indicates that the interaction assumed is of the right order of magnitude.

Merrill[9] has considered Co I $3d^8(^3F)4s$ as a three-vector problem, assuming Russell-Saunders coupling in the parent ion. His $2A=-456.34$ compares favorably with $a'=-465$ for the interaction integral for the $3d$ electrons. His $-B/2=1210.9$, calculated from the interval a^2F-b^4F, is considerably less than $G_2'=1290$, which is influenced by a^2D and a^2P as well as by a^2F. While the approximations made in the three vector problem have some effect, the difference between the values of these parameters is ascribed mainly to the influence of second order interactions which have not yet been identified.

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[9] Merrill, Phys. Rev. **46**, 487 (1934).

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Zeeman Effect in the Arc Spectrum of Cobalt

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Zeeman patterns for 151 lines in the range λ3200 to λ6500 are measured and g-factors for 100 terms are determined. All the experimental g-factors are compared with their theoretical values for LS coupling and those for the deep even terms are compared with theoretical values for intermediate coupling. The experimental values for the multiplets, b^4P, a^2D, $m^2D°$, $y^4F°$ and $m^2P°$ deviate rather widely from the theoretical values. The Zeeman patterns indicate changes in classifications for λ4549.67 and λ6450.24 and decide the quantum numbers for two incompletely analyzed terms.

Analysis of the cobalt arc spectrum[1, 2] has been extended to include more than twelve hundred lines and many of the terms have been assigned to electron configurations. This analysis makes possible a study of the Zeeman effect in electron coupling intermediate between the LS and (jj) types for even multiplicity. No extensive work has been done on the Zeeman effect in the cobalt arc spectrum. Unresolved Zeeman separations have been measured for a number of lines by several observers,[3, 4] but the data are neither sufficiently accurate nor complete to permit the determination of g-factors.

This article presents an investigation of the Zeeman effect for 151 lines in the range λ3200 to λ6500 from which the g-factors for 100 terms are calculated. The experimental values for the deep, even terms are compared with the theoretical g-factors given by Marvin in the preceding article. Zeeman patterns calculated from the g-factors are compared with the resolved patterns observed by Rybár.[4]

The spectrograph, an Anderson 21-foot concave grating on a Paschen mounting, as well as the magnet, and Gaertner comparator were those used by Marvin and Baragar[5] in their investigation on nickel. The quartz lens and calcite plate were also used to form separate images of the components of vibration parallel and perpendicular to the magnetic field, in order that they might be photographed separately. Strips of carbon and electrolytic cobalt, crossing each other at right angles between the magnetic poles, were used for arc electrodes. The cobalt electrode was fixed in position and insulated from the magnet pole by a fused quartz disk. The carbon electrode was vibrated by means of a cam arrangement to produce an intermittent arc. To prevent excessive heating and melting of the cobalt due to continuous arcing the cam was arranged to keep the electrodes separated during

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[1] M. A. Catalán, Zeits. f. Physik **47**, 89 (1928).

[2] An. soc. espán. fis y quim. **27**, 832 (1929).

[3] N. A. Kent, Astrophys. J. **13**, 289 (1901); I. M. Graftdijk, Arch. neérlandaises, Series 3a, **2**, 192 (1912).

[4] Rybár, Physik. Zeits. **12**, 889 (1911).

[5] H. H. Marvin and A. E. Baragar, Phys. Rev. **43**, 973 (1933).

about one-eighth of each revolution. The current from a 220-volt d.c. source was controlled by a variable series resistance. Since the carbon electrode had to be replaced every few minutes and magnetic debris had to be removed from the arc even more often, the arc was operated in open air. A slight broadening of the lines has no serious detrimental effect on unresolved patterns. The spectrum was photographed several times in the range λ3200 to λ5000. The time of exposure was about six hours. The three best perpendicular component spectrograms and the two best parallel component spectrograms were measured in the second and third orders. Only one measurable spectrogram of each component was made in the range λ5000 to λ6500. The time of exposure for each of these spectrograms was about forty hours. They were measured in the first and second orders.

The field strength, about 25,000 gauss, was calculated for the range λ3200 to λ5000 from the Zeeman patterns of the Ca II lines λ3934 and λ3968 and the Ca I line λ4227. The sodium *D* lines were used for the longer wavelength range. Measurements made on the Zeeman pattern for the cobalt line λ4867.68 in both ranges were consistent.

Several sets of nine measurements each were made on each pattern at intervals of a few weeks or more in order to reduce personal bias to the status of indeterminate error. The total number of measurements made on each line ranged from about 60 on the stronger patterns to about 150 on some of the weaker patterns. Lines having terms with nearly equal g-factors give unresolved Zeeman patterns which are easily measured. In the case of more widely differing g-factors the patterns are nebulous, and the center of intensity is not well defined. In most cases it appears to have a position nearer the strongest component than that given by the formulae of Shenstone and Blair,[6] which were used in calculating the g-factors. In a number of cases where the patterns were extremely broad an attempt was made to measure the magnetic shift of the strongest component in the pattern. The g-factors calculated from these measurements are generally consistent with those calculated from other patterns, but they were given minor weight in fixing average values. In the case of resolved patterns the g-factors were calculated by the method of Landé.

