Zeeman Effects in the Arc Spectrum of Ruthenium

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(Received August 16, 1940)

Measurements on resolved Zeeman patterns of 450 lines of normal ruthenium are reported. Five exposures to each polarized component of the light from a 4-ampere arc, operated in magnetic fields of intensity between 71,000 and 92,200 gauss, resulted in 85 plates which were measured on an automatic comparator. J and g values have been determined from the various patterns. When data from the various lines arising from a given term are averaged, g values for 140 terms are obtained which appear to be correct to within ± 0.003 unit. The results obtained have been used to further the classification of Ru I, and to aid in the assignment of L and S values to highly perturbed terms. Though g values frequently depart strongly from values calculated for LS coupling, it is usually possible to assign meaningful L and S designations. Asymmetrical patterns in lines arising from the terms $y^5D_3^0$ and $y^5D_4^0$ are discussed.

THE spectrum of the normal ruthenium atom (Ru I), has been partially analyzed by Sommer,[1] who classified about 1000 lines as combinations of 113 terms, of which he determined g values for 63. Meggers and Laporte[2] had previously arranged a number of Ru underwater-spark absorption lines in multiplets, and Paulson[3] had listed constant differences in the spectrum. Between the appearance of Sommer's two papers, Meggers and Laporte[4] classified a number of lines into 18 multiplets involving 20 terms, and published Zeeman separations for 9 lines (unresolved triplets).

The *M.I.T. Wavelength Tables*[5] list 2824 strong ruthenium lines, while more than 8000 lines have been assigned definitely, and several thousand more tentatively, to the ruthenium spectrum in the card catalog compiled by the M.I.T.-W.P.A. wave-length project. McFee[6] has extended Sommer's classification of Ru I, and the wavelength data are in excellent condition for a further extension of the classification, which is now in progress.[7] Improved Zeeman determinations were found to be greatly needed to aid in the assignment of term designations, however. The strongest field intensity previously used to study Ru I was 35,000 gauss (Sommer), and the availability of fields approaching 100,000 gauss[8] made possible increased magnetic resolution.

In the present paper Zeeman data are given for 450 classified lines of Ru I, with g values for 140 terms which appear to have about tenfold greater internal consistency than g values previously published for Ru I. These data are of value to further the assignment of L and S values to highly-perturbed terms, to test and use the Pauli g group sum rule, and to throw further light on the perturbations existing in the normal ruthenium atom.

EXPERIMENTAL METHOD

To produce electrodes which could be burned in the horizontal arc,[8] one part of ruthenium metal powder was mixed with five parts of silver powder, and compressed at 20,000 lb. per square inch to form billets of $\frac{1}{8}$ inch thickness, which were then sintered and turned to round rods. Light from the arc, taken transversely to the

TABLE I. *Characteristics of grating spectrographs used.*

GRATING	LINES PER IN.	RANGE OF SPECTRUM	ORDER USED	DISPERSION	NO. OF PLATES
F	30,000	3190–4400A	1	0.8A/mm	3
		2200–3045	2	0.4	4
G	30,000	2085–4400	1	0.8	6
H	15,000	3335–11,400	1	1.6	10
		4103–5700	2	0.8	—

[1] L. A. Sommer, Zeits. f. Physik **37**, 1 (1926); Naturwiss. **13**, 840 (1925).
[2] W. F. Meggers and Otto Laporte, Science **61**, 635 (1925).
[3] E. Paulson, Physik. Zeits. **16**, 81 (1915).
[4] W. F. Meggers and Otto Laporte, J. Wash. Acad. Sci. **16**, 143 (1926).
[5] John Wiley and Sons, New York, 1939.
[6] R. H. McFee, unpublished M.Sc. thesis, M.I.T. (1938).
[7] J. R. McNally, Jr., M.I.T. thesis in preparation.
[8] G. R. Harrison and F. Bitter, Phys. Rev. **57**, 15 (1940).

TABLE II. *Some typical Zeeman patterns in the arc spectrum of ruthenium.*

λ	I	Class.	Zeeman Pattern
5636.235	100	$a^5D_3 - z^5D_4^0$	(0, 0.064, 0.124, —) —, —, 1.425, 1.488, 1.552, 1.616, **1.677**.
4547.853	20	$b^3P_1 - x^5F_2^0$	(0, 0.374) **0.691**, 1.063, —.
4517.818	60	$a^5D_2 - z^5S_2^0$	(—, **1.596**) 0.432, **1.233**, —, 2.831.
4460.035	150	$a^5P_3 - z^5S_2^0$	(0, 0.408, 0.816) **0.807**, 1.214, 1.625, 2.032, —.
4449.336	125	$a^5D_3 - y^5F_3^0$	(—, 0.430, **0.645**) 0.769, 0.987, **1.204**, **1.420**, 1.633, 1.852.
4390.435	150*R*	$a^5D_3 - z^3G_4^0$	(0, 0.303, 0.605, 0.907) **0.206**, 0.508, 0.811, 1.115, 1.418, 1.720, —.
4385.648	125	$a^5D_2 - z^3G_3^0$	(0, 0.364, 0.722) **0.144**, 0.505, 0.860, 1.227, —.
4361.211	40	$a^3F_4 - y^5F_5^0$	(0, 0.194, 0.387, 0.578, 0.773) —, —, 1.091, 1.280, 1.473, 1.665, 1.858, 2.052, **2.243**.
4217.268	100	$a^3F_4 - z^7P_4^0$	(0.374, 0.749, 1.122, **1.496**) 0.841, 1.215, 1.588, **1.963**, **2.335**, 2.716, —, 3.459.
4206.016	100	$a^3F_3 - z^3G_3^0$	(0.327, 0.653, **0.980**) 0.208, 0.541, **0.868**, **1.195**, 1.521, 1.847.
4127.868	25	$b^3P_1 - x^5D_1^0$	(0.129) 1.439, 1.568.
4085.429	40	$a^5P_1 - y^5D_1^0$	(0.458) 1.522, 1.978.
4076.733	60	$a^5D_2 - z^3D_1^0$	(0, 0.715) 0.520, 1.233, **1.943**.
4062.988	12	$b^3P_1 - 41_1^0$	(0.129) 1.440, 1.563.
3984.858	60	$a^3F_3 - z^3D_2^0$	(0, 0.174, 0.348) 0.850, 1.023, 1.196, 1.369, **1.541**.
3964.896	50	$a^5F_5 - z^7D_5^0$	(0.198, 0.393, 0.588, 0.785, **0.982**) 0.611, 0.808, 1.002, 1.201, **1.396**, **1.592**, 1:787, 1.985, 2.180, 2.374.
3942.063	12	$a^5F_1 - z^5D_2^0$	(0, 1.319) 0, 1.326, **2.641**.
3931.759	50	$a^5P_1 - z^5P_1^0$	(0.398) 1.975, 2.385.
3925.925	60	$a^5F_5 - z^7D_4^0$	(0, 0.228, 0.457, 0.685, 0.913) **0.485**, 0.712, 0.939, 1.168, **1.395**, 1.622, 1.849, 2.075, 2.304.
3920.915	20	$a^5D_3 - z^5P_3^0$	(0.231, 0.457, **0.687**) 0.961, 1.190, **1.417**, **1.645**, 1.874, 2.102.
3867.839	60	$a^3F_4 - z^3D_3^0$	(0, 0.154, 0.307, 0.458) 0.828, 0.978, 1.129, 1.282, 1.434, 1.587, **1.738**.
3846.676	12	$a^5D_2 - z^5P_1^0$	(0, 1.152) **0.074**, 1.233, 2.380.
3843.159	10	$a^5F_1 - z^5D_1^0$	(0.943) 0, 0.943.
3831.795	60	$a^3G_5 - b40_5^0$	(0.148, 0.288, 0.431, 0.573, **0.714**) 0.476, 0.616, 0.756, 0.903, **1.048**, 1.188, 1.331, 1.472, 1.615, 1.756.

magnetic field, was reflected axially out of the 10,000-ampere solenoid by an aluminum first-surface mirror, and was sent through a 50-mm diameter Rochon prism formed of two quartz prisms suitably cut, separated by a thin film of castor oil. One plane-polarized beam was then focused, by means of a 45-mm quartz-fluorite achromatic lens of 500 mm focus, on the slit of grating *G* (Table I). Light which did not pass through this slit was caught on a small plane mirror and returned to a concave mirror which sent it through the slit of grating *F*. The beam of opposite polarization was sent, by means of a single aluminized mirror, through the slit of grating *H*.

