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The Spectrum of Neutral Tungsten, W I

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An analysis of the W I spectrum has yielded 300 levels, of which 201 have been given tentative magnetic g values. Configurations, as well as L and S values, have been assigned to the 65 levels $5d^46s^2\,{}^5D\,{}^3HGFDP$, $5d^56s\,{}^{7,5}S\,{}^5G$, $5d^46s({}^6D)7s\,{}^{7,5}D$, $5d^46s({}^6D)6p\,{}^{7,5}FDP$ with 18 definite ambiguities due to a mixing of eigenfunctions. All the low levels are believed to be known. The ionization potential is (7.94 ± 0.1) volts. A rectangular array of the transitions is given.

1. INTRODUCTION, AND SUMMARY OF RESULTS

THE science of the classification of atomic spectra has progressed so far in the last fifteen years that it seems desirable to view what has been accomplished and where knowledge is still lacking.

Naturally classification began with the simplest spectra. A spectrum may be called simple if it shows one or both of the following traits:

(1) It has but few lines.

(2) It shows pronounced coupling character.

Passing over the trivial case of the alkali-like spectra, we see that to the first category there belong the spectra of the occupants of those columns of the periodic table characterized by partly filled p shells. The spectra of the alkaline earths and of Ni, Pd, Pt, with almost closed d shells, also belong in this category. In most of these elements, notably among the heavier ones of them, regularities consisting of constant differences, i.e., levels, have been known for a long time (Runge, Paschen, Paulson).

The most typical representatives of the second category are the famous spectra of Cr and Mn, in which multiplets were first discovered. Other, though not such typical, representatives are the spectra of the other elements of the iron group. For all these the classification has been carried through to a high degree of completion. Some of the spectra of the second long period and a few rare earths are also to be counted in this category although the latter exhibit their characteristic features to a still slighter degree.

Spectra that cannot be regarded as belonging to either of the above categories are the most numerous, and most of them are as yet incompletely or not at all investigated. They exhibit multitudes of lines of approximately equal intensity. From a theoretical point of view only little that is helpful may be said about them. Interactions are so general and so complex that no quantum numbers other than J and the parity value can be ascribed. No grouping of the levels is apparent, and the assignment of further quantum numbers, whether vector sums of electronic quantum numbers or electronic quantum numbers (configurations) themselves, would in general therefore be unjustified. Fortunately there often occur among spectra of this uninviting class, groups of levels that exhibit traces of coupling simply because the chances for perturbing interactions are relatively small among the lowest levels. In a few of these somewhat tractable spectra rather complete classifications have been published, notably those of certain rare earths by Albertson, Harrison, Meggers, Russell, and their co-workers.

The spectrum of neutral tungsten, W I, on which we are reporting here, is of the kind described in the previous paragraph. Its investigation was begun at the Bureau of Standards seventeen years ago, in the heyday of multiplet spectroscopy, in an attempt to find multiplets in a spectrum of an element of the third long period. W I was expected to be the easiest spectrum in this period, since both Cr I and Mo I showed from the then prevailing point of view a relatively simple structure. As we know now, this simplicity arises from the occurrence of configurations involving five equivalent d-electrons, for which spin-orbit interaction vanishes.[1] On the other hand it has become clear that in W I the simplifying influence of d^5 is considerably obscured

[1] W. Albertson, Astrophys. J. **84**, 26 (1936), points out the corresponding fact for seven f-electrons and its bearing upon the relative simplicity of portions of certain spectra in the middle of the rare earth group.

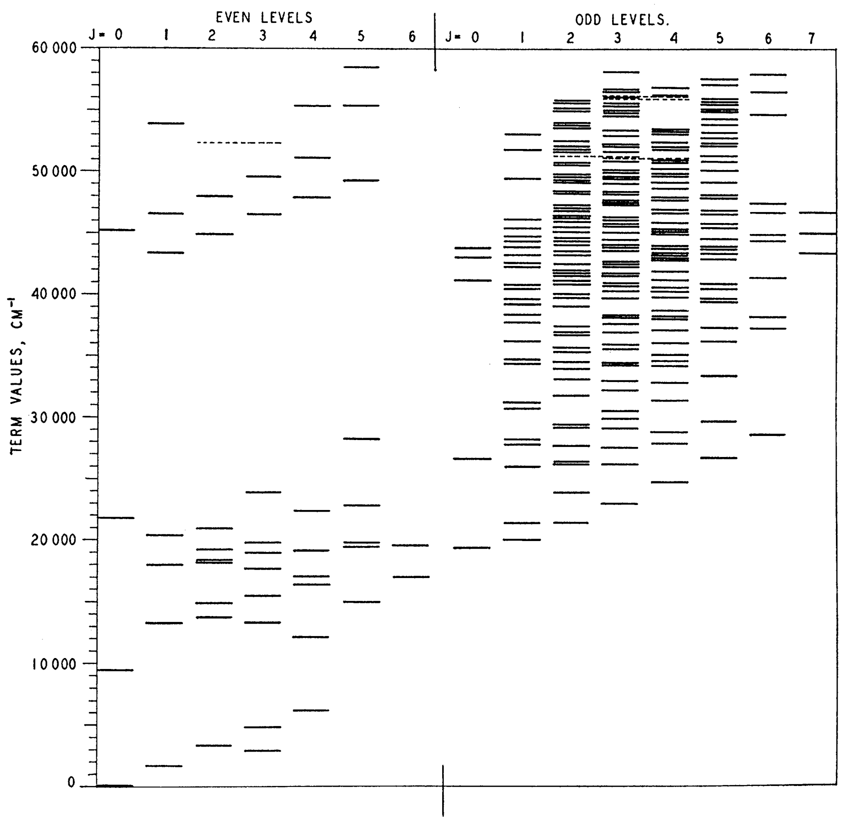

FIG. 1. Energy levels of neutral tungsten, W I. The first ionization level, W II $5d^46s$ ^6S, lies at 64.4×10^3 cm^{-1}.

by its relative instability and by mixture with other configurations, and that, as compared with its neighbors in the Pt group, the spectrum of W shows no such singularly simple structure as was exhibited by those of Cr and Mo in the Fe and Pd groups, respectively.

Most of the new material in this paper is incorporated in Table I, which is a rectangular array in which an attempt has been made to gather all the important information available concerning the properties of the neutral tungsten atom. Closely related to Table I is Table II, the list of classified lines. Because Tables I and II are designed for reference rather than continuous reading, and on account of the length of the explanatory matter that accompanies them, the presentation of this matter is postponed to Section 4, which is devoted to it.

Briefly stated, the present status of W I is that 2378 lines have been given assignment as 2567 transitions (including 169 double and 10 triple assignments) among 50 even and 250 odd levels (of which 16 are established only tentatively and listed with question marks), and tentative g values have been assigned to 201 of the levels. Figure 1 is the general level diagram. As for the assignment of quantum numbers, of course parity and J values are given for all the levels (except for ambiguities in J, in 4 cases). Further than that, surprisingly enough for an atom in this part of the periodic table, it has been found practical to assign approximate configuration and LS-coupling quantum numbers, with only 18 cases of evident mixing of eigenfunctions, to 65 levels: $5d^46s^2\,{}^5D\,{}^3HGFDP$, $5d^56s\,{}^{7,5}S\,{}^5G$, $5d^46s({}^6D)7s\,{}^{7,5}D$, $5d^46s({}^6D)6p\,{}^{7,5}FDP$. Clues as to possible structural properties are given for about 10 other levels. The rest of the odd levels cannot at present be interpreted. In the study of the low levels, formulas have been used for the configuration d^4 (LS interaction is neglected) after Ostrofsky,[2] and for the configuration d^5 (where the LS in-

[2] M. Ostrofsky, Phys. Rev. **46**, 604 (1934); see also for corrected formulae: O. Laporte, Phys. Rev. **61**, 302 (1942).

TABLE I. Level and transition array for W I.

Structure	Name		$5d^46s(^6D)6p$ (cm⁻¹)	g	$^7F_0$ $193_0°$ 19389.38 0/0		$^7F_1$ $200_1°$ 20064.26 1.54A		$^7F_2$ $214_2°$ 21448.66 1.48A		$^7D_1$ $214_1°$ 21453.80 2.51A		$^7F_3$ $230_3°$ 23047.19 1.53B		$^7D_2$ $239_2°$ 23964.58 1.93B		$^7F_4$ $247_4°$ 24763.30 1.50B	
$5d^46s^2$	$^5D_0$	D_0	0.00	0/0			5KZ	−04			6Z	−03						
	$^5D_1$	D_1	1670.27	1.51A	2	−18	3z	−03	5K?z	+01	8KZ	+02			6KZd	00C		
$5d^56s$	$^7S_3$	S_3	2951.27	1.98A					—				—		4Kz	−01C	—	
$5d^46s^2$	$^5D_2$	D_2	3325.50	1.48A			2	+13	—		7K?ζ	−21	6K?z	+01	6Kz	+01		
	$^5D_3$	D_3	4829.99	1.50A					0u	−1			2z	+04	6KZ	+03	6K?z	00
	$^5D_4$	D_4	6219.30	1.49A									1u	−07C			1	−01
	$^3P_0$	09_0	9528.01	0/0			—				2	+01						
	$^3H_4$	12_4	12161.96	0.99B									—				—	
	$^3P_1$	13_1	13307.09	1.32B											—			
	$^3G_3$	13_3	13348.53	0.92A									—		—		—	
	$^3F_2$	13_2	13777.71	1.09B											1.0	+13		
	$^3P_2$	14_2	14976.17	1.06B														
	$^3H_5$	15_5	15069.94	1.05B													—	
	$^3F_3$	15_3	15460.00	1.17B														
	$^3G_4$	16_4	16431.30	1.02B														
	$^3H_6$	17_6	17008.48	1.4 C														
	$^3F_4$	17_4	17107.01	1.19B														
—	—	17_3	17701.16	1.02C														
$5d^46s^2$	^3D	18_1	18082.84	0.7 C														
	$^5G_2$	18_2	18116.83	1.08C														
	$^5S_2$	$18_2'$	18280.48	1.43C														
	$^5G_3$	18_3	18974.48	1.06A														
$5d^46s^2$	$^3D_2$	19_2	19253.59	1.18A														
$5d^56s$	$^5G_4$	19_4	19256.22	1.20B														
	$^5G_5$	19_5	19535.00	1.21B														
	$^5G_6$	19_6	19648.48	1.32B														
$5d^46s^2$	$^3G_5$	$19_5'$	19826.02	1.20A														
	$^3D_3$	19_3	19827.67	1.28A														
$5d^56s$	$^5P_1$?	20_1	20427.82	2.1 C														
—	—	20_2	20983.07															
$5d^56s$	$^5D_0$?	21_0	21856.3	0/0														
	$^5D_4$?	22_4	22476.65	1.48C														
	$^5F_5$?	22_5	22852.82	1.2 C														
—	—	23_3	23930.07	1.4 C														
—	—	28_5	28233.41															
$5d^46s(^6D)7s$	$^7D_1$	43_1	43451.89	2.83B	2Z	00	3fZ	+06	3ζ	−03	1	−03			2	−01		
	$^7D_2$	44_2	44919.74	1.9 C			3ζ	+02C	5=	+03	3z	+01c	4K?Z	−01	0	+02		
	$^5D_0$	45_0	45225.18	0/0			0 .	−02			1u	00						
	$^5D_1$	46_1	46458.20		—		—		0z	−04	2=	+03			0	+08		
	$^7D_3$	46_3	46496.50	1.74B					2z	+02			5	+02	3z	−03C	4Z	00
	$^7D_4$	47_4	47975.45	1.68A									2z	−01			1=	−02
	$^5D_2$	48_2	48078.33	1.55B			—		0u	00	0	+03	1z	−09	—			
	$^7D_5$	49_5	49354.58	1.7 C													0	−05C
	$^5D_3$	49_3	49655.95	1.66B					—				3	+03C	0	−02	—	
	$^5D_4$	51_4	51123.08	1.4 C									—				—	
—	—	52_{23}	52284.71				—		3Kz	00	—		1	00	—		—	
—	—	53_1	53847.81		—		—		0	+01	—				—			
—	—	55_4	55333.03	1.45B									0	−18			2	+02
—	—	55_5	55380.87														2	+15C
—	—	?58_5	58630.9														0	+28
					$193_0°$		$200_1°$		$214_2°$		$214_1°$		$230_3°$		$239_2°$		$247_4°$	

teraction energy vanishes), as published by Laporte.[3]

At this point it is appropriate to consider the degree of completeness of the classification. The relative term "complete," applied to the classification of an atomic spectrum, carries quite different meanings from the two points of view of the experimental spectroscopist and the theoretician. The experimentalist considers a classification complete if it accounts for all the lines on a reasonably exposed plate, or at least for all that show by their behavior under various conditions that they belong to levels especially populous or stable, or otherwise interesting. The theoretician wants, of the infinite number of levels, the identification of certain limited sets, such as the approximately defined configurations. In any atom so complicated as tungsten, the two kinds of completeness are incompatible, for almost every configuration possesses some improbable levels, the discovery of which would require heavily exposed plates, that would present many new lines to be classified, that would yield new part-configurations, etc.

[3] O. Laporte, Phys. Rev. **61**, 302 (1942).

TABLE I—*Continued.*

$^5F_1$ 259_4° 25983.57 0.54*B*	$^7D_3$ 261_3° 26189.11 1.80*B*	$^7P_2$ 262_2° 26229.68 1.84*B*	$^7F_2$ 263_2° 26367.22 0.87*B*	$^5D_0$ 266_0° 26629.51 0/0	$^7F_5$ 266_5° 26676.41 1.46*B*	$^7P_3$ 274_3° 27488.05 1.72*A*	— 276_2° 27662.44 1.21*A*	$^5D_1$ 277_1° 27778.46 1.25*B*	
3*fK?Z* −10								3*Z* +04	D_0
4*Z* +01		4ζ −03	2 −02	3*Z* −03			5*fZ* 00	3= +01	D_1
	6*GKZ* −01	6*rGKz* 00	5*fKZ*. −01			6*ρ'K* −03	5*K?Z* −01		S_3
4*f*= −01*C*	3*z* −01	4*z* −01	—			5*fz* 00*c*	0 00	4*z* −02	D_2
	6*K?Z* −01	2 −01	1 +07*C*			4*f*= 00*C*	3ζ −03		D_3
	6*K?z* 00				6*K?z* −03	3*z* 00*c*			D_4
—								5*Z* 00	09_0
	1 00				—	—			12_4
2 +01		1 +16	2 +02	2 +03			3 −01	3 −03	13_1
	—	2 +01				—	4 +02		13_3
—	1 +04	—	3 +03			1*u* −14	2 +03	3 −01	13_2
.5 +19	.7 +16	.4 −04	1 −05			—	2 +06	2 00	14_2
					—				15_5
	.3 +12	.4 +13	.2 +28*C*			1 +03	—		15_3
	—					.0 +29			16_4
									17_6
					—	—			17_4
						—	—		17_3
							—	—	18_1
								.3 +12	18_2
									$18_2'$
									18_3
									19_2
									19_4
									19_5
									19_6
									$19_5'$
									19_3
									20_1
									20_2
									21_0
									22_4
									22_5
									23_3
									28_5
2*u* −37		4 00	2 −03	0*u* +3			—	0*u* −1	43_1
—	1*u* +03	2 +02	0 +05			4*z* −07	2 +09	1 −18	44_2
1*u* 00								—	45_0
—		—	—	0*u* −09			2 −03	1 +02	46_1
	0*u* +10	0*u* +14	—			2*z* +01	—		46_3
	4*z* −07				5*K?z* −05	—			47_4
—	—	—	—			—	0 −01	—	48_2
					3= +05				49_5
	—	—	1 −13*C*			—	—		49_3
	—				2*z* −03	—			51_4
—	0*u* +02	2 −13	1 +11			0 +01	—	—	52_{23}
—		0 00	1 −32	0 +05			—	—	53_1
	1 −01				—	—			55_4
					0 −01				55_5
					—				$?58_5$
259_1°	261_3°	262_2°	263_2°	266_0°	266_5°	274_3°	276_2°	277_1°	

From the theoretical point of view, of course, the present classification of W I is far from complete. Even in $5d^46s^2$, which is the lowest configuration, hardly more than one-half of the 34 levels are known. Experimentally, however, the situation can perhaps be compared favorably with that in almost any other spectrum of comparable complexity; see remarks made under 3(c).

2. CRITICAL RÉSUMÉ OF PREVIOUS DATA AND INTERPRETATIONS

Heretofore a large amount of experimental data but a relatively small amount of classification and interpretation on the arc spectrum of tungsten have been available. Although an exhaustive review is unnecessary, certain aspects of the problem and some of the most important previous work are discussed in the following historical and critical account.

(a) Line Measurements

The older line measurements are collected in Kayser's *Handbuch*.[4] The most extensive of all the lists is that of Exner and Haschek,[5] whose

[4] H. Kayser, *Handbuch der Spectroscopie* (1912), Vol. 6, p. 787.

[5] F. Exner and E. Haschek, *Die Spektren der Elemente bei normalem Druck* (Leipzig, 1911, 1912).

TABLE I—*Continued.*

	$^7P_4$ $278_4°$ 27889.56 1.71*A*	$^5P_1$ $281_1°$ 28187.84 2.34*A*	$^7F_6$ $?285_6°$ 28599.81	$^7D_4$ $287_4°$ 28797.21 1.61*A*	$^5F_3$ $291_3°$ 29139.10 1.06*B*	$^5D_2$ $291_2°$ 29195.84 1.28*A*	$^5P_2$ $293_2°$ 29393.38 1.83*A*	$^7D_5$ $297_5°$ 29773.27 1.55*A*	$^5D_3$ $299_3°$ 29912.80 1.31*A*
D_0		6*KZ* +02							
D_1		5*KZ* +05				5*z* −03	3*z* 00		
S_3	8*GKZ* +01			5*fK?Z* +01	6*Z* 00	5*Z* −02	5*zKz* +05		6*K?Z* +05
D_2		4*Z* 00			4*z* −01*C*	3= +03	5*fZ* −02		4*fz* −03
D_3	0 +12			5*z* +03	1*u* +25*C*	—	—		—
D_4	4= +01*c*			—	3*z* −02			4*K?z* +03*c*	5*z* +01
09_0		1*Z* 00*C*							
12_4	—			1 −02	—			2 −03*C*	2*K?* +11
13_1		2 −05				4 00	—		
13_3	—			—	—	1 +02	—		1*u* −27
13_2		—			2 +07	2 −02*c*	2 −04		1 −06
14_2		—			1 −05	—	4 −08		5*u* 00*c*
15_5	—		1 +05	—				2 −08	
15_3	1 −05			—	—	2 +03*C*	—		1 −07
16_4	—			—	2 +02			—	—
17_6			—					—	
17_4	—			—	—			—	—
17_3	—			—	2 −01	—	—		—
18_1		—				.4 −05*C*	—		
18_2		1.8 +16			.5 +09	.1 −24	1.5 +12		3 −01
$18_2'$		.1 +03			.2 +09	2.0*u* +04*C*	.4 +05*C*		3 −01
18_3				—	1.0 +16	.7 +04	.4 +07		.4 −03
19_2					—	—	.4 +14		.3 +12
19_4				.0 +21	.3 +20			(*C* +44)	2.5 +01
19_5								.8 +13	
19_6								1.2 +18	
$19_5'$								.4*n* −04	
19_3							.1*ud* +14		.3 +11
20_1									
20_2									
21_0									
22_4									
22_5									
23_3									
28_5									
43_1		2 +03				—	1 −06*c*		
44_2		2 −06			0*u* −1	—	—		—
45_0		1*u* +15							
46_1		0 +11				1*u* −03			
46_3	0 −01			4*z* −11*C*	2*u* −06	—	2 −04		2 +08
47_4	0 +08			2*f* −02	—			6*K?z* −02	—
48_2		0*u* −24*C*			0 +12	—	2 −08		(*C* −40)
49_5	3 −03		2 +04	0*u* −24*C*				2 +01	
49_3	—			0 −03	(*C* −53)	—	0*u* +28		0*u* −04*C*
51_4	—			0*f* +14	—			0 +01	0*u* −20
52_{23}	—			—	—	—	—		—
53_1						—	—		
55_4	0 +11			1*z* +04	—			0*u* 00	—
55_5	—			2 00				1*z* +02	
$?58_5$	—			—				—	
	$278_4°$	$281_1°$	$?285_6°$	$287_4°$	$291_3°$	$291_2°$	$293_2°$	$297_5°$	$299_3°$

comparison of arc and spark intensities was useful in isolating the transitions belonging to the neutral atom. The high accuracy of their measurements was exceeded only by that of Miss Belke's[6] important work, which justified the retention of seven digits, and by that of Kiess and Meggers[7] in the longer wave-lengths. In the farthest photographic infra-red we have made use of Cohen's[8] unpublished list, but have not classified any lines that occur exclusively on it. In the extreme ultraviolet the hitherto published material has been supplemented by a new list,[9]

[6] M. Belke, Zeits. f. Wiss. Photographie **17**, 132 and 145 (1918). In this paper 3179.964 should read 3179.064 and 5020.369 should read 5040.369.

