac{1}{2}}$
3221.12	B		1	31036.2	
3220.46	B		2	31042.5	$ep^2P_{\frac{1}{2}}{}^0-6s^2P_{\frac{1}{2}}$
3212.70	B		1	31117.5	
3210.48	B		6	31139.0	$ep^2D_{2\frac{1}{2}}{}^0-ed3_{2\frac{1}{2}}$
3206.88	B		3	31174.0	$ep^2S_{\frac{1}{2}}{}^0-6s^2P_{1\frac{1}{2}}$
3206.39	B		1	31178.7	$cp^2F_{3\frac{1}{2}}{}^0-ed^4F_{4\frac{1}{2}}$
3201.04	B		3	31230.9	
3189.34	B		4	31345.4	
3184.59	B		5	31392.1	$ap^4P_{1\frac{1}{2}}{}^0-6s^4F_{2\frac{1}{2}}$
3154.62	B		1	31690.4	
3153.16	S	2*u*	10	31705.1	$ep^2P_{\frac{1}{2}}{}^0-6s^2P_{1\frac{1}{2}}$
3149.83	B		1	31738.6	
3147.39	B		1	31763.2	
3146.51	B		1	31772.1	
3144.16	B		4	31795.8	
3138.33	B		3	31854.9	
3137.33	B		8	31865.0	$bp^4S_{1\frac{1}{2}}{}^0-6s^4P_{1\frac{1}{2}}$
3136.67	B		5	31871.7	
3135.41	S	10*ua*	3	31884.5	$bp^4D_{3\frac{1}{2}}{}^0-ed3_{2\frac{1}{2}}$
3123.61	B		3	32005.0	
3122.98	B		3	32011.4	
3117.70	B		1	32065.7	
3105.17	S	8*uA*	15	32195.1	$ap^4F_{2\frac{1}{2}}{}^0-6s^4F_{3\frac{1}{2}}$
3098.68	B		1	32262.4	$ep^2S_{\frac{1}{2}}{}^0-ed8_{1\frac{1}{2}}$
3098.69	B		1	32263.3	
3091.28	B		1	32339.7	
3087.34	B		1	32381.0	

TABLE III (*continued*)

Wave-length	Author	I_1	I_2	Wave number	Designation
3086.26	S	3*u*	4*d*	32392.3	$ap^2F_{2\frac12}^0-6s^2F_{3\frac12}$ $ap^2F_{2\frac12}^0-6s^4F_{2\frac12}$
3083.18	B		1	32424.6	
3081.60	B		4	32441.3	
3079.97	B		2	32458.4	
3078.44	B		2	32474.6	
3077.01	B		6	32489.7	$bp^4D_{2\frac12}^0-ed3_{2\frac12}$
3072.11	B		1	32541.5	
3068.88	E	3*uA*	8	32575.7	$ap^2D_{2\frac12}^0-6s^4F_{3\frac12}$
3055.07	S	10*uA*	35	32723.0	$kp^2G_{4\frac12}^0-6s^2G_{4\frac12}$
3053.87	B		4	32735.8	$kp^2G_{4\frac12}^0-6s^2G_{3\frac12}$
3040.16	B		2	32883.5	$cp^2D_{2\frac12}^0-ed3_{2\frac12}$
3026.09	S	10*uA*	25	33036.3	$kp^2G_{3\frac12}^0-6s^2G_{3\frac12}$
3024.81	B		1	33050.3	$ap^2D_{1\frac12}^0-6s^4F_{2\frac12}$
3024.27	B		2	33056.2	
3020.86	B		1	33093.5	$bp^4D_{1\frac12}^0-ed4_{\frac12}$
3018.95	B		3	33114.5	$bp^4S_{1\frac12}^0-6s^2D_{2\frac12}$
3014.72	S	5*ua*	4	33160.9	$bp^4P_{2\frac12}^0-6s^2F_{2\frac12}$
3013.59	S	5*ua*	4	33173.4	$bp^4P_{1\frac12}^0-6s^2F_{2\frac12}$
2997.49	B		8	33351.5	$kp^2F_{3\frac12}^0-6s^2D_{2\frac12}$
2989.61	B		1	33439.5	
2955.28	S	2*uA*	5	33827.9	$ap^2G_{3\frac12}^0-6s^2F_{3\frac12}$
2951.66	B		2	33869.4	$cp^2D_{1\frac12}^0-ed4_{\frac12}$
2946.44	S	2*uA*	3	33929.4	$ep^2P_{1\frac12}^0-6s^2P_{\frac12}$
2944.53	B		1	33951.4	
2939.45	S	3*uA*	4	34010.1	$ep^2S_{\frac12}^0-6s^2P_{\frac12}$
2934.84	E	20*uA*	15	34063.5	$ap^4F_{3\frac12}^0-6s^4F_{3\frac12}$
2925.28	E	10*uA*	15	34174.8	$ap^2F_{2\frac12}^0-6s^2F_{2\frac12}$
2920.36	E	5*uA*	5	34232.3	$ap^2D_{1\frac12}^0-6s^4F_{1\frac12}$
2911.03	E	1*uA*	6	34344.1	$ep^2D_{2\frac12}^0-6s^2P_{1\frac12}$
2910.69	B		2	34346.1	
2900.25	E	2*u*	4	34469.7	
2889.97	E	2*u*	4	34592.3	$ep^2P_{1\frac12}^0-6s^2P_{1\frac12}$
2880.32	E	3*uA*	4	34708.2	$ep^2D_{1\frac12}^0-6s^2P_{\frac12}$
2877.88	E	100*uA*	20	34737.6	$ap^4F_{4\frac12}^0-6s^4F4_{\frac12}$
2871.20	E	100*uA*	25d	34818.5	$ap^2F_{3\frac12}^0-6s^2F_{3\frac12}$ $ap^2F_{3\frac12}^0-6s^4F_{2\frac12}$
2870.16	E	1*uA*	4	34831.0	$ap^2D_{1\frac12}^0-6s^2F_{2\frac12}$
2854.03	B		1	35027.9	
2853.51	S	10*uA*	10*d*	35034.3	$ap^4F_{2\frac12}^0-6s^2F_{3\frac12}$ $ap^4F_{2\frac12}^0-6s^4F_{2\frac12}$
2850.73	E	5*uA*	6	35068.4	$ap^2F_{2\frac12}^0-ed^4D_{2\frac12}$
2837.48	E	20*uA*	25	35232.2	$cp^2F_{3\frac12}^0-ed3_{2\frac12}$
2837.12	S	5*uA*	40	35336.7	$ap^2F_{2\frac12}^0-ed^4F_{3\frac12}$
2826.33	E	3*uA*	4	35371.2	$ep^2D_{1\frac12}^0-6s^2P_{1\frac12}$
2822.94	E	10*uA*	8*d*	35413.6	$ap^2D_{2\frac12}^0-6s^2F_{3\frac12}$ $ap^2D_{2\frac12}^0-6s^4F_{2\frac12}$
2821.68	E	30*uA*	15	35429.4	$ap^4\ F_{4\frac12}-6s_4\ F_{3\frac12}$
2815.31	B		1	35509.6	
2808.75	B		1	35592.6	$bp^4D_{3\frac12}^0-ed9_{2\frac12}$ $ep^2D_{2\frac12}^0-6s^2D_{2\frac12}$
2808.30	E	5*uA*	10	35598.3	$kp^2F_{2\frac12}^0-6s^2G_{3\frac12}$
2807.34	E	5*uA*	25	35610.4	$ap^2G_{3\frac12}^0-6s^2F_{2\frac12}$
2805.31	B		3	35636.2	
2800.74	B		10	35694.4	$bp^4D_{2\frac12}^0-6s^4P_{1\frac12}$
2800.44	E	5*uA*	20	35698.2	$ap^4G_{3\frac12}^0-6s^4F_{3\frac12}$
2792.68	B		1	35797.4	$ap^4F_{1\frac12}^0-6s^4F_{2\frac12}$
2791.62	B		2	35811.0	$bp^4D_{1\frac12}^0-6s^4P_{1\frac12}$
2791.32	B		1	35814.8	$cp^2P_{\frac12}^0-ed4_{\frac12}$
2791.11	B		4	35817.5	
2787.73	E	100*uA*	50	35860.9	$ap^2G_{4\frac12}^0-6s^2F_{3\frac12}$
2781.48	B		5	35941.5	$ep^2D_{2\frac12}^0-6s^2P_{1\frac12}$