Exposures of from 20 to 60 minutes duration served to produce satisfactory spectrograms with all three gratings; the Rochon prism was then inverted, and the spectrum was photographed again with all three gratings. A field-free exposure was finally taken. In this way π, σ, and no-field exposures were obtained on 23 plates, each 20 inches long, in three hours of operation of the magnet. Eastman type I–O plates were used between 4200 and 2500A, with type I plates of suitable sensitization for the shorter and longer regions.

The data reported in the various tables were obtained from four sets of exposures, as follows:

Set Number	*Field*
Z-33*a*	92,200 gauss
Z-33*b*	71,260
Z-49	88,350
Z-74, π on *F*, *G*; σ on *H*	88,040
Z-74, σ on *F*, *G*; π on *H*	89,310

The field intensities were calculated from the two silver lines 3280.683 and 3382.891A, and are believed to be correct to within ± 0.3 percent. The calcium lines 3933.666, 3968.468, and the copper lines 3247.540, 3273.962, were used as additional checks on the field intensities. The current through the solenoid was held constant to within 0.1 percent during an exposure.

All spectra were measured in both directions with an automatic comparator,[9] provided with a new all-electric maximum-picker,[10] which functioned most satisfactorily. Patterns for many lines were measured twice at each of three fields, and the final *g* values reduced from these data were usually found consistent to within ± 0.003 unit.

RESULTS

In complex spectra of metals of the type under discussion, and especially at the strong fields used, the technique of reduction is of necessity somewhat different from that used with sharp and narrow patterns of the sort obtained with gaseous discharges, for example. The patterns often overlap and show blends, so that interpretation may be difficult and some components may appear to be shifted in position. The usual criterion of precision which demands equal separations between components (for symmetrical patterns) is less likely to be fulfilled, and the correct *g* values can best be determined by using only the most clearly resolved components to obtain the fundamental separation

[9] G. R. Harrison, J. Opt. Soc. Am. **25**, 169 (1935); Rev. Sci. Inst. **9**, 15 (1938).

[10] G. R. Harrison and J. P. Molnar, J. Opt. Soc. Am. **30**, 343 (1940).