[7] C. C. Kiess and W. F. Meggers, Sci. Pap. Bur. Stand. **16**, 51 (1920); C. C. Kiess, unpublished list of lines in the region ν11333 to ν9541, kindly placed at our disposal.

[8] I. Cohen, A. B. thesis, Wisconsin, 1937 (deposited at the Library of the University of Wisconsin). Belke's (reference 6) lines in the third order were used as standards.

[9] Obtained by Mack on Schumann plates with a Hilger E-1 quartz spectrograph at Palmer Physical Laboratory, with the valuable advice and aid of Professor Shenstone. Belke's lines, and beyond their limit, Shenstone's silver arc lines, were used as standards. Although the standards are believed to be good to about 0.2 cm^{-1}, it is evident from the disagreement of our tungsten lines with the combination principle that the lines listed are uncertain by several times that amount.

TABLE I—*Continued.*

$^5P_3$	—	—	$^5F_4$	—	—	$^5D_4$	—	—	
$305_3°$	$306_1°$	$313_1°$	$314_4°$	$318_2°$	$322_3°$	$328_4°$	$329_3°$	$331_2°$	
30586.61	30683.45	31323.41	31432.87	31817.61	32238.00	32828.11	32957.56	33141.40	
1.64*A*	1.39*A*	0.86*A*	1.32*B*	1.52*B*	1.3*C*	1.7*C*	1.43*B*	1.51*B*	
	2 +12	1*KZ* +04							D_0
	2*z* 00	2= +02*C*		3*z* 00				4*dKz* −02	D_1
8*rKZ* +05			5*z* −02	3*A*? +02	3= +02	0 +13	5*K*= +02	4*KZ* +03*c*	S_3
3*z* +05*C*	3*z* +03	6ζ +14*C*		3*fz* −01	3*z* 00		3*Kz* +02	1 −04*c*	D_2
5*fK*?*z* 00			3*fz* −01	—	3*Az* +02	6ζ −07*C*	3*z* 00	?0 +44	D_3
5ρ′*fk*?*z* −04			2 −01		2*f* −02	3 −02*C*	2 +01*C*		D_4
	0 −06	3*Z* −06							09_0
—			—		—	0 −17*C*	2 +01		12_4
	1*u* −17	0*u* +3		?0 −43				2 00	13_1
1 −06			0*u* +29	0*u* −29	—	—	—	—	13_3
4 +08	1 00	2 −11		—	0 −20		0*u* +02	0*u* +5	13_2
4 −05	1 −14	2 00		—	—		0 −05	2*f* −10*c*	14_2
			—			0 +02			15_5
2*u* −03			2*u* −12	2 +01	0*u* −2	2*u* −22	—	0 −08	15_3
—			1*u* −07		0*u* 0	—	—		16_4
									17_6
—			—		2 −09	1*u* −05	—		17_4
1 −03			—		—	—	2 −04	1*u* +03	17_3
	—	2 +01		—				—	18_1
4 +05	1. −05	3 +05		—	—		—	—	18_2
3 +03	2 +04	?3 +03		3 −04	2 −03		2 +18*C*	—	$18_2'$
—			—	3 +02	3 −02	2 +03*C*	—	—	18_3
.1 +30	2 +03	—		2 00	1 00		1 −01	1 −08	19_2
.2 +17			?2 −01		2 +04	—	3 −04		19_4
			2 +03			—			19_5
									19_6
			3 +03			3 +05			$19_5'$
3*u* +10			2 −03	2 +02	2 −02	1 −04	3 +09	3 +01	19_3
	.4 +10	.1 +05		1 −09				2 −01	20_1
.2 +17	.0 +01	.2 +24		2 +08	—		1 +04	1*u* +05	20_2
									21_0
					.4 +05	—	2.5 +10		22_4
						?.2*un* +52			22_5
									23_3
									28_5
	—	—		—				—	43_1
—	—	—		1 +01	1 +02		—	—	44_2
	2 −12	1 +04							45_0
	—	—		2 +04				—	46_1
—			1*u* +17*C*	—	—	—	1 +06	—	46_3
2 +02			3 +02		0*u* +09	2*u* −14*C*	—		47_4
1*u* +34	2*u* −10	—		1*u* −34	—		3*u* −07	5*u* −30*C*	48_2
			0*u* 00			—			49_5
—			1 +02	1*z* +11	1*z* +07	1*u* −02*C*	0*ud* −09		49_3
0 +19			—		—	0*u* −1	(*C* −09)		51_4
—	—	—	—	—	2*z* +08*C*	—	—	—	52_{23}
	—	(*C* +46)		—				0 −03	53_1
2*z* −10*C*			0 +13		—		—		55_4
			—			—			55_{54}
			—						$?58_{56}$
$305_2°$	$306_1°$	$313_1°$	$314_4°$	$318_2°$	$322_2°$	$328_4°$	$329_3°$	$331_2°$	

whose lines are much more intense than Exner and Haschek's and extend to considerably higher frequencies, but are less accurately measured.

Since the completion of what we thought was to be our final list, the M.I.T. tables[10] have appeared, covering almost the whole range of all the previous lists. The accuracy of the tungsten lines in this list, as judged by self-consistency under the combination principle, compares favorably with that in any of the other lists except the middle portions of those of Belke, Kiess, and Meggers. The list is rich in lines although it needs to be supplemented by others throughout its range. If our work were starting now we should undoubtedly use the M.I.T. list as the principal basis for our work throughout the spectrum, instead of limiting our principal changes to the region $\nu > 40{,}000$ cm^{-1} as we have done for the sake of economy.

(b) Special Excitation Conditions

Certain lines evidently belonging to the lowest levels are distinguished by their reversal in the arc or their presence among de Gramont's[11] or

[10] G. R. Harrison, *Massachusetts Institute of Technology Wavelength Tables* (John Wiley and Sons, 1939).

[11] A. de Gramont, Comptes rendus **171**, 1106 (1920).

TABLE I—*Continued.*

	$^5F_5$ 333_5° 33370.06 1.39*B*	— 339_2° 33943.98	— 341_4° 34121.60 1.5*C*	— 342_3° 34228.54	— 343_1° 34342.37 1.56*A*	— 343_3° 34353.99 0.71*C*	— 344_2° 34485.83 0.82*C*	— 346_4° 34632.59 0.89*C*	— 347_1° 34719.32 0.15*B*
D_0					4*Z* +05				5*rM*?*H*?*A*?*KZ* −01
D_1		—			1 +06		5*rKz* 00		5*A*?*KZ* −03
S_3		2 +01	5*Kz* +08	—		3 +02	3 −02	2 +06	
D_2		—		2*dz* +02	2 −01	3*z* −01	4*K*= +06		3 00
D_3		2*z* +03	3*z* +03	0 +05		2*Z* +04	2*y* +01	5*K*?*z* +01*C*	
D_4	5*z* −04		0 −04	2*z* +03		—		3 −06	
09_0					3*Z* −04				—
12_4	0 −04		1 −02	2 −02		3*z* −01		3*z* −04	
13_1		0 +09			2 −02		2 −04		0 +13
13_3		3 −02	0 −15	2 −03		0*u* −15	4*z* −04	—	
13_2		—		2*u* +12	—	0 +02	—		3 +26
14_2		—		3*z* 00	0*u* +3	—	2 +01		0*u* −04
15_5	—		0*u* +17					0 +01	
15_3		0 00	2*u* −03	—		—	—	—	
16_4	0 00		0*u* 00	2*u* −13		—		0*uf* +18	
17_6	—								
17_4	1 +07		1*u* +03	2 00*C*		2 −07		0 −04	
17_3		2 −04*C*	—	0*u* −3		1*u* +07*C*	2 −03	0*u* +2	
18_1		—			—		1 +02		—
18_2		—		—	2 −07	—	1 +03		4 +04
$18_2'$		1 −01		—	1*u* −04	—	2 −03		3 +04
18_3		4 00	2*u* +08*C*	1*u* +02		2*u* +19*C*	2 −04	2*u* +06	
19_2		3*u* −02		1 −03		1*u* −20*C*	3 +12		3 −08
19_4	—		2*u* +10	2 −09		3*u* −07*C*		—	
19_5	2 +01		2 −02					3*u* +12*C*	
19_6	3 −06								
$19_5'$	2 +04		2*d* +18					—	
19_3		—	2 −03	—		?2 −40	4 +02	—	
20_1		—			1*u* +08		(*C* +44)		—
20_2		—		—	3 +04*C*	—	—		(*C* −38)
21_0					—				—
22_4	.4 −03		3 −02	2 −01		2 00		—	
22_5	.1 +25*c*		.4 +18					1 −02	
23_3		2 +15	2.0 +08	.1 +01	—	.1 +01	—	—	
28_5									
43_1									
44_2		—		—	—	—	—		—
45_0					—				.5 00
46_1		—			—		1 +03		2 −01
46_3		—	—	—		—	—	—	—
47_4	1 +04		2 −19*C*	—		—		—	
48_2		—		?1 +33	2 −09*C*	—	1 −04		3 +33
49_5	3 −02		1*u* +03					—	
49_3		—	0*u* +22	—		—	—	1*u* +05	
51_4	1*u* −05		2 00	0*u* +30		—		—	
52_{23}		—	—	—		—	—	—	—
53_1		—				—	—		—
55_4	3*z* −06*C*		—	—		—		—	
55_{54}	—		3 +15*C*			—		0*E* −01	
?58_{56}	—		—					—	
	333_5°	339_2°	341_4°	342_3°	343_1°	343_3°	344_2°	346_4°	347_1°

Thompson's[12] raies ultimes, King's[13] furnace lines, or the underwater spark lines of Hulburt,[14] Meggers,[15] and Allin and Ireton.[16] They were especially useful in the early part of the analysis. King's method yields less information here than usual on account of the low volatility of tungsten. In the light of the present classification, Hulburt's and Meggers' underwater spark lines are evidently the only such lines with much physical significance.

The revised Rowland[17] and Miss Moore[18] lists give 9 sure, and 11 other possible, tungsten absorption lines in the spectrum of the sun's disk, and 3 unquestioned and 6 questioned tungsten

[12] K. Thompson, plate kindly taken at the University of Michigan upon our request.

[13] A. S. King, Astrophys. J. **75**, 379 (1932).

[14] E. O. Hulburt, Phys. Rev. **24**, 129 (1924).

[15] W. F. Meggers, unpublished work kindly placed at our disposal.

[16] E. J. Allin, Trans. Roy. Soc. Canada **21**, Sec. 3, 231 (1927); E. J. Allin and H. J. C. Ireton, *ibid.* **21**, Sec. 3, 127 (1927).

[17] C. E. St. John, C. E. Moore, L. M. Ware, E. F. Adams, and H. F. Babcock, *Revision of Rowland's Preliminary Table of Solar Spectrum Wave-Lengths* (Carnegie Institution of Washington, 1928) publication no. 396; cf. H. N. Russell Astrophys. J. **70**, 11 (1929).

[18] C. E. Moore, *A Multiplet Table of Astrophysical Interest* (Princeton University Observatory, 1933); *Atomic Lines in the Sunspot Spectrum* (Princeton University Observatory, 1933).

TABLE I—*Continued.*

$\overline{351_4}$° 35116.73 1.2*B*	$\overline{353_2}$° 35311.46 1.0*C*	$\overline{354_3}$° 35499.10 1.0*C*	$\overline{357_2}$° 35731.92 1.5*C*	$\overline{359_3}$° 35943.17 1.4*C*	$\overline{360_4}$° 36082.27 1.24*B*	$\overline{361_1}$° 36190.42 1.62*A*	$\overline{362_5}$° 36275.08 1.27*B*	$\overline{366_2}$° 36673.67 1.50*B*	
						4*rZ* +02			D_0
	3 +09		5*rKz* +06			4*rA*?*z* +02		4*Kz* −05	D_1
3*K* +08	2 +03	—	6*rKz* +03*C*	—	64*Kz* +02			5*AKZ* +07	S_3
	—	4*z* +08	2 −02	1 −01		5*rKz* 00		5*z* 00	D_2
5*Kz* +08	—	2*z* +14*C*	—	1 +05	5*Kz* +02			1 +07	D_3
2 +02		—		2*z* −03	—		5*K*?*z* 00		D_4
						—			09_0
3= −03		2*z* +01		2*z* +02	—		2*z* +02		12_4
	1 −03		2 −02			1 00		1*z* 00	13_1
2 −03	3*z* −02*C*	2= −04	3 −04	—	0 −13			3*z* −01	13_3
	3= 00	—	1= +02	0*u* −32		3*Z* 00		1*u* 00	13_2
	2 00	—	—	0 +04		3 −02		—	14_2
2*z* 00*C*					3 −03		1 −02		15_5
0 +01	—	—	2 00	0 −10	—			—	15_3
—		3 −01		—	—		—		16_4
							0*u* −01		17_6
0*u* +1		0*u* −10*c*		—	0 +14		—		17_4
—	2 00	0*z* +13	—	—	0 −11			0 +16	17_3
	—		2*u* +11*C*			0 +04		—	18_1
	0*u* −13	—	1 00	1 +18		1*u* −44		—	18_2
	1 +35	0*u* −12	1 +02	0 +01		—		—	$18_2'$
1 −04	1 +11	2 +02	4 −08	2*u* −04	—			4*z* −01*C*	18_3
	1 −11	2 +25*C*	1 +21	0*u* −01		2 +01		—	19_2
2 +12		2 −10*C*		0*u* 00	—		1*u* −07		19_4
2 −05					2 +01		—		19_5
							4 +02		19_6
4 −10					—		0*u* −1		$19_5'$
—	0*u* +26	0*u* 0	4 −01	4 −11	—			1 00	19_3
	—		3 −01			1*u* +18		2 −09*C*	20_1
	—	—	2 −04	1 −10	—	3 00		2*C* +13	20_2
						—			21_0
2 −03	—	—		—	1 +01		1 −04		22_4
—					—		1 00		22_5
.2 +12	—	2 −22	2 +01	1 −02	—			—	23_3
									28_5
									43_1
									44_2
									45_0
	—		.4 −03			.1 +24		.0 +03	46_1
—	—	—	—	—	—			—	46_3
—				—	—		—		47_4
	—	—	—	—		1 +14		—	48_2
—					—		1 +10		49_5
2 +02	—	—	—	1 −04	1 +05			—	49_3
1 +15				—	—		2*u* −01		51_4
—	—	—	—	—	—	—		—	52_{23}
	—		—			—		0 +22*C*	53_1
—		—		—	—		—		55_4
—					—		—		55_5
—					—		0 +04		$?58_5$
351_4°	353_2°	354_3°	357_2°	359_3°	360_4°	361_1°	362_5°	366_2°	

lines in the sunspot spectrum. On the disk, sure identifications have been made of at least one line for each of the lowest 6 levels (none for any higher even levels), and in the spot spectrum 5 lines, 2 unquestioned and 3 questioned ones, arise from $d^5s\ {}^7S_3$, and the rest, 1 unquestioned and 3 questioned ones, from various $d^4s^2\ {}^5D$ levels.

(c) Previous Publications of Levels

Incidental to his Zeeman effect work, Jack[19] tried to find series in tungsten with the aid of Preston's rule. He allowed a tolerance of about 2 cm^{-1}, and all his differences are meaningless. Paulson[20] made a rectangular array in which two differences, D_2-D_1 and 239_2-214_1, are real. In 1925 Laporte[21] published a preliminary extract from an array of about 70 levels which was the forerunner of our Table I. Most of the material that now comprises our final report has been communicated privately to several workers, and some of it has been published with our permission.[22,23] The most important general papers on

[19] R. Jack, Diss. Göttingen (1908); Ann. der Physik **28**, 1032 (1909).

[20] E. Paulson, Diss. Lund. (1914).

[21] O. Laporte, Naturwiss. **13**, 627 (1925).

[22] Bacher and Goudsmit, *Atomic Energy States* (McGraw-Hill, 1932). We have rejected six levels of this tentative list.

[23] C. E. Moore, *Term Designations for Excitation Potentials* (Princeton University Observatory, 1934).

TABLE I—*Continued.*

	$368_3°$ 36874.31 1.50*A*		$369_2°$ 36904.11 1.57*B*		$371_4°$ 37146.29 1.1*C*		$372_6°$ 37297.5		$373_5°$ 37309.13 1.25*B*		$374_2°$ 37466.26 1.28*B*		$376_3°$ 37674.04 1.13*A*		$377_1°$ 37773.94		$380_4°$ 38001.10 1.1*C*	
D_0															0	+40		
D_1			3	−06							0	−11			4*rz*	−02		
S_3	8*rMH?A?KZ*	−03	7*rMHAKZ*	−07	4*A?*	+02					6*rMHA?KZ*	00	5*rMH?A?ζ*	03				—
D_2	5*Kz*	+06	3	+07							2	00	4*z*	+02	2	00		
D_3	3*K*	+08	1	+10	5*Kz*	+04					3	+07*c*	6*K*=	−10			3*z*	+01
D_4	3	+12			2*z*	+04			2*fGKdz*	−17			2	+02			3	+03
09_0															0	+18		
12_4		—			3ζ	+01			3*z*	00			2*z*	+02			0	−28
13_1			0	+19							2*z*	+14*C*				—		
13_3	2	00		—	0	−03					2*z*	−02	4	−01			1*z*	−07
13_2	0	−05		—							0	−12		—	2	00		
14_2	2	00	2	−01							2	−01*C*	0	−05		—		
15_5						—	0	−2	3	−02								—
15_3	3	−04	3	−02	3*z*	−03					2=	−03*c*		—				—
16_2	1	−04*C*				—			2	−02			2	−02			3=	−05
17_6								—	0	+06								
17_4		—				—			0	+15				—				—
17_3	0	−01		—	0	−13					0	−14		—				—
18_1				—								—			0	+02		
18_2	0*u*	+3		—								—	0	+05		—		
$18_2'$		—		—								—	0*u*	+15	0	−09		
18_3		—	0*u*	−11		—					0	−18		—				—
19_2	1	+49	0*u*	0		—					0	+09	0	00	1	00		
19_4	2	−11			0*u*	+05			1*u*	−19			0*u*	−06				—
19_5					2	−01*C*		—		—							0	−21
19_6							2*u*	+2*C*	2	+21								
$19_5'$					0	−01	0*u*	+1		—							2	−33
19_3	2	00	1	−14		—						—	0*u*	+1			0	00
20_1			1	+02								—				—		
20_2	3	−01		—							2*u*	+17	2*d*	+07	1	−01		
21_0																—		
22_4	1	−21			3	−02			2*u*	+15				—			1	−12
22_5						—	2	+2	1	+01								—
23_3		—		—		—						—		—				—
28_5																		—
43_1																		
44_2																		
45_0																		
46_1				—														
46_3		—		—														
47_4		—				—				—				—				—
48_2	.3	−01		—								—		—		—		
49_5						—		—		—								—
49_3		—		—	1	−07						—		—			1	+03
51_4	?1*d*	+43				—			2	−02			1	−07				—
52_{23}		—		—		—					2*u*	−21*C*		—		—		—
53_1				—								—			1*u*	+17		
55_4		—				—			0*u*	+5				—				—
55_5						—	0*u*	−3		—								—
$?58_5$						—		—		—								—
	$368_3°$		$369_2°$		$371_4°$		$372_6°$		$373_5°$		$374_2°$		$376_3°$		$377_1°$		$380_4°$	

the spectrum that have appeared recently[24] are the extensive work of Catalán and Poggio,[25] who listed 42 real levels not previously published, of which 29 had been independently placed on our list. We gave up our intensive search for levels several years ago, supposing that the law of diminishing returns made further search useless. Laun[26] has reported several levels, including the

[24] Although this paper does not purport to cover more than the extranuclear structure of the atom, it should be recorded in this section that N. S. Grace and K. R. More, Phys. Rev. **45**, 166 (1934), studied the hyperfine structure of a few lines associated with the $d^4s^2\,{}^5D$ (but none associated with $d^5s\,{}^7S$) and found separations into three components with a total spread of about 0.1 cm^{-1}, which they reconciled with the level scheme by ascribing to each of the ^5D levels among the various isotopes, the following spread with respect to the rest of the levels of the spectrum: Isotope 182, most stable; Isotope 183, nuclear angular momentum $I=\frac{1}{2}$, levels doubled and components approximately coincident with isotopes 182 and 184, respectively. (This might have been tested by an intensity study of a D_0 line.) Isotope 184, about 0.05 or 0.06 cm^{-1} less stable than 182. Isotope 186, about 0.09 to 0.11 cm^{-1} less stable than 182.