Lines for which Zeeman shifts were present in both parallel and perpendicular component patterns were considered first, since from these measurements the g-factors could be calculated directly. Combinations of intermediate terms with the terms of the deep multiplets a^4F, b^4F, and a^2F were considered next. From four to twelve combinations were found with each of these terms. The values of the g-factors were weighted according to the apparent quality of the patterns and the precision of the measurements. The balance of the quartet and doublet terms were then approached through combinations with terms for which the g-factors were already determined. The intermediate sextet terms were approached through combinations with deep quartet terms. In a few instances values calculated from LS coupling were assigned to g-factors and were later adjusted to produce the best self-consistency among all the terms affected. The g-factors for the high even terms were calculated from combinations with the intermediate terms. Finally, the g-factors for a few intermediate sextet terms had to be calculated from combinations with high terms. The g-factors were all adjusted and readjusted throughout the work to obtain what seemed to be the best possible self-consistency of the results as a whole.

Most of the lines in the range λ3400 to λ3600 and a few lines of longer wavelengths showed strong self-reversals in the no-field spectrograms and a decided tendency toward reversal in the Zeeman patterns. For the lines λ3405.12 and λ3453.51 the reversals of the Zeeman patterns were clean cut and complete. The reversals had little detrimental effect on the measurements of unresolved patterns for which the magnetic shifts were relatively large, but small shifts which were reversed could not be measured.

Table I shows the wavelengths, the classification of the lines, the observed Zeeman patterns, and the weighted average g-factors. Zeeman patterns are calculated from these g-factors for comparison with the observed patterns. Most of the wavelengths are taken from the tables of

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[6] Shenstone and Blair, Phil. Mag. **8**, 765 (1929).