TABLE III. *Classified lines and g values in the arc spectrum of ruthenium.*

λ(A)	I	T_1	T_2	g_1	g_2
5921.446	25	a^3P_2	$z^5D^0_3$	1.530	1.423
5699.047	125	a^5P_3	$z^5D^0_4$	1.623	1.483
5636.235	100	a^5D_3	$z^5D^0_4$	1.425	1.488
5510.714	100	a^3G_5	16^0_4	1.188	1.274
5456.134	40	a^3F_2	$z^5D^0_3$	1.091	1.428
5385.879	25	b^3P_2	$y^5F^0_2$	1.315	1.028
5335.930	100	a^5P_3	$z^5D^0_3$	1.621	1.422
5309.267	125	a^5D_4	$z^5D^0_4$	1.44	1.47
5195.019	100	a^5P_3	$z^5F^0_4$	1.628	1.368
5155.136	125	a^5D_1	$z^5D^0_2$	1.794	1.325
5151.067	40	a^5D_2	$z^5D^0_2$	1.233	1.323
5147.237	60	a^3F_3	$z^5D^0_3$	1.193	1.424
5136.550	125	a^5P_2	$z^5D^0_3$	1.559	1.424
5093.826	60	a^5D_0	$z^5D^0_1$	0/0	0.953
5057.331	100	a^3F_4	$z^5D^0_4$	1.280	1.485
5014.954	20	a^3F_2	$z^5D^0_1$	1.094	0.964
5011.227	25	a^5P_1	$z^5D^0_0$	1.980	0/0
4921.074	40	a^5D_3	$z^5F^0_3$	1.417	1.297
4907.888	20	a^5D_2	$z^5F^0_2$	1.24	1.17
4903.053	60	b^3F_3	$y^5F^0_3$	1.081	1.201
4895.597	12	a^3P_2	$y^5F^0_3$	1.541	1.206
4869.153	125	a^5D_4	$z^5F^0_4$	1.446	1.364
4844.557	20	a^5D_2	$z^5F^0_1$	1.232	0.567
4815.523	20	b^3F_2	$y^5F^0_2$	0.765	1.032
4757.841	125	a^5D_4	$z^3G^0_5$	1.445	1.230
4709.484	150	b^3F_4	16^0_4	1.259	1.274
4681.786	100	a^3F_2	$z^5G^0_3$	1.092	0.947
4654.315	125	a^5D_2	$z^5G^0_3$	1.237	0.945
4647.606	125	a^3F_3	$y^5F^0_4$	1.198	1.366
4605.665	15	a^3D_2	$x^5D^0_3$	1.162	1.425
4601.763	20	b^3F_2	$z^3D^0_2$	0.766	1.019
4599.085	100	b^3F_3	$z^3D^0_3$	1.087	1.129
4592.520	100	a^3P_2	$z^3D^0_3$	1.535	1.129
4591.103	60	a^3F_2	$z^5G^0_2$	1.087	0.377
4580.072	25	a^3P_0	$z^3D^0_1$	0/0	0.520
4559.982	20	b^3F_4	$y^5F^0_3$	1.246	1.196
4552.110	7	a^5D_3	$z^5G^0_3$	1.419	0.938
4547.853	20	b^3P_1	$x^5F^0_2$	1.440	1.065
4530.854	60	$a10_2$	$f59^0_3$	1.343	1.000
4520.950	25	a^5D_1	$z^5S^0_2$	1.795	2.033
4517.818	60	a^5D_2	$z^5S^0_2$	1.232	2.032
4516.893	100	b^3F_2	$z^3D^0_1$	0.763	0.521
4510.097	25	a^3F_3	$z^7P^0_4$	1.189	1.651
4508.561	15	a^1P_1	$b59^0_1$	0.93	0.93
4498.145	125	b^3F_4	$z^3G^0_4$	1.256	1.114
4480.448	60	a^3D_2	$y^3D^0_3$	1.162	1.384
4467.260	20	a^1P_1	$d59^0_0$	0.926	0/0
4460.035	150	a^5P_3	$z^5S^0_2$	1.627	2.035
4449.336	125	a^5D_3	$y^5F^0_3$	1.419	1.203
4444.507	40	a^5P_2	$z^5G^0_3$	1.569	0.942
4428.461	125	a^5P_3	$z^3G^0_4$	1.623	1.114
4424.781	25	a^3P_1	$y^5D^0_0$	1.680	0/0
4421.456	60	a^5D_3	$z^5S^0_2$	1.420	2.035
4410.026	150	a^3F_2	$z^3G^0_3$	1.087	0.869
4404.818	25	b^3D_2	$y^3P^0_2$	1.174	1.294
4397.797	150	b^3F_4	$z^3G^0_3$	1.257	0.870
4390.435	150*R*	a^5D_3	$z^3G^0_4$	1.417	1.114
4385.648	125	a^5D_2	$z^3G^0_3$	1.226	0.865
4385.391	125	a^5D_4	$z^5G^0_5$	1.447	1.265
4372.208	125	a^5D_4	16^0_4	1.446	1.276
4361.211	40	a^3F_4	$y^5F^0_5$	1.281	1.474
4354.802	12	a^3P_2	$z^3D^0_1$	1.534	0.519
4354.131	25	a^3F_3	$y^5F^0_3$	1.20	1.20
4349.698	20	b^3P_1	$y^3D^0_2$	1.442	1.173
4346.476	15	a^3P_2	$y^5F^0_3$	1.567	1.206
4342.068	60	a^3F_2	$y^5F^0_2$	1.089	1.035
4337.266	15	a^3F_4	$y^5F^0_4$	1.283	1.366
4327.429	7	a^3F_3	$z^5S^0_2$	1.194	2.029
4326.825	20	a^3P_2	$y^5D^0_2$	1.529	1.473
4325.052	25	b^3P_2	$x^5D^0_3$	1.320	1.428
4319.869	20	a^5P_2	$z^5S^0_2$	1.562	2.032
4318.433	15	a^5D_2	$y^5F^0_2$	1.231	1.029
4316.638	12	a^3F_2	$z^7P^0_2$	1.084	2.055
4297.711	60	a^3F_3	$z^3G^0_4$	1.19	1.11
4295.928	20	b^3F_4	$z^3D^0_3$	1.26	1.13
4294.791	20	a^5D_3	$z^3G^0_3$	1.421	0.871
4293.284	15	a^5D_2	$z^7P^0_2$	1.235	2.061
4287.046	15	b^3P_2	$y^3D^0_2$	1.313	1.172
4284.331	25	a^5D_2	$z^3D^0_3$	1.227	1.127
4277.255	7	b^3P_0	$x^5D^0_1$	0/0	1.570
4260.004	12	a^3P_2	$y^5D^0_1$	1.54	1.54
4258.987	15	b^3P_2	$z^3P^0_2$	1.316	1.470
4248.143	12	a^3D_2	41^0_1	1.15	1.56
4246.334	15	a^1G_4	$a40^0_4$	0.991	1.107
4243.061	100	a^5D_4	$y^5F^0_5$	1.447	1.203
4241.053	100	a^5P_3	$z^7P^0_2$	1.626	2.062
4232.322	40	a^5P_3	$z^3D^0_3$	1.621	1.127
4230.312	60	a^5D_3	$y^5F^0_2$	1.422	1.034
4229.309	40	b^3P_1	$y^3D^0_1$	1.440	0.752