[25] M. A. Catalán and F. Poggio, Ann. Soc. Espan. Fisica y Quimica **32**, 255 (1934); Zeeman Verhandelingen (1935), p. 387; F. Poggio, Ann. Soc. Espan. Fisica y Quimica **33**, 171 (1935). We have rejected 13 Catalán-Poggio levels.

[26] D. D. Laun, Phys. Rev. **48**, 572 (1935); J. Research Nat. Bur. Stand. **21**, 207 (1938). Laun's report included some levels that were already in Catalán and Poggio's or our array, and some that we have rejected; of the Laun levels that we have incorporated in our list, we have altered several J values.

TABLE I—*Continued.*

380_3° 38052.98 1.11*B*	382_6° 38203.03	382_3° 38206.32	382_4° 38259.34	?384_1° 38429.82	387_4° 38748.43	390_2° 39030.23	391_1° 39183.17 1.01*C*	393_5° 39360.98 1.13*C*	
				—			1*MAZ* −14		D_0
				—		2 −34	3*A*? −25		D_1
3*MAKZ*−06		3 −03	5*MsAKz*−06		5*Mz* −07	4*rM?z* −01			S_3
4*M* +01		4*MuA?Kz*−06		2*M*? −17		4 −04	2 −03		D_2
5 −23		3 +02	3 +02		6*H?A?z*−04	4*A?z* −05			D_3
2 +01		3 +03	3*Kdz* +02		1*A?K?* −09*c*			5*z* −03	D_4
				0 +01			—		09_0
2 +09		4*fz* −03*C*	2 −02		—			3*z* +02	12_4
				2*z* +28*C*		2*z* +02	1 +05		13_1
2= −01		—	0*z* −06		—	3*z* −02			13_3
(*Cz* +42)		2 +07		1*z* +39*C*		3*z* +01	3*z* +03*C*		13_2
3*z* 00		0 +27		—		—	—		14_2
	—		0 +04		3*z* −01			2*z* 00	15_5
1 00		2 −02	3*z* −01		1 +17*C*	3*z* −01			15_3
2 00		0*u* −39	0*u* +16		0 +16			—	16_4
	2 00							1 −03	17_6
—		2 −01	1 00		—			1*z* −04	17_4
0*u* +07		0*u* +26	—		0 +04	0 +08			17_3
				—		0 +10	—		18_1
0 −03		0*u* +07		—		0*u* −21	2 00		18_2
0 +08		0 00		0 +05		—	—		$18_2'$
—		—	3 +01		—	0 −04			18_3
0 +1		0 +16		—		—	—		19_2
—		2 −03	—		—			0*f* −01	19_4
	0 +09		0*u* −01*C*		3 −04			—	19_5
	0*z* −01							0*u* −30	19_6
	1 00		0 −07		0 −08			0 +07	$19_5'$
—		0 −01	1 +02		—	3 +02			19_3
				0*u* +06		3 −02	—		20_1
1 +01		—		—		—	—		20_2
				—			—		21_0
—		—	—		2 −01			0*u* −05	22_4
	—		—		—			1*u* +11	22_5
—		1 −04	—		2*u* −12*C*	1*u* +04*C*			23_3
	—		—		.1 +10			.3*u* +12	28_5
									43_1
									44_2
									45_0
									46_1
									46_3
—		—	—						47_4
—		.2 −06							48_2
	—		—		—			—	49_5
—		—	—		.2 −02*C*	—			49_3
—		—	—		—			1 −06	51_4
—		—	—	—	—	—	—		52_{23}
				2 +12*C*		—	—		53_1
—		—	—		—			0*u* +07	55_4
	—		2 00*C*		—			0*u* −16	55_5
	—		—		—			—	?58_5
380_3°	382_6°	382_3°	382_4°	?384_1°	387_4°	390_2°	391_1°	393_5°	

important low odd level 214_2 that led to our identification of the $5d^46s6p$ triads.

(d) Zeeman Effect

The early Zeeman effect measurements of Jack[19] are by far the best that have been published. Perhaps the most striking proof of their excellence, in harmony with their almost complete self-consistency within about 1 percent as shown by our analysis, is the ready explainability of the asymmetries of all six of the classified lines among his seven asymmetric pattern measurements.[27] Beining's[28] lines, on the other hand, although each one as published shows an utterly complete self-consistency to 0.001 *g*-value unit, are inconsistent among themselves by as much as 25 percent, as is evident from work[21] referred to by that author! We were able to use a few of Beining's data after applying an empirical correction factor:

$$g_{\text{Beining}} = g_{\text{accepted}} \cdot (0.7375 + 1.25 \times 10^{-5}\nu).$$

Catalán and Poggio[25] give *g* values for 95 levels, if we include Laporte's[21] *g* values and omit levels we have rejected. They use the same experimen-

[27] J. E. Mack and O. Laporte, Phys. Rev. **51**, 291 (1937).

[28] H. Beining, Zeits. f. Physik **42**, 146 (1927). We have estimated intensity trends from Beining's interpretations, and corrected several evident misprints in this paper.

TABLE I—*Continued.*

	$396_5°$ 39613.98 1.20*C*	$396_1°$ 39636.56 1.44*C*	$396_3°$ 39646.35 1.46*B*	$397_2°$ 39707.02 1.00*C*	$397_4°$ 39719.90 1.17*B*	$400_2°$ 40011.44 1.0*C*	$402_4°$ 40233.91 1.53*A*	$402_3°$ 40269.29 1.03*B*	$404_1°$ 40411.05 1.58*A*
D_0		0 +01							.7 +08
D_1		3*MAz* −22		0 +24		2*Mz* −18			3*M?z* −19
S_3			4*MsA?*=−04	2*A?* −10*C*	4*Msz* −06	2 −21	4*MAz* −17	3*A* −08	
D_2		2 −01	—	2 −03		3*z* −26		?1 −11	3*Mz* −19
D_3			3 −03	2*M?A?*−06	2 −01	3*z* 00	2 −01	—	
D_4	4*z* +03		3 +01		3 00		3 +02	4 −13*c*	
09_9		3*Z* 00							?3*Z* +01
12_4	—		3*z* +03		—		0 +04	—	
13_1		0 +25*C*		—		—			2 +22*C*
13_3			2*z* −04*C*	4*z* +03	0 −41	—	—	—	
13_2		2 +01*C*	—	3*z* +02		4*z* +10		4*fz* +07	—
14_2		3*z* −02	0 −08	1*z* −04		—		3*z* +01	2*z* +10*C*
15_5	2*z* +01				0 +51		0 −09		
15_3			1*d*= −53*C*	1*z* −02	2*z* +04	2ζ −02	2*z* 00	1 −01	
16_4	2 +02		0 −11		1 00*C*		2 +05	0 −09	
17_6	0 −24								
17_4	2*z* +03		0 +08		2*z* +02		1 +02	—	
17_3			—	(*C* +37)	0 +13	0 −01	—	—	
18_1		—		0 −08		2 −01			0*u* +15
18_2		—	—	0 +10*C*		—		3*z* −01	6*dY* +09*C*
$18_2'$		1 −01	2 00	0*f* +04		—		3*z* 00	2 00
18_3			—	—	0*u* +35	2 −04	3 −01*C*	1 −04	
19_2		—	2*f* +02	—		1 +02		0 −01	3 00
19_4	1 +01		0*f* +01		—		0*u* −05	4*Kz* +23*C*	
19_5	—				—		—		
19_6	0 +12								
$19_5'$					0*u* −19				
19_3			0 +10	0*u* −10*C*	0*u* +07	0*f* +15	—	—	
20_1		3 +01		—		—			0 −06
20_2		—	0 +12	0*u* +25*C*		—		—	?2 +42
21_0		—							—
22_4	2 −05		2 +01		—		0*u* +11	0 +17	
22_5	1*f* −01				0*u* +12		—		
23_3			1 00	—	1*u* +15	—	—	—	
28_5	—				—		—		
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5	—				—				
49_3				—	—				
51_4	—		?1 +44		—		—	—	
52_{23}		—	—	—	—	—	—	—	—
53_1		—		—		—			—
55_4	—		—		—		—	.1*u* +06*C*	
55_5	—				—		2*u* +24*C*		
$?58_5$	—				—		—		
	$396_5°$	$396_1°$	$396_3°$	$397_2°$	$397_4°$	$400_2°$	$402_4°$	$402_3°$	$404_1°$

tal data and the same general methods of reducing unresolved patterns[29] as we. Our agreement is on the whole very good. In all except 15 of the 92 of these levels for which we had already independently calculated *g* values, their values and ours agree within 10 percent, and in most cases the agreement is considerably better.

We have had access to Ellingson's[30] new Zeeman effect data from plates taken at Wisconsin. Just as this report is about to be submitted for publication, Professor Harrison has very kindly sent us some remarkable Zeeman effect plates taken in very strong fields with the new M.I.T. magnet.[31] Preliminary *g* data[32] from these plates indicate values appreciably more self-consistent than Jack's, justifying a general reconsideration of the *g* values, which is under way.[30] A few tentative results of Ellingson's or our investigations of the Wisconsin or M.I.T. plates are incorporated in our tables with no attempt to differentiate them from the older work by means of any distinctive symbols.

[29] A. G. Shenstone and H. A. Blair, Phil. Mag. **8**, 765 (1929).

[30] E. Ellingson, in preparation.

[31] F. C. Bitter and G. R. Harrison, Phys. Rev. **56**, 15 (1940).

[32] J. H. Roberson and J. E. Mack, Phys. Rev. **55**, 1126 (1939); **57**, 1074 (1940); J. H. Roberson, J. E. Mack, and G. R. Harrison, Phys. Rev. **58**, 895 (1940).

TABLE I—*Continued.*

$404_5°$ 40476.37 1.04*B*	$405_4°$ 40582.99	$406_3°$ 40665.84 0.96*C*	$407_1°$ 40770.74 1.28*C*	$408_2°$ 40868.31 1.26*B*	$409_5°$ 40911.92 1.03*C*	$409_3°$ 40923.77 1.32*B*	$411_2°$ 41104.46 1.5*C*	?$411_0°$ 41127.28 0/0	
			.7*MZ* −03						D_0
			2*M* −18	1*z* −12			2 −37	2*M* +03	D_1
	4*MAy* −19*C*	—		—		3*M* −22	—		S_3
		3*MA* −29	1*A*? −30	3*MAz* −24		0 +01	3*z* −28*C*		D_2
	2 −07	3 −02		5*rAz* 00		4*rz* −01	3 00		D_3
4*A*?*Kz* +01	—	2 +02			—	2 −02			D_4
			—						09_0
1*z* +04	2 +05	2*z* +01			0 +21	3*z* +05*C*			12_4
			3*z* 00	3*z* +08*C*			0 −06	—	13_1
	1 +08	—		2 00		3= +04	0 −02		13_3
		—	2*z* +10	3*A*?*z* +08		—	1 +10		13_2
		—	2*z* −01	2 +17*C*		1 −01	2*z* −07*C*		14_2
—	—				2 +01				15_5
	2*z* +04*c*	—		0 +13		2*z* +01	—		15_3
—	1 +07	—			1*z* −04	—			16_4
1 +03					0 −07				17_6
0 +10	1*z* −27	—			2=*y* +03	0 −09			17_4
	—	2 −06		—		0*u* +10	—		17_3
			1 −01	(*C* +32)			—	1 −02	18_1
		?*ou* −44	1 −03	2*z* −01		—	0 −02		18_2
		—	2= −18*C*	—		0*z* −10	1 00		$18_2'$
	—	1 +05		1 −04		0 +03	—		18_3
		0 +13*C*	2 00	0 +08		4= +09*C*	—		19_2
2 −05	1 −07	—			—	—			19_4
3 −02*C*	—				3 −05				19_5
—					0 −05				19_6
—					—				$19_5'$
	—	2 00		1 +02		—	2 00		19_3
			0 +10	1 −01			1 00	—	20_1
		—	0 −07	0 +09		0 00	0 +12		20_2
			0 0						21_0
0 +08	—	1 00			1*u* +02	2 00			22_4
—	—				—				22_5
	1*u* −02*C*	0*u* +2		—		—	0 −05*C*′		23_3
1 +02	—				—				28_5
									43_1
									44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
.2 +15	1 −25	—			—	—			51_4
	—	—	—	—		—	—		52_{23}
			—	—			—		53_1
—	—	—			—	—			55_4
—	1 +25				—				55_5
—	—				—				?58_5
$404_5°$	$405_4°$	$406_3°$	$407_1°$	$408_2°$	$409_5°$	$409_3°$	$411_2°$	?$411_0°$	

The unusual magnetic interaction of the levels of 214_1 and 214_2 has been pointed out:[32] In moderately strong magnetic fields their sublevels of the same M value repel one another in such a way as to give rise to extremely asymmetric Zeeman effect patterns. Harrison's plates show several other similar but less marked interactions. Further work is being done on this phenomenon.[33]

3. INTERPRETATION

(a) Low Even Levels

The actual distribution of the levels of W I can be seen from Fig. 1. The low even levels belong to the configurations $5d^46s^2$, $5d^56s$, and possibly $5d^6$. The levels arising from these configurations are well known to be:

$$d^4s^2 \text{ or } d^6\text{: } {}^5D\ {}^3PPDFFGH\ {}^1SSDDFGGI,$$
$$d^5s\text{: } {}^{7,5}S\ {}^{5,3}PDFG\ {}^{3,1}SPDDDFFGGHI.$$

Immediate results to be read from Fig. 1 or from the observed values are that the lowest six levels are $5d^46s^2\ {}^5D_{01234}$ and $5d^56s\ {}^7S_3$ and that in certain obvious respects these six levels, like the lowest levels of most spectra, exhibit strong resemblances to LS coupling properties. There might still exist some doubt as to which of the two $J=3$ levels is ${}^7S_3$ and which ${}^5D_3$, or more cor-

[33] J. H. Roberson, in preparation.

TABLE I—*Continued.*

	411_4° 41198.05 1.22*B*	414_6° 41417.43 1.23*A*	414_3° 41499.37 1.11*A*	415_2° 41583.16 1.06*B*	416_3° 41694.28 1.28*A*	417_2° 41734.07 1.1*C*	418_4° 41871.91 1.11*C*	419_2° 41978.60 0.8*C*	422_3° 42251.45 1.32*B*
D_0									
D_1				2*Mz* −25		.9*Mz* −05		.8*Mz* +03	
S_3	3*MA*?*z*−14		0 +02	2 −30	3*M*? −23	0 +49*c*	2 −17	0 +41	——
D_2			1 −29	3*MA*?=−20	2 −14	2*z*? −23		0*fA*? +22	2 −30
D_3	4*rAz* +02		0 +28	1 −08	——	3*z* −12	2 −17	2 −28	3*Mz* −26
D_4	3 −07		4*MZ* 00		5*rz* −09		1 −01		5*rMz* −01
09_0									
12_4	3 −06		1 +04		——		0*u* +14		——
13_1				1*z* +02		0 +36		——	
13_3	1 +06		1 00	2*z* +01	——	3*z* +01	——	1 00	——
13_2			——	0 +07	——	3*dz* +07		2*z* −01*c*	——
14_2			3*z* +04	1 +01	3*fz* +04	——		3*z* +04	——
15_5	2*z* +11*C*	3*z* +04					——		
15_3	——		0 −02	0 +28	——	0 −18*C*	0 +35	3*z* +02	——
16_4	——		1*z* −02		——		——		——
17_6		3*z* −02							
17_4	1*z* +04		0 −15		1*z* −02		3*z* −20*C*		1*z* +03*c*
17_3	0 +28		——	?1*uz* +36	——	1 00	——	——	——
18_1				2*z* +01		1 −02*c*		1*z* −04	
18_2			3*z* 00	(*Cz* −38)	2*z* +01	1*z* 00		——	2*z* +01
$18_2'$			1 −01	1*z*? −02	3 +03	——		2 +01	3*z* +02
18_3	2 −03		2*z* −04*c*	2*z* −05	1*f* −04	——	3*z* 00	3*z* −09	——
19_2			2*z* 00	0*u* −07	——	——		?0 −37	3*z* −01
19_4	0*u* +17		2*z* −04		2*z* −02		3= −01		2*z* −04
19_5	1 −01	0 +23					0 +22		
19_6		2= −06							
$19_5'$	3*z* −01	0*u* +05					2*z* +01		
19_3	——		——	——	1 −02	3*z* −01	3*z* 00	——	2*z* +01
20_1				0 +04		0*u* +04		——	
20_2			0*u* +02*c*	——	0 −12	2*c* +06		0*u* −14	(*Cz* +37)
21_0									
22_4	0*u* −2		2 +01		——		0 +16		1*f* +03
22_5	——	——					——		
23_3	——		0*u* +13	0 −43	——	0*u* 00	1 +13	——	2 −01
28_5	——	2 +02							
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4	——		——						
52_{23}	——		——	——	——	——	——	——	?.0 +37
53_1				——		——		——	
55_4	——		——		——		——		——
55_5	——	——					——		
?58_5	——	——					——		
	411_4°	414_6°	414_3°	415_2°	416_3°	417_2°	418_4°	419_2°	422_3°

rectly, what linear combination of the pure eigenfunctions represents the actual levels; but in view of the *g* values it appears safe to assert that the lower is almost purely $^7S_3$, and the higher, $^5D_3$. This is the assignment published by one of us[21] in the first paper on W I. We shall now investigate whether any even levels beyond the lowest six can be assigned, in the usual approximate sense, to configurations and, if so, whether a hint may be obtained as to other quantum numbers.

As was pointed out above, the number of known even levels is much smaller than the large number that the theory predicts for d^4s^2 (i.e., 34) and d^5s (i.e., 74). In composing a table of the levels to be expected, one is therefore first faced with the difficulty of deciding upon an approximate order in which they follow one another. Theoretical reasoning to the usual approximations as to the order of the levels is not of very great value here because different choices of the parameters would array the levels in different orders. We have here taken as a starting point in our study that order of the terms of a configuration which has been found to be correct in the Cr I spectrum.[34] Since this chromium order will serve only as a guide of the crudest sort or, in

[34] C. C. Kiess, Bur. Stand. J. Research **5**, 775 (1930); J. Research Nat. Bur. Stand. **15**, 79 (1935).