TABLE III (*continued*)

Wave-length	Author	I_1	I_2	Wave number	Designation
2781.32	B		1	35943.6	
2776.63	E	150*uA*	50	36004.3	$ap^4G_{5\frac{1}{2}}{}^0-6s^4F_{4\frac{1}{2}}$
2770.00	B		1	36090.5	
2765.83	B		4	36144.9	
2762.95	B		3	36182.5	
2751.55	B		3	36332.4	$bp^4D_{2\frac{1}{2}}{}^0-6s^2D_{1\frac{1}{2}}$
2751.06	E	4*uA*	8	36338.9	$bp^4D_{3\frac{1}{2}}{}^0-6s^2D_{2\frac{1}{2}}$
2750.51	S	1*uA*	4	36346.2	
2745.48	B		1	36412.7	
2732.36	B		3	36587.6	$cp^2D_{1\frac{1}{2}}{}^0-6s^4P_{1\frac{1}{2}}$
2732.07	B		5	36591.5	$cp^2D_{2\frac{1}{2}}{}^0-ed9_{2\frac{1}{2}}$
2731.61	B		7	36597.6	$ap^2D_{2\frac{1}{2}}{}^0-6s^4F_{1\frac{1}{2}}$
2731.36	B		4	36600.9	$ap^2F_{3\frac{1}{2}}{}^0-6s^2F_{2\frac{1}{2}}$
2726.78	E	5*uA*	20	36662.4	$kp^2F_{3\frac{1}{2}}{}^0-6s^2G_{4\frac{1}{2}}$
2709.82	B		5	36891.9	$ep^2P_{\frac{1}{2}}{}^0-fd\ 14$
2707.29	S	1*u*		36926.4	
2703.21	E	5*uA*	4	36982.0	$ap^4F_{1\frac{1}{2}}{}^0-6s^4F_{1\frac{1}{2}}$
2696.18	E	5*u*	6*d*	37078.5	{ $ap^4G_{2\frac{1}{2}}{}^0-6s^2F_{3\frac{1}{2}}$ { $ap^4G_{2\frac{1}{2}}{}^0-6s^4F_{2\frac{1}{2}}$
2693.72	E	10*uA*	35	37112.4	$kp^2H_{5\frac{1}{2}}{}^0-6s^2G_{4\frac{1}{2}}$
2680.67	S	1*u*	3	37293.0	$bp^4D_{2\frac{1}{2}}{}^0-6s^2P_{1\frac{1}{2}}$
2678.95	E	5*uA*	12	37317.0	$ap^4G_{4\frac{1}{2}}{}^0-6s^4F_{4\frac{1}{2}}$
2677.48	B		5	37337.4	$cp^2D_{2\frac{1}{2}}{}^0-6s^2D_{2\frac{1}{2}}$
2676.86	E	5*uA*	10	37346.1	$ap^4D_{2\frac{1}{2}}{}^0-6s^4F_{3\frac{1}{2}}$
2660.19	E	1*u*	5	37580.1	$ap^4F_{1\frac{1}{2}}{}^0-6s^2F_{2\frac{1}{2}}$
2653.57	B		2	37673.9	
2651.09	E	5*uA*	5	37709.1	$ap^4F_{2\frac{1}{2}}{}^0-ed^4D_{2\frac{1}{2}}$
2650.38	B		5	37719.3	$cp^2P_{\frac{1}{2}}{}^0-ed8_{1\frac{1}{2}}$
2644.07	B		3	37809.2	$kp^2F_{2\frac{1}{2}}{}^0-fd14$
2641.67	B		8	37843.6	
2636.37	B		1	37919.6	{ $ap^2G_{4\frac{1}{2}}{}^0-ed^4D_{3\frac{1}{2}}$ { $ap^2F_{3\frac{1}{2}}{}^0-ed^4G_{4\frac{1}{2}}$
2636.17	B		1	37922.5	
2633.41	B		1	37962.3	{ $cp^2P_{1\frac{1}{2}}{}^0-6s^4P_{\frac{1}{2}}$ { $ap^2F_{3\frac{1}{2}}{}^0-ed^4F_{3\frac{1}{2}}$
2632.33	E	2*u*	2	37977.8	$ap^4F_{2\frac{1}{2}}{}^0-ed^4F_{3\frac{1}{2}}$
2630.78	B		3	38000.9	$bp^4S_{1\frac{1}{2}}{}^0-fd13_{2\frac{1}{2}}$
2630.16	E	20*uA*	25	38009.2	$ap^4G_{4\frac{1}{2}}{}^0-6s^4F_{2\frac{1}{2}}$
2628.85	E	5*uA*	5	38028.1	$ap^4D_{1\frac{1}{2}}{}^0-6s^4F_{2\frac{1}{2}}$
2625.08	M	2*uA*	30	38082.7	$ap^2F_{2\frac{1}{2}}{}^0-ed^4G_{3\frac{1}{2}}$
2624.63	E	2*uA*	3	38089.3	$ap^2D_{2\frac{1}{2}}{}^0-ed^4D_{2\frac{1}{2}}$
2620.38	E	2*uA*	4	38151.0	$ap^4D_{\frac{1}{2}}{}^0-6s^4F_{\frac{1}{2}}$
2618.86	M	4*uA*	12	38173.2	$bp^4P_{2\frac{1}{2}}{}^0-ed3_{2\frac{1}{2}}$
2618.01	S	2*uA*	4	38185.6	{ $bp^4P_{1\frac{1}{2}}{}^0-ed3_{2\frac{1}{2}}$ { $cp^2D_{1\frac{1}{2}}{}^0-6s^2P_{1\frac{1}{2}}$
2615.12	S	1*u*	25	38227.8	
2612.89	B		4	38260.4	$ap^4G_{2\frac{1}{2}}{}^0-6s^4F_{1\frac{1}{2}}$
2606.20	E	2*uA*	6	38358.6	$ap^2D_{2\frac{1}{2}}{}^0-ed^4F_{3\frac{1}{2}}$
2600.79	B		1	38438.3	$cp^2P_{1\frac{1}{2}}{}^0-6s^2D_{2\frac{1}{2}}$
2597.52	B		1	38486.7	$ap^2F_{2\frac{1}{2}}{}^0-ed^2F_{3\frac{1}{2}}$
2594.41	B		1	38532.9	$cp^2P_{\frac{1}{2}}{}^0-6s^4P_{1\frac{1}{2}}$
2594.17	E	10*uA*	10*d*	38536.4	{ $ap^4G_{3\frac{1}{2}}{}^0-6s^2F_{3\frac{1}{2}}$ { $ap^4G_{3\frac{1}{2}}{}^0-6s^4F_{2\frac{1}{2}}$
2592.09	M	1*u*	2	38567.4	$cp^2F_{2\frac{1}{2}}{}^0-ed8_{1\frac{1}{2}}$
2588.58	B		1	38619.6	$bp^4D_{\frac{1}{2}}{}^0-ed4_{\frac{1}{2}}$
2587.15	E	3*uA*	50	38641.0	$kp^2G_{4\frac{1}{2}}{}^0-gd^2F_{3\frac{1}{2}}$
2586.52	B		2	38650.4	$bp^4S_{1\frac{1}{2}}{}^0-fd14$
2583.02	B		6	38702.8	$kp^2G_{3\frac{1}{2}}{}^0-gd^2D_{2\frac{1}{2}}$
2582.20	B		1	38715.1	
2580.23	B		1	38744.6	
2572.65	E	1*uA*	2	38858.8	$ap^4G_{2\frac{1}{2}}{}^0-6s^2F_{2\frac{1}{2}}$
2568.85	B		1	38916.2	$kp^2H_{4\frac{1}{2}}{}^0-6s^2G_{4\frac{1}{2}}$