4225.092	25	a^1P_1	$b63^0_2$	0.95	1.03
4220.675	60	b^3P_1	$x^5D^0_2$	1.443	1.443
4217.268	100	a^3F_4	$z^7P^0_4$	1.285	1.658
4207.636	20	b^3P_0	41^0_1	0/0	1.570
4206.016	100	a^3F_3	$z^3G^0_3$	1.196	0.870
4198.875	60	a^5P_2	$z^3G^0_3$	1.559	0.865
4197.579	100	a^5D_3	$z^3D^0_3$	1.417	1.128
4196.871	60	b^3P_1	$x^5D^0_0$	1.443	0/0
4182.644	15	a^5D_4	$z^7P^0_3$	1.448	1.895
4170.051	20	b^3P_2	$y^3D^0_1$	1.316	0.756
4167.512	100	a^3F_2	$z^3D^0_2$	1.085	1.023
4166.876	20	a^3F_4	$z^5G^0_3$	1.287	0.947
4161.656	25	b^3P_2	$x^5D^0_2$	1.317	1.442
4150.299	20	a^5D_0	$z^3D^0_1$	0/0	0.518
4148.375	60	a^5D_1	$z^3D^0_2$	1.808	1.031
4146.771	100	a^5P_1	$y^5D^0_2$	1.991	1.483
4145.738	125	a^5D_2	$z^3D^0_2$	1.233	1.024
4144.164	150	a^3F_3	$y^5F^0_2$	1.199	1.037
4137.234	25	a^5P_2	$y^5F^0_2$	1.559	1.032
4127.868	25	b^3P_1	$x^5D^0_1$	1.445	1.570
4127.440	20	a^5F_3	$z^5D^0_4$	1.24	1.48
4123.813	20	a^3D_3	$a50^0_2$	1.320	0.878
4123.064	25	a^3F_2	$y^5D^0_3$	1.086	1.494
4120.987	25	a^3F_3	$z^7P^0_2$	1.192	2.054
4113.383	40	a^3D_1	$a53^0_1$	0.676	0.893
4112.741	125	a^3F_3	$z^3D^0_3$	1.199	1.135
4107.837	25	a^1G_4	44^0_4	0.996	1.118
4101.745	20	a^5D_2	$y^5D^0_3$	1.233	1.497
4097.791	20	a^3P_1	$z^3D^0_1$	1.092	0.527
4097.026	15	a^5P_3	$z^3D^0_1$	1.63	1.03
4091.062	20	b^3D_2	56^0_3	1.179	1.281
4085.429	40	a^5P_1	$y^5D^0_1$	1.983	1.524
4085.429	40	a^3D_1	54^0_2	0.678	0.890
4082.794	15	a^3P_0	$x^5F^0_1$	0/0	0.148
4080.600	125	a^3F_4	$y^5F^0_3$	1.291	1.217
4079.277	12	a^5D_1	$z^3D^0_1$	1.78	0.51
4076.733	60	a^5D_2	$z^3D^0_1$	1.235	0.523
4073.00	2	a^3F_2	$y^5D^0_2$	1.089	1.478
4071.398	12	b^3P_2	$x^5D^0_1$	1.314	1.570
4068.366	40	a^1G_4	$a44^0_4$	0.991	0.892
4067.613	25	a^3D_3	52^0_3	1.333	1.163
4064.456	20	a^5D_3	$z^3D^0_2$	1.422	1.027
4064.105	15	a^5D_0	$y^5D^0_1$	0/0	1.527
4062.988	12	b^3P_1	41^0_1	1.445	1.570
4054.051	40	a^5P_3	$y^5D^0_3$	1.625	1.497
4052.195	25	a^5D_2	$y^5D^0_2$	1.227	1.470
4051.400	125	a^5P_3	$y^5D^0_4$	1.61	1.48
4049.413	15	a^3D_2	$y^3P^0_2$	1.167	1.299
4045.762	25	b^3D_2	57^0_2	1.18	1.18
4039.210	25	a^1G_4	$a45^0_5$	0.996	1.141
4037.737	12	a^5P_1	$y^5D^0_0$	1.982	0/0
4032.205	20	a^5F_2	$z^5D^0_3$	0.999	1.425
4023.833	25	a^5F_4	$z^7D^0_3$	1.347	1.737
4022.161	40	a^5D_3	$y^5D^0_3$	1.421	1.488
4020.995	15	a^3D_2	$y^3P^0_1$	1.160	1.609
4013.505	15	a^5D_4	$z^3D^0_3$	1.458	1.141
4008.269	20	b^3P_2	41^0_1	1.308	1.566
4007.535	20	b^3P_0	$y^5P^0_1$	0/0	2.312
4005.640	25	a^5P_3	$y^5D^0_2$	1.626	1.481
3996.509	10	a^5D_2	$z^5P^0_3$	1.24	1.65
3995.977	30	a^5D_1	$y^5D^0_1$	1.793	1.523
3993.531	10	a^5D_2	$y^5D^0_1$	1.230	1.519
3987.795	3	a^3D_3	55^0_3	1.330	1.238
3984.858	60	a^3F_3	$z^3D^0_2$	1.198	1.025
3979.424	60	a^5F_4	$z^5D^0_4$	1.347	1.485
3978.445	60	a^5P_2	$z^3D^0_2$	1.569	1.028
3969.794	8	a^3P_2	$x^5F^0_3$	1.52	1.26
3964.896	50	a^5F_5	$z^7D^0_5$	1.397	1.594
3957.449	8	a^5P_1	$z^5P^0_2$	1.985	1.808
3952.678	20	a^3D_3	56^0_3	1.33	1.28
3951.207	10	a^5P_3	$z^5P^0_3$	1.62	1.64
3950.412	10	a^5D_1	$y^5D^0_0$	1.796	0/0
3950.214	12	a^3F_4	$z^3G^0_3$	1.280	0.866
3949.417	10	b^3F_2	$x^5D^0_3$	0.74	1.41
3946.314	8	a^3P_1	$z^3P^0_2$	1.691	1.475
3945.572	50	a^3G_3	44^0_4	0.753	1.112
3942.063	12	a^5F_1	$z^5D^0_2$	0	1.324
3933.546	20	a^5F_3	$z^5D^0_3$	1.247	1.427
3931.759	50	a^3G_4	$a40^0_4$	1.032	1.105
3931.759	50	a^5P_1	$z^5P^0_1$	1.981	2.384
3925.925	60	a^5F_5	$z^7D^0_4$	1.397	1.625
3920.915	20	a^5D_3	$z^5P^0_3$	1.423	1.650
3914.853	20	a^5P_2	$z^3D^0_1$	1.563	0.518
3912.112	10	a^5D_0	$z^5P^0_1$	0/0	2.384
3911.144	6	a^3P_1	$z^3P^0_1$	1.683	1.312
3909.075	30	a^3G_3	$a44^0_4$	0.764	0.898
3908.765	12	a^1G_4	50^0_4	0.988	1.032
3898.361	12	a^3F_3	$y^5D^0_2$	1.197	1.478
3897.236	12	b^3F_4	$x^5F^0_5$	1.259	1.400
3892.773	10	a^1P_1	$a70^0_2$	0.928	1.086
3892.209	50	a^5P_2	$y^5D^0_2$	1.559	1.478
3891.410	20	a^3D_3	58^0_3	1.334	1.168
3890.197	30	a^3F_2	$z^5P^0_2$	1.090	1.808
3887.772	15	a^3D_2	52^0_3	1.16	1.16