TABLE I—*Continued.*

$422_1°$ 42262.26 1.5*C*	$424_2°$ 42449.56	$425_3°$ 42514.14 1.22*B*	$425_1°$ 42573.36 1.3*C*	$426_3°$ 42601.12 1.12*C*	$428_5°$ 42865.93 1.11*B*	$429_4°$ 42910.70 1.18*A*	$430_4°$ 43034.09	?$430_0°$ 43053.82 0/0	
.8 +09			.6 +28						D_0
.9*M* +12*C*	.9*ufz* +09		.8*M* +10					.8*M* +09	D_1
	—	—		1*MAz* −27*C*		0 +05	—		S_3
2 −27	1*Az* −19	0 −47	2*Mz* −14	2*Mz* −20					D_2
	4*Mz* +05	—		2 −21		3*Mz* −19	?0*d* +44		D_3
		1 −49		2 −33*C*	1*u* −17	2*A*? −11	3*Az*? −13		D_4
3*A* +01			3*A*? −02						09_0
		3*z* 00		0 +20	2*z* +13	2 +12	—		12_4
1*fz* 00	0 +49		—					0 −05*C*	13_1
	—	3= −02		—		2 00	0 +36		13_3
1 +02	—	0 +11	—	3*z* +07					13_2
1 +06	—	3*z* −02*C*	—	—					14_2
					0 −07	4*Kz* +05	—		15_5
	—	0 +23		3=? +02		2*z* 00	—		15_3
		0 +06		2*Az* 00	2 +07	2 +04*C*	3*fz* +08*C*		16_4
					—				17_6
		—		—	—	—	—		17_4
	—	1= −10		1 −01		—	1 +03		17_3
—	—		0 −04					—	18_1
1*uz* −02	2*z* 00	2*z* −24	—	—					18_2
2*fz* 00	0*z* −13	—	—	2*z* +03					$18_2'$
	—	—		0 −11		0 −24	—		18_3
1 −03	0 −03	—	0 +04	—					19_2
		1ζ −07		2*z* −10	2*z* 00	1 −03	3*z* −02		19_4
					—	2*z* −03	1*uz* +02		19_5
					—				19_6
					1 00	3*z* −03	4*z* −06		$19_5'$
	1 −01	0 −18		3 00		3*z* −03	—		19_3
—	0 +09		1 00					2*Z* 00	20_1
2 −02	0*u* +39	2 −06	0 00*C*	0 +02					20_2
—			—						21_0
		—		0 +09	—	2*f* −04	0*u* +25*C*		22_4
					0 −14	0 +30	—		22_5
	0 −19	0*u* +22		1*z* −22*C*		—	—		23_3
					1 −04	2 −03*C*	2 +06		28_5
									43_1
									44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
									51_4
—	—	—	—	—					52_{23}
—	—		—					—	53_1
		—		—	—	—	—		55_4
					—	—	—		55_5
					—	—	—		?58_5
$422_1°$	$424_2°$	$425_3°$	$425_1°$	$426_3°$	$428_5°$	$429_4°$	$430_4°$	?$430_0°$	

other words, since no detailed feature typical of Cr I will play a role in what follows, it seems that this is not too objectionable a procedure. However, any attempt to extrapolate W from Cr and Mo must reckon with two strong tendencies revealed by the $d^4s^2\,{}^5D$ and $d^5s\,{}^7S$ assignments already made: first, levels of d^4s^2 are relatively much lower in W, i.e., the configuration d^5s has lost its extra stability with respect to d^4s^2, of which it had about 8000 cm^{-1} in Cr and 11000 cm^{-1} in Mo; second, (*LS*) separations are enormously increased, which is a natural consequence of the increase in atomic number. (Compare the following over-all separations of the $d^5s^2\,{}^5D$: Cr 557 cm^{-1}, Mo 1380 cm^{-1}, W 6219 cm^{-1}.) In order to trace these two tendencies separately, though crudely, one might draw to scale on one strip of paper those levels of Cr I[35] that belong to d^4s^2, and on another, those that belong to d^5s; then (contrary to the actual case of Cr but in agreement with the assignments in W I) place $d^5s\,{}^7S$ in the midst of the levels of $d^4s^2\,{}^5D$; and finally, imagine the levels in each term to spread to per-

[35] We have chosen Cr I because relatively little information is available upon the analogous configurations: in Mn II, C. W. Curtis, Phys. Rev. **53**, 474 (1938); in Fe III, P. Swings and B. Edlén, Astrophys. J. **88**, 618 (1938), and in Mo I, W. F. Meggers and C. C. Kiess, J. Opt. Soc. Am. **12**, 417 (1926), M. A. Catalán and P. de Magariage, Ann. Soc. Espan. Fisica y Quimica **31**, 707 (1933).

TABLE I—*Continued.*

	?431_4° 43185.41 1.3*C*	432_1° 43217.27 1.3*C*	432_2° 43227.64 1.3*C*	432_4° 43250.97 1.14*B*	433_5° 43330.81	434_7° 43411.46 1.20*A*	434_3° 43478.59 1.3*C*	435_2° 43514.67 0.9*C*	437_4° 43720.86
D_0		.8*M*? −11							
D_1		.8 +08	.8*M*? −21					.8 +09	
S_3	—		.8 +02	.7*s* +08			—	—	—
D_2		1 −06*C*	0 +02				.9*MA*? +01	.8*M*? −17*C*	
D_3	3*fMz* +15		2 −25	2*M*? −15			0 −06	?0 −56	0 +26
D_4	0 00			3*M* −20	—		—		1*d* −49
09_0		—							
12_4	—			—	—		—		—
13_1		—	—					2 +04	
13_3	0 −12		3*fz* +03	3*f* +03			2 −03	1 +04	0 +19
13_2		2*z* +03	0 +03				1 00	1 −10	
14_2		1 +23	2*z* −02				—	2*z* −03	
15_5	1 −08*C*			1*z* −02	4*z* 00*C*				2*z* +02
15_3	—		0 −04*C*	3*z* −01			1*z* 00	2*z* −01	4*z* +01*C*
16_4	—			—	—		—		3 +04
17_6					—	2*z* +04			
17_4	—			—	—		—		0 +01
17_3	—		0 +07	1*z* −02			—	4*z* +08*C*	—
18_1		—	(*C* −37)					2*z* −03	
18_2		1 −03	0*z* −32				2*z* −04	2*z* −04	
$18_2'$		—	—				—	0 +05	
18_3	—		1 −05	3*z* −03			1 +05	—	2*z* −06*C*
19_2		0 −10	0 −19				3*z* 00	—	
19_4	1 −16			—	0 −08		—		—
19_5	—			2*f* −01	—				1*d*=*y* −04*C*
19_6					—	3*Z* −05			—
$19_5'$	—			0 −09	0 +12				2*z* −03
19_3	—		1 −02	1*u* +01			(*C* +32)	0 −03	
20_1		2 −06	—					?0 −44	
20_2		0 −27	—				0 +20	3*z* +29*C*	
21_0		—							
22_4	—			—	0*u* −06		?0 −33		—
22_5	—			—	—				—
23_3	—		—	—			—	—	—
28_5	—			1 +05	(*C* +31)				—
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}							—	—	—
53_1		—	—					—	
55_4	—			—	—		—		—
55_5	—			—	—				—
?58_5	—			2*u* −23*C*	1 +14				—
	?431_4°	432_1°	432_2°	432_4°	433_5°	434_7°	434_3°	435_2°	437_4°

haps ten times the total separation of the corresponding Cr I term. In this way one would be led to realize that the dozen or so even levels, which follow ^7S and ^5D, i.e., up to perhaps 18000 cm^{-1}, are all d^4s^2 with the exception of d^5s $^5S_2$, which, evidently having lost its *LS* character almost completely, is somewhere among them; and that the other d^5s terms, such as $^5G_{23456}$, are not among these earlier even levels. To what extent can we now identify in the energy diagram the terms $^3P\,^3H\,^3F\,^3G\ldots\ldots$ (listed here according to the order in which they occur in Cr I) which, according to theory,[2] are next in line? The levels $^3P_0$ and $^3H_6$ are immediately identified with 09_0 and 17_6, for their unique J values make them independent of coupling. The other $J=6$ level, 19_6, we identify with d^5s $^5G_6$. The reason for this choice rather than the opposite one is that (*LS*) separations within d^5s terms are expected to be small in comparison with those of d^4s^2, and within a few hundred cm^{-1} of 19_6 there are enough levels with proper J values and g values not violently discrepant to constitute the whole ^5G term, while the nearest $J=5$ level to 17_6 is almost 2000 cm^{-1} distant.

These and further identifications are summarized in Fig. 2a in which the interpreted levels have been plotted to scale as in Fig. 1.

TABLE I—*Continued.*

	437_5° 43741.33 1.09*C*	?437_0° 43790.0 0/0	438_3° 43850.77 1.17*B*	438_1° 43892.60 1.05*B*	439_5° 43924.17 1.2*C*	439_2° 43975.20 1.15*C*	439_4° 43985.36 1.24*C*	440_3° 44020.48 1.2*C*	443_1° 44353.42 1.02*C*
D_0				.7*ufvM* +2					.8 +2
D_1		.6 +47		.7 +20		.9*uM* +10			.3 0
S_3			—			5 +47*c*	.6 +02	.4 +5	
D_2			.9*uMAz* +04	.8 00		.9*uMz* +06		.9*M* +51	.7*A* +04
D_3			3*Mz* −16			1*M*?*z* −20	—	—	
D_4	—		4*MAz* +04*C*		—		2 −26	1 −40	
09_0				3*A* −03					0 +09
12_4	—		—		—		3 +06	1 +03	
13_1		2 −02		1 +02		—			3 −04
13_3			—			—	3*A* +09	—	
13_2			—	0 +15		—		2 +07	2*z* +06
14_2			—	—		—		1 −01	—
15_5	—				—		2 +04		
15_3			—			—	1 −03	3*Az* −04	
16_4	2*z* +08		—		—		—	—	
17_6	—				2*z* +11				
17_4	1*uf* +03		1 00		0*u* +33		3*z* +01	—	
17_3			—			0 −15*C*	0 +26*C*	—	
18_1		0 −14		—		2 −05*C*			0 −14
18_2			—	0 +08		—		3*z* −01	3*z* −01
$18_2'$			—	1*z* 00		1*z* +01		1 −03	—
18_3			—			2*z* −02	2*z* −05	—	
19_2			—	0*z* +09		1*z* −01		—	2*z* 00
19_4	4*z* −02		3*z* 00		—		—	3*z* −06*C*	
19_5	?0*z* −35				2*z* +05		2*z* −04		
19_6	1*z* −01				2*z* 00*c*				
$19_5'$	1= +02				—		2*z* −03*C*		
19_3			0 −11			1*z* +02	2 −01	1= −02	
20_1		—		—		0 +15			—
20_2			1 +04	—		2*f* −17		?2*z* +47	—
21_0				2*Z* +2					—
22_4	—		—		2 −02		—	1*u* −09	
22_5	0*u* 00				—		0*u* +17		
23_3			0 +02			—	—	—	
28_5	—				2 −03*C*		0*u* −4		
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}									
53_1		—		—		—			
55_4	—		—		—		—	—	
55_5	—				—		—		
?58_5	—				—		—		
	437_5°	?437_0°	438_3°	438_1°	439_5°	439_2°	439_4°	440_3°	443_1°

By means of inclined lines connecting levels we have indicated to what extent we believe the levels to be groupable with some justification into multiplets. Where a connecting line branches out into two such lines, a pair of levels lie sufficiently close together to destroy through interaction any decided individuality. Such a pair should, of course, be used twice. Levels 18_2, $18'_2$, and 19_2 account for $d^5s\ {}^5G_2$ and ${}^5S_2$ and for $d^4s^2\ {}^3D_2$. The ordinarily prominent g value ($g=2$) that one would expect in $d^5s\ {}^5S_2$ with ideal (LS) coupling is offset in the g-sum by the uncommonly small g value of ${}^5G_2$ ($g=\frac{1}{3}$). The g value of 20_1 strongly indicates $d^5s\ {}^5P_1$. Probably 21_0 (and perhaps 22_4) must be assigned to $d^5s\ {}^5D$, though $d^4s^2\ {}^1S$ is a possibility. Thus 20_2 and one $J=3$ level (say 17_3) are the only even levels below 21,000 cm^{-1} left unaccounted for. Since all the d^4s^2 $J=5$ levels have been accounted for, 22_5 must be ${}^5F_5$ (or possibly a ${}^3G_5$) of d^5s.

We do not attempt any further identifications among the low even levels, for there is little theoretical or empirical indication of the most likely levels to follow.

We have made an exhaustive search in this neighborhood, and believe it highly probable that all the levels below 22,000 cm^{-1} *have been found.*

TABLE I—*Continued.*

	443_2° 44367.45 1.1*C*	443_6° 44390.33 1.28*B*	444_3° 44446.95 1.38*A*	445_5° 44546.69 1.3*C*	445_2° 44596.27 1.11*C*	447_1° 44737.18 1.1*C*	449_6° 44923.78 1.23*A*	449_4° 44940.47 1.20*A*	449_7° 44970.72 1.20*A*
D_0						.7 −70			
D_1	.0 −33*C*				.6 −2	.4 +3			
S_3	.6 +06		.3*m* −1		.0*f* +22			.4 −3	
D_2	.7 +48		.8*M*? −02		.7 +02	.8*M*? +06			
D_3	——		2*Mz* −14		1 −19			.7 −08	
D_4			2*A* −22	2*Mz* −22				——	
09_0						3*M* −08*c*			
12_4			——	2 +01				——	
13_1	3*z* 00				2 +02	4*f* −02			
13_3	——		——		1 +02			4*z* +10	
13_2	2 +04		2*z* +01*C*		——	——			
14_2	1 +01		——		2*z* +01	——			
15_5		0 +14*C*		2*z* +04*C*			——	——	
15_3	2 +04		3*z* +02		——			2*z* +05	
16_4			0 +18	1 00*c*				2= −04*C*	
17_6		3*z* +08		3*z* −28			2 +11		2*z* +04
17_4			——	0 +28				1*u* +05	
17_3	——		0 −03		2*z* −03			——	
18_1	0 −15*C*				1 −01	0*uf* +03			
18_2	——		0 −40*C*		2 00*C*	0 −18			
$18_2'$	0 −06		——		2 00	2*z* +08			
18_3	3*f* −04		2= +01		1*z* −05			——	
19_2	——		1 +06		1*z* −02	——			
19_4			2*z* +01	2*z* +23*C*				1*z* 00	
19_5		3ζ +17*C*		——			2*z* 00	3*z* +02*C*	
19_6		2= −01		4*fz* −04			4= 00		3*Z* −04
$19_5'$		2*z* −01		——			3*fK*?*z* +01	3*z* 00	
19_3	0 −08		2= −01		——			——	
20_1	0 −15				——	1*u* 00*C*			
20_2	1*u* +03		——		——	——			
21_0						——			
22_4			1 −02	2 −06				2 −02	
22_5		1 −21*C*		——			——	——	
23_3	——		——		0 −22*C*			2 −01	
28_5		1*u* +13		4 +01			——	2*u* +01	
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}									
53_1									
55_4			——	——	——			——	
55_5		——		——			——	——	
?58_5		1*u* +06		2 −06			——	——	
	443_2°	443_6°	444_3°	445_5°	445_2°	447_1°	449_6°	449_4°	449_7°

(b) High Even Levels, Series, and Ionization Potential

The apparent thinning out of the even levels from here upward is to be regarded as not real but only caused by incomplete wave-length material. As in most arc spectra, among levels of the same parity as the ground level (i.e., in this case, even) it becomes increasingly difficult in this region to establish higher levels because combinations involving them are generally faint. Of course the still higher "third set" levels again show strong combinations, this time downward to low odd levels.

The occurrence of series is the only circumstance that runs counter to the general tendency toward increasing level density and hopeless complexity with increasing energy. Among complex spectra tungsten is especially fortunately situated for the discovery of series, for a reason that we shall now outline.

If many levels of about equal probability are associated with a single value of the current principal quantum number n, the search for series is subject to all the difficulties inherent in the study of a complex spectrum. On the other hand, the identity of, say, only one or two S terms may be harder to establish than that of one or two

TABLE I—*Continued.*

450_3° 45014.54 1.3*C*	450_2° 45019.02	451_4° 45116.70 1.2*C*	452_4° 45262.51 1.1*C*	$?453_1^\circ$ 45374.07	454_2° 45422.24 0.63	454_5° 45451.58 1.16*B*	455_3° 45551.32 1.30*A*	456_3° 45677.66 1.24*A*	
				.4 +2					D_0
	.2 −2			—	.5*M*? 0				D_1
—	.4 0	.7 +08	—		.4 +3		.5 0	—	S_3
.7*M*? +03	.8*M* 00			—	.7 −06		.1*s* −4	.8*M* −02	D_2
.6 +03	.8*M*? −03*C*	1.0*Mz* +26*C*	.8*M* +03		.9*M* −14*C*		.9*Mz* +01	.5 +07	D_3
—		2 −25	0 +08			—	0 +27	—	D_4
				—					09_0
1 −01		2 00	2 +01			—	—	0*u* −3	12_4
	—			3*z* −08	0 +26				13_1
0 +30	—	—	—		—		1 +02	2 −01	13_3
0 +38*C*	2 +03*C*			0 +21	1 +09		2 −01	4*z* +02	13_2
2*z* +01	2 −03			0 +47	1 −06*c*		—	3*z* +07	14_2
		—	0 +12			1 +04			15_5
2*z* +02	1*z* −02	—	5*K*?*z* +10*C*		0*f* +22*C*		2 +11	—	15_3
—		—	—			—	0 +03	0 +08	16_4
									17_6
1*z* +02		—	1 00			3*fz* +04	—	—	17_4
1 00	0 +29	—	3*z* −05*C*		2*dz* −05		—	2= −02	17_3
	(C −39)			1 −06	1 +06				18_1
1*z* 00	—			3*z* −07	0 −02		—	—	18_2
2*z* 00	2 −27*C*			3*A*?*z* −09*C*	3=? 00*C*		2*z* 00	(*C* −36)	$18_2'$
—	4*fz* −15*C*	1 +01	1 00		1 −01		2*z* −09	2= −05	18_3
0 +03	1 −04			0 +02	—		2*z* +05*C*	—	19_2
0 +02		—	—			1*z* −01	3*z* −07*C*	3*z* +03	19_4
		—	—			—			19_5
						2*z* −02*C*			19_6
		2*z* +02*C*	0*z* +26			—			$19_5'$
0 +14	—	3*z* +02	2*z* +14*C*		2*z* −02		—	0 +02*C*	19_3
	0 +03*C*			—	—				20_1
1*Z* +02	—			—	2 −03		0 −10	1 +39	20_2
				0 +35					21_0
1 −06		2 −02	0 −07*c*			—	—	2*z* −07	22_4
		0*u* 00	—			2*z* 00			22_5
0 −10	—	2 −01	0 +07		—		—	—	23_3
		0*u* +29	—			0*u* −12			28_5
									43_1
									44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
									51_4
									52_{23}
									53_1
—		—	—			—	—	—	55_4
		—	—			—			55_5
		—	—			—			$?58_5$
450_3°	450_2°	451_4°	452_4°	$?453_1^\circ$	454_2°	454_5°	455_3°	456_3°	

multiplet terms of predictable spread. The latter may be considered the optimum conditions for the discovery of series in complex spectra.

In a configuration of z equivalent electrons, l^z, there are usually several terms of the highest multiplicity; but if $z=2l+1$, there is only a term ${}^{2l+2}S$, and if $z=2l+1\pm1$, there is only a term ${}^{2l+1}l$. (Here we are neglecting the cases $z\leqslant 2$ and $z\geqslant 4l$, for we are considering complex spectra.) If one or two s-electrons are added, i.e., in the configurations $l^{2l}ns$ and $l^{2l}s\cdot ns$, the situation is similar, but two terms of different multiplicity are of comparable importance. Thus, in $l^{2l}s\cdot ns$ the important terms are ${}^{2l+3}l$ and ${}^{2l+1}l$.

In the long periods ($l=2$), so long as s^2 plays an important part, the above optimum conditions occur in the sixth and eighth columns.[36] In W I in particular, $d^4s\cdot s$ ${}^7D$, ${}^5D$ series might be expected to be prominent. Actually, we have identified all the members of $5d^46s\cdot 7s$ ${}^7D$, ${}^5D$ and searched unsuccessfully[37] for higher members of

[36] Albertson (reference 1) has remarked somewhat similarly on the dependence of the prominence of series upon z for the special case of the rare earths, $z=3$.

[37] It is possible that 53_1 is in reality $5d^46s8s$ ${}^7D_1$, which would lead to an ionization potential near the lower limit of the range given in the next paragraph; but our failure to find any of the remaining members of the septet in spite of the close predictability of the separations argues against this supposition.