TABLE III (*continued*)

Wave-length	Author	I_1	I_2	Wave number	Designation
2568.02	E	4*u*	10	38928.8	$kp^2H^0_{4\frac{1}{2}}-6s^2G_{3\frac{1}{2}}$
2567.20	B		3	38941.3	$cp^2F^0_{3\frac{1}{2}}-ed8_{2\frac{1}{2}}$
2565.92	B		1	38960.7	$ap^4F^0_{3\frac{1}{2}}-ed^4D_{3\frac{1}{2}}$
2565.72	B		1	38963.7	
2564.51	E	3*uA*	40	38982.1	$kp^2G^0_{3\frac{1}{2}}-gd^2F_{2\frac{1}{2}}$
2563.33	S	2*uA*	2	39000.0	
2561.67	B		4	39025.3	
2561.43	B		2	39029.0	
2553.74	E	1	20	39146.4	
2552.26	B		2	39169.2	$cp^2P_{\frac{1}{2}}-6s^2D_{1\frac{1}{2}}$
2551.54	B		4	39180.3	
2543.35	B		3	39306.4	$cp^2P^0_{\frac{1}{2}}-6s^4P_{\frac{1}{2}}$
2541.99	E	10*uA*	30	39327.4	$kp^2G^0_{4\frac{1}{2}}-gd^2G_{4\frac{1}{2}}$
2539.30	E	50*uA*	10	39369.1	$ap^4D^0_{3\frac{1}{2}}-6s^4F_{4\frac{1}{2}}$
2535.94	E	1	10	39421.3	
2534.11	E	5*uA*	35	39449.7	
2533.94	B		10	39452.4	
2532.21	E	1*u*	15	39479.3	
2526.76	B		4	39564.5	
2525.19	E	4*u*	10	39589.1	
2521.30	E	2*u*	5	39650.2	$bp^4D^0_{3\frac{1}{2}}-6s^2G_{4\frac{1}{2}}$
2520.59	E	1	1	39661.3	$bp^4D^0_{3\frac{1}{2}}-6s^2G_{3\frac{1}{2}}$
2518.13	E	7*uA*	40	39700.0	$kp^2G^0_{3\frac{1}{2}}-gd^2G_{3\frac{1}{2}}$
2515.33	E	5*uA*	20	39744.2	$bp^4P^0_{2\frac{1}{2}}-6s^4P_{2\frac{1}{2}}$
2513.11	B		1	39779.4	$ep^2P^0_{1\frac{1}{2}}-fd14$
2511.22	B		2	39809.3	$ap^4D^0_{1\frac{1}{2}}-6s^2F_{2\frac{1}{2}}$
2508.92	E	10*uA*	8	39845.7	$ap^4F^0_{3\frac{1}{2}}-ed^4F_{3\frac{1}{2}}$
2508.06	E	3*uA*	15	39859.5	$ep^2S^0_{\frac{1}{2}}-fd14$
2500.11	S	1*u*	12	39986.2	
2499.11	E	5*uA*	6	40002.1	$ap^4F^0_{3\frac{1}{2}}-ed^4G_{4\frac{1}{2}}$
2498.22	E	5*uA*	15	40016.4	$cp^2F^0_{2\frac{1}{2}}-6s^2D_{1\frac{1}{2}}$
2491.02	B		1	40132.1	$cp^2P^0_{\frac{1}{2}}-6s^2P_{1\frac{1}{2}}$
2488.62	B		1	40170.8	
2487.78	B		8	40184.4	$ap^4D^0_{2\frac{1}{2}}-6s^4F_{2\frac{1}{2}}$
2484.01	E	1	2	40245.3	
2482.60	E	1	1	40268.2	$bp^4D^0_{2\frac{1}{2}}-6s^2G_{3\frac{1}{2}}$
2481.75	E	2*u*	12	40281.9	
2479.03	E	20*uA*	12	40326.2	$ap^4F^0_{4\frac{1}{2}}-ed^4D_{3\frac{1}{2}}$
2478.84	B		4	40329.2	{ $ap^2G^0_{3\frac{1}{2}}-ed2_{2\frac{1}{2}}$ { $ap^2D^0_{1\frac{1}{2}}-ed4_{\frac{1}{2}}$
2478.57	B		2	40333.6	
2477.46	E	2*uA*	6	40351.7	$ap^2D^0_{1\frac{1}{2}}-ed^4F_{1\frac{1}{2}}$?
2476.57	B		20	40366.2	
2476.11	B		1	40373.8	
2475.89	B		2	40377.3	
2473.52	B		5	40416.0	
2472.96	B		1	40425.2	
2471.45	B		1	40449.8	
2469.77	B		6	40477.3	$ep^2D^0_{2\frac{1}{2}}-fd13_{2\frac{1}{2}}$
2469.06	B		2	40489.0	
2468.68	B		1	40495.2	$ap^4G^0_{3\frac{1}{2}}-ed^4D_{3\frac{1}{2}}$
2467.92	E	1	2	40507.7	$ap^2F^0_{3\frac{1}{2}}-ed^4G_{3\frac{1}{2}}$
2465.42	B		2	40548.8	
2463.97	E	1*uA*	4	40572.6	
2462.60	B		1	40595.2	
2461.89	B		4	40606.9	
2459.72	E	3*u*	7	40642.8	
2457.02	B		3	40687.4	
2456.31	B		2	40699.2	
2453.49	E	2*u*	6	40745.9	$ap^4F^0_{4\frac{1}{2}}-ed^4H_{5\frac{1}{2}}$
2452.76	B		4	40758.1	$ap^2F^0_{2\frac{1}{2}}-6s^4P_{2\frac{1}{2}}$
2452.39	E	3*u*	20	40764.2	