3884.676	20	a^3G_3	45^0_3	0.754	0.967
3884.016	20	a^1G_4	51^0_4	0.993	1.195
3882.006	12	a^5F_2	$z^5D^0_2$	1.000	1.327
3880.806	5	b^3P_1	$y^3P^0_2$	1.42	1.29
3876.648	12	b^3P_2	45^0_3	1.313	0.966
3876.082	20	b^3P_1	$y^5P^0_1$	1.436	2.315
3873.525	30	a^5D_1	$z^5P^0_2$	1.81	1.81
3871.215	10	a^5D_2	$z^5P^0_2$	1.230	1.800
3867.839	60	a^3F_4	$z^3D^0_3$	1.286	1.136
3865.403	10	a^3F_2	$z^5P^0_1$	1.090	2.388
3859.712	6	a^3H_4	$f59^0_3$	0.830	0.990
3858.686	4	a^3D_1	$d59^0_0$	0.681	0/0
3856.459	50	a^5F_3	$z^5F^0_4$	1.251	1.363
3854.727	10	b^3P_1	$y^3P^0_1$	1.449	1.611
3852.137	12	b^3D_2	$f59^0_3$	1.173	0.997
3846.805	5	a^3F_3	$z^5P^0_3$	1.197	1.646
3846.676	12	a^5D_2	$z^5P^0_1$	1.229	2.383
3843.159	10	a^5F_1	$z^5D^0_1$	0	0.944
3842.661	6	a^3P_1	$x^5D^0_0$	1.688	0
3840.985	8	a^3H_6	$a56^0_6$	1.164	1.013
3840.76	4	a^5P_2	$z^5P^0_3$	1.57	1.65
3839.695	50	a^3G_5	$a40^0_4$	1.190	1.112
3838.728	10	a^3G_3	$y^3P^0_2$	0.74	1.28
3835.048	50	a^1G_4	52^0_3	0.990	1.156
3831.795	60	a^3G_5	$b40^0_5$	1.187	1.045
3830.877	10	b^3P_2	$y^3P^0_2$	1.31	1.31
3828.714	30	a^5P_3	$z^5P^0_2$	1.625	1.807
3826.105	8	a^3D_2	54^0_2	1.156	0.884
3824.932	30	a^3P_2	$x^5D^0_3$	1.527	1.419
3822.091	50	a^3D_3	$a59^0_4$	1.338	1.247
3819.767	12	b^3F_2	$y^3D^0_1$	0.76	0.76
3819.033	50	a^5F_2	$z^5F^0_3$	0.997	1.295
3812.718	12	a^3G_4	44^0_4	1.032	1.112
3808.684	50	a^1G_4	53^0_3	0.990	1.128
3805.434	10	b^3P_2	$y^3P^0_1$	1.313	1.602
3800.261	12	a^5D_3	$z^5P^0_2$	1.41	1.80
3799.347	70*r*	a^5F_5	$z^5D^0_4$	1.394	1.479
3798.901	70	a^5F_4	$z^5D^0_3$	1.347	1.427
3798.052	30	a^5F_1	$z^5F^0_2$	0	1.170
3795.175	12	a^3P_2	$y^3D^0_2$	1.538	1.175
3794.924	20	a^5P_1	$x^5F^0_2$	1.991	1.071
3794.924	20	a^3D_3	$c59^0_2$	1.331	1.026
3790.513	70	a^5F_3	$z^5D^0_2$	1.248	1.317
3779.964	10	a^3P_0	$x^5D^0_1$	0/0	1.563
3778.701	12	a^3G_4	$a44^0_4$	1.029	0.892
3777.759	3	b^3D_2	63^0_2	1.16	1.16
3777.586	60	a^5F_1	$z^5D^0_0$	0	0/0
3773.170	12	a^3P_2	$z^3P^0_2$	1.540	1.476
3767.350	50	a^3G_3	49^0_3	0.756	0.885
3764.032	6	a^1G_4	55^0_3	0.995	1.237
3761.508	12	a^3G_3	50^0_4	0.758	1.036
3760.031	20	a^5F_1	$z^5F^0_1$	0	0.567
3759.836	12	a^5D_4	$z^5P^0_3$	1.440	1.640
3755.931	30	a^3G_4	45^0_3	1.02	0.96
3755.727	6	a^5P_1	$x^5F^0_1$	1.979	0.145
3755.090	20	a^3F_2	$x^5F^0_3$	1.085	1.272
3753.545	30	a^3G_4	$a45^0_5$	1.038	1.145
3744.219	8	a^5P_3	$x^5F^0_4$	1.627	1.359
3742.280	70	a^5F_2	$z^5F^0_2$	0.998	1.158
3739.465	20	a^3G_3	$a50^0_2$	0.750	0.888
3738.629	8	a^3G_3	51^0_4	0.760	1.195
3737.741	6	a^5D_0	$x^5F^0_1$	0/0	0.149
3733.049	10	a^3F_2	$x^5F^0_2$	1.085	1.065
3732.029	6	b^3P_2	$a50^0_2$	1.315	0.895
3730.592	2	a^3F_3	$z^5P^0_2$	1.187	1.803
3730.433	12	a^5F_3	$z^5F^0_3$	1.247	1.291
3728.030	100	a^5F_5	$z^5F^0_5$	1.39	1.39
3726.926	100	a^5F_4	$z^5F^0_4$	1.340	1.366
3726.096	12	a^3G_5	44^0_4	1.184	1.115
3725.486	8	a^3P_0	41^0_1	0/0	1.558
3724.969	12	a^5P_2	$z^5P^0_2$	1.569	1.812
3722.312	5	b^3D_2	$b63^0_2$	1.19	1.03
3719.329	20	a^3H_4	64^0_3	0.832	0.930
3717.004	30	a^5D_3	$x^5F^0_4$	1.418	1.364
3716.179	12	a^3F_4	$y^5D^0_4$	1.279	1.497
3715.562	12	a^5D_2	$x^5F^0_2$	1.240	1.071
3712.295	30	b^3D_2	64^0_3	1.171	0.933
3703.206	12	a^3P_2	$y^3D^0_1$	1.537	0.754
3702.240	6	a^5P_2	$z^5P^0_1$	1.569	2.396
3700.991	50	a^3H_4	$a64^0_5$	0.840	1.035
3697.861	4	b^3P_1	$a53^0_1$	1.43	0.89
3697.764	8	a^5P_3	$x^5F^0_3$	1.625	1.279
3696.587	50	a^3P_2	$x^5D^0_2$	1.534	1.442
3693.591	20	a^3G_5	$a44^0_4$	1.197	0.902
3685.951	10	b^3P_2	52^0_3	1.313	1.159
3685.068	8	a^3D_1	$a63^0_1$	0.677	0.800
3676.670	8	a^3D_1	$b63^0_2$	0.674	1.027
3675.262	6	b^3P_1	54^0_2	1.447	0.892
3671.219	10	a^5D_3	$x^5F^0_3$	1.426	1.281
3669.494	50	a^3G_5	$a45^0_5$	1.194	1.146
3661.353	60	a^5F_4	$z^3G^0_5$	1.348	1.237
3650.322	3	a^3F_3	$x^5F^0_4$	1.199	1.361
3646.114	2	a^3G_4	49^0_3	1.034	0.894
3640.640	3	a^3G_4	50^0_4	1.03	1.03
3638.016	1	a^3D_2	$c59^0_2$	1.160	1.022
3637.466	2	a^3G_3	54^0_2	0.753	0.883