TABLE I—*Continued.*

	457_5° 45789.71 1.19*B*	458_4° 45869.00 1.36*A*	459_2° 45902.45 0.5*C*	460_3° 46067.97 1.46*B*	461_1° 46104.55	462_2° 46291.61 0.3*C*	463_2° 46327.71 0.8*C*	463_3° 46385.44 1.4*C*	465_5° 46506.35 1.38*A*
D_0					.0 +05				
D_1			.7 +5		.4 −5	.6*M* +1	.3 +2		
S_3		.5 +6	.6 −3	.6 +06		.7*M*? +2*C*	—	—	
D_2			.7*ρ* +03	.4*f* −2	.3 0	.6 −1	.0*f* 0	.9*M* −07	
D_3		1.0*rMz* +08	.7*fM* −03	.9*uMu* −07		—	.8*A* +12	.9*M*? +04	
D_4	0 +01	1*MAz* −12*C*		2 −23				.8 −03	1.0*Mz* −08*C*
09_0					2 −10				
12_4	3 +03	0 −01		—				2 −01	—
13_1			—		1 +03	—	0 +34		
13_3		3 +03*c*	0 −04	3 +01*C*		—	0 −15	—	
13_2			1 +06	1 00	0 −05	—	—	0 −24	
14_2			—	—	—	1 +02	—	3 −03	
15_5	4*z* +08	—							—
15_3		—	—	0 +21		—	1*u* +08	2*z* +01	
16_4	1 00	—		0 −10*C*				0 −12	0 +05
17_6	—								—
17_4	3*z* −05	3*z* −13*C*		0 +20				—	—
17_3		—	(*Cz* −41)	1*z* 00		—	0 −24	?1 −48	
18_1			0 +13		0*u* −07	—	—		
18_2			0 −05	—	—	2*z* −04	1 +04	—	
$18_2'$			—	1 −01	0 +08	3*z* +02	—	—	
18_3		—	—	3*A*?*z* −01*C*		—	—	0 +04	
19_2			2*z* +08	1 +01	—	0 −03*C*	—	2*z* −01	
19_4	2 −03	—		—				2*z* −03	3*z* +02
19_5	—	2*z* +06						—	—
19_6	2*uz* −06								3*Az* −03
$19_5'$	—	—							—
19_3		—	1 −04	0 −33		—	—	2*z* −03	
20_1			2 −06		1 00	1 −04	—		
20_2			0 00	—	—	0 +16	—	—	
21_0					—				
22_4	—	2 +05		—				0 +01	1*z* −03
22_5	—	0 +11							—
23_3		3*r* −12	—	1 −06		0*u* −38	2*z* 00	0 −16	
28_5	0*u* +09	—							—
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}									
53_1									
55_4	—								
55_5	—								
$?58_5$	—	—							—
	457_5°	458_4°	459_2°	460_3°	461_1°	462_2°	463_2°	463_3°	465_5°

this series and for members of the $5d^5 \cdot ns\ {}^7S$, ${}^5S$ series. The intervals and g values in the D series may be studied in Fig. 3 and Table III. The distributions of the intervals are quite similar; and in particular the distribution in $5d^46s7s\ {}^7D$ is remarkably like that in the limit term W II $5d^46s\ {}^6D$. The sagging of the middle levels of $5d^46s\ {}^6D\ 7s\ {}^5D$ compared with those of $5d^46s7s\ {}^7D$ might have been expected from a qualitative consideration of the Landé interval rule. The over-all separations of $d^4s^2\ {}^5D$, $d^4s\cdot s\ {}^7D$, and $d^4s\cdot s\ {}^5D$ may be predicted,[38] in an LS coupling approximation, to have the relative values

$$\tfrac{14}{15}\Delta\nu(d^4s^2\ {}^5D) = \Delta\nu(d^4s\cdot s\ {}^7D) = \Delta\nu(d^4s\cdot s\ {}^5D).$$

The interpretation of these higher levels opens the way for the spectroscopic determination of the ionization potential. The application of a Rydberg formula to $5d^46s({}^6D)ns{}^5D_0$ for $n=6$, 7 yields a limit of 66,299 cm^{-1}, which is brought by a Ritz correction of (-2.8 ± 1) percent to 64.4 $\times 10^3$ cm^{-1}. The 2.8 percent correction, estimated from other spectra, is not so reliable as similar estimates in other parts of the periodic table because of the paucity of data in the neighborhood of tungsten. Since the limit $5d^46s\ {}^6D_{\frac{1}{2}}$ is, according

[38] O. Laporte, *Handbuch der Astrophysik* (Berlin, Springer, 1930), Vol. 3, Part 2, p. 644.

TABLE I—*Continued.*

$466_4°$ 46625.03 1.14*B*	$466_6°$ 46672.15 1.18*B*	?$467_7°$ 46755.26	$468_2°$ 46806.40 1.1*C*	$468_5°$ 46854.76 1.21*B*	$469_4°$ 46931.81 1.0*C*	$470_2°$ 47079.36 1.3*C*	$473_2°$ 47337.76 0.9*C*	$473_3°$ 47361.69 1.3*C*	
									D_0
			—			.4 +5	—		D_1
—			—		.7 +7	—	—	—	S_3
			.6 −3			.6*M*? −4	.6 −2	.3 −1	D_2
.4 +2			.7 −2		.9 +15	.8ρ′ −12	.6 +2	.7 −3	D_3
.9*Mz* −01				.8 −04	.8*Mz* +04*C*			.7*d* −14	D_4
									09_0
2 00*C*				—	2 −02			1*u* −08	12_4
			—			3 +01	1 −03		13_1
0*u* +26			1 −04		3 +05*C*	1 +02	2 −04	2 −02	13_3
			3*z* −01			3 −01	—	—	13_2
			3 +04			—	2 −03	—	14_2
—	4*z* +05			?0 +46	2 +02				15_5
1 +03			3*f* +02		—	—	3 +02	1*u* +02	15_3
—				0 +07	—			2 +02	16_4
	0 −03	1 −10*C*		—					17_6
0 +01				—	0 −41			—	17_4
0 +10			0 +32		—	—	0 −03	1 00	17_3
			0 −06			0 +25	—		18_1
			—			2*z* 00	—	—	18_2
			—			0 +23	—	—	$18_2'$
0 +08			0 −02		—	—	0 +36	2*z* −05	18_3
			0*f* −20			—	2*z* −01	—	19_2
0 +03				3*z* 00	—			—	19_4
—	3*z* −03			1*z* +02	1 +01*c*				19_5
	3= 00	5*z* 00		3*z* −02					19_6
3*z* −04	0 +16			2*z* +02	—				$19_6'$
—			—		2 +04*C*	—	—	3*z* +07	19_3
			—			—	2ζ 00		20_1
			—			—	0 +08*C*	—	20_2
									21_0
—				1 +19	—			0 +06*C*	22_4
—	—			0 −12	—				22_5
0 −13			—		1 −07	1 −05	1*u* −04	3 −03	23_3
(C +37)	—			0 +31	—				28_5
									43_1
									44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
									51_4
									52_{23}
									53_1
									55_4
									55_5
—	1 −03			—	—				?58_5
$466_4°$	$466_6°$	?$467_7°$	$468_2°$	$468_5°$	$469_4°$	$470_2°$	$473_2°$	$473_3°$	

to Laun,[26] the normal level of W II, we have[37, 39, 40] for the ionization energy:

$$\text{W I } 5d^4 6s^2\ {}^5D_0 = \text{W II } 5d^4 6s\ {}^6D_{\frac{1}{2}} = (7.94 \pm 0.1) \text{ volts.}$$

Russell's[41] estimate of 6.7×10^4 cm^{-1} = 8.1 volts was obtained from our data at an earlier stage by considering S_3, 46_3 as members of a $d^5ns\ {}^7S_3$ series and subtracting two percent as a probable Ritz correction.

(c) Odd Levels

In the past there has been no successful attempt to assign quantum numbers other than J to the odd levels.[42, 43] We are essaying the in-

[39] We ought to mention, but we give no weight to, the possibility that a whole series member has been missed in the difficult region 34×10^3 to 42×10^3 cm^{-1}, which would bring the ionization energy down to 6.4 volts. This region has been searched without result.

[40] Of course the ±1 percent and ±0.1 volt recorded here represent only a crude guess as to our error.

[41] H. N. Russell, Astrophys. J. **70**, 11 (1929).

[42] Laporte, reference 21, misidentified the levels 214_1, 239_2, and 261_3 as a ^5P term.

[43] A. T. Williams, Comptes rendus **199**, 1201 (1934) made the following attempts at assignment of L and S by comparison with Cr and Mo, without benefit of g value:

$214_1\ {}^5P$	$347_1\ {}^5F$	$382_4\ {}^7P$
$239_2\ {}^5P$	$361_1\ {}^5D$	$387_4\ {}^5F$
$261_3\ {}^7P$	$368_3\ {}^7P$	$396_3\ {}^7P$
$262_2\ {}^7P$	$369_2\ {}^7P$	$397_2\ {}^5P$
$278_4\ {}^7P$	$376_3\ {}^7P$	$402_3\ {}^7P$.

TABLE I—*Continued.*

	474_3° 47483.70 1.29*B*		475_6° 47541.49 1.23*C*		475_3° 47593.37 1.2*C*		476_4° 47689.29 1.4*C*		478_5° 47850.76		479_4° 47968.55 1.23*B*		481_5° 48138.33 1.2*C*		481_3° 48170.53		482_2° 48244.24 1.4*C*	
D_0																		
D_1																	.6	−6
S_3		—				—		—				—				—		—
D_2	.6	−4				—									1*f*	+1	.6*M*	+3
D_3	.6	−02			.5*uf*	−21	.6	−10			.5	+24			.7*M*?	0*C*	.7	+2
D_4	.6	+02			.5	+10	.5	+33	.6	+06		—	.9*M*	+11	.8*u*	+11		
09_0																		
12_4	3*fH*	−12			0	+18		—	3*fz*	00	3	+02		—		—		
13_1																	2	−08
13_3	2	+17			1*u*	−04		—			3	−02			3	−08		—
13_2	0	−10*C*				—									2	+05	3	+03
14_2	0	−21				—									2	−07	2	00
15_5				—				—	6*rKz*	−14*C*	?1	+44*c*	1	−03				
15_3	0*u*	−34			2*f*	+09		—			2	−02			2	+06	1	+03
16_4		—			2	+08	0*f*	+22		—	2	+03	3	+08		—		
17_6									1	−37				—				
17_4	0	+35			?0	+52	2	+05		—		—	2	−01		—		
17_3	0	+02			(*C*	−45)		—				—				—	0	−06
18_1																	0	+24
18_2	1	−03			2*z*	+25*C*										—		—
$18_2'$	1	+01			0	−01										—		—
18_3	2=	−09*C*			1	+01						—				—	0	−21
19_2		—			0	+18										—		—
19_4	2*z*	−07			0	+21		—		—	3*z*	+03	0	+26		—		
19_5			0	+01			3*z*	−03		—	1*z*	00		—				
19_6			3=	00					2	+03			2*z*	−02				
$19_5'$			3*z*	−01				—	0	+12	0	−07	1*z*	00				
19_3	0	+14			0	+26*C*		—				—				—		—
20_1																	2*A*?*z*	−01
20_2	2*z*	−01			1	+01										—	3*z*	−01*C*
21_0																		
22_4	0*z*	−17			0	−18	3*f*=	−02	0	−10		—		—		—		
22_5				—			0	+09	0	+06		—	1	00				
23_3	(*Cz*	+37)			2	00		—				—				—		—
28_5			0*u*	−16			1	+02		—	0	+07	0	+01				
43_1																		
44_2																		
45_0																		
46_1																		
46_3																		
47_4																		
48_2																		
49_5																		
49_3																		
51_4																		
52_{23}																		
53_1																		
55_4																		
55_5																		
$?58_5$				—				—		—		—		—				
	474_3°		475_6°		475_3°		476_4°		478_5°		479_4°		481_5°		481_3°		482_2°	

terpretation of individual odd levels in the region of low energy; for the rest of the levels we shall offer only a brief statistical discussion.

Even a casual glance at an energy plot of the odd levels in columns according to J value (Fig. 1) shows in the region 20,000–30,000 cm^{-1} the stepped structure that is characteristic of multiplets. Although there is hardly a semblance of Landé interval ratios, it is evident, from a qualitative study of the energies, g values, and intensities, that the levels form the pair of triads $5d^46s(^6D)6p\ ^{7,5}FDP$. Every one of the multiplets overlaps all the other five, except for the gap between the adjacent levels $^7P_4=278_4$ and $^5P_1=281_1$; and there are levels extraneous to the multiplet within each multiplet interval, except at the bottom of the ^7F. In view of this complexity the following, though probably without general significance, is a striking fact: except for the case of $^7P_4$ and $^7D_4$, the levels of each J value in the triad are ordered in energy according to S and L: $^7FDP\ ^5FDP$. Ambiguities in LS assignment, offering further possible exceptions to this regularity, occur in the three cases of 261_3 and 274_3 ($^7D_3$ and $^7P_3$), 263_2 and 276_2 ($^5F_2$ and an extraneous level, mentioned below), and 314_4 and

TABLE I—*Continued.*

483_2° 48318.80 1.4*C*	483_3° 48326.40	486_4° 48676.18 1.20*B*	490_3° 49072.09 1.26*C*	491_4° 49147.95	491_2° 49151.84	491_5° 49187.87 1.25*B*	492_2° 49270.22	494_3° 49417.90	
									D_0
.4 −6					.5*f* −4	— —			D_1
—	—	—	—	—	—		—	—	S_3
.6*f* +2	—		—		—		.8 +1	—	D_2
.5 −1	.7 −16	—	.8*f* +68	2*u* 0	.6 0		.6 +3	.0 0	D_3
	.8*uM* +47	.8*uM* −02	.6 −2	3*f* −2		.7*M* +10		.7*M* 0	D_4
			—						09_9
	—	—	—	—		3*MA*?*z* −14		—	12_4
2 −05					—		—		13_1
2 −15	—	3*Az* −24	2 −05	2 −05	1 +01		—	2 −06	13_3
2 +02*C*	2 −03		1 +03		1 +02		0 +33	—	13_2
1 +03	2 −03		1 +01		—		2 −07	1 00	14_2
		—				3 00			15_5
0 +27*C*	?2 −11	—	—	—	—		0 +18*C*	2 −09	15_3
	—	—	—	—		1*d* +04		—	16_4
						—			17_6
	—	1 −10*C*	—	—		1 +09		1 +03	17_4
2 +08*C*	1 +06	2 −17	2 00	3*z* −04	—		1 +01*C*	1*d* 00	17_3
0 +37					0 +12		2 −01		18_1
—	—		—		—		—	—	18_2
2*z* +06*C*	—		—		—		0 +04	—	$18_2'$
1*f* +06	—	—	2*z* +01	—	—		—	—	18_3
—	—		—		—		0 −21	—	19_2
	0 −23	2*AKz* −15	0 −01*C*	1 −03*c*		—		0 −04*C*	19_4
		—		—		2= +29*C*			19_5
						2*z* +03			19_6
		—		1 +01		1 +05			19_5,
—	0 +31	0 +11	0 −10	0 +25*C*	—		0 +04	0 +12	19_3
—					—		—		20_1
—	0*u* +07		0 +16		—		—	—	20_2
			—						21_0
	0 +26*C*	0 +15	—	—		2 −03		—	22_4
		—		3*z* −10*C*		—			22_5
—	—	2*z* +21*C*	1 −03	—	0 +06		0 +11	1*A*= −03	23_3
		1 +20*C*		—		—			28_5
									43_1
									44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
									51_4
									52_{23}
									53_1
									55_4
									55_5
									?58_5
483_2°	483_3°	486_4°	490_3°	491_4°	491_2°	491_5°	492_2°	494_3°	

328_4 ($^5F_4$ and $^5D_4$). Among all the levels of the two triads there is (if ?285_6 is real) no level missing, and but one extraneous level, *viz.*, the uninterpreted 276_2. The g sum for the seven $J=2$ levels is so low that, clearly, the interloper must be one of the predicted levels discussed in the next paragraph: Σg_{obs} (seven levels including 276_2) $=10.4$, Σg_{calc} (six ideal LS-coupling levels $^{7,5}FDP)=10\frac{1}{6}$.

A short distance above these triads is a close group of four adjacent levels 343_3, 344_2, 346_4, 347_1, with exceptionally small g values. This can only be interpreted as an indication of levels arising from the addition of a p electron to ionic levels with large L and small S, e.g., $5d^46s(^4HGF\ .....)6p\,^5I_4\,^5H_3\,^5G_2\,^5F_1$ ($g_{\text{ideal}\ LS}=0.60, 0.50, 0.33, 0.00$, respectively).

There is no indication that any of the six levels arising from $5d^5(^6S)6p$ are low; they would all have large g values in either (L) (S) or (LS ion) (electron) coupling.

Upon the suggestion of Professor H. N. Russell a table has been compiled which gives additional qualitative support to the above assignments of L and S values. At the top and at the left-hand side the odd and even levels were listed respec-

TABLE I—*Continued.*

	494_1° 49443.72	495_3° 49514.34 1.3*C*	495_2° 49517.26	496_4° 49636.58	497_2° 49700.02 1.9*C*	497_4° 49788.60	499_3° 49966.04	501_5° 50137.52 1.11*B*	501_3° 50185.68
D_0	—								
D_1	.5 0		.5 +5		.5 −4				
S_3		—	—	—	—	—	—		—
D_2	.2*f* −63	.6 +3	.3 +3		.5 −3		—		—
D_3		.5 −2	—	—	.6*Mu* −4	.7*M* −1	—		.4 +6
D_4		.8*Mu* −27		—		.7*fv′M* −76	.7*M* +1	.3 −4	.6 +02
09_0	0 −33								
12_4		0 −34		—		0 +02	—	2*M*?*z* −30	1 −16
13_1	—		—		0 −05				
13_3		—	2 −02	3 −08	—	3 −20*C*	—		0 +01
13_2	1 +08*C*	—	2 −05		—		—		1 −02
14_2	—	0 −27	2 +02*C*		—		3 −14		(*C* −42)
15_5				1 −04		—		2 −07	
15_3		2 −05	—	3*z* −06	0*u* +22*C*	—	2 −01		—
16_4		—		00 +16		2 −09	0 −31	0 −33*C*	1 +01
17_6								—	
17_4		2 −05*C*		(*C* −53)		—	0 +04	?3 −55	—
17_3		—	3 +03*C*	—	—	—	2 00		—
18_1	1 −01		1 +03		0 +07				
18_2	0 +06	3*z* −02	1 +03		—		1 +04		1 +02
$18_2'$	—	1 +02	0 +33*C*		2*z* −02		2*K* +07		—
18_3		0 −01	0 +24*C*	—	—	—	—		2 +02
19_2	4*y* +03*C*	0 +37	0 +29		(*C* −42)		—		—
19_4		—		0 +28		—	—	—	1 +02
19_5				0 +13		—		2*z* +04	
19_6								—	
$19_5'$				1 +04		0*f* −12*C*		2*z* +04	
19_3		0 −04*c*	0 +12	2*z* +05	—	—	0 +09		—
20_1	1 −06		—		—				
20_2	0 +03	—	2*f* +02		—		0 +35		—
21_0	—								
22_4		0 +30*C*		0 −11		1 −05	1 −04	?0*A* −42	—
22_5				1*z* −02		1 +01*c*		—	
23_3		—	—	—	—	(*C* +33)	—		0 −14
28_5				—		0 +20		1*u* −02	
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}									
53_1									
55_4									
55_5									
?58_5									
	494_1°	495_3°	495_2°	496_4°	497_2°	497_4°	499_3°	501_5°	501_3°

tively, not according to their position, but according to their L and S values, as if W I obeyed LS coupling. In the body of the table intensities were put, as taken from Table I. They clearly showed intensity gradations according to the old qualitative intensity rules for LS multiplets. Because all the data for the compilation of such a table are at the reader's disposal in Table I, it is not included here.

In an attempt towards further interpretation of odd levels, $N_J(\nu)$ was plotted as a function of ν, where $N_J(\nu)$ is the number of odd levels of a definite J with energy less than ν. The broken curves thus obtained were compared with the same curves derived from the odd levels of Ti I, Cr I, and Fe I, whose spectra are supposed to be rather exhaustively classified. No definite statistical information could, however, be derived from these curves since the $N_J(\nu)$ plots seem, to a considerable extent, to be independent of the number of optically involved electrons.

In view of the fact that the $N_J(\nu)$ curves for W I lie reasonably close to those for Ti I, Cr I and Fe I, one may merely conclude that in the regions investigated, the spectrum W I is now classified with a comparable degree of completion.