TABLE I. *Zeeman patterns and g-factors for lines of the Co I spectrum.*

λ	COMBINATION $x-y$	ZEEMAN EFFECT PATTERNS Observed		ZEEMAN EFFECT PATTERNS Calculated	g-FACTORS g_x	g-FACTORS g_y
3247.18	$b^4P_{5/2} - [F^\circ_{7/2}D^\circ_{7/2}]$	(0), 1.330		(0), 1.329	1.534	1.443
3254.20	$b^4P_{5/2} - (^4P^\circ_{3/2})$	(0), 1.377		(0), 1.377	1.534	1.743
3283.45		(0), 1.096				
3334.15	$b^4F_{9/2} - y^4F^\circ_{7/2}$	(0), 1.675		(0), 1.663	1.334	1.146
3354.39	$b^4F_{7/2} - y^4F^\circ_{5/2}$	(0), 2.200	(a)	(0), 2.195	1.245	0.865
3367.11	$b^4F_{9/2} - y^4G^\circ_{7/2}$	(0), 2.310	(a)	(0), 2.325	1.334	1.051
3385.23	$b^4F_{7/2} - y^4G^\circ_{5/2}$	(1.303), 2.548	(b)	(1.310), 2.560	1.245	0.719
3388.18	$b^4F_{5/2} - y^4F^\circ_{3/2}$	(0.893), 1.930	(b)	(0.892), 1.932	1.040	0.445
3395.38	$b^4F_{5/2} - y^2G^\circ_{7/2}$	(0), 0.787		(0), 0.781	1.040	0.925
3405.12	$b^4F_{9/2} - y^4F^\circ_{9/2}$	(0), 1.324		(0.074), 1.324	1.334	1.314
3409.18	$b^4F_{7/2} - y^4F^\circ_{7/2}$	(—), 1.195		(0.292), 1.195	1.245	1.146
3414.74	$b^4F_{3/2} - z^2D^\circ_{3/2}$	(0,611). —	(c)	(0.612), 0.604	0.400	0.808
3417.16	$b^4F_{5/2} - y^4F^\circ_{5/2}$	(—), 0.952		(0.383), 0.952	1.040	0.865
3431.58	$a^4F_{7/2} - z^4D^\circ_{5/2}$	(0), 1.110		(0), 1.103	1.237	1.344
3433.04	$b^4F_{3/2} - y^4F^\circ_{3/2}$	(—), 0.423		(0.063), 0.423	0.400	0.445
3442.92	$a^4F_{5/2} - z^4D^\circ_{3/2}$	(0), 0.952		(0), 0.951	1.042	1.163
3443.65	$b^4F_{7/2} - y^4G^\circ_{7/2}$	(—), 1.148		(0.573), 1.148	1.245	1.051
3453.51	$b^4F_{9/2} - y^4G^\circ_{11/2}$	(0), 1.100		(0), 1.100	1.334	1.262
3455.24	$a^4F_{3/2} - z^4D^\circ_{1/2}$	(—), 0.596	(a)	(0.196), 0.597	0.401	0.009
3461.17	$z^6D^\circ_{9/2} - [F_{9/2}G_{11/2}]$	(0), 1.278			1.525	
3462.81	$b^4F_{3/2} - y^4F^\circ_{5/2}$	(0), 1.593	(a)	(0), 1.563	0.400	0.865
3465.80	$a^4F_{9/2} - z^4G^\circ_{11/2}$	(0), 1.153		(0), 1.148	1.333	1.276
3474.02	$b^4F_{5/2} - y^4F^\circ_{7/2}$	(0), 1.280		(0), 1.279	1.040	1.146
3483.42	$b^4F_{7/2} - y^4F^\circ_{9/2}$	(0), 1.435		(0), 1.435	1.245	1.314
3485.35		(0), 1.170				
3489.41	$a^2F_{7/2} - y^2D^\circ_{5/2}$	(0), 1.113		(0), 1.113	1.148	1.176
3491.32	$a^4F_{3/2} - z^4D^\circ_{3/2}$	(1.140), —	(c)	(1.143), 0.782	0.401	1.163
3495.69	$b^4F_{3/2} - y^4G^\circ_{5/2}$	(0), 0.950		(0), 0.958	0.400	0.719
3496.68	$b^4F_{7/2} - z^2G^\circ_{7/2}$	(1.178), —	(c)	(1.183), 1.076	1.245	0.907
3502.28	$b^4F_{9/2} - y^4D^\circ_{7/2}$	(0), 1.213		(0), 1.212	1.334	1.404
3506.32	$b^4F_{7/2} - y^4D^\circ_{5/2}$	(0), 1.133		(0), 1.131	1.245	1.336
3509.84	$b^4F_{5/2} - y^4G^\circ_{7/2}$	(0), 1.063		(0), 1.065	1.040	1.051
3510.42	$a^4F_{7/2} - z^4D^\circ_{7/2}$	(0.569), 1.316	(c)	(0.581), 1.320	1.237	1.403
3512.64	$b^4F_{5/2} - y^4D^\circ_{3/2}$	(0), 0.926		(0), 0.922	1.040	1.197
3513.48	$a^4F_{7/2} - z^4G^\circ_{9/2}$	(0), 1.102		(0), 1.094	1.237	1.185
3518.35	$a^2F_{5/2} - y^2D^\circ_{3/2}$	(0), 0.896		(0), 0.896	0.870	0.835
3520.09	$a^4F_{7/2} - z^4F^\circ_{5/2}$	(0), 1.746	(a)	(0), 1.745	1.237	1.034