TABLE III.—*Continued.*

λ(A)	I	T_1	T_2	g_1	g_2	λ(A)	I	T_1	T_2	g_1	g_2	λ(A)	I	T_1	T_2	g_1	g_2
3635.516	2	a^5P_1	$z^3P_2^0$	1.985	1.470	3401.505	30	a^3D_1	$w^5D_0^0$	0.673	0/0	3111.912	50	a^5D_2	54_2^0	1.232	0.892
3634.929	50	a^5F_3	$y^5F_4^0$	1.253	1.371	3392.537	100	a^5F_5	$y^5F_5^0$	1.404	1.478	3100.839	70	a^5F_4	26_3^0	1.350	1.508
3631.711	2	a^3F_4	$z^5P_3^0$	1.280	1.644	3391.890	50	b^3P_0	$a67_1^0$	0/0	1.348	3091.873	50	a^5F_2	$z^5P_1^0$	1.001	2.388
3619.202	2	a^3G_4	51_4^0	1.030	1.195	3389.500	60	a^5F_2	$y^5F_2^0$	1.002	1.026	3089.801	60	a^3F_3	51_4^0	1.19	1.19
3616.951	2	b^3F_4	$x^5D_3^0$	1.256	1.424	3388.709	80	b^3F_2	53_3^0	0.764	1.136	3080.193	30	b^3F_2	$b63_2^0$	0.75	1.01
3608.727	2	a^5D_2	$x^5D_3^0$	1.239	1.430	3385.707	50	b^3P_1	63_2^0	1.435	1.156	3054.937	70	a^5P_2	52_3^0	1.559	1.157
3605.641	2	a^5P_1	$z^3P_1^0$	1.979	1.308	3380.175	60	a^5P_2	$y^3D_1^0$	1.570	0.764	3048.785	60	a^5F_3	$z^5P_2^0$	1.248	1.810
3599.764	12	a^5P_3	$x^5D_4^0$	1.615	1.479	3379.605	60	b^3F_3	49_3^0	1.082	0.888	3045.710	60	a^3F_2	59_2^0	1.083	1.006
3590.886	2	a^3D_2	$e59_1^0$	1.168	0.809	3374.646	80	a^5P_2	$x^5D_2^0$	1.557	1.447	3042.475	70	a^5F_1	$x^5F_2^0$	0	1.070
3589.215	60	a^5F_1	$z^5G_2^0$	0	0.373	3371.860	70	a^5D_2	$y^5P_3^0$	1.237	1.631	3040.310	60	a^5F_4	$z^5P_3^0$	1.347	1.648
3584.198	2	a^5D_1	$y^3D_2^0$	1.792	1.171	3368.451	100	a^5F_2	$z^3D_3^0$	1.003	1.131	3038.176	80	a^5P_2	53_3^0	1.58	1.14
3579.768	3	a^5F_3	14_2^0	1.249	1.497	3362.335	50	a^3D_3	$a70_2^0$	1.333	1.087	3034.060	60	a^5D_2	59_2^0	1.233	1.005
3572.015	3	a^3P_1	$y^5P_1^0$	1.684	2.321	3362.003	60	b^3F_2	54_2^0	0.765	0.883	3033.451	70	a^5D_4	51_4^0	1.448	1.197
3567.155	3	b^3P_1	59_2^0	1.442	1.005	3359.095	70	a^5F_3	$z^3G_3^0$	1.245	0.868	3030.781	30	a^5P_3	57_2^0	1.633	1.190
3564.562	4	a^5D_1	$z^3P_2^0$	1.81	1.48	3347.613	60	b^3P_2	63_2^0	1.316	1.160	3020.882	60	a^5F_2	$x^5F_3^0$	1.001	1.275
3561.894	2	b^3P_0	$e59_1^0$	0/0	0.811	3341.664	70	b^3F_4	44_4^0	1.257	1.119	3017.236	100	a^5F_1	$x^5F_1^0$	0	0.143
3556.626	3	a^3P_1	$y^3P_0^0$	1.680	0/0	3335.686	70	a^3P_1	57_2^0	1.685	1.179	3013.359	60	a^3F_3	55_3^0	1.198	1.232
3553.848	4	a^3P_1	$y^3P_1^0$	1.679	1.606	3332.643	60	a^3F_4	$x^5D_4^0$	1.276	1.481	3012.916	60	a^5D_3	57_2^0	1.418	1.181
3550.269	4	a^5F_3	$z^7P_4^0$	1.253	1.658	3324.995	60	a^5F_1	$z^3D_2^0$	0	1.020	3008.259	50	a^3F_2	$b59_1^0$	1.094	0.965
3546.982	2	a^5D_3	$x^5D_3^0$	1.42	1.42	3317.888	50	a^5D_3	$y^5P_3^0$	1.428	1.635	3006.590	70	a^5F_2	$x^5F_2^0$	1.001	1.068
3541.631	60	a^3F_4	$x^5F_5^0$	1.294	1.407	3316.386	80	a^3P_2	52_3^0	1.533	1.158	3001.642	60	a^5D_3	58_3^0	1.420	1.161
3541.046	10	a^3G_5	51_4^0	1.18	1.18	3315.228	60	a^5F_4	$z^3G_4^0$	1.340	1.111	2994.964	80	a^5F_3	$x^5F_4^0$	1.24	1.35
3539.369	60	a^5F_2	$z^5G_2^0$	1.001	0.378	3315.047	50	a^5P_2	$x^5D_1^0$	1.56	1.56	2988.948	250	a^5F_5	$y^5D_4^0$	1.39	1.52
3535.831	60	a^5D_1	$z^3P_1^0$	1.796	1.312	3310.957	30	a^5F_4	$z^7P_3^0$	1.356	1.906	2987.705	30	a^5D_1	$c59_2^0$	1.798	1.028
3532.814	60	a^1G_4	$f59_3^0$	0.99	0.99	3304.507	12	b^3P_1	66_2^0	1.42	1.42	2986.335	20	a^5D_2	$c59_2^0$	1.23	1.03
3531.390	60	a^5D_2	$y^3D_3^0$	1.241	1.390	3303.995	60	b^3P_2	$b63_2^0$	1.317	1.028	2981.935	60	a^5F_2	$x^5F_1^0$	0.992	0.139
3528.683	60	a^5F_2	$y^5F_3^0$	1.002	1.204	3301.587	70	a^5F_5	$z^5G_5^0$	1.396	1.268	2968.954	60	a^3F_3	57_2^0	1.21	1.21
3520.130	60	a^5D_1	$z^3P_0^0$	1.791	0/0	3297.955	50	b^3F_4	45_3^0	1.250	0.959	2968.482	15	a^3P_2	$a67_1^0$	1.537	1.364
3519.635	70	a^5F_4	$y^5F_4^0$	1.350	1.364	3294.110	60	a^5F_5	16_4^0	1.40	1.30	2959.736	12	a^5D_4	55_3^0	1.444	1.233
3514.488	70	a^5F_3	$z^5G_3^0$	1.247	0.941	3284.932	30	a^5D_3	$y^5P_2^0$	1.40	1.69	2958.000	60	a^3F_3	58_3^0	1.191	1.167
3501.354	30	b^3P_1	$c59_2^0$	1.449	1.027	3274.706	60	b^3F_3	54_2^0	1.087	0.891	2954.486	100	a^5P_2	58_3^0	1.558	1.160
3497.937	30	a^5D_1	$x^5D_1^0$	1.985	1.573	3273.078	60	a^5P_2	41_1^0	1.56	1.56	2949.500	80	a^3F_4	51_4^0	1.282	1.199
3495.973	60	a^5P_3	$y^3D_3^0$	1.628	1.389	3268.208	60	b^3P_2	66_2^0	1.32	1.42	2946.991	60	a^3F_3	59_2^0	1.201	1.015
3494.251	50	a^5D_2	$x^5D_2^0$	1.237	1.441	3266.445	50	b^3F_3	55_3^0	1.090	1.230	2943.921	50	a^5D_3	$c59_2^0$	1.422	1.029
3490.716	12	b^3P_1	$d59_0^0$	1.441	0	3256.331	50	a^5D_1	$y^5P_1^0$	1.791	2.318	2940.358	50	a^5D_4	56_3^0	1.451	1.285
3481.297	70	a^5P_2	$x^5D_3^0$	1.557	1.420	3254.708	50	a^5D_2	$y^5P_1^0$	1.229	2.312	2939.944	30	a^3P_1	$w^5D_2^0$	1.68	1.48
3473.746	70	b^3F_3	45_3^0	1.083	0.970	3254.542	50	a^5F_2	$y^5D_3^0$	1.001	1.495	2919.608	80	a^5F_1	$z^3P_1^0$	0	1.308
3472.231	60	a^5D_3	$y^3D_3^0$	1.419	1.389	3243.498	70	a^3F_4	$y^3D_3^0$	1.280	1.375	2916.255	100	a^5F_4	$x^5F_4^0$	1.35	1.35
3456.620	60	a^3D_2	64_3^0	1.164	0.938	3241.235	60	a^5D_1	$y^3P_1^0$	1.792	1.605	2905.650	50	a^5F_2	$z^3P_2^0$	1.003	1.473
3452.903	60	a^5F_3	$y^5F_3^0$	1.24	1.21	3242.165	80	a^3P_1	$d59_0^0$	1.684	0/0	2887.995	30	a^5F_4	$x^5F_3^0$	1.34	1.28
3448.953	70	b^3F_2	$a50_2^0$	0.763	0.890	3239.605	50	a^3P_2	56_3^0	1.541	1.285	2886.536	60	a^5F_2	$z^3P_1^0$	1.001	1.318
3440.205	100	a^5F_4	$z^7P_4^0$	1.349	1.658	3238.527	100	a^3D_2	$a70_2^0$	1.167	1.095	2883.595	30	a^5F_3	$x^5D_3^0$	1.253	1.429
3440.205	100	a^5D_4	$x^5D_4^0$	1.440	1.475	3232.751	50	a^3F_3	$y^5P_2^0$	1.196	1.715	2881.276	30	a^5F_1	$x^5D_0^0$	0	0/0
3438.368	70	a^5P_2	$z^3P_2^0$	1.564	1.474	3227.885	20	a^5P_3	$y^3P_2^0$	1.626	1.298	2874.984	80	a^5F_5	$x^5F_5^0$	1.40	1.40
3436.737	300*R*	a^5F_4	$z^5G_5^0$	1.34	1.26	3226.374	50	a^5F_1	$y^5D_1^0$	0	1.515	2854.074	60	a^5F_3	$z^3P_2^0$	1.249	1.469
3435.186	60	a^5F_1	$y^5F_2^0$	0	1.028	3223.274	60	a^5F_2	$y^5D_2^0$	0.998	1.478	2843.171	30	a^5D_1	66_2^0	1.793	1.420
3433.260	60	a^3P_2	$y^3P_2^0$	1.533	1.301	3212.969	10	b^3F_4	49_3^0	1.256	0.886	2834.001	30	a^5F_3	$y^3D_3^0$	1.242	1.375
3432.741	70	b^3F_4	$a40_4^0$	1.254	1.109	3196.591	50	a^5F_1	$y^5D_0^0$	0	0/0	2818.952	50	a^5P_3	66_2^0	1.629	1.428
3430.772	70	a^5F_2	$z^3G_3^0$	0.999	0.869	3194.738	4	a^3G_4	$a64_5^0$	1.03	1.03	2817.093	50	a^5F_2	$x^5D_1^0$	0.994	1.565
3429.542	60	a^3P_2	$y^5P_1^0$	1.534	2.314	3192.069	10	b^3F_4	51_4^0	1.253	1.196	2722.697	40	a^5D_1	$w^5D_2^0$	1.794	1.480
3425.964	30	a^3D_2	66_2^0	1.162	1.420	3189.976	50	a^5F_3	$y^5D_3^0$	1.251	1.498	2721.562	60	a^5D_2	$w^5D_2^0$	1.236	1.487
3420.078	60	a^3P_1	$a53_1^0$	1.686	0.890	3186.044	80	a^5F_2	$y^5D_1^0$	0.998	1.515	2719.515	100	a^5D_4	$w^5D_4^0$	1.46	1.46
3419.252	30	a^5F_1	$z^7P_2^0$	0	2.061	3171.239	20	a^5D_0	$a53_1^0$	0/0	0.886	2702.832	80	a^3F_3	$w^5D_3^0$	1.197	1.449
3417.353	1	a^5F_3	$z^3G_4^0$	1.244	1.113	3168.525	100	b^3F_2	$f59_3^0$	0.757	0.994	2701.338	60	a^3F_2	$w^5D_1^0$	1.087	1.439
3416.182	50	a^3P_0	$a53_1^0$	0/0	0.898	3159.923	70	a^5F_3	$y^5D_2^0$	1.250	1.481	2664.757	60	a^5F_4	$y^5P_3^0$	1.346	1.625
3411.636	80	a^5P_2	$z^3P_1^0$	1.571	1.318	3158.889	60	b^3F_4	52_3^0	1.258	1.170	2651.841	100	a^3F_4	$w^5D_4^0$	1.284	1.473
3409.277	100	a^5P_2	$y^3D_3^0$	1.556	1.380	3140.973	60	b^3F_4	53_3^0	1.253	1.142	2651.292	60	a^3F_3	$w^5D_2^0$	1.21	1.50
3405.880	50	b^3P_2	$f59_3^0$	1.319	0.995	3140.484	50	a^3F_2	$a53_1^0$	1.094	0.898						
3401.739	100	a^5P_1	$y^5P_2^0$	1.984	1.712	3125.963	70	a^5F_3	$z^5P_3^0$	1.248	1.647						

g_1-g_2. To illustrate the degree of uniformity found, some typical patterns have been included in Table II. Space requirements forbid the inclusion of the detailed patterns for all of the lines listed in the main table (Table III), but the g values obtained for a given term from different lines show such good agreement that the method of reduction used appears justified. Since only classified lines are included in Table III, it is possible to compare various independent determinations of a given g value. The final averaged values for 140 terms are given in Table IV.