TABLE I—*Continued.*

$502_4°$ 50284.57 1.03*B*	$504_2°$ 50494.68	$507_2°$ 50718.85	$508_3°$ 50800.43 1.0*C*	$508_5°$ 50806.08	$508_4°$ 50894.05	$509_4°$ 50909.40 1.2*C*	$510_{34}°$ 51072.17	$511_{32}°$ 51182.48	
									D_0
	—	—						—	D_1
—	—	—	—		—	.0*f* +1	—	—	S_3
	—	—	—				—	.3*f* +2	D_2
.4 +6	.0 −17	.8 +6	.7 +8		.5 +4	.9 +2	—	.0*f* +29	D_3
.6 −4			.4 0	—	.5 0	—	—	—	D_4
									09_0
0 +07			0 +21	1 −22	2 −17	0 −06	—	?3*Mz* +10*C*	12_4
	0*f* −02	0 +23						—	13_1
2*z* −11	0 +12	0 −14	—		0 +04	0 +07	—	0 −17	13_3
	—	—	?0*uA* +60				—	—	13_2
	—	—	2*f* +19*C*				—	2 −09	14_2
2 −01				2 −09	2*f* +34*C*	1 +31	—		15_5
—	3 −28	—	0 00		1 00	0 +10	—	—	15_3
—			—	2 −03	2 +32*C*	—	1 −02	—	16_4
				1 −02					17_6
2 +05			2 +03	3 +02	1 +09	0 +27	2 −03	—	17_4
—	—	2 −03	—		—	2 +01	1 −03	0 +11	17_3
	0 −08	(*C* +36)						—	18_1
	1 −12	0 −16	0*u* −23				—	—	18_2
	—	2 +03	(*C* +55)				?2 +03	0 −01*C*	$18_2'$
?0 +48	0 +38	—	1 +01		—	1 −01	1 +07	0 +09	18_3
	2 +25*C*	2*f* +05	1 +02				—	—	19_2
3*z* +13*C*			—	—	—	—	3 +18*C*	—	19_4
—				—	—	—	?2 +11*C*		19_5
				2 +03					19_6
—				—	—	0*uf* +23	—		$19_5'$
—	—	—	—		—	—	—	—	19_3
	0 +10	0 +07							20_1
	—	0 +19	—				—	—	20_2
									21_0
—			—	—	—	—	—	—	22_4
—				2*z* +01	0 −02	—	?0 +03		22_5
0 +27*C*	—	—	2 −02		—	2*z* +05	3=? −34*C*	—	23_3
—				—	0 −11	1 −02	—		28_5
									43_1
									44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
									51_4
									52_{23}
									53_1
									55_4
									55_5
									?58_5
$502_4°$	$504_2°$	$507_2°$	$508_3°$	$508_5°$	$508_4°$	$509_4°$	$510_{34}°$	$511_{32}°$	

4. DESCRIPTION OF TABLE I, LEVEL AND TRANSITION ARRAY, AND TABLE II, LINE LIST

(A)

Table I, the rectangular array, serves at the same time as a list of all the known energy levels[44] of W I with their properties and as a compilation of the transitions among these levels with all their pertinent data (except that on the Zeeman effect for the individual lines).

[44] Notation as to the discoverer of each level has been omitted from the already bulky Fig. 1 and Table I. Interested readers may search the papers referred to in Section 2c.

At the head of each row and each column occurs the description of a level: each row in the body of the table is headed by the description of an even level, and each column by that of an odd level. The description of each level consists of the following items, respectively:

(1) The approximate structural symbol (only if the structure is approximately known, of course). Where symbols are bracketed together they are indifferently interchangeable, e.g., it would have had as much meaning to give the level 17_3 the structural symbol $5d^56s\,^5G_3$ or $5d^46s^2\,^3D_3$ as to leave its interpretation blank; cf. Sections 3a, 3c.

TABLE I—*Continued.*

	512_5° 51290.71	?516_3° 51600.38	?$516'_2$° 51606.4	516_2° 51693.82	517_1° 51763.28	518_4° 51856.06	520_3° 52015.23	520_4° 52059.72	520_5° 520.8112
D_0									
D_1									
S_3		—	.4 +1.5	—		—	—	—	
D_2		.4 0	—	—	—		—		
D_3		.4 −4	.0*f* 0	—		—	—	0 −01	
D_4	—	.7 +4				.7 +4	—	—	.9 +4
09_0					.8 +25				
12_4	2ζ +34	—				0 +25	2 +13	1 −11	0 +05
13_1			0 +06	—	—				
13_3		—	—	0 +18		0*u* +07	2 −32	—	
13_2		2*A* −16*c*	0 −05	—	—		0 −41		
14_2		—	—	0 −03	1*u* +01		—		
15_5	2 −03					—		—	0 +36
15_3		—	0 +36*C*	2 00		2 −01	—	—	
16_4	—	1*u* +05				—	—	—	3 −06
17_6	2 +02								1 −06
17_4	—	2 +10				2 −02	—	1 −04	1 +11
17_3		—	—	2 00		3 00	—	1 +03	
18_1			—	—	0 −09				
18_2		—	—	—	0 +02		1 +03		
$18_2'$		—	—	0 −15	—		0 +03		
18_3		—	0 +04	3 +11*C*		—		2 −01	
19_2		2 +10	0 −19	—	—		0*u* +43		
19_4	2 −04	—				—	—	?2 00	1 00
19_5	—					—		2*A*? +01	?0 −50
19_6	1*d* +04								—
$19_5'$	—					2 −02		—	—
19_3		—	—	—		—	4 +14	—	
20_1			—	—	—				
20_2		2 +29*C*	—	—	—		—		
21_0					—				
22_4	—	—				0 +12	—	—	0 −02
22_5	—					0*u* +06		—	1 +07
23_3		—	—	—		—	—	—	
28_5	—					0 +36		—	—
43_1									
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}									
53_1									
55_4									
55_5									
?58_5									
	512_5°	?516_3°	?516_2°	$516'_2$°	517_1°	518_4°	520_3°	520_4°	520_5°

(2) The name. If the existence of the level is doubtful, the name is preceded by a question mark. The name of each of the lowest six levels is the approximate structural symbol, abbreviated to a capital letter and subscript. The name of each of the other levels consists of the first two (for even levels) or three (for odd levels) digits in its excitation energy value, and its J value as a subscript.[45] In cases of doubtful J, both J values are used. The additional symbol "°" is used to distinguish an odd level in this table, but not in the rest of the paper, for a three-digit-and-subscript name is sufficient. In a few instances it is necessary to distinguish one of a pair of otherwise identical level symbols by a prime.

(3) The energy, measured in cm^{-1} from the most stable level, D_0.

(4) The tentative Zeeman effect g value, followed by one of the letters A, B, C, indicating its reliability. The uncertainty of g for "A" levels is about 0.01; for "B" levels, between 0.01 and 0.1; and for "C" levels, greater than 0.1.

At each appropriate row-column intersection

[45] This system has the advantages of showing the level's parity and approximate energy without requiring any more digits than if the levels were numbered serially, while at the same time the list can be supplemented to almost any probable future requirement, with no more emergency symbols than an occasional prime.

Table I—*Continued.*

?521_2° 52152.54	522_3° 52255.75	523_5° 52395.48	524_4° 52436.40	525_2° 52503.43	527_5° 52774.04	529_3° 52943.38	530_1° 53042.02	531_4° 53118.29	
				—					D_0
									D_1
—	—		?.2*f* +7	—		—			S_3
—	—			—		—	.0 +4		D_2
—	—		—	—		—		—	D_3
	—	.5 +2	.3 −1		.3 −1	—	.4 +4	—	D_4
									09_0
	.8 +06	.9*Mz* +08	.8*M*?*A* +04		.7*A* +08	.9 +20		.3 +1	12_4
2 −15				—			—		13_1
—	—		0 −03	—		0 +01		—	13_3
—	2 −15*C*			0 +02		0 −05	—		13_2
—	0 +47			0*f* +14		—	2*u* +40		14_2
		—	0 −04		0 −26			0 +36	15_5
—	1*ufA*? −04*C*		0*f* −38	—		—		1 −35	15_3
	2*f* 00*C*	2 −04	—		1 +03	2 +05		—	16_4
		—			—				17_6
	—	1 −04	—		—	—		2 −02	17_4
2 +07	2 +01		1 −17	1 +38		—			17_3
—				—			—		18_1
—	—			2 00		0 −09	0 −08		18_2
1 00	2 +01		—	—		—	—		18_2′
—	—		—	1 −06		—		2 +01	18_3
2 +10*c*	—			1 00		—	1 +12		19_2
	—	—	—		3 00*C*	—		—	19_4
		1 00	—		—			3 +04*C*	19_5
		1 +04			1 −01				19_6
		1*A* +04	0 −34		3 00			2 +01	19_5′
—	—		—	—		—		—	19_3
—				—			—		20_1
—	—			0 +22*C*		0 +42	2 −06		20_2
							—		21_0
	0 00*C*	—	0 +01		0*uf* −42	—		—	22_4
		—	0 +21		—	—		—	22_5
—	—		—	—		2*z* −13*C*		0*u* +25	23_3
		(*C* +48)	—		—			0 +22*C*	28_5
							—		43_1
									44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
									51_4
									52_{23}
									53_1
									55_4
									55_5
									?58_5
?521_2°	522_3°	523_5°	524_4°	525_2°	527_5°	529_3°	530_1°	531_4°	

the properties of a transition are recorded, as follows:

(1) The intensity and sometimes one or more of the symbols *f*, *r*, *G*, *M*, *H*, *A*, *K*, *y*, *Z*, *z*, ζ, =, etc., from Table II, below, showing the character of the line. In order to give some degree of consistency to the intensities in Table I, we have divided the intensities from certain of the newer investigations ($\nu > 40{,}000$ and $\nu < 11{,}340$) by 10. Lines not given arc intensities in the first column of Table II are here given the arbitrary intensity 0. Almost all these zeros are for lines recorded only by Exner and Haschek or by M.I.T. This arbitrary zero usually, but not always, signifies low intensity. For further discussion of the intensities, see the discussion of them in connection with Table II.

(2) The discrepancy, ν_{observed} minus $\nu_{\text{calculated}}$ (to be read with a decimal point before the first digit if no decimal point is given) between the observed wave number given in Table II and that calculated by applying the Ritz combination principle to the energy values given above and to the left in Table I. This item is identical with the last column of Table II.

(3) If appropriate, one or more of the following: *c* or *C*. The same observed line fits more than one allowed transition. In case the criteria at

TABLE I—*Continued.*

	$531_5°$ 53194.22 1.3*C*	$532_4°$ 53238.39	$533_4°$ 53345.60	$533_3°$ 53390.44	$536_2°$ 53669.42	$?537_2°$ 53748.90	$538_5°$ 53862.73	$539_2°$ 53949.38	$543_5°$ 54310.20
D_0									
D_1									
S_3									
D_2									
D_3		.0 +2	.4 +8	—	—	.0*f* −2		—	
D_4	.5 −1	—	—	—			—		.2*f* +6
09_0									
12_4	—	.6 +07	.5 +1	.0 +04			.5 −1		.5*u* 0
13_1					.4*y* −01	.1*uf* 0		1 −19	
13_3		0 00	1*u* −27	.0*f* −09	.2*f* −1	.6 −12*C*		2 −35	
13_2				—	1 00*C*	0*f* +19		4 +10	
14_2				0 +05	0 00	—		—	
15_5	2*M*? +04	1*f* −24					2 −15		—
15_3		3*z* +29*C*	0 +36	0 +08		—		2 +07	
16_4	1*A*?*z* −06	—	1 −26	—					—
17_6	2 −01						0 +02*C*		1 −18
17_4	2 +49	—	1 −11	1 −06			2*A*? −07*C*		0 +02
17_3		2 −03	0 −42	—	—	—		—	
18_1					1 −07	1 +03*C*		2 −04	
18_2				0 +03	—	2 +03		—	
$18_2'$				1 00	—	—		11 −04	
18_3	—	2 +03	—	1 −02*C*	—	—		—	
19_2				—	3 +11*C*	—		—	
19_4	—	—	—	—			1*u* −02		—
19_5	—	—	0 −20*C*				2 +02		—
19_6	—						1 +01		2 +04
$19_5'$	2 +01	—	—				3 +01		—
19_3		1 +01	3 −11*c*	0 −09	—	—		—	
20_1					1 −05	3 −13		—	
20_2				4 −09*C*	0*u* −42	—		—	
21_0									
22_4	—	0 +30	—	—			1 −01		2 +14*C*
22_5	—	—	0*u* +14				—		—
23_3		0 +18	0 +04	—	—	—		—	
28_5	—	—	—				—		—
43_1					—	—		—	
44_2									
45_0									
46_1									
46_3									
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}									
53_1									
55_4									
55_5									
$?58_5$									
	$531_5°$	$532_4°$	$533_4°$	$533_3°$	$536_2°$	$?537_2°$	$538_5°$	$539_2°$	$543_5°$

hand do not make one assignment much more probable than the other "*C*" is placed after the discrepancy at each intersection. In case they do, for the more probable assignment "*c*" is placed after the discrepancy, and for the less probable assignment "*C*" replaces the intensity and the whole set of symbols for the transition is enclosed in parentheses ( ), corresponding to the parentheses about the assignment of the same line in Table II.

? (before the intensity). Doubtful assignment. (A question mark in any other position refers only to the symbol immediately before it.)

— (alone). Transition allowed by the Laporte rule and the *J*-selection rule, for which no line has been observed.

(B)

Table II, the list of classified lines of the neutral tungsten atom, incorporates all the available information regarding each line, except for the omission of the details of the Zeeman effect patterns and all but one of the many intensity estimates. The data are given in five principal columns, as follows:

(1) *I*, arc intensity and special excitation data. (In the extreme ultraviolet, $\nu > 40{,}000$ cm^{-1}, two columns I_{LM} and I_T are devoted to these data,

TABLE I—*Continued.*

545_3° 54556.56	547_6° 54733.16	548_3° 54859.13	549_3° 54911.54	550_5° 55009.13	550_2° 55032.65	$550_5'^\circ$ 55043.26	?$550_2'^\circ$ 55084.09	553_3° 55389.28	
									D_0
									D_1
									S_3
									D_2
—									D_3
—		—	—	—		—		—	D_4
									09_0
.6 +02		.0*f* −32*C*	.6*z* +19	.7 +3		.8 00		—	12_4
					.5*s* −2		.0*f* +08		13_1
.6 −10		—	.8*f* −04		.5 +1		.6 +1	.5 0	13_3
—		.6 00	—		—		.6 −04	.7*A* +08	13_2
—		—	—		0*f* 00		—	.5 +07	14_2
	2*MZ* +01			0 +17		0 −2			15_5
0 +15		—	0 −08		0*u* −34		—	—	15_3
—		—	—	—		—		0 −18	16_4
	1 −15			—		—			17_6
—		0 +39*C*	0 +37	—		—		0 −21	17_4
—		0 +18	0 +03		0 +19		—	—	17_3
					—		0 −11		18_1
3*C* +14		—	—		—		—	0 +09	18_2
—		—	—		—		—	—	$18_2'$
1 −14		1*A* −03	—		2 00		—	1*u* −03	18_3
—		2 +02	—		—		—	—	19_2
—		1 +01	—	2 00*C*		0 −16		2 −02	19_4
	1*u* −02			2 +03		1 00			19_5
				1 +17		—			19_6
	?2 +15			—		1 +01			$19_5'$
—		—	1*d* +05*C*		—		—	—	19_3
					—		—		20_1
0 +01		—	1*f* −10		(*C* +28)		—	1 +26	20_2
									21_0
0 −15	—	—	—	—		—		—	22_4
	—			—		—			22_5
—		1 +42*C*	—		—		—	—	23_3
	—			—		—			28_5
					—		3*C* +11		43_1
—		—	—		—		—	—	44_2
									45_0
									46_1
									46_3
									47_4
									48_2
									49_5
									49_3
									51_4
									52_{23}
									53_1
									55_4
									55_5
									?58_5
545_3°	547_6°	548_3°	549_3°	550_5°	550_2°	$550_5'^\circ$	?$550_2'^\circ$	553_3°	

as noted below.) A key to the symbols used in this column is given below.

(2) λ, wave-length in air, in Angstrom units.

(3) ν, vacuum wave number, in cm^{-1} (followed in the regions ν18174 to ν14313 and ν11333 to ν10915, by certain observational discrepancy values discussed below).

(4) Classification.

(5) Discrepancy, $\nu_{\text{observed}}-\nu_{\text{calculated}}$. (A decimal point belonging before the first digit has been omitted.)

For brevity, only one value is given in each column for each line except as noted in this paragraph and the next. Rather than weighing the data from various sources, we have followed the simple practice of using the most recent arc intensity and wave-length data in each case (see the second paragraph below), except in connection with the M.I.T. list, which unfortunately became available to us only after Tables I and II were in nearly their final form. While the full use of this list would have enhanced the self-consistency of these tables appreciably both in intensity and in wave number values, a sampling study shows that it would have changed the term values so slightly as scarcely to justify the required alteration. For $\nu<40{,}000$ cm^{-1}, therefore, we have made use of the M.I.T. list only for lines

TABLE I—*Continued.*

	554_5° 55492.08	555_3° 55545.91	?556_2° 55619.70	557_5° 55795.55	558_2° 55835.12	559_{34}° 55955.41	559_5° 55987.86	561_3° 56108.50	561_{34}° 56174.64
D_0									
D_1									
S_3									
D_2									
D_3									
D_4	—	—		—		—	.0 +2	—	—
09_9									
12_4	—	—		.3*u* +2		.5 −4	.0 +1	.5 −4	—
13_1			.4*z* −21						
13_3		.3 −1	.4*z* +1		.6*u* +1	.3 +1		.3 −3	.0 +1
13_2		.7 +3	—		.6 −4	—		.5 +1	?.0*f* −2
14_2		.3*f* +3	—		.3 0	—		.7 +02	—
15_5	.2 0			.9*M*? +01		?.0 +36	.6 +07		—
15_3		.3 +1	—		.5 +13	.3 0		—	.5 +08
16_4	0 −11	—		0 +25		0 +02	—	—	—
17_6	2 +29*C*			0 +43			1 −32		
17_4	2 −30	1 −11				—	—	—	—
17_3		—	—		—	—		—	0 +34
18_1			0 +25		0 +23*C*				
18_2		—	—		0 −23	?0 −06		—	—
$18_2'$		0 +03	—		—	—		—	—
18_3		—	—		—	—		0 −02	1 −35
19_2		—	2 00		0 +27	—		0 −24*C*	—
19_4	1 00	—		2 −09		—	1*f* −07	—	1 −27
19_5	2 −20			—		?1 −08	—		—
19_6	3 +03			0 −31*c*			—		
$19_5'$	1 +03*C*			0 +01		—	—		—
19_3		—	—		—	3 −08		—	—
20_1			0 −07*C*		—				
20_2		0 +09	—		—	—		—	?0 +24*c*
21_0									
22_4	—	—		?0 +55		—	—	1 +12	—
22_5	1 +17			—		—	—		—
23_3		—	—		—	—		—	—
28_5	—			—		—	—		—
43_1			—		—				
44_2		—	—		2.0 +02*C*	—		—	—
45_0									
46_1									
46_3								—	—
47_4									
48_2									
49_5									
49_3									
51_4									
52_{23}									
53_1									
55_4									
55_5									
?58_5									
	554_5°	555_3°	?556_2°	557_5°	558_2°	559_{34}°	559_5°	561_3°	561_{34}°

not found on previous lists, and lines for which the M.I.T. wave-length yields a wave number different by more than 0.5 cm^{-1} from the value that would previously have been used (a circumstance that occurs only for a few Exner-Haschek lines, e.g., $\nu24836$). In the region $\nu > 40{,}000$ cm^{-1}, on the other hand, the M.I.T. list has been used as much as possible, and two intensity columns are listed, I_L for intensities from data original with this investigation and I_T for those from the M.I.T. list. Our list (from which only the classified lines are set down here) includes many lines not found elsewhere but it is incomplete with respect to certain lines which we erroneously supposed to be spark lines, and it is inferior to the M.I.T. list in wave number self-consistency.

Because of a falling off in the self-consistency of some of the lists near their ends, an auxiliary column immediately following the wave number column is used to compare the observed wave number values in certain regions of overlap; in particular, values are recorded for $\nu_{\text{Belke}} - \nu_{\text{Kiess-Meggers}}$ in the region $\nu18{,}174$ to $\nu14{,}313$ and for $\nu_{\text{Kiess-Meggers}} - \nu_{\text{Kiess}}$ in the region $\nu11{,}333$ to $\nu10{,}915$.