3521.57	$b^4F_{9/2} - z^2F^\circ_{7/2}$	(0), 1.625		(0), 1.597	1.334	1.184
3523.44	$b^4F_{3/2} - y^4D^\circ_{1/2}$	(—), 0.570	(a)	(0.170), 0.570	0.400	0.060
3526.86	$a^4F_{9/2} - z^4F^\circ_{9/2}$	(0), 1.338		(0.026), 1.337	1.333	1.340
3529.04	$a^4F_{5/2} - z^4G^\circ_{7/2}$	(0), 0.974		(0), 0.977	1.042	1.013
3529.82	$b^4F_{7/2} - y^4G^\circ_{9/2}$	(0), 1.003		(0), 0.984	1.245	1.150
3533.36	$a^4F_{3/2} - z^4G^\circ_{5/2}$	(0), 0.697		(0), 0.697	0.401	0.570
3543.27	$b^4P_{5/2} - (m^2F^\circ_{7/2})$	(0), 1.058		(0), 1.073	1.534	1.329
3550.60	$a^4F_{5/2} - z^4F^\circ_{3/2}$	(0.317), (0.948), 1.980	(a)(d)	(0.321), (0.963), 2.005	1.042	0.400
3552.99	$b^4P_{3/2} - (m^2D^\circ_{3/2})$	(—), 1.322		(0.560), 1.321	1.513	1.128
3560.90	$b^4F_{3/2} - y^4D^\circ_{3/2}$	(1.192), 0, 0.803, 1.584	(c)(e)	(1.196), 0.002, 0.799, 1.596	0.400	1.197
3564.96	$b^4F_{5/2} - z^2G^\circ_{7/2}$	(0), 0.742		(0), 0.741	1.040	0.907
3569.38	$a^2F_{7/2} - y^2F^\circ_{7/2}$	(0), 1.144		(0.009), 1.147	1.148	1.145
3574.96	$b^4F_{5/2} - y^4D^\circ_{5/2}$	(0.743), 1.188	(c)	(0.740), 1.188	1.040	1.336
3585.16	$b^4F_{7/2} - y^4D^\circ_{7/2}$	(0.464), 1.328		(0.469), 1.325	1.245	1.404
3587.19	$a^2F_{5/2} - y^2F^\circ_{5/2}$	(0), 0.870		(0), 0.870	0.870	0.870
3594.87	$a^4F_{5/2} - z^4F^\circ_{5/2}$	(0), 1.038		(0.018), 1.038	1.042	1.034
3602.08	$a^4F_{3/2} - z^4F^\circ_{3/2}$	(0), 0.400		(0.001), 0.401	0.401	0.400
3605.37	$b^4F_{7/2} - z^2F_{7/2}$	(—), 1.214		(0.180), 1.215	1.245	1.184
3611.70		(0), 0.907				
3627.81	$b^4F_{7/2} - z^2G^\circ_{9/2}$	(0), 0.884		(0), 0.890	1.245	1.116
3631.34	$a^4F_{7/2} - z^4F^\circ_{9/2}$	(0), 1.516		(0), 1.520	1.237	1.340
3632.84		(0), 1.152				
3634.72		(0), 0.871				
3641.79	$a^2D_{3/2} - (m^2D^\circ_{5/2})$	(0), 1.296	(a)	(0), 1.300	1.100	1.180
3643.19	$a^2D_{3/2} - (m^2D^\circ_{3/2})$	(0), 1.115		(0.039), 1.114	1.100	1.128
3647.66	$a^4F_{3/2} - z^4F^\circ_{5/2}$	(0), 1.996)	(a)	(0), 1.984	0.401	1.034
3652.54	$a^4F_{5/2} - z^4F^\circ_{7/2}$	(0), 1.526		(0), 1.526	1.042	1.257
3662.16		(0), 1.152				
3676.56		(0), 1.062				
3683.05	$a^2D_{5/2} - (m^2D^\circ_{5/2})$	(—), 1.220		(0.170), 1.219	1.258	1.180
3684.48	$a^2D_{5/2} - (m^2D^\circ_{3/2})$	(0), 1.466	(a)	(0), 1.453	1.258	1.128
3693.12	$a^2D_{5/2} - [o^2F^\circ_{7/2}]$	(0), 1.039	(f)	(0), 1.040	1.258	1.161
3693.48	$a^2D_{3/2} - (m^2P^\circ_{3/2})$	(0), 1.118		(0.067), 1.124	1.100	1.148
3702.25		(0), 0.962				
3704.06	$a^2F_{5/2} - y^2F^\circ_{7/2}$	(0), 1.867	(a)	(0), 1.833	0.870	1.145
3708.83	$a^2D_{3/2} - (n^2F^\circ_{5/2})$	(0), 1.127		(0), 1.126	1.100	1.115
3730.48	$b^4P_{5/2} - z^4P^\circ_{3/2}$	(0), 1.369		(0), 1.369	1.534	1.754
3732.40	$b^4P_{5/2} - z^4P^\circ_{5/2}$	(0), 1.548		(0.061), 1.548	1.534	1.562
3733.50	$a^2D_{5/2} - (n^2F^\circ_{7/2})$	(0), 1.163		(0), 1.163	1.258	1.216
3734.15	$a^2D_{3/2} - (m^2F^\circ_{5/2})$	(0), 1.074		(0), 1.074	1.100	1.085
3735.93	$a^2D_{5/2} - (m^2P^\circ_{3/2})$	(0), 1.425	(a)	(0), 1.423	1.258	1,148
3745.50	$a^2F_{7/2} - y^2D^\circ_{7/2}$	(0.673), 1.038		(0.658), 1.037	1.148	0.925