TABLE III (*continued*)

Wave-length	Author	I_1	I_2	Wave number	Designation
2451.04	B		8	40786.2	
2450.95	E	10*uA*	8	40788.2	
2449.92	S	2*u*	4	40805.3	
2444.20	E	20*uA*	12	40900.7	$ap^2F_{3\frac{1}{2}}^0-ed^4F_{2\frac{1}{2}}$
2443.88	B		1	40906.0	
2443.45	E	5*uA*	5	40913.3	$ap^2F_{3\frac{1}{2}}^0-ed^2F_{3\frac{1}{2}}$
2442.01	B		2	40937.4	
2441.81	B		1	40940.8	
2440.01	B		6	40969.9	
2437.81	E	10*uA*	10	41007.9	$ap^4F_{4\frac{1}{2}}^0-ed^4F_{4\frac{1}{2}}$
2436.39	E	20*uA*	25	41031.8	$ap^4F_{4\frac{1}{2}}^0-ed^4G_{5\frac{1}{2}}$
2432.72	B		1	41093.8	$bp^4D_{3\frac{1}{2}}^0-fd12_{2\frac{1}{2}}$
2431.46	B		25	41115.0	$ap^4F_{2\frac{1}{2}}^0-ed^4F_{2\frac{1}{2}}$
2426.71	B		3	41195.6	
2426.08	E	8*uA*	30	41206.2	
2425.74	B		6	41212.0	$ap^4F_{4\frac{1}{2}}^0-ed^4F_{3\frac{1}{2}}$
2425.02	B		3	41224.2	$bp^4D_{3\frac{1}{2}}^0-fd13_{2\frac{1}{2}}$
2422.62	E	4*uA*	12	41265.0	$kp^2F_{2\frac{1}{2}}^0-gd^2D_{2\frac{1}{2}}$
2422.37	B		8	41269.3	$ap^2D_{3\frac{1}{2}}^0-1_{3\frac{1}{2}}$
2421.95	E	2*uA*	4	41276.4	$ap^4G_{3\frac{1}{2}}^0-ed^4F_{4\frac{1}{2}}$
2420.22	B		1	41306.0	$bp^4D_{2\frac{1}{2}}^0-fd10_{1\frac{1}{2}}$
2419.41	E	2*uA*	4	41319.9	$ap^2F_{2\frac{1}{2}}^0-ed2_{2\frac{1}{2}}$
2418.56	B		3	41334.4	
2418.33	B		3	41337.2	$bp^4P_{\frac{1}{2}}^0-6s^4P_{1\frac{1}{2}}$
2417.09	B		3	41359.5	
2416.57	E	6*uA*	20	41368.3	{ $ap^4D_{2\frac{1}{2}}^0-6s^4F_{1\frac{1}{2}}$ { $ap^4F_{4\frac{1}{2}}^0-ed^4G_{4\frac{1}{2}}$
2416.32	B		2	41372.7	
2415.21	E	1*uA*	22	41391.6	
2414.95	B		2	41396.1	$ap^2F_{2\frac{1}{2}}^0-ed7_{2\frac{1}{2}}$
2413.91	B		8	41414.0	$ap^2D_{1\frac{1}{2}}^0-6s^4P_{2\frac{1}{2}}$
2413.20	B		1	41426.1	
2411.67	E	5*uA*	15	41452.5	$ap^2G_{3\frac{1}{2}}^0-ed6_{3\frac{1}{2}}$
2410.55	B		15	41471 6	
2408.47	B		1	41507.5	$ap^2D_{2\frac{1}{2}}^0-ed^2F_{3\frac{1}{2}}$
2406.34	B		60	41544.2	$kp^2F_{2\frac{1}{2}}^0-gd^2F_{2\frac{1}{2}}$
2405.99	E	1	2	41550.3	$ap^2G_{4\frac{1}{2}}^0-ed^4G_{3\frac{1}{2}}$
2401.38	E	30*uA*	40	41630.1	
2401.13	B		12	41634.4	
2400.97	E	5*uA*	12	41637.1	$ap^2G_{3\frac{1}{2}}^0-ed^2G_{4\frac{1}{2}}$
2400.31	E	1	2	41648.5	
2399.38	B		4	41664.6	
2398.72	B		25	41676.2	
2397.49	B		1	41697.6	$cp^2D_{2\frac{1}{2}}^0-fd10_{1\frac{1}{2}}$
2398.38	B		1	41699.4	$bp^4D_{2\frac{1}{2}}^0-fd12_{2\frac{1}{2}}$
2396.40	B		4	41716.5	$ap^2G_{4\frac{1}{2}}^0-1_{3\frac{1}{2}}$
2396.11	B		7	41721.6	
2394.55	B		8	41748.8	
2391.35	E	1	8	41804.6	
2391.06	B		3	41809.6	$cp^2D_{2\frac{1}{2}}^0-fd11_{1\frac{1}{2}}$
2390.71	E	2*uA*	15	41815.8	$bp^4D_{1\frac{1}{2}}^0-fd12_{2\frac{1}{2}}$
2389.89	E	1	2	41830.5	$bp^4D_{2\frac{1}{2}}^0-fd13_{2\frac{1}{2}}$
2387.55	B		5	41871.1	
2386.25	B		20	41894.0	$bp^4P_{1\frac{1}{2}}^0-ed8_{2\frac{1}{2}}$
2385.01	E	3*uA*	8	41915.6	$ap^2D_{2\frac{1}{2}}^0-ed2_{2\frac{1}{2}}$
2383.43	E	4*uA*	15	41943.6	$ap^4F_{3\frac{1}{2}}^0-ed^4F_{2\frac{1}{2}}$
2383.25	B		2	41946.6	$bp^4D_{1\frac{1}{2}}^0-fd13_{2\frac{1}{2}}$
2382.70	B		7	41956.4	$ap^2G_{4\frac{1}{2}}^0-ed^2F_{3\frac{1}{2}}$
2382.46	E	30*uA*	35	41960.5	
2382.26	B		2	41964.1	
2382.10	B		1	41966.9	$ap^4D_{2\frac{1}{2}}^0-6s^2F_{2\frac{1}{2}}$
2381.78	B		2	41972.6	$bp^4P_{\frac{1}{2}}^0-6s^2D_{1\frac{1}{2}}$