A chronological list (starting with the oldest) of the sources of the arc intensity and wave-length data compiled in Table II, with the wave

TABLE I—*Concluded.*

$562_4°$ 56255.64		?$564_3°$ 56484.40		$565_6°$ 56526.58		$567_3°$ 56717.16		$568_4°$ 56831.70		$571_5°$ 57143.49		$575_5°$ 57560.75		?$579_6°$ 57919.11		$580_3°$ 58091.6		
																		D_0
																		D_1
																		S_3
																		D_2
																		D_3
																		D_4
																		09_0
.3	0		—				—	.4	−0		—		—				—	12_4
																		13_1
4*f*	+3	.5*h*	−1			.4	−4	.5	+2								—	13_3
		.3	−4				—										—	13_2
		.1	−4				—									.2	−6	14_2
.7	+05				—			.4*V′*	+6	.8	−09		—		—			15_5
.4*s*	+15	.5	00*c*			.2	−3	.3	+3							.4*u*	+1	15_3
	—	.4	−09					.6	−2*c*	.8*M*	+36*C*	.4	−13				—	16_4
				1*MuA*	−30					.6	−06	.7	+05	.8	−06			17_6
0	+27		—				—	0	−06	.7	−3	.6	+05			.5	−04	17_4
	—	0	+05*C*			0	−27		—							.6	−09	17_3
																		18_1
			—				—										—	18_2
			—				—									0	−14	$18_2'$
	—		—			0	+−1	0*u*	+20								—	18_3
		0	+10			0	+28										—	19_2
	—		—				—	0	+28	2	−22	0	−34				—	19_4
1	−12			2	−27				—	0	−14		—		—			19_5
					—						—		—	2*f*	−27			19_6
	—			1	−13				—		—	0	−02	0	+26			$19_5'$
	—		—			0	−01		—								—	19_3
																		20_1
			—			2	−06										—	20_2
																		21_0
	—		—			0*u*	−27*C*		—		—	1*d*	−18*C*				—	22_4
2	−47			0	+36			0	+05		—		—		—			22_5
	—		—				—	0	+36*C*							0	−24	23_3
	—				—				—		—		—	0	−07*C*			28_5
																		43_1
			—				—										—	44_2
																		45_0
	—		—															46_1
							—		—								—	46_3
													—				—	47_4
																		48_2
																		49_5
																	—	49_3
																		51_4
																		52_{23}
																		53_1
																		55_4
																		55_5
$562_4°$		?$564_3°$		$565_6°$		$567_3°$		$568_4°$		$571_5°$		$575_5°$		?$579_6°$		$580_3°$		?58_5

number ranges covered, is given below:

Exner and Haschek[5]	$\nu\nu$44,434−14,779
Belke[6]	44,231−14,313
Kiess and Meggers[7]	18,174−10,915
Kiess[7]	11,333− 9,541
This investigation[9]	49,488−39,938
Massachusetts Institute of Technology[10]	49,832−10,915.

The symbols used in the intensity column to designate the character of the lines or the source of the data are as follows:

A—underwater spark absorption line, Allin or Allin and Ireton.[16]

B—data from the arc line list of Belke.[6]

d—partly resolved pair.

E—data from the arc line list of Exner and Haschek.[5]

f—intensity greater in spark than in arc.

G—raie ultime, de Gramont.[11]

H—underwater spark absorption line, Hulburt.[14]

K—furnace lines, King.[13] $\nu\nu$44,958−33,923.

L—data from the arc line list of this investigation.[9,18]

M—underwater spark absorption lines, Meggers.[15] $\nu\nu$35,308−17,750.

m—probably an arc line masked by a spark line.

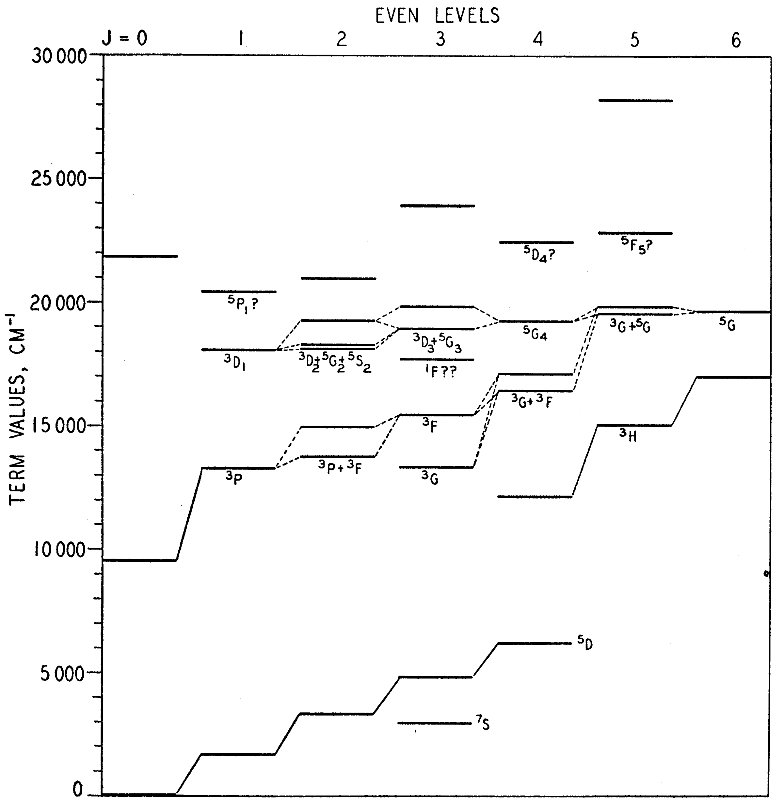

FIG. 2a. Interpreted low even levels. Except for the low ^7S and the quintets above 18,000 cm^{-1}, which belong to $5d^56s$, all these interpreted levels belong to $5d^46s^2$.

n—possibly a molecular band.

r—reversed.

ρ—shows a red shift in the spark with respect to its position in the arc.

ρ'—diffuse on the red side.

S—solar spectrum line.[17, 18]

s—especially sharp.

T—data from the arc line list of M.I.T.

u—especially diffuse.

v—shows a violet shift in the spark with respect to its position in the arc.

v'—diffuse on the violet side.

y—Zeeman-effect pattern seriously inconsistent with our assignment of *J* and *g* values.

z—incompletely resolved Zeeman-effect pattern not requiring any of the symbols =, *y*, or *ζ* (i.e., usually an unresolved triplet).

Z—completely resolved weak-field Zeeman-effect pattern.

ζ—asymmetric, completely resolved Zeeman-effect pattern.

= incompletely resolved Zeeman-effect pattern indicating $\Delta J=0$.

– (after intensity value) the intensity value given is for a line not resolved in the list being used in this region, but resolved by the investigation indicated by the letter to the right; the wave number given here comes from that investigation.

Where the first symbol in the intensity column is a letter, the line is not found in the list principally used in that region. Where the first symbol is a number followed by a hyphen and a letter, the intensity is that of a blend, recorded as a single line on the list principally used and resolved by another observer. In either case the wave number given is that of the observer indicated by the letter (*B*, *E*, *L*, or *T*). When the first symbol is a number followed immediately by a letter referring to an observer, only the symbol immediately following the letter is associated with the observer referred to (e.g., a number after *M* refers to the intensity given by Meggers for the line in the underwater spark spectrum) except for a few instances where a number or letter is followed by the letter *T*, in which case the wavelength and wave number are taken from the M.I.T. tables because of an exceptionally large difference between it and the previous values.

Parentheses about a classification and its corresponding discrepancy indicate an assignment that is possible but improbable relative to another assignment made for the same line.

5. NOTES ON CERTAIN LEVELS AND LINES

This section is devoted to a few isolated notes on certain levels and lines. The conclusions that depend upon (published) Zeeman-effect work, i.e., those concerning the reality or the J values of certain levels, are subject to verification in the course of a reinvestigation of the Zeeman effect, now in progress. Because of this reinvestigation we have omitted any discussion of the discrepancies between our classification and the results of Zeeman-effect studies ("y" lines, Tables I and II) insofar as in our opinion they do not affect the validity of our conclusions but arise from trivial causes such as masking or fortuitous wave number coincidences.

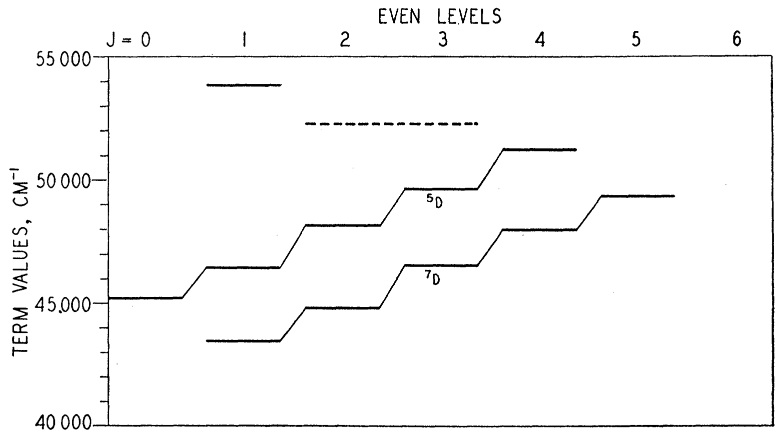

FIG. 2b. Interpreted high even levels. These belong to $5d^46s(^6D)7s$.

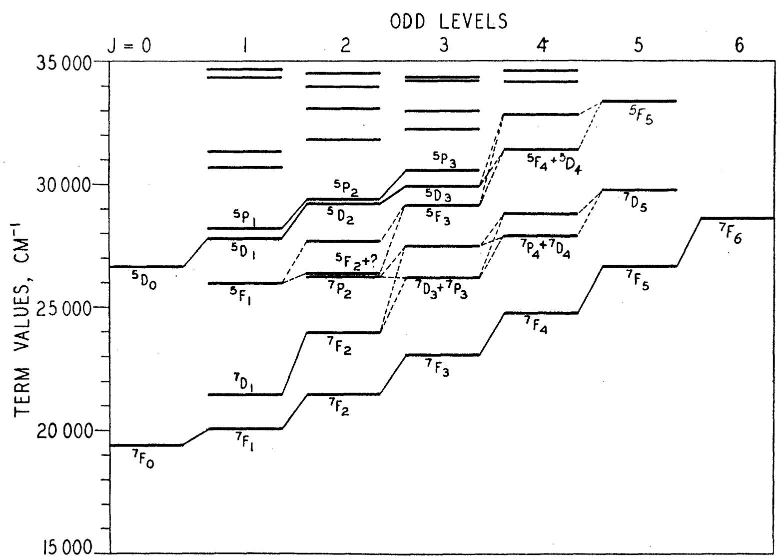

FIG. 2c. Interpreted high odd levels. These belong to $5d^46s(^6D)7p$.

(A) $5d^46s^2\,{}^5D$ and $5d^56s\,{}^7S$

In the underwater spark, the sun, and the conditions for de Gramont's raies ultimes, ^7S show a considerably greater intensity sum than any other level. This is satisfactorily accounted for by a consideration of the factor $(2J+1)\exp-[h\nu/kT]$, which is shown in the following tabulation to be appreciably greater for $^7S_3$ than for any other level in the atom, throughout a wide temperature range that undoubtedly covers the temperatures encountered in these investigations:

	1000°K	2000°K	4000°K	8000°K
$^5D_0$	1.0	1.0	1.0	1.0
$^5D_1$	0.27	0.90	1.6	2.2
$^7S_3$	0.10	0.84	2.4	4.1
$^5D_4$	0.0012	0.10	0.96	2.3

Moreover, d^5s is the only low configuration that combines with both d^4sp and d^5p in one-electron transitions. Not so easy to understand is the preference of ^7S for combination with lower odd levels than ^5D in the underwater spark, as shown in Table IV; one might have expected that the tendency of levels with large spin vectors to be low, which would lead to such a preference, would be more than offset by the contrary tendency of d^4sp levels to be lower than those based on d^5. Table IV is principally an extract from Table I, showing all the surely absorbed and unambiguously classified Meggers underwater spark lines;

TABLE II. Classified lines of neutral tungsten, W I.

Intensity (See text)		λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
	4	2008.64	49768.8	D_4-559_5	+2
	3	2010.74	49716.9	D_2-530_1	+4
2*f*	8	2020.13	49485.8	S_3-524_4	+7
	6*f*	2043.55	48918.7	D_3-537_2	−2
4		2054.56	48656.6	$S_3-?516'_2$	+1.5
3		2060.50	48516.4	D_3-533_4	+8
	10	2065.09	48408.6	D_3-532_4	+2
4	5	2070.81	48274.9	$D_2-?516_3$	0
2*f*		2078.70	48091.5	D_4-543_5	+6
5	8	2081.39	48029.4	D_1-497_2	−4
	21*f*	2084.48	47958.2	S_3-509_4	+1
3		2088.88	47857.2	D_2-511_{32}	+2
5		2089.31	47847.5	D_1-495_2	+5
	10	2092.54	47773.5	D_1-494_1	0
	10	2098.25	47643.6	D_4-538_5	+2
5*f*		2105.43	47481.2	D_1-491_2	−4
	5*f*	2116.638	47229.72	D_3-520_4	−01
5		2128.13	46974.8	D_4-531_5	−1
	4*f*	2137.15	46776.4	$D_3-?516'_2$	0
4		2137.45	46770.0	$D_3-?516_3$	−4
4		2143.05	46647.8	D_1-483_2	−6
6		2146.47	46573.4	D_1-482_2	−6
3		2147.34	46554.6	D_4-527_5	−1
5		2155.69	46374.2	D_2-497_2	−3
	f	2156.688	46352.78	D_3-511_{32}	+29
3		2163.02	46217.0	D_4-524_4	−1
3		2165.19	46192.1	D_2-495_2	+3
6		2164.33	46189.1	D_2-495_3	+3
5		2164.93	46176.4	D_4-523_5	+2
2	*f*	2167.687	46117.59	D_2-494_1	−63
	10	2168.298	46104.60	D_0-461	+05
9	15	2169.48	46079.6	D_3-509_4	+2
5		2170.19	46064.5	D_3-508_4	+4
7		2174.59	45971.2	D_3-508_3	+8
8		2175.84	45944.8	D_2-492_2	+1
8		2178.46	45889.5	D_3-507_2	+6
	4	2189.197	45664.52	D_3-504_2	−17
7		2190.51	45637.2	D_4-518_4	+4
4		2199.28	45455.2	D_3-502_4	+6
4		2201.49	45409.6	D_1-470_2	+5
7		2202.85	45381.5	$D_4-?516_3$	+4
4		2203.20	45374.3	D_0-453_1	+2
4		2204.08	45356.3	D_3-501_3	+6
6*f*	12	2221.85	44993.5	D_2-483_2	+2
7*M*2		2223.56	44958.5	D_3-497_4	−1
6*M*2	8	2225.54	44919.0	D_2-482_2	+3
6*M*5*u*	10	2227.98	44869.6	D_3-497_2	−4
1*f*		2229.20	44845.1	D_2-481_3	+1
7		2234.59	44747.0	D_0-447_1	−2
5		2237.23	44684.2	D_3-495_3	−2
5		2237.70	44674.8	D_4-508_4	0
4		2237.96	44669.7	12_4-568_4	0
3	6	2238.56	44657.6	D_1-463_2	+2
6*M*3		2240.38	44621.4	D_1-462_2	+1
	12	2242.06	44587.9	D_3-494_3	0
4		2242.41	44581.1	D_4-508_3	0
6	10	2249.5	44440.5	D_3-492_2	+3
4	10	2249.84	44433.8	D_1-461_1	−5
8		2253.91	44353.6	D_0-443_1	+2
6	3	2255.52	44321.9	D_3-491_2	0
	2*u*	2255.72	44318.0	D_3-491_4	0
8*f*	12	2259.555	44242.78	D_3-490_3	+68
7	15	2260.07	44232.7	D_1-459_2	+5
6		2263.90	44157.8	D_2-474_3	−4
3		2267.22	44093.3	12_4-562_4	0
6		2268.68	44064.9	D_4-502_4	−4
3		2270.16	44036.1	D_2-473_3	−1
6		2271.40	44012.1	D_2-473_2	−2
7	10	2273.00	43981.2	S_3-469_4	+7
6	10	2273.76	43966.40	D_4-501_3	+02
5		2274.81	43946.1	12_4-561_3	−14
3		2276.28	43917.8	D_4-501_5	−4
7*ufvM*5	20	2277.58	43892.8	D_0-438_1	+2
	4*f*	2281.04	43826.0	12_4-559_5	+1
5		2282.76	43793.1	12_4-559_{34}	−4
6} *M*5?	{	2284.82	43753.5	D_2-470_2	−4
5}	{ 3	2284.90	43752.0	D_1-454_2	0
7*M*10	10	2285.17	43746.8	D_4-499_3	+1
3*u*		2291.09	43633.8	12_4-557_5	+2
7*fvM*4	20	2294.544	43568.18	D_4-497_4	−1.12
4	4	2297.38	43514.4	09_0-530_1	+4
7	3	2298.340	43496.25	D_3-483_3	−16
5	8	2298.74	43488.7	D_3-483_2	−1
5	4	2299.02	43483.4	13_3-568_4	+2
6		2299.31	43480.6	D_2-468_2	−3
7	8	2302.67	43414.5	D_3-482_2	+2
4		2305.12	43368.2	17_6-567_3	−4
2		2306.17	43348.5	D_1-450_2	−2
7*M*10?	12	2306.60	43340.5	{ S_3-462_2; { D_3-481_3	+2 0
8*f′M*15*u*	12	2309.036	43294.77	D_4-495_3	−27
8*M*10?	8	2313.188	43217.06	D_0-432_1	−11
7*M*12		2316.26	43159.8	D_4-494_3	0
5	2	2317.39	43138.8	D_3-479_4	+24
5	2*u*	2317.55	43135.8	$13_3-?564_3$	−1
6	8	2318.58	43116.6	S_3-460_3	+06
2		2318.67	43114.8	14_2-580_2	−6
4	5	2321.24	43067.2	D_1-447_1	+3
9*M*10	12	2321.634	43059.87	D_2-463_3	−07
	2*f*	2324.74	43002.2	D_2-463_2	0
7*M*10	10	2326.562	42968.67	D_4-491_5	+10
6	10	2326.71	42966.0	D_2-462_2	−1
6		2327.52	42950.9	S_3-459_2	−3
3	*f*	2328.72	42928.8	D_4-491_4	+2
6		2328.88	42925.8	D_1-445_2	−2
5	4	2329.29	42918.3	S_3-458_4	+6
4*f*	2*f*	2329.88	42907.4	13_3-562_4	+3
8*M*1	15	2331.303	42881.30	$12_4-550'_5$	00
6	5	2332.50	42859.2	D_3-476_4	−10
6		2332.86	42842.6	D_4-490_3	−2
7	7	2333.14	42847.5	12_4-550_5	+3
5	4	2334.30	42826.2	13_3-561_{34}	+1
3		2336.87	42779.1	D_2-461_1	0
5	8	2337.743	42763.17	D_3-475_3	−21
3		2337.93	42759.7	13_3-561_3	+03
6*z*	10	2338.476	42749.77	12_4-549_3	+19
3		2340.86	42706.3	$13_2-?564_3$	−4
	12	2341.374	42696.85	{ D_1-443_2; { 12_4-548_3	−33 −32
3	3	2342.12	42683.2	D_1-443_1	0
6	5	2343.744	42653.69	D_3-474_3	−02
4*u*		2344.95	42631.7	15_3-580_3	+1
3	4	2346.31	42607.0	13_3-559_{34}	+1
5	5	2346.69	42600.1	S_3-455_3	0
7*f*	10	2347.967	42576.98	D_2-459_2	+03
6	8	2348.151	42573.64	D_0-425_1	+28
7		2350.48	42531.4	D_3-473_3	−3
6	5	2351.78	42508.0	D_3-473_2	+2
6*u*	8	2352.96	42486.7	13_3-558_2	+1
4	3	2353.81	42471.3	S_3-454_2	+3
8*uM*15	12	2354.611	42456.86	D_4-486_4	−02
	f	2357.93	42397.1	13_2-561_{34}?	+2
6	10	2358.072	42394.62	12_4-545_3	+02
8*M*15	15	2360.433	42352.14	D_2-456_3	−02
5	6	2361.62	42330.9	13_2-561_3	+1
4*z*		2362.65	42312.4	$13_1-?556_2$	−2
9*uM*20	15	2363.06	42305.03	D_1-439_2	+10
4*z*	8	2364.95	42271.3	$13_3-?556_2$	+1
8	12	2365.448	42262.35	D_0-422_1	+09
8*f*	12	2366.182	42249.25	D_3-470_2	−12
8	12	2366.952	42235.50	09_0-517_1	+25
1*s*		2367.52	42225.4	D_2-455_3	−4
7	10	2367.68	42222.53	D_1-438_1	+20
3		2369.10	42197.3	13_2-555_3	−1
7	10	2370.881	42165.52	S_3-451_4	+09
5	8	2371.85	42148.2	12_4-543_5	0
6	4	2373.43	42120.2	$D_1-?437_0$	+5
8*M*5*u*	12	2374.144	42107.57	D_4-483_3	+47
9	12	2374.460	42101.97	D_3-469_4	+15
7	10	2374.758	42096.68	D_2-454_2	+06