TABLE I—(*Continued*).

λ	COMBINATION	ZEEMAN EFFECT PATTERNS			g-FACTORS	
	$x-y$	Observed		Calculated	g_x	g_y
3749.93	$a^2D_{3/2}-(z^2P^\circ_{1/2})$	(−), 1.200		(0.200), 1.200	1.100	0.700
3755.45	$a^2D_{5/2}-(m^2F^\circ_{7/2})$	(0), 1.431		(0), 1.418	1.258	1.329
3842.06	$a^2F_{7/2}-z^2D^\circ_{5/2}$	(0), 1.086		(0), 1.086	1.148	1.198
3845.47	$a^2F_{7/2}-y^2G^\circ_{9/2}$	(0), 1.201		(0), 1.201	1.148	1.167
3861.17	$a^2F_{5/2}-z^2D^\circ_{3/2}$	(0), 0.916		(0), 0.917	0.870	0.808
3873.12	$b^4F_{9/2}-z^4D^\circ_{7/2}$	(0), 1.212		(0), 1.213	1.334	1.403
3873.96	$b^4F_{7/2}-z^4D^\circ_{5/2}$	(0), 1.115		(0), 1.121	1.245	1.344
3876.84	$b^4F_{9/2}-z^4G^\circ_{9/2}$	(0.669), 1.255	(c)	(0.670), 1.260	1.334	1.185
3881.88	$b^4F_{5/2}-z^4D^\circ_{3/2}$	(0), 0.947		(0), 0.948	1.040	1.163
3894.09	$a^2F_{5/2}-y^2G^\circ_{7/2}$	(0), 0.991		(0), 0.994	0.870	0.925
3894.48	$b^4F_{3/2}-z^4D^\circ_{1/2}$	(0.195), 0.592	(a)	(0.196), 0.598	0.400	0.009
3906.30	$b^4F_{7/2}-z^4G^\circ_{7/2}$	(0.771), −	(c)	(0.812), 1.129	1.245	1.013
3909.94	$a^4F_{9/2}-z^6G^\circ_{11/2}$	(0), 1.356		(0), 1.356	1.333	1.340
3917.13	$a^2P_{3/2}-(m^2D_{3/2})$	(0.250), 1.210	(c)	(0.249), 1.211	1.294	1.128
3935.97	$a^2F_{7/2}-y^4F^\circ_{9/2}$	(0), 1.674		(0), 1.605	1.148	1.314
3940.90	$b^4F_{3/2}-z^4D^\circ_{3/2}$	(1.145), −	(c)	(1.145), 0.782	0.400	1.163
3941.74	$b^4F_{9/2}-z^4G^\circ_{11/2}$	(0), 1.138		(0), 1.146	1.334	1.276
3945.32	$a^2F_{7/2}-z^2F^\circ_{5/2}$	(0), 1.809	(a)	(0), 1.828	1.148	0.876
3952.92	$a^2F_{7/2}-z^2G^\circ_{7/2}$	(0.727), 1.031		(0.712), 1.028	1.148	0.907
3957.94	$b^4F_{5/2}-z^4D^\circ_{5/2}$	(0.769), 1.190	(c)	(0.770), 1.192	1.040	1.344
3969.13		(0), 1.162				
3973.15	$b^4P_{5/2}-x^4D^\circ_{5/2}$	(0.322), 1.454		(0.331), 1.459	1.534	1.383
3974.73	$b^4F_{7/2}-z^4D^\circ_{7/2}$	(0.564), 1.319	(c)	(0.553), 1.324	1.245	1.403
3978.66	$b^4F_{7/2}-z^4G^\circ_{9/2}$	(0), 1.060		(0), 1.080	1.245	1.185
3979.53	$a^4F_{7/2}-z^6G^\circ_{9/2}$	(0), 1.340		(0), 1.331	1.237	1.271
3990.31	$b^4P_{3/2}-x^4D^\circ_{3/2}$	(0.383), 1.391	(c)	(0.365), 1.392	1.513	1.270
3991.69	$b^4F_{5/2}-z^4G^\circ_{7/2}$	(0), 0.977		(0), 0.979	1.040	1.013
3995.31	$a^2F_{7/2}-y^4G^\circ_{9/2}$	(0), 1.145		(0), 1.154	1.148	1.150
3997.91	$a^2F_{5/2}-y^4F^\circ_{7/2}$	(0), 1.846	(a)	(0), 1.836	0.870	1.146
4013.95	$b^4P_{1/2}-x^4D^\circ_{1/2}$	(1.311), 1.324		(1.315), 1.328	2.642	0.013
4020.90	$b^4F_{9/2}-z^4F^\circ_{9/2}$	(0), 1.136		(0.022), 1.337	1.334	1.340
4035.56	$z^4G^\circ_{11/2}-f^4H_{13/2}$	(0), 1.176		(0), 1.176	1.276	1.249
4045.40	$a^2F_{5/2}-y^4G^\circ_{7/2}$	(0), 1.294		(0), 1.277	0.870	1.051
4058.60	$b^4P_{1/2}-x^4D^\circ_{3/2}$	(0.687), 0.592	(a)	(0.686), 0.584	2.642	1.270
4066.38	$a^2F_{7/2}-y^4D^\circ_{7/2}$	(0.770), 1.265		(0.756), 1.276	1.148	1.404
4068.55	$b^4P_{3/2}-x^4D^\circ_{5/2}$	(0), 1.290		(0), 1.286	1.513	1.383
4086.31	$b^4P_{5/2}-x^4D^\circ_{7/2}$	(0), 1.328		(0), 1.327	1.534	1.442
4092.40	$a^2F_{7/2}-z^2F^\circ_{7/2}$	(0), 1.168		(0.106), 1.166	1.148	1.184
4110.54	$a^2F_{5/2}-z^2F^\circ_{5/2}$	(0), 0.873		(0.013), 0.873	0.870	0.876
4118.78	$a^2F_{5/2}-z^2G^\circ_{7/2}$	(0), 0.953		(0), 0.953	0.870	0.907
4121.33	$a^2F_{7/2}-z^2G^\circ_{9/2}$	(0), 1.063		(0), 1.060	1.148	1.116
4339.64	$b^2P_{3/2}-(m^2P^\circ_{3/2})$	(0.233), 1.241	(c)	(0.257), 1.234	1.319	1.148
4466.89	$z^6F^\circ_{7/2}-e^6F_{7/2}$	(0.144), 1.412		(0.139), 1.416	1.439	1.392
4469.57	$z^6F^\circ_{9/2}-e^6F_{9/2}$	(−), 1.452		(0.104), 1.454	1.468	1.440
4471.58	$z^6F^\circ_{5/2}-e^6F_{5/2}$	(0), 1.342		(0.018), 1.342	1.338	1.346
4530.99	$z^6F^\circ_{11/2}-e^6F_{11/2}$	(0), 1.463		(0.018), 1.463	1.465	1.461
4534.00	$z^6F^\circ_{3/2}-e^6F_{5/2}$	(0), 1.509		(0), 1.509	1.129	1.346
4543.81	$b^2D_{5/2}-(m^2D^\circ_{5/2})$	(0.142), 1.214		(0.146), 1.214	1.247	1.180
4549.67	$z^6F^\circ_{5/2}-e^6F_{7/2}$	(0), 1.459		(0), 1.459	1.338	1.392
4565.60	$z^6F^\circ_{7/2}-e^6F_{9/2}$	(0), 1.444		(0), 1.436	1.439	1.438
4581.62	$z^6F^\circ_{9/2}-e^6F_{11/2}$	(0), 1.435		(0), 1.445	1.468	1.461
4629.38	$z^6D^\circ_{9/2}-e^6F_{9/2}$	(0.320), 1.487		(0.323), 1.482	1.525	1.438
4663.41	$z^6D^\circ_{7/2}-e^6F_{7/2}$	(0.458), 1.469		(0.458), 1.470	1.547	1.392
4682.36	$z^6D^\circ_{5/2}-e^6F_{5/2}$	(0.753), −	(c)	(0.753), 1.497	1.648	1.346
4749.68	$z^6D^\circ_{9/2}-e^6F_{11/2}$	(0), 1.330		(0), 1.317	1.525	1.461
4776.33	$z^6G^\circ_{3/2}-e^6F_{1/2}$	(0.343), 0.404		(0.343), 0.404	0.162	−0.484
4780.00	$z^6G^\circ_{5/2}-e^6F_{3/2}$	(0), 0.702		(0), 0.702	0.865	1.082
4792.87	$z^6G^\circ_{7/2}-e^6F_{5/2}$	(0), 0.909		(0), 0.909	1.152	1.346
4813.48	$z^6G^\circ_{9/2}-e^6F_{7/2}$	(0), 1.054		(0), 1.059	1.271	1.392
4840.27	$z^6G^\circ_{11/2}-e^6F_{9/2}$	(0), 1.130		(0), 1.123	1.341	1.438
4867.68	$z^6G^\circ_{13/2}-e^6F_{11/2}$	(0), 1.176		(0), 1.176	1.385	1.461
5212.70	$z^4F^\circ_{9/2}-f^4F_{9/2}$	(−), 1.356		(0.110), 1.354	1.340	1.368
5266.48	$a^2G_{9/2}-y^2F^\circ_{7/2}$	(0), 1.075		(0), 1.075	1.120	1.145
5280.63	$z^4G^\circ_{9/2}-f^4F_{7/2}$	(0), 1.024	(a)	(0), 1.024	1.185	1.231
5352.05	$z^4G^\circ_{11/2}-f^4F_{9/2}$	(0), 1.075		(0), 1.069	1.276	1.368
5369.58	$a^4P_{3/2}-y^4D^\circ_{5/2}$	(0), 1.026		(0), 1.023	1.754	1.336
5483.34	$a^4P_{5/2}-y^4D^\circ_{7/2}$	(0), 1.013	(a)	(0), 0.957	1.585	1.404
6082.49	$z^4F^\circ_{9/2}-e^4F_{9/2}$	(−), 1.332		(0.074), 1.330	1.340	1.320
6116.98	$a^4P_{1/2}-z^4D^\circ_{1/2}$	(1.348), −		(1.348), 1.357	2.705	0.009
6282.64	$a^4P_{3/2}-z^4D^\circ_{5/2}$	(0), 1.033		(0), 1.037	1.754	1.344
6450.24	$a^4P_{5/2}-z^4D^\circ_{7/2}$	(0), 1.160		(0), 1.176	1.585	1.403
6455.03	$z^4D^\circ_{7/2}-e^4F_{9/2}$	(0), 1.168		(0), 1.175	1.403	1.320