TABLE III (*continued*)

Wave-length	Author	I_1	I_2	Wave number	Designation
2379.51	B		15	42012.6	$ap^4G_{5\frac12}{}^0-ed^4H_{5\frac12}$
2379.31	B		10	42016.2	
2378.55	E	2*uA*	30	42029.5	
2376.77	B		2	42061.1	$bp^4D_{\frac12}{}^0-fd11_{1\frac12}$
2374.97	B		3	42092.9	$cp^2D_{2\frac12}{}^0-fd12_{2\frac12}$
2374.23	B		4	42106.1	$bp^4S_{1\frac12}{}^0-gd^2D_{2\frac12}$
2373.97	E	1	8*d*	42110.6	$bp^4P_{\frac12}{}^0-6s^4P_{\frac12}$
2372.96	E	2	4	42128.6	
2369.07	B		4	42197.8	$cp^2D_{1\frac12}{}^0-fd10_{1\frac12}$
2368.54	B		4	42207.2	$ap^2D_{1\frac12}{}^0-ed3_{2\frac12}$
2367.59	B		4	42224.0	$ap^2F_{3\frac12}{}^0-ed5_{3\frac12}$
2365.46	E	0*uA*	20	42262.2	$kp^2H_{4\frac12}{}^0-gd^2G_{3\frac12}$
2364.75	E	3*uA*	7	42274.9	$ap^4G_{5\frac12}{}^0-ed^4F_{4\frac12}$
2364.61	B		7	42277.3	
2364.07	B		7	42287.0	
2363.91	B		6	42289.9	
2363.41	E	5*uA*	18	42298.8	$ap^4G_{5\frac12}{}^0-ed^4G_{5\frac12}$
2362.95	B		8	42307.0	
2362.83	B		1	42309.2	$cp^2D_{1\frac12}{}^0-fd11_{1\frac12}$
2361.23	E	1*uA*	15	42337.9	$ap^4F_{2\frac12}{}^0-ed^4F_{1\frac12}$
2360.97	B		30	42342.5	$kp^2F_{3\frac12}{}^0-gd^2D_{2\frac12}$
2360.76	B		1	42346.2	
2359.14	E	4*uA*	75	42375.3	$ap^4G_{5\frac12}{}^0-5d^4H_{6\frac12}$
2358.95	B		3	42378.8	
2357.43	B		3	42406.1	
2355.57	E	3*uA*	20	42439.5	$ap^4F_{2\frac12}{}^0-ed5_{3\frac12}$
2355.34	B		3	42443.7	$ap^2F_{3\frac12}{}^0-ed6_{3\frac12}$
2350.72	E	1*uA*	10	42527 1	
2349.38	B		2	42551.3	
2349.02	E	2*uA*	8	42557.9	
2347.76	B		25	42580.6	$kp^2F_{3\frac12}{}^0-gd^2F_{3\frac12}$
2347.38	B		1	42587.5	
2347.17	E	8*uA*	10	42591.4	$ap^4F_{3\frac12}{}^0-ed^4G_{3\frac12}$
2345.52	B		8	42621.4	$kp^2F_{3\frac12}{}^0-gd^2F_{2\frac12}$
2344.77	B		1	42635.0	$ap^4G_{5\frac12}{}^0-ed^4G_{4\frac12}$
2342.50	B		1	42676.3	
2341.93	E	1	6	42686.8	
2340.26	B		3	42717.2	$ap^2D_{2\frac12}{}^0-ed^4F_{1\frac12}$
2339.95	E	1	15	42722.9	$cp^2D_{1\frac12}{}^0-fd13_{2\frac12}$
2339.65	B		1	42728.3	
2338.10	E	1*u*	2	42756.7	$ap^4F_{3\frac12}{}^0-1_{3\frac12}$
2335.57	B		5	42802.9	
2335.43	B		3	42805.5	
2334.04	E	1*uA*	2	42831.0	$ap^2G_{3\frac12}{}^0-ed7_{2\frac12}$
2333.32	B		3	42844.2	
2332.81	B		2	42853.6	
2332.47	E	4*uA*	8	42859.8	$ap^4D_{2\frac12}{}^0-ed^4D_{2\frac12}$
2331.94	B		1	42869.5	
2329.96	E	3*uA*	5	42906.0	$ap^4G_{4\frac12}{}^0-ed^4D_{3\frac12}$
2329.76	B		1	42909.7	$cp^2P_{1\frac12}{}^0-fd11_{1\frac12}$
2328.56	E	3*uA*	4	42931.8	$ap^4G_{2\frac12}{}^0-1_{3\frac12}$
2327.35	M	3*uA*	8	42954.1	
2326.11	E	1	7	42977.0	$bp^4P_{2\frac12}{}^0-6s^2P_{1\frac12}$
2325.12	E	3*uA*	3*d*	42995.3	$cp^2F_{3\frac12}{}^0-6s^2G_{4\frac12}$
2324.07	E	3*uA*	8	43014.7	
2323.34	E	2*uA*	12	43028.2	$ap^2F_{2\frac12}{}^0-6s^2D_{1\frac12}$
2322.79	B		3	43038.4	$ap^2D_{2\frac12}{}^0-ed6_{3\frac12}$
2320.56	B		5*d*	43079.7	$ap^4F_{1\frac12}{}^0-ed4_{\frac12}$
2319.40	E	4*uA*	10	43101.4	$ap^4F_{1\frac12}{}^0-ed^4F_{1\frac12}$
2318.12	B		1	43125.1	$bp^4D_{\frac12}{}^0-fd14$
2317.96	E	2*uA*	5	43128.1	$ap^4D_{2\frac12}{}^0-ed^4F_{3\frac12}$
2317.23	B		1	43141.7	

TABLE III (*continued*)