In Tables II and III the wave-lengths used are taken from the *M.I.T. Wavelength Tables*, while the intensities are those given in the arc column of the same tables. The term designations are those of McNally,[7] based on an extension of the analysis of Sommer.[1] In Table II the π components are in parenthesis, while the strongest lines of a pattern are in boldface. In Table III g_1 is the g value of the even term T_1, while g_2 is that of the odd term T_2.

In Table IV the same term designations are used, while the term values are those derived by McFee[6] from M.I.T. wave-length data. The column headed g (Theor.) contains the theoretical g values for the term designations used,

TABLE IV. *Term values and theoretical and measured g values in the arc spectrum of ruthenium.*

Term	Term Value	g (Theor.)	g (Meas.)	No. Meas.	No. Lines	Term	Term Value	g (Theor.)	g (Meas.)	No. Meas.	No. Lines	Term	Term Value	g (Theor.)	g (Meas.)	No. Meas.	No. Lines
							Even Terms										
a^5F_5	0	1.400	1.397	12	6	b^3F_4	9120.69	1.250	1.255	15	11	b^3P_1	13,981.80	1.500	1.441	26	12
a^5F_4	1190.67	1.350	1.349	21	12	a^3F_2	9183.69	0.667	1.089	31	17	a^1G_4	14,700.34	1.000	0.992	18	8
a^5F_3	2091.52	1.250	1.249	32	17	a^5D_0	9492.35	0/0	0/0	7	5	b^3P_0	14,827.53	0/0	0/0	10	5
a^5F_2	2713.22	1.000	1.000	38	17	a^5P_1	9620.33	2.500	1.985	21	10	a^3D_2	15,054.01	1.167	1.162	13	9
a^5F_1	3105.46	0	0	31	18	a^3P_2	10,623.49	1.500	1.534	24	14	a^3H_6	15,550.17	1.167	1.164	1	1
a^3F_4	6545.05	1.250	1.284	20	13	b^3F_3	10,654.52	1.083	1.086	10	6	a^3D_3	16,190.63	1.333	1.333	7	4
a^5D_4	7483.14	1.500	1.447	21	12	b^3F_2	11,447.23	0.667	0.764	13	7	a^3H_5	16,240.02	1.033	1.041	1	1
a^5P_2	8043.77	1.833	1.563	32	16	a^3P_0	11,752.74	0/0	0/0	8	6	a^3D_1	16,712.59	0.500	0.676	12	6
a^3F_3	8084.13	1.083	1.196	35	20	a^3P_1	11,786.17	1.500	1.684	8	6	b^3D_2	17,046.01	1.167	1.175	10	5
a^5D_3	8575.45	1.500	1.420	30	17	a^3G_5	12,207.10	1.200	1.190	7	4	a^3H_4	17,096.83	0.800	0.834	6	3
a^5P_3	8770.98	1.667	1.624	29	16	a^3G_4	12,816.69	1.050	1.033	11	6	a^1P_1	20,242.05	1.000	0.927	3	2
a^5D_2	9057.64	1.500	1.232	42	21	b^3P_2	13,645.73	1.500	1.315	31	15	$a10_2$	20,933.76	—	1.343	2	1
a^5D_1	9073.06	1.500	1.795	21	14	a^3G_3	13,699.11	0.750	0.757	23	9						
							Odd Terms										
$z^7D_5^0$	25,214.32	1.600	1.592	2	1	$y^5D_2^0$	33,728.67	1.500	1.477	16	8	$y^3P_1^0$	39,916.71	1.500	1.606	7	4
$z^7D_4^0$	25,464.54	1.650	1.625	4	1	$z^5P_3^0$	34,072.44	1.667	1.646	11	6	49_3^0	40,235.39	—	0.890	10	4
$z^7D_3^0$	26,035.63	1.750	1.737	2	1	$y^5D_1^0$	34,091.16	1.500	1.522	10	6	50_4^0	40,276.54	—	1.035	3	2
$z^5D_4^0$	26,312.86	1.500	1.486	7	5	$y^5D_0^0$	34,379.78	0/0	0/0	8	4	$a50_2^0$	40,433.18	—	0.889	6	4
$z^5D_3^0$	27,506.63	1.500	1.425	11	8	$x^5F_5^0$	34,772.64	1.400	1.402	3	2	51_4^0	40,439.24	—	1.196	6	4
$z^5F_4^0$	28,014.88	1.350	1.364	5	3	$z^5P_2^0$	34,881.94	1.833	1.808	13	7	52_3^0	40,768.17	—	1.159	12	5
$z^5D_2^0$	28,465.60	1.500	1.324	8	5	$z^5P_1^0$	35,046.74	2.500	2.385	10	5	53_3^0	40,948.78	—	1.137	8	4
$z^3G_5^0$	28,495.26	1.200	1.230	8	2	$x^5F_4^0$	35,471.22	1.350	1.364	4	3	$a53_1^0$	41,016.66	—	0.892	7	6
$z^5F_3^0$	28,890.60	1.250	1.293	6	3	$x^5F_3^0$	35,806.65	1.250	1.276	7	4	54_2^0	41,182.69	—	0.887	15	7
$z^5D_1^0$	29,118.48	1.500	0.953	3	3	$x^5F_2^0$	35,963.89	1.000	1.069	8	4	55_3^0	41,260.11	—	1.235	8	5
$z^5F_2^0$	29,427.44	1.000	1.164	4	2	$x^5F_1^0$	36,238.86	0.000	0.145	6	5	56_3^0	41,482.69	—	1.286	6	4
$y^5F_5^0$	29,467.93	1.400	1.474	5	2	$x^5D_4^0$	36,542.67	1.500	1.481	3	2	$a56_6^0$	41,577.82	—	1.013	1	1
$z^5D_0^0$	29,570.05	0/0	0/0	3	2	$x^5D_3^0$	36,760.40	1.500	1.426	19	7	57_2^0	41,756.21	—	1.182	4	3
$y^5F_4^0$	29,594.63	1.350	1.370	7	4	$y^3D_2^0$	36,965.26	1.167	1.173	9	4	58_3^0	41,880.86	—	1.163	3	3
$z^5F_1^0$	29,693.73	0.000	0.567	4	2	$z^3P_2^0$	37,119.04	1.500	1.469	12	8	59_2^0	42,007.24	—	1.007	8	4
$z^5G_4^0$	29,890.99	1.150	1.654	1	1	$z^3P_1^0$	37,346.86	1.500	1.311	8	6	$a59_4^0$	42,346.79	—	1.247	1	1
14_2^0	30,018.39	—	1.497	1	1	$y^3D_3^0$	37,367.03	1.333	1.379	7	4	$b59_1^0$	42,415.85	—	0.965	2	1
$z^7P_4^0$	30,250.42	1.750	1.656	9	4	$z^3P_0^0$	37,473.00	0/0	0/0	1	1	$c59_2^0$	42,534.04	—	1.025	7	6
$z^5G_5^0$	30,279.74	1.267	1.263	5	3	$y^3D_1^0$	37,619.54	0.500	0.756	9	5	$d59_0^0$	42,621.04	—	0/0	5	3
16_4^0	30,348.49	—	1.276	5	2	$x^5D_2^0$	37,667.86	1.500	1.442	9	4	$e59_1^0$	42,894.54	—	0.810	3	3
$z^5G_3^0$	30,537.13	0.911	0.944	9	5	$x^5D_0^0$	37,802.30	0/0	0/0	3	2	$f59_3^0$	42,998.32	—	0.995	8	5
$z^5G_2^0$	30,958.89	0.333	0.375	8	2	$x^5D_1^0$	38,200.61	1.500	1.569	9	4	63_2^0	43,509.17	—	1.158	2	2
$y^5F_3^0$	31,044.36	1.250	1.204	13	6	$a40_4^0$	38,243.47	—	1.107	3	3	$a63_1^0$	43,841.57	—	0.800	1	1
$z^5S_2^0$	31,186.10	2.000	2.034	10	6	$b40_5^0$	38,297.16	—	1.048	4	1	$b63_2^0$	43,903.74	—	1.026	4	2
$z^3G_4^0$	31,345.86	1.050	1.111	14	5	41_1^0	38,587.25	—	1.566	7	5	64_3^0	43,975.78	—	0.934	6	3
$z^7P_3^0$	31,384.77	1.917	1.895	1	1	42_3^0	38,706.42	—	1.631	5	3	$a64_5^0$	44,109.12	—	1.033	2	1
$z^3G_3^0$	31,852.94	0.750	0.868	21	8	$y^5P_2^0$	39,008.72	1.833	1.713	6	2	66_2^0	44,234.72	—	1.422	7	4
$y^5F_2^0$	32,207.68	1.000	1.032	20	8	44_4^0	39,037.22	—	1.115	7	5	$w^5D_4^0$	44,243.49	1.500	1.473	1	1
$z^7P_2^0$	32,343.35	2.333	2.059	8	5	$a44_4^0$	39,273.33	—	0.895	8	4	$a67_1^0$	44,301.22	—	1.350	2	1
$z^3D_3^0$	32,392.00	1.333	1.133	12	8	45_3^0	39,433.83	—	0.968	6	4	$w^5D_3^0$	45,071.31	1.500	1.449	1	1
$z^3D_2^0$	33,172.07	1.167	1.026	16	7	$a45_5^0$	39,450.67	—	1.142	7	3	$w^5D_2^0$	45,790.44	1.500	1.484	2	1
$y^5D_3^0$	33,430.70	1.500	1.496	10	6	$y^3P_2^0$	39,742.19	1.500	1.299	7	4	$a70_2^0$	45,923.30	—	1.089	3	3
$y^5D_4^0$	33,446.86	1.500	1.492	3	2	$y^5P_1^0$	39,773.54	2.500	2.315	6	3	$w^5D_0^0$	46,102.99	0/0	0/0	1	1
$z^3D_1^0$	33,580.19	0.500	0.522	19	7	$y^3P_0^0$	39,894.61	0/0	0/0	1	1	$w^5D_1^0$	46,191.18	1.500	1.439	1	1