(a) Strongest components in the σ-pattern.
(b) Strongest components in both patterns.
(c) Strongest components in the π-pattern.
(d) π-pattern completely resolved.
(e) σ-pattern completely resolved.
(f) Components of adjacent lines overlap.

TABLE II. *Comparison of observed g-factors with their theoretical values for LS and intermediate couplings.*

Configuration	Term	*g*-factors *LS*	Obs.	Int.	Configuration	Term	*g*-factors *LS*	Obs.
$3d^74s^2$	$a^4F_{9/2}$	1.333	1.333	1.330	$3d^74s4p$ (^5F)	$z^6G^\circ_{13/2}$	1.385	1.38
	$a^4F_{7/2}$	1.238	1.237	1.238		$z^6G^\circ_{11/2}$	1.343	1.34
	$a^4F_{5/2}$	1.029	1.042	1.030		$z^6G^\circ_{9/2}$	1.272	1.27
	$a^4F_{3/2}$	0.400	0.401	0.401		$z^6G^\circ_{7/2}$	1.143	1.15
	$b^4P_{5/2}$	1.600	1.53	1.597		$z^6G^\circ_{5/2}$	0.857	0.87
	$b^4P_{3/2}$	1.733	1.51	1.720		$z^6G^\circ_{3/2}$	0.000	0.16
	$b^4P_{1/2}$	2.667	2.64	2.645		$z^6F^\circ_{11/2}$	1.455	1.46
	$a^2G_{9/2}$	1.111	1.12	1.112		$z^6F^\circ_{9/2}$	1.434	1.47
	$b^2P_{3/2}$	1.333	1.32	1.272		$z^6F^\circ_{7/2}$	1.397	1.44
						$z^6F^\circ_{5/2}$	1.314	1.34
$3d^84s$	$b^4F_{9/2}$	1.333	1.334	1.333		$z^6F^\circ_{3/2}$	1.067	1.13
	$b^4F_{7/2}$	1.238	1.245	1.237		$z^6D^\circ_{9/2}$	1.556	1.53
	$b^4F_{5/2}$	1.029	1.040	1.028		$z^6D^\circ_{7/2}$	1.587	1.55
	$b^4F_{3/2}$	0.400	0.400	0.402		$z^6D^\circ_{5/2}$	1.657	1.65
	$a^4P_{5/2}$	1.600	1.58	1.579		$z^4G^\circ_{11/2}$	1.273	1.28
	$a^4P_{3/2}$	1.733	1.75	1.719		$z^4G^\circ_{9/2}$	1.172	1.19
	$a^4P_{1/2}$	2.667	2.71	2.664		$z^4G^\circ_{7/2}$	0.984	1.01
	$a^2F_{7/2}$	1.143	1.148	1.142		$z^4G^\circ_{5/2}$	0.571	0.57
	$a^2F_{5/2}$	0.857	0.870	0.859		$z^4F^\circ_{9/2}$	1.333	1.34
	$a^2D_{5/2}$	1.200	1.26	1.219		$z^4F^\circ_{7/2}$	1.238	1.26
	$a^2D_{3/2}$	0.800	1.10	0.879		$z^4F^\circ_{5/2}$	1.029	1.03
	$a^2P_{3/2}$	1.333	1.29	1.268		$z^4F^\circ_{3/2}$	0.400	0.40
						$z^4D^\circ_{7/2}$	1.429	1.40
$3d^9$	$b^2D_{5/2}$	1.200	1.25	1.200		$z^4D^\circ_{5/2}$	1.371	1.34
						$z^4D^\circ_{3/2}$	1.200	1.16
						$z^4D^\circ_{1/2}$	0.000	0.01