Wave-length	Author	I_1	I_2	Wave number	Designation
2315.65	B		5	43171.2	$ap^4G_{2\frac{1}{2}}^0-ed^2F_{3\frac{1}{2}}$
2314.73	B		1	43188.2	
2314.47	E	1	4	43193.2	$cp^2P_{1\frac{1}{2}}^0-fd12_{2\frac{1}{2}}$
2313.80	B		4	43205.7	
2312.29	B		6	43233.9	$ep^2P_{1\frac{1}{2}}^0-gd^2D_{2\frac{1}{2}}$
2310.57	B		10	43266.0	{ $ap^2G_{4\frac{1}{2}}^0-ed5_{3\frac{1}{2}}$ { $kp^2F_{3\frac{1}{2}}^0-gd^2G_{4\frac{1}{2}}$
2307.40	E	20*uA*	25	43325.4	$ap^4G_{4\frac{1}{2}}^0-ed^4H_{5\frac{1}{2}}$
2306.99	B		2	43333.2	
2306.71	B		2	43338.4	
2305.70	E	1	10	43357.3	
2304.89	S	1*u*	3	43372.7	$cp^2D_{1\frac{1}{2}}^0-fd14$
2304.35	B		7	43382.8	
2303.47	B		1	43399.3	$ap^4F_{2\frac{1}{2}}^0-6s^4P_{2\frac{1}{2}}$
2303.28	B		1	43402.9	$ap^4F_{3\frac{1}{2}}^0-ed2_{2\frac{1}{2}}$
2302.14	B		3	43424.4	
2295.71	B		4	43546.1	
2295.51	E	3*uA*	12	43549.9	$ap^2D_{1\frac{1}{2}}^0-ed8_{2\frac{1}{2}}$
2294.02	B		4	43578.1	$ap^4G_{2\frac{1}{2}}^0-ed2_{2\frac{1}{2}}$
2293.52	E	5*uA*	10	43587.7	$ap^4G_{4\frac{1}{2}}^0-ed^4F_{4\frac{1}{2}}$
2292.97	B		2	43598.1	
2290.72	B		1	43640.8	$ap^2F_{2\frac{1}{2}}^0-6s^2D_{2\frac{1}{2}}$
2287.55	B		10	43701.3	
2286.78	B		8	43716.1	$kp^2H_{5\frac{1}{2}}^0-gd^2G_{4\frac{1}{2}}$
2283.40	E	3*uA*	3	43780.9	
2283.09	B		3	43786.8	
2282.87	E	3*u*	5	43790.9	$ap^4G_{4\frac{1}{2}}^0-ed^4F_{3\frac{1}{2}}$
2282.40	E	2	12	43800.9	$ap^2D_{2\frac{1}{2}}^0-6s^4P_{2\frac{1}{2}}$
2281.37	E		4*d*	43819.7	{ $ap^2D_{1\frac{1}{2}}^0-6s^4P_{\frac{1}{2}}$ { $ap^2F_{3\frac{1}{2}}^0-ed7_{2\frac{1}{2}}$
2280.43	B		25	43837.8	
2277.33	E	4*ua*	3	43897.4	
2275.92	E	5*ua*	10	43924.7	
2274.70	E	2*ua*	3	43948.3	$ap^4G_{4\frac{1}{2}}^0-ed^4G_{4\frac{1}{2}}$
2272.13	B		1	43998.0	
2270.11	E	6*uA*	40	44037.1	$ap^4F_{2\frac{1}{2}}^0-ed7_{2\frac{1}{2}}$
2269.11	B		1	44046.5	
2268.42	B		1	44069.9	
2266.43	B		2	44108.6	$ap^4D_{1\frac{1}{2}}^0-ed^4F_{2\frac{1}{2}}$
2265.69	B		4	44123.0	$ap^4F_{4\frac{1}{2}}^0-1_{3\frac{1}{2}}$
2264.68	B		3	44142.6	$cp^2P_{\frac{1}{2}}^0-fd10_{1\frac{1}{2}}$
2263.63	B		2	44163.2	$ap^4F_{1\frac{1}{2}}^0-6s^4P_{2\frac{1}{2}}$
2262.30	B		15	44189.0	
2261.72	E	2*uA*	20	44200.4	
2261.29	B		20	44208.8	
2260.45	E	6*uA*	18	44225.2	$ap^4G_{3\frac{1}{2}}^0-ed^4G_{3\frac{1}{2}}$
2259.32	S	1*u*	5	44247.2	$ap^4D_{\frac{1}{2}}^0-ed4_{\frac{1}{2}}$
2259.03	S	1*u*	3	44253.1	$cp^2P_{\frac{1}{2}}^0-fd11_{1\frac{1}{2}}$
2257.06	B		1	44291.7	$ep^2D_{1\frac{1}{2}}^0-gd^2F_{2\frac{1}{2}}$
2254.30	B		20	44345.8	
2253.74	B		2	44357.0	
2252.98	B		1	44371.8	
2252.60	S	2*u*	5	44379.3	$ap^4G_{2\frac{1}{2}}^0-ed^4F_{1\frac{1}{2}}$
2247.40	S	3	3	44482.0	$ap^4G_{2\frac{1}{2}}^0-ed5_{3\frac{1}{2}}$
2245.11	S	1*u*	3	44527.3	$ap^4D_{1\frac{1}{2}}^0-ed2_{2\frac{1}{2}}$
2243.47	B		4	44559.8	
2243.29	B		1	44563.5	
2243.17	S	0*u*	2	44565.8	
2242.54	B		7	44578.3	
2242.34	B		1	44582.3	$ep^2D_{2\frac{1}{2}}^0-gd^2D_{2\frac{1}{2}}$
2241.51	B		4	44598.9	$ap^2D_{2\frac{1}{2}}^0-ed8_{1\frac{1}{2}}$
2240.57	S	1*u*	2	44617.7	$ap^4G_{3\frac{1}{2}}^0-ed^4F_{2\frac{1}{2}}$

TABLE III (*continued*)