while that headed g (Meas.) contains the final g values obtained by averaging a number of independent determinations, the number of which is given in the next column. The final column gives the number of spectrum lines (each measured several times) whose patterns were reduced to give the final average.

An example of the use of Zeeman effect data in determining L and S values is given by the terms $9057.64-a^5D_2$ and $9183.69-a^3F_2$. The designations of these two terms were originally interchanged, but a consideration of the g values of each leads to the adopted notation. The theoretical LS g value for a^5D_2 is 1.500, while that for a^3F_2 is 0.667. Mutual perturbation between two such terms would be expected to bring their g values closer together, and we find, in fact, 1.232 and 1.089. If the original term designations had been kept the two g values would have crossed. Intensity considerations make either designation possible for either term, and each term does, of course contain much of both designations.

Similar considerations have led to interchange of the designations of the terms a^5D_1 and a^5P_1, where a theoretical g value of 1.500 has been

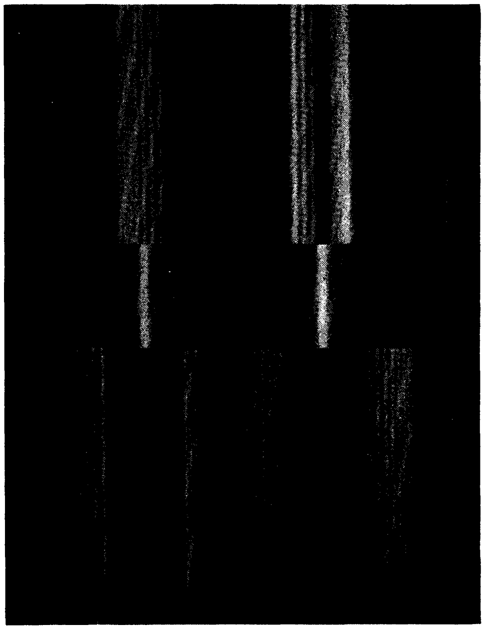

FIG. 1. Asymmetrical Zeeman patterns at 88,350 gauss produced by magnetic perturbations between terms $y^5D_3^0$ and $y^5D_4^0$ of Ru I. To the left, line 3100.839, to the right 3099.283A. The π components are above and the σ components below, while the center strip shows the two lines without magnetic resolution.

raised by perturbation to 1.795, while one of 2.500 has been reduced to 1.985.

ASYMMETRICAL PATTERNS

Several dozen patterns are found to be asymmetrical to a degree which renders uncertain calculation of meaningful g values. Some of these occur in lines which originate in the terms $y^5D_4^0$ and $y^5D_3^0$, which lie only 16.16 cm^{-1} apart. Though these terms have different J values they both have the calculated LS g value 1.500, and when the asymmetries are averaged the measured g values are 1.492 and 1.496, respectively. Two lines, which show the asymmetries arising from the mutual perturbations between these magnetic sub-terms, 3100.839 and 3099.283A, are reproduced in Fig. 1.

The displacements from the zero position of the magnetic sub-levels of these two terms by a field of 88,700 gauss were determined by averaging measurements on six pairs of lines at several close-lying fields (Z-49, Z-74). The results are as follows, all positions being given in cm^{-1}:

m	-4		∓ 3		∓ 2		∓ 1		0		± 1		± 2		± 3		$+4$
$y^5D_4^0$	-24.54,		-18.14,		-11.86,		-5.65,		$+0.53$,		$+6.69$,		$+12.70$,		$+18.68$,		$+24.59$
Δ		-6.40		-6.28		-6.21		-6.18		-6.16		-6.01		-5.98		-5.91	
$y^5D_3^0$			$+18.19$,		$+11.86$,		$+5.59$,		-0.59,		-6.72,		-12.78,		-18.74		
Δ				$+6.33$		$+6.27$		$+6.18$		$+6.13$		$+6.06$		$+5.96.$			

The pattern for the two terms taken together is seen to remain essentially symmetrical, while the various magnetic sub-levels having identical m values repel one another.

A great many partially-resolved patterns which are found on the plates can be reduced to give further data, but as methods for dealing with this material are now being improved, their discussion will be postponed. The application of the g group Sum Rule to the data, the detailed consideration of asymmetrical patterns, and the interpretation of the magnetic perturbations observed, will be postponed until the spectrum is more fully classified.

We are grateful to the M.I.T.–W.P.A. Wavelength Project for valuable data and assistance, and to the Rumford Committee of the American Academy of Arts and Sciences for a grant to assist in the purchase of pure chemicals.

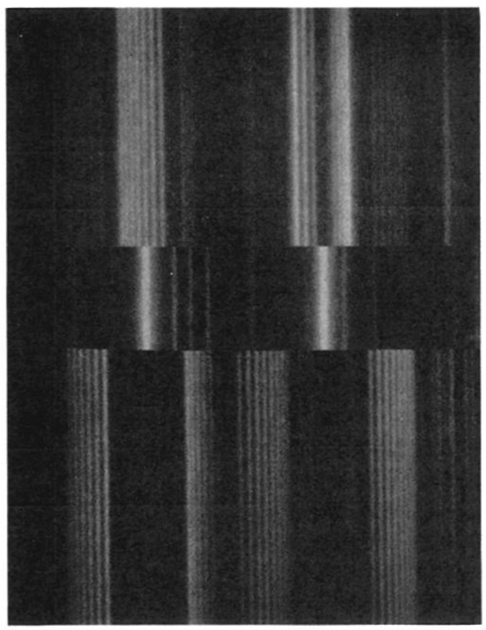

FIG. 1. Asymmetrical Zeeman patterns at 88,350 gauss produced by magnetic perturbations between terms $y^5D_3^0$ and $y^5D_4^0$ of Ru I. To the left, line 3100.839, to the right 3099.283A. The π components are above and the σ components below, while the center strip shows the two lines without magnetic resolution.