Configuration	Term	*g*-factors *LS*	Obs.	Configuration	Term	*g*-factors *LS*	Obs.
$3d^74s4p$ (^3F)	$x^4D^\circ_{7/2}$	1.429	1.44		$y^4F^\circ_{7/2}$	1.238	1.15
	$x^4D^\circ_{5/2}$	1.371	1.38		$y^4F^\circ_{5/2}$	1.029	0.87
	$x^4D^\circ_{3/2}$	1.200	1.27		$y^4F^\circ_{3/2}$	0.400	0.45
	$x^4D^\circ_{1/2}$	0.000	0.01		$y^4D^\circ_{7/2}$	1.429	1.40
	$z^2G^\circ_{9/2}$	1.111	1.12		$y^4D^\circ_{5/2}$	1.371	1.34
	$z^2G^\circ_{7/2}$	0.889	0.91		$y^4D^\circ_{3/2}$	1.200	1.20
	$z^2F^\circ_{7/2}$	1.143	1.18		$y^4D^\circ_{1/2}$	0.000	0.06
	$z^2F^\circ_{5/2}$	0.857	0.88		$y^2G^\circ_{9/2}$	1.111	1.17
	$z^2D^\circ_{5/2}$	1.200	1.20		$y^2G^\circ_{7/2}$	0.889	0.92
	$z^2D^\circ_{3/2}$	0.800	0.81		$y^2F^\circ_{7/2}$	1.143	1.14
					$y^2F^\circ_{5/2}$	0.857	0.87
$3d^74s4p$ (−)	$z^4P^\circ_{5/2}$	1.600	1.56		$y^2D^\circ_{5/2}$	1.200	1.18
	$z^4P^\circ_{3/2}$	1.733	1.75		$y^2D^\circ_{3/2}$	0.800	0.83
	$(m^2F^\circ_{7/2})$	1.143	1.33				
	$(m^2F^\circ_{5/2})$	0.857	1.09	$3d^74s5s$ (^5F)	$e^6F_{11/2}$	1.455	1.46
	$(n^2F^\circ_{7/2})$	1.143	1.22		$e^6F_{9/2}$	1.434	1.44
	$(n^2F^\circ_{5/2}$	0.857	1.12		$e^6F_{7/2}$	1.397	1.39
	$(m^2D^\circ_{5/2})$	1.200	1.18		$e^6F_{5/2}$	1.314	1.35
	$(m^2D^\circ_{3/2})$	0.800	1.13		$e^6F_{3/2}$	1.067	1.08
					$e^6F_{1/2}$	−0.667	−0.48
$3d^84p$ (^3F)	$y^4G^\circ_{11/2}$	1.273	1.26		$f^4F_{9/2}$	1.333	1.37
	$y^4G^\circ_{9/2}$	1.172	1.15		$f^4F_{7/2}$	1.238	1.23
	$y^4G^\circ_{7/2}$	0.984	1.05				
	$y^4G^\circ_{5/2}$	0.571	0.72	$3d^85s$ (^3F)	$e^4F_{9/2}$	1.333	1.32
	$y^4F^\circ_{9/2}$	1.333	1.31				

Kayser and Konen,[7] volume VIII, though a few wavelengths for unclassified lines are found in volume VII. The term notation for the completely analyzed terms is that suggested by Russell, Shenstone and Turner.[8] In Catalán's tables[1] λ4549.67 is assigned to the transition $Z^4D^\circ_{7/2}-[^4G_{9/2}\ ^4F_{7/2}]$ and the transition $Z^6F^\circ_{5/2}-e^6F_{7/2}$ is given for λ4543.84 in the earlier tables.[9] It is evident from the term values that the latter transition corresponds to λ4549.67 giving alternative classifications for this line. Judging from the Zeeman pattern, $Z^6F^\circ_{5/2}-e^6F_{7/2}$ seems to be the more probable classification. λ6450.24 is assigned to $a^2G_{7/2}-Z^2G^\circ_{7/2}$ by Catalán in 1928,[1] but considering the Zeeman pattern as well as the very great relative intensity of the line, the classification[9] $a^4P_{5/2}-Z^4D^\circ_{7/2}$ was chosen instead. The difference of the term values for this classification is also more consistent with the assigned wavelength of the line.

In Table II the weighted, average *g*-factors are compared with their theoretical values for *LS* coupling. For the deep terms the theoretical *g*-values given in the preceding article on intermediate coupling are also listed for comparison. The observed values are fairly consistent with those calculated by Marvin except for the multiplets b^4P, a^2D and b^2D, where $j=5/2$ or $3/2$. Most of the *g*-factors are estimated to be reliable to about 0.01, but the reliability varies greatly with the number of combinations of the terms and the type of Zeeman patterns. Because of their many combinations the multiplets a^4F, b^4F and a^2F are probably reliable to 0.005. The *g*-factors for terms which appear in only one combination or those which appear in lines of wavelengths longer than λ5000 may be uncertain by 0.03 or even more.[10]

A number of the observed *g*-values differ rather widely from the values given by *LS*

TABLE III. *Incompletely analyzed terms with suggested classifications and the corresponding LS and observed g-factors.*