Wave-length	Author	I_1	I_2	Wave number	Designation
2237.42	B		1	44680.5	$ap^4D_{3\frac{1}{2}}^0-6s^2F_{2\frac{1}{2}}$
2235.05	B		3	44727.7	
2234.25	B		15	44743.8	
2232.63	B		4	44776.2	
2231.36	B		10	44801.8	$ap^4F_{1\frac{1}{2}}^0-ed7_{2\frac{1}{2}}$
2230.75	B		2	44814.0	
2230.43	B		4	44820.5	$ap^4D_{1\frac{1}{2}}^0-ed^23_{2\frac{1}{2}}$ $ep^2D_{2\frac{1}{2}}^0-gd^2F_{3\frac{1}{2}}$
2229.76	B		4	44833.9	$kp^2H_{4\frac{1}{2}}^0-gd^2F_{3\frac{1}{2}}$
2229.55	B		1	44838.1	
2228.68	B		1	44855.5	
2228.40	B		5	44861.2	$ep^2D_{2\frac{1}{2}}^0-gd^2F_{2\frac{1}{2}}$
2224.91	B		1	44931.5	
2224.14	B		2	44947.1	
2223.63	S	25*ua*	25	44957.5	$ap^4D_{3\frac{1}{2}}^0-ed^4D_{3\frac{1}{2}}$
2223.57	B		2	44958.6	
2222.20	S	25*ua*	25	44986.3	
2220.40	B		1	45022.9	
2220.20	S	0	5	45026.9	
2216.49	B		4	45102.2	$cp^2F_{2\frac{1}{2}}^0-fd11_{1\frac{1}{2}}$
2212.50	B		1	45183.7	
2210.57	S	0*u*	2	45223.1	
2206.32	B		4	45310.1	
2205.95	B		1	45317.8	$cp^2P_{\frac{1}{2}}^0-fd14$
2205.41	S	0*u*	25	45328.9	$bp^4D_{3\frac{1}{2}}^0-gd^2D_{2\frac{1}{2}}$
2204.80	B		2	45341.4	
2204.55	S	0*u*	4	45346.5	
2201.97	B		1	45399.6	
2200.09	B		2	45438.4	
2196.16	S	1*u*	20	45519.7	$kp^2H_{4\frac{1}{2}}^0-gd^2G_{4\frac{1}{2}}$
2193.88	S	0*u*	15	45567.0	$bp^4D_{3\frac{1}{2}}^0-gd^2F_{3\frac{1}{2}}$
2193.47	S	3*u*	4	45575.5	
2192.69	B		7	45591.8	$kp^2F_{2\frac{1}{2}}^0-gd^2G_{3\frac{1}{2}}$
2192.11	B		1	45603.8	
2191.92	B		3	45607.8	$bp^4D_{3\frac{1}{2}}^0-gd^2F_{2\frac{1}{2}}$
2190.55	B		4	45636.3	
2190.45	S	10*ua*	7	45638.7	$ap^4D_{3\frac{1}{2}}^0-ed^4F_{4\frac{1}{2}}$
2184.34	S	0*u*	2	45766.1	
2181.54	B		1	45824.7	
2180.72	S	0*u*	2*d*	45841.9	$ap^4D_{3\frac{1}{2}}^0-ed^4F_{3\frac{1}{2}}$
2178.30	B		5	45892.9	$ap^4F_{4\frac{1}{2}}^0-ed6_{3\frac{1}{2}}$
2172.92	B		3	46006.7	
2171.38	S	3*u*	1	46039.2	$ap^4D_{2\frac{1}{2}}^0-1_{3\frac{1}{2}}$
2166.36	B		3	46145.9	
2166.04	B		1	46152.6	$ap^4D_{\frac{1}{2}}^0-ed8_{1\frac{1}{2}}$
2164.41	B		3*d*	46187.4	
2163.18	B		2	46213.7	$bp^4D_{2\frac{1}{2}}^0-gd^2F_{2\frac{1}{2}}$
2161.35	B		3	46252.9	$bp^4D_{3\frac{1}{2}}^0-gd^2G_{4\frac{1}{2}}$
2158.74	S	0*u*	2*d*	46308.6	
2157.85	B		1	46327.6	$cp^2D_{2\frac{1}{2}}^0-gd^2D_{2\frac{1}{2}}$
2155.91	B		2	46369.5	
2141.28	S	1*u*	1	46686.2	
2140.69	B		3	46699.1	
2124.33	S	1*u*	2	47058.8	$bp^4P_{\frac{1}{2}}^0-fd11_{1\frac{1}{2}}$

E—Exner & Naschek
M—Meggers
S—Shenstone
B—Author
u—Diffuse
A—strong in arc
a—weak in arc.
Wave numbers measured, wave-lengths calculated.

I_1—Meggers' intensities except for Shenstone's lines.
I_2—Author's estimates from Schüler tube.
Author—Original observer.

work unnecessary. The standards used were the corrected Pd II sharp lines from Shenstone's classification. In general no greater variation than 0.5 cm^{-1} was necessary in satisfying the combination principle with new terms. All the normally diffuse lines were included, even when they had been previously given by Shenstone, since the accuracy of measurement is here much greater, since some of the classifications have been altered and since the usual displacement of the diffuse lines by 2–3 cm^{-1} prevents a consistent scheme. The complete line list of Pd II is obtainable by adding that here given to that of Shenstone's sharp lines.

TABLE IV. *Origin of high terms of Pd II.*

Pd III Config.	Pd III Term	Added Electron	Terms Theoretical	Terms Empirical
$4d^8$	^3F	$6s$	$^{4,2}F$	$6s^{4,2}F$
		$5d$	$^{4,2}P, D, F, G, H$	$ed^4 D, F, G, H$ parts of
	^3P	$6s$	$^{4,2}P$	$6s^{4,2}P$ parts doubtful.
		$5d$		None identified.
	^1S	$6s$		None identified.
		$5d$		None identified.
	^1D	$6s$	^2D	$6s\,^2D$
		$5d$	$^2S, P, D, F, G$	fd Not nameable.
	^1G	$6s$	^2G	$6s\,^2G$
		$5d$	$^2D, F, G, H, I$	$gd\,^2D, F, G.$

In Table IV are given the electron configurations of the high terms, the predicted terms and those thought to have been found. The lettering corresponds to that in the list of high terms given in Table V. Where a term could not be reasonably placed in a group it was left unlettered.

The $6s$ **group.** It was found possible to complete the $6s$ group satisfactorily, except for the $^2P_{\frac{1}{2}}$ term, and possibly the $^4P_{1\frac{1}{2}}$ term, the former being particularly doubtful, as it requires the crossing over of the components of the doublet.

The convergence of the terms is odd in part. The $^4F_{4\frac{1}{2}}\,^4F_{3\frac{1}{2}}$ separation has decreased from 2013.3 to 692.2 in going from the $5s$ to the $6s$ group, and these terms appear to be approaching the same limit as would be expected with the inverted type of convergence pointed out by Shenstone,[3,4] i.e., where equal J values do not cross. The $^4F_{2\frac{1}{2}}$ and $^2F_{3\frac{1}{2}}$ however, which are also expected to have the same limit have already crossed over each other, although just by one cm^{-1}. It would be interesting to find what would happen in the next series member as well as to investigate the "strong field" Zeeman pattern of the present one. The lines are too diffuse to do this with a source in air, but it might be accomplished at low pressure. The $^4F_{1\frac{1}{2}}$ and $^2F_{2\frac{1}{2}}$ have converged considerably, again as expected. The doubtful validity of two of the P terms renders a discussion of their convergence profitless. The ^2D has converted from -1227.2 to -612.9 while the ^2G which in the first member had an interval of only 108.2 has closed to 12.5. The indication is that each doublet is going to its own limit.

[3] Shenstone, Nature **122,** 727 (1928).

[4] Hund, Zeits. f. Physik **52,** 601 (1928).