Term Value	Suggested Classifications Catalán	Authors	*g-factors* *LS*	Obs.
43130.13	$(z^2P^\circ_{1/2})$	$(z^2P^\circ_{1/2})$	0.667	0.700
43537.62	$(m^2P^\circ_{3/2})$	$(m^2P^\circ_{3/2})$	1.333	1.148
43847.86	$[o^2F^\circ_{7/2}]$	$[o^2F^\circ_{7/2}]$	1.143	1.161
45904.66	$(^4P^\circ_{3/2})$	$(^4P^\circ_{3/2})$	1.733	1.743
45971.09	$[F^\circ_{7/2},D^\circ_{7/2}]$	$^4D^\circ_{7/2}$	1.429	1.443
53511.70	$F_{9/2},G_{11/2}$	$^6F_{11/2}$	1.455	1.449
53617.94	$f^4H_{13/2}$	$f^4H_{13/2}$	1.231	1.249

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[7] Kayser and Konen, *Handbuch der Spectroscopie.*

[8] Russell, Shenstone and Turner, Phys. Rev. **33**, 900 (1929).

[9] Catalán and Beckert, Zeits. f. Physik **32**, 336 (1925).

[10] Because of systematic errors due to personal judgment and other causes which cannot be completely eliminated, the probable errors of the measurements give a false impression of the accuracy of the results and are therefore omitted from this discussion.

TABLE IV. *Comparison of resolved Zeeman patterns observed by Rybár*[4] *with those calculated from our experimental g-factors.*

λ		ZEEMAN PATTERNS								
3385.23	Rybár	(0.26),	(0.82),	(1.37),	—,	—,	—,	—,	2.01,	2.51
	Cal.	(**0.26**),	(0.79),	(1.32),	−0.07,	0.46,	0.98,	1.51,	2.03,	**2.56**
3388.18	Rybár	(0.32),	(0.83),	—,	0.76,	1.34,	1.93			
	Cal.	(**0.30**),	(0.89),	0.15,	0.74,	1.34,	**1.93**			
3462.81	Rybár	(0.24),	(0.73),	—,	0.67,	1.16,	1.63			
	Cal.	(**0.23**),	(0.70),	0.17,	0.63,	1.10,	**1.56**			
3491.32	Rybár	(—),	(1.18),	0.02,	0.80,	1.59				
	Cal.	(0.38),	(**1.14**),	0.02,	**0.78**,	1.54				
3495.69	Rybár	(0.17),	(0.48),	—,	—,	0.91,	1.18			
	Cal.	(**0.16**),	(0.48),	0.24,	0.56,	0.88,	**1.20**			
3550.60	Rybár	(0.30),	(0.91),	—,	—,	1.28,	1.90			
	Cal.	(**0.32**),	(0.96),	0.08,	0.72,	1.36,	**2.01**			
3560.90	Rybár	(—),	(1.22),	0.00,	0.82,	1.60				
	Cal.	(0.40),	(**1.20**),	0.00,	**0.80**,	1.60				
3704.06	Rybár	(0.20),	(0.53),	(—),	—,	—,	—,	—,	1.44.	1.74
	Cal.	(**0.14**),	(0.41),	(0.69),	0.46,	0.73,	1.01,	1.28,	1.56,	**1.83**
3940.90	Rybár	(—),	(1.17),	0.00,	0.80,	1.59				
	Cal.	(0.38),	(**1.14**),	0.02,	**0.78**,	1.54				

coupling. These differences may be substantiated in part by unmistakable peculiarities in certain observed patterns. In the case of λ3543.27, which is due to the transition $b^4P_{5/2}-(m^2F^\circ{}_{7/2})$, the magnetic shifts of the σ components are given for *LS* coupling by 0, 0.46, 0.92, 1.37, 1.83, 2.29, the two strongest components having no magnetic displacement. A relatively large split, sharp on the inner edge and shaded off on the outer edge, is observed. In case of *LS* coupling for λ3552.99, $b^4P_{3/2}-(m^2D^\circ{}_{3/2})$, the stronger component in the π pattern has a magnetic shift of 1.40 while the observed shift was not large enough to permit measuring. The magnetic shift of the stronger component in the π pattern of λ3693.48, $a^2D_{3/2}-(m^2P^\circ{}_{3/2})$, is 0.800 for *LS* coupling, but the observed pattern shows no shift. For λ4339.64, $b^2P_{3/2}-(m^2P^\circ{}_{3/2})$, *LS* coupling predicts no shift, but a shift of 0.233 was observed. Assuming *LS* coupling for λ3643.19, $a^2D_{3/2}-(m^2D^\circ{}_{3/2})$, the σ pattern is a sharp doublet with a shift of 0.800, while the observed pattern shades off on either side showing the presence of other components, and the measured shift of the center of intensity is 1.115. Although the type of pattern observed for each of these lines is consistent with its classification, the g-factors for one or both terms in each case must differ rather widely from those given for *LS* coupling.

Table III is a list of seven incompletely analyzed terms and their probable g-factors. The term values and the classifications suggested by Catalán[1, 2] are given in the first two columns. The last three columns show respectively the classifications indicated by the Zeeman effect, the *LS* g-factors, and the observed g-factors.

Of the previous investigations on the Zeeman effect in the cobalt arc spectrum,[3, 4] Rybár's work seems to be the most accurate. The sixteen unresolved patterns which are listed in his article show fair agreement with our observed patterns. Table IV is a comparison of Rybár's nine resolved patterns with the corresponding patterns calculated from our experimental g-factors. His magnetic shifts on either side of the central position are averaged and reduced to the normal field of about 21,400 gauss for convenience in comparison.