Table V. *High terms of Pd II.*

No.	Term	Designation				
*61	79535.0	$6s^4F_{4\frac{1}{2}}$	*			
*62	80227.2	$6s^4F_{3\frac{1}{2}}$	*			
*63	83065.0	$6s^2F_{3\frac{1}{2}}$	.	*		
*64	83066.0	$6s^4F_{2\frac{1}{2}}$	*	.		
*65	84249.0	$6s^4F_{1\frac{1}{2}}$	*	.		
*66	84847.5	$6s^2F_{2\frac{1}{2}}$		*		
*67	85123.5	$ed^4D_{3\frac{1}{2}}$	*			
68	85543.5	$ed^4H_{5\frac{1}{2}}$	.	*		
69	85740.9	$ed^4D_{2\frac{1}{2}}$	*			
*70	85805.6	$ed^4F_{4\frac{1}{2}}$			*	
71	85829.3	$ed^4G_{5\frac{1}{2}}$		.		*
72	85905.8	$ed^4H_{6\frac{1}{2}}$		*	.	.
*73	86009.3	$ed^4F_{3\frac{1}{2}}$			*	.
74	86166.0	$ed^4G_{4\frac{1}{2}}$			.	*
75	88754.7	$ed^4G_{3\frac{1}{2}}$			.	*
76	88920.4	$1_{3\frac{1}{2}}$			.	
77	89147.2	$ed^4F_{2\frac{1}{2}}$			*	
78	89160.0	$ed^2F_{3\frac{1}{2}}$?			.	
79	89566.6	$ed\ 2_{2\frac{1}{2}}$			.	
*80	89859.2	$ed\ 3_{2\frac{1}{2}}$			.	
81	90345.9	$ed\ 4_{\frac{1}{2}}$			.	
82	90368.7	$ed^4F_{1\frac{1}{2}}$			*	
83	90470.5	$ed\ 5_{3\frac{1}{2}}$				
84	90690.2	$ed\ 6_{3\frac{1}{2}}$				
85	91430.6	$6s^4P_{2\frac{1}{2}}$	*			
86	92068.7	$ed\ 7_{2\frac{1}{2}}$				
87	92251.1	$ed\ 8_{1\frac{1}{2}}$	.			
88	93063.6	$6s^4P_{1\frac{1}{2}}$	?*			
89	93567.5	$ed\ 9_{2\frac{1}{2}}$	.			
90	93700.7	$6s^2D_{1\frac{1}{2}}$	.	*		
91	93837.4	$6s^4\ P_{\frac{1}{2}}$	*	.		
92	93999.6	$6s^2\ P_{\frac{1}{2}}$??		.	*	
93	94313.6	$6s^2D_{2\frac{1}{2}}$		*	.	
94	94662.6	$6s^2P_{1\frac{1}{2}}$			*	
*95	97625.0	$6s^2G_{4\frac{1}{2}}$	*			
96	97637.5	$6s^2G_{3\frac{1}{2}}$	*			
97	98674.0	$fd10_{1\frac{1}{2}}$				
98	98785.1	$fd11_{1\frac{1}{2}}$				
99	99068.6	$fd12_{2\frac{1}{2}}$				
100	99199.3	$fd13_{2\frac{1}{2}}$				
101	99849.0	$fd14$				
102	103304.2	$gd^2D_{2\frac{1}{2}}$				
103	103542.6	$gd^2F_{3\frac{1}{2}}$	*			
104	103583.5	$gd^2F_{2\frac{1}{2}}$	*			
105	104228.3	$gd^2G_{4\frac{1}{2}}$		*		
106	104301.5	$gd^2G_{3\frac{1}{2}}$		*		

* Previously given by Shenstone, reference 2.

Intervals

$6s^4F$	692.2	2838.8	1183.0
$6s^2F$	1782.5		
ed^4D	617.4	—	—
ed^4H	−362.5	—	—
ed^4F	203.7	3137.9	1221.5
ed^4G	336.7	2588.7	—
$6s^4P$	1633.0	773.8	
$6s^2D$	−612.9		
$6s^2G$	12.5		
gd^2F	40.9		
gd^2G	73.2		

The 5d **group.** The terms built on the $d^8\ {}^3F$ of Pd III should be found in three groups with separations similar to those of the components of the ${}^3F$. This ${}^3F$ of Pd III has not been found, but the $d^8s^2\ {}^3F$ of Pd I which is known should have separations of about the same magnitudes. Its intervals are 3100 and 1500. The terms here designated "*ed*" which are considered to be those built on the ${}^3F$ of Pd III are sharply divided into but two groups. The second group does in fact start at about 3,000 above the first but it shows no definite division within itself. This is to be expected, however, considering the narrowness of the interval.

The lower "*ed*" group which is quite distinct, which shows the proper quantum numbers to be based on the ${}^3F_4$, and in which the naming of the terms was possible from intensities of combination is composed entirely of quartets of high inner quantum numbers. This apparent separation of the quartets and doublets seems to indicate the inverted type of convergence. In Ni I Russell[5] found this situation with the quintets and triplets of the $d^8s \cdot 4p$ configuration, but it was not general throughout the spectrum.

The combinations made by the remainder of the "*ed*" group indicate a coupling in which the L vector is losing its identity. The "*fd*" group which is quite probably based on the ${}^1D$ of the ion from its position, had to be left nameless also for this reason. The "*gd*" group gave much more complete combinations, and these terms could be assigned L values quite definitely. The "*gd*" ${}^2H$ and ${}^2I$ could not be found although the ${}^2H$ at least should make sufficient combinations. It is noteworthy that the "*gd*" group lies at about 19,000 above the beginning of the "*ed*" just as does the $5s^2G$ above the $5s^4F$.

The unassigned lines. The type of coupling makes it difficult to find new terms by the method of differences as the expected differences frequently do not occur. The labor involved in a method of trial of lines is probably not warranted until more idea of the positions of the missing terms can be obtained. The several unassigned strong lines are quite likely due to missing terms of high L and J whose combinations will be very few.

Excitation limit with helium. The extent of excitation of these two spectra and the points of maximum excitation are in agreement with the discussion of these points by R. A. Sawyer.[6] He has found that with metals of high melting point as cathodes where the presence of the atoms of the cathode substances in the discharge is due to sputtering rather than vaporization, that the principal processes of excitation start from the normal state of the atom. Thus the highest levels excited to any great extent will be those which lie at the energy of the helium ion, 24.48 volts, 198, 290 cm^{-1} above the normal state of the metal atom. Further, there should be an intensity maximum at this energy as well as at 19.75 volts, the metastable potential of helium. Neither of the spectra here considered was measured in the region where the excitation maximum due to the metastable potential would occur, but they may be considered as regards the energy of the helium ion.

[5] H. N. Russell, Phys. Rev. **34,** 821 (1929).

[6] Sawyer, Bulletin, Am. Phys. Soc **5,** No. 2, Abstract 22, April (1930).

In the case of silver the lowest term of the ion $d^{10}\ {}^1S_0$ is at $-39{,}163.9$ cm^{-1} from the $4d^95s\ {}^3D_3$ which has been used as the zero level. The ionization potential of Ag I is 59,370 cm^{-1}. Subtracting these energies from that of the helium ion leaves about 99,750 cm^{-1} available for excitation, on the scale used. This is much too low for the $4f$ electron levels which from analogy with other spectra are to be expected to lie about 20,000 cm^{-1} above the $5d$, i.e., at about 110,000.

In the case of palladium the lowest term $4d^9\ {}^2D$ is at $-25{,}081$ cm^{-1}, while the ionization potential of Pd I is about 67,060. About 106,150 cm^{-1} is thus available for excitation, and there should be an intensity maximum of the lines arising from terms in this neighborhood. The "*gd*" doublet terms at 104,000 do in fact give rise to the group of lines which, compared to the ordinary spark, is enhanced most in intensity and which is quite as strong as even the lowest of the high set of terms. Nothing can be said about the limit of excitation as no higher spectrum than the $5d$ was sought, and it is probably just within the available energy.

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