TABLE II—*Continued.*

Intensity (See text)		λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
8	10	2376.069	42073.46	15_5-571_5	−09
4	4	2376.39	42067.7	S_3-450_2	0
6		2377.00	42057.0	13_2-557_5	−4
5	4	2377.92	42040.7	13_3-553_3	0
4		2380.85	41988.9	S_3-449_4	−3
7	8	2381.57	41976.2	D_3-468_2	−2
8	15	2382.986	41951.34	D_4-481_3	+11
9*M*10	12	2384.817	41919.14	D_4-481_5	+11
	12	2389.072	41844.49	D_1-435_2	+09
4	4	2391.89	41795.2	D_3-466_4	+2
	8	2392.927	41777.08	$13_1-?550'_2$	+08
7	10	2393.42	41768.5	13_1-555_3	+3
4*v*′	4	2393.77	41762.4	15_5-568_4	+6
6	6	2395.30	41735.7	$13_3-?550'_2$	+1
5*s*	6	2395.89	41725.54	13_1-550_2	−2
5		2397.21	41700.7	12_4-538_5	−1
8*M*6	12	2397.723	41693.52	D_2-450_2	00
7*M*4	8?	2397.979	41689.07	D_2-450_3	+03
5	3	2398.27	41684.0	13_3-550_2	
	1*f*	2400.505	41645.22	S_3-445_2	+22
6	12	2401.294	41631.52	D_4-478_5	+06
7*fA*	15	2502.441	41611.65	13_2-553_3	+08
8	10	2405.256	41562.97	13_3-549_3	−04
8 *M*10?		2405.592	41557.16	D_1-432_2	−21
9 *M*10?	15	2405.688	41555.49	D_3-463_3	+04
8	10	2406.175	41547.08	D_1-432_1	+08
1		2408.45	41507.8	$14_2-?564_3$	−4
8*A*	10	2409.031	41497.84	D_2-463_2	+12
3*m*		2409.16	41495.6	S_3-444_3	−1
5	7	2410.529	41470.32	D_4-476_4	+33
6	9	2313.778	41416.24	S_3-443_2	+06
8*M*5?	12	2414.040	41411.74	D_2-447_1	+06
8*M*10	15	2415.679	41383.64	$D_1-?430_0$	+09
5	9	2416.232	41374.17	D_4-475_3	+10
3		2416.36	41371.9	15_3-568_4	+2
6	10	2420.200	41306.34	$13_2-?550'_2$	−04
7	2*f*	2422.285	41270.79	D_2-445_2	+02
6	7	2422.659	41264.42	D_4-474_3	+02
2		2423.10	41257.0	15_3-567_3	−2
9*uM*5*u*	20	2424.216	41237.91	D_3-460_2	−07
5	6	2424.770	41228.49	12_4-533_3	+04
6	7*d*	2425.980	41207.93	13_2-545_3	−10
7	10	2427.287	41185.75	15_5-562_4	+05
5		2427.41	41183.7	12_4-533_4	+1
7	10	2429.843	41142.43	D_2-443_2	+48
7	10	2430.438	41132.35	14_2-561_3	+02
4	4	2430.617	41129.32	16_4-575_5	−13
8*M*2?	10	2431.084	41121.43	D_2-444_3	−02
6	9	2433.45	41081.42	13_2-548_3	00
6	7	2433.743	41076.50	12_4-532_4	+07
7*fM*4	12	2433.984	41072.43	D_3-459_2	−03
4		2434.14	41069.7	S_3-440_3	+5
10*M*2*z*	30	2435.962	41029.09	D_3-458_4	+08
6	8	2436.258	41034.11	S_3-439_4	+02
7*A*	12	2436.623	41027.96	D_2-443_1	+04
5	6	2436.835	41024.40	S_3-439_2; $15_3-?564_3$	+47; 00
5	4	2439.204	40984.55	17_4-580_3	−04
	3	2440.88	40956.4	12_4-531_4	+1
6	5	2443.172	40917.99	15_5-559_5	+07
8	15	2443.615	40910.57	$17_6-?579_6$	−06
8*M*5*u*	18	2444.056	40903.19	D_1-425_1	+10
5	5*d*	2445.246	40885.83	15_5-559_{34}?	+36
3		2446.70	40859.3	14_2-558_2	0
5	8	2447.374	40847.74	D_3-456_3	+07
4*s*	3	2450.494	40795.75	15_3-562_4	+15
9	12	2451.342	40781.62	12_4-529_3	+20
9*uz*	15*f*	2451.477	40779.38	D_1-424_2	+09
7*M*5*Z*	12*f*	2451.998	40770.71	D_0-407_1	−03
9 *M*5*d*	15	2454.713	40725.62	15_5-557_5	+01
9 *M*5*d*	15	2454.971	40721.34	D_3-455_3	+01
5	5	2455.370	40714.72	15_3-561_{34}	+08
8*M*5	12	2455.501	40712.55	D_4-469_4; 16_4-571_5	+04; +36
9*M*6	15	2456.531	40695.49	D_2-40_3	+51
9*uM*8	18	2459.295	40649.76	D_2-439_2	+06
8	12	2460.162	40635.42	D_4-468_5	−04
7*A*	12	2461.572	40612.16	12_4-527_5	+08
9*uM*8*z*		2459.315	40649.45	D_2-439_2	−25
9*M*3	15	2462.788	40592.11	D_1-422_1; D_3-454_2	+12; −14
3	3*f*	2464.128	40570.04	14_2-555_3	+30
8	15	2464.307	40567.10	D_2-438_1	00
7	1*f*	2465.204	40552.32	17_6-575_5	+05
9*uM*6*A*	15	2466.848	40525.31	D_2-438_3	+04
3		2468.67	40495.4	15_3-559_{34}	0
0	10	2471.209	40453.79	17_4-575_5	+05
1*uf*		2471.94	40441.8	$13_1-?537_2$	0
8*M*10	15	2472.508	40432.55	D_3-452_4	+03
2		2473.14	40422.1	15_5-554_5	0
5	4	2473.692	40413.18	14_2-533_3	+07
7	7	2473.818	40411.13	D_0-404_1	+08
9*M*15	20	2474.149	40405.72	D_4-466_4	−01
6	6	2474.484	40400.25	$13_3-?537_2$; 16_4-568_4	−12; −2
6	10	2475.091	40390.35	17_3-580_3	−09
5	7	2476.017	40375.25	15_3-558_2	+13
4	5	2476.810	40362.32	13_1-536_2	−01
4		2476.82	40362.2	13_1-536_2	−1
8*M*6*z*	10	2480.126	40308.36	D_1-419_2	+03
7*s*	10	2480.654	40299.78	S_3-432_4	+08
10*M*8*z*	25	2481.443	40286.97	D_3-451_4; D_4-465_5	+26; −08
8	10	2482.098	40276.34	S_3-432_2	−03
8*M*2?*A*	10	2482.212	40274.48	12_4-524_4	+04
9*M*5*z*	20	2484.735	40233.60	12_4-523_5	+08
8*M*10?	15	2487.492	40189.00	D_2-435_2; D_3-450_2	−17; −03
6	10	2487.766	40184.58	D_3-450_3	+03
4	3	2487.940	40181.77	13_2-539_2	+10
8	10	2488.910	40166.11	D_4-463_3	−03
9*M*8*A*?	8	2489.718	40153.08	D_2-434_3	−01
6	9	2490.843	40134.95	17_6-571_5	−06
7	12	2492.367	40110.40	D_3-449_4	−08
8	10	2493.393	40093.90	12_4-522_3	+11
3		2493.88	40086.0	15_3-555_3	+1
9*M*9*z*	20	2495.264	40063.85	D_1-417_2	+05
	4*f*	2495.722	40056.48	14_2-550_2	00
4	4	2495.938	40053.01	$16_4-?564_3$	−09
	10*f*	2496.638	40041.79	13_3-533_3	−12
7		2496.98	40036.2	17_4-571_5	−3
1*u*		2499.447	39996.80	13_3-533_4	−27
L		2500.93	39973.1	$15_5-550'_5$	−2
Tf		2501.036	39971.38	$13_2-?537_2$	+19
E		2501.781	39959.48	S_3-429_4	+05
ET		2503.042	39939.36	15_5-550_5	+17
E		2504.31	39919.21	12_4-520_5	+05
E		2504.55	39915.38	09_0-494_1	−33
2*z*		2504.718	39912.64	D_1-415_2	−25
E		2505.37	39902.16	D_2-432_2	+02
1		2505.658	39897.65	12_4-520_4	−11
1		2506.032	39891.71	D_2-432_1; 13_2-536_2	−06; 00
T		2506.148	39889.86	13_3-532_4	00
1		2508.455	39853.18	12_4-520_3	+13
2		2508.754	39848.44	D_4-460_3	−23
E		2511.11	39810.98	18_2-580_3	−14
1		2513.948	39766.09	D_3-445_2	−19
E		2516.57	39724.63	17_4-568_4	−06
E		2518.49	39694.35	12_4-518_4	+25
2*M*4*z*		2520.468	39663.23	15_5-547_6	+01
1*M*10*Az*		2521.336	39649.58	S_3-426_3; D_4-458_4	−27; −12
ET		2522.15	39636.57	D_0-396_1	+01
2*M*15*z*		2523.421	39616.82	D_3-444_3	−14
E		2524.82	39594.86	13_3-529_3	+01
Eu		2526.26	39572.31	15_3-550_3	−34
E		2526.38	39570.42	D_4-457_5	+01

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
E	2529.34	39524.13	16_4-559_{34}	+02
1*M*5*uA*	2529.745	39517.80	17_6-565_6	−30
2*M*	2533.641	39457.04	$D_1-?411_6$	+03
E	2534.00	39451.46	15_3-549_3	−08
2	2535.13	39433.82	D_1-411_2	−37
E	2539.00	39364.50	16_4-557_5	+25
E	2541.08	39332.29	D_4-455_3	+27
2*M*10*z*	2545.358	39275.42	D_2-426_3	−20
2*M*20*z*	2547.155	39247.72	D_2-425_1	−14
1*z*	2550.39	39197.92	D_1-408_2	−12
E	2551.02	39188.17	D_2-425_3	−47
1*M*30*AZ*	2551.360	39183.03	D_0-391_1	−14
E	2552.49	39165.62	13_2-529_3	−05
E	2553.58	39148.90	17_4-562_4	+27
1*M*5*u*?*z*	2553.839	39145.01	D_3-439_2	−20
2*A*	2554.878	39129.09	12_4-512_5	+34
1*Az*	2555.218	39123.87	D_2-424_2	−19
2*M*2	2556.760	39100.29	D_1-407_1	−18
E	2556.99	39096.71	15_3-545_3	+15
E	2557.57	39087.84	13_3-524_4	−03
E	2559.35	39060.67	16_4-554_5	−11
E	2560.49	39043.29	D_4-452_4	+08
E	2561.51	39027.74	S_3-419_2	+41
3*M*8*z*	2561.980	39020.62	{ D_3-438_3; { 12_4-511_{32}?	−16 +10
E	2562.30	39015.71	17_3-567_3	−27
1	2564.713	38979.06	17_6-559_5	−32
E	2566.11	38957.80	16_4-553_3	−18
2	2567.517	38936.49	D_2-422_1	−27
2	2568.232	38925.65	D_2-422_3	−30
2	2568.574	38920.47	S_3-418_4	−17
2	2570.113	38897.15	D_4-451_4	−25
E	2570.51	38891.13	D_3-437_4	+26
E	2572.42	38862.27	$09_0-?483_1$	+23
2	2573.545	38845.30	$13_1-?521_2$	−15
2	2577.045	38792.54	15_5-538_5	−25
E	2577.38	38787.50	17_6-557_5	+43
E	2577.66	38783.29	{ S_3-417_2; { $17_3-?564_3$	+49 +05
E	2580.05	38747.38	12_4-509_4	−06
3 } *M*30*d* {	2580.355	38742.78	S_3-416_3	−23
3*z* }	2580.501	38740.59	D_1-404_1	−19
2	2581.079	38731.92	12_4-508_4	−17
E	2581.48	38725.92	13_2-525_2	+20
E	2583.66	38693.25	14_2-536_2	00
E	2584.27	38684.12	D_3-435_2	? −56
2	2585.454	38666.38	13_3-520_3	−32
EfA?	2586.33	38653.32	D_2-419_2	+22
E	2586.65	38648.54	D_3-434_3	−06
1	2586.959	38643.88	12_4-508_5	−22
E	2587.31	38638.68	12_4-508_3	+21
2	2587.782	38631.59	S_3-415_2	−30
E	2593.39	38548.12	S_3-414_3	+02
Eu	2596.11	38507.60	13_3-518_4	+07
E	2596.66	38499.45	15_3-539_2	+07
E	2597.71	38483.89	{ 13_2-522_3; { 17_6-554_5	−15 +29
E	2598.39	38473.82	17_3-561_{34}	+34
1	2600.763	38438.79	17_4-555_3	−11
2*M*5*u*?	2601.979	38420.83	D_3-432_4	−15
ET	2602.419	38414.32	14_2-533_3	+05
2*z*	2602.825	38408.34	D_2-417_2	−23
2	2603.567	38397.40	D_3-432_2	−25
E	2604.42	38384.77	17_4-554_5	−30
2	2605.518	38368.64	D_2-416_3	−14
3*EfM*1*z*	2606.406	38355.57	$D_3-?431_4$	+15
E	2607.10	38345.47	13_3-516_2	+18
2*M*3*z*	2607.398	38340.99	D_1-400_2	−18
2*M*2*z*	2608.338	38327.17	D_4-445_5	−22
E	2609.90	38304.19	19_4-575_5	−34
E	2610.23	38299.37	$13_1-?516'_2$	+06
E	2611.41	38282.06	17_4-553_3	−21
2*Ef*	2612.210	38270.36	$19_6-?579_6$	−27
3*M*10 = } *A* {	2613.090	38257.46	D_2-415_2	−20
3*M*8*z* }	2613.830	38246.64	S_3-411_4	−14
E	2614.48	38237.11	13_2-520_3	−41
2*A*	2615.144	38227.43	D_4-444_3	−22
E	2616.37	38209.50	15_3-536_2	+08
Ed	2616.71	38204.54	D_3-430_4	? +44
1	2618.833	38173.58	D_2-414_3	−29
1*Ef*	2619.201	38168.21	15_5-532_4	−24
2*M*10*u*?	2622.217	38124.32	15_6-531_5	+04
E	2622.33	38122.68	12_4-502_4	+07
E	2624.35	38093.35	$19'_5-?579_6$	+26
3*M*5*z*	2625.232	38080.52	D_3-429_4	−19
1*u*	2626.272	38065.45	14_2-530_1	+40
E	2627.43	38048.71	15_5-531_4	+36
E	2628.24	38036.99	D_1-397_2	+24
1	2629.166	38023.56	12_4-501_3	−16
2*M*2?*z*	2632.510	37975.26	12_4-501_5	−30
3*M*2	2632.717	37972.28	S_3-409_3	−22
3*M*10*Az*	2633.147	37966.07	D_1-396_1	−22
E	2635.60	37930.80	15_3-533_3	+36
2	2638.639	37887.05	19_4-571_5	−22
E	2638.71	37885.96	15_3-533_4	+36
Eu	2640.70	37857.42	18_3-568_4	+20
E	2642.02	37838.52	18_2-559_{34}?	−06
E	2642.35	37833.78	13_3-511_{32}	−17
E	2642.71	37828.64	$13_2-?516'_2$	−05
2*A*	2643.142	37822.51	$13_2-?516_3$	−16
E	2644.37	37804.90	17_4-549_3	+37
1	2644.626	37801.28	D_4-440_3	−40
3*z*	2646.209	37778.68	{ D_2-411_2; { 15_3-532_4	−28 +29
E	2646.51	37774.34	D_0-377_1	+40
2	2646.752	37770.92	D_3-426_3	−21
2	2647.111	37765.81	D_4-439_4	−25
E	2648.04	37752.51	{ 17_4-548_3; { 18_1-558_2	+39 +23
E	2648.73	37742.69	19_4-567_3	+01
E	2649.29	37734.71	$19'_5-575_5$	−02
1	2650.006	37724.55	17_6-547_6	−15
E	2650.46	37718.06	18_2-558_2	−23
E	2651.46	37703.84	15_5-527_5	−26
1	2654.694	37657.94	15_3-531_4	−35
4*M*20*Az*	2656.558	37631.51	{ S_3-405_4; { D_4-438_3	−19 +04
E	2656.90	37626.66	12_4-497_4	+02
4*M*10*z*	2657.398	37619.62	D_3-424_2	+05
ET	2658.194	37608.35	19_5-571_5	−14
ET	2658.906	37598.28	D_2-409_3	+01
E	2660.50	37575.76	19_4-568_4	+28
E	2661.55	37560.94	13_3-509_4	+07
E	2662.64	37545.56	13_3-508_4	+04
3*M*10*Az*	2662.853	37542.57	D_2-408_2	−24
E	2663.24	37537.11	$18_1-?556_2$	+25
Ef	2663.93	37527.40	14_2-525_2	+14
3*A*?	2664.977	37512.65	D_1-391	−25
1*Ld*	2665.800	37501.07	D_4-437_4	−49
E	2668.45	37463.85	19_2-567_3	+28
1*A*?	2669.796	37444.94	D_2-407_1	−30
3*M*6*z*	2671.489	37421.20	D_3-422_3	−26
E	2672.15	37411.99	13_1-507_2	+26
E	2675.14	37370.18	13_3-507_2	−11
E	2675.41	37366.42	15_5-524_4	−04
2	2675.893	37359.62	D_1-390_2	−34
E	2676.44	37352.04	12_4-495_3	−34
3*M*5*A*	2677.296	37340.05	D_2-406_3	−31
E	2677.90	37331.68	17_3-550_2	+19
3*AT*	2678.883	37317.94	S_3-402_3	−08
2	2680.060	37301.54	17_6-543_5	−18
E	2680.37	37297.14	19_5-568_4	+44
4*M*20*Az*	2681.431	37282.47	S_3-402_4	−17
E	2681.60	37280.05	14_2-522_3	+47
E	2682.14	37272.54	18_2-553_3	+09
E	2682.65	37265.46	18_2-555_3	+03
E	2685.14	37230.91	$19_2-?564_3$	+10
E	2686.62	37210.41	17_3-549_3	+03
E	2687.14	37203.21	17_4-543_5	+02
1	2687.389	37199.81	18_3-561_{34}	−35

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
Ef	2688.27	37187.57	13_1-504_2	−02
E	2690.40	37158.15	17_3-548_3	+18
2	2691.113	37148.33	D_3-419_2	−28
E	2691.26	37146.27	13_3-504_2	+12
E	2692.15	37134.00	18_3-561_3	−02
3*M*8*z*	2695.683	37085.36	D_2-404_1	−19
2	2697.531	37059.96	S_3-400_2	−21
2	2698.857	37041.75	D_3-418_4	−17
3*M*7 =	2699.607	37031.47	D_4-432_4	−20
3*M*4*z* } *A* {	2700.022	37025.77	12_4-491_5	−14
Eu	2700.20	37023.32	13_2-508_3	? +60
E	2701.06	37011.54	15_5-520_5	+36
E	2701.82	37001.14	$18_1-?550'_2$	−11
2	2702.537	36991.31	19_5-565_6	−27
Ef	2703.60	36976.78	15_3-524_4	+38
E	2704.38	36966.11	$D_4-?431_4$	00
?1	2706.022	36943.68	D_2-402_3	−11
?2*z*	2706.590	36945.93	13_3-502_4	−11
1	2707.894	36918.15	19_4-561_{34}	−27
1	2708.195	36914.04	16_4-533_4	−26
3*z*	2708.935	36903.96	D_3-417_2	−12
E	2710.00	36889.48	19_3-567_3	−01
E	2712.56	36854.67	17_6-538_5; 19_2-561_3	+02 −24
ET	2713.847	36837.16	13_3-501_3	+01
3*Az*	2715.506	36814.66	D_4-430_4	−13
1*uEfA*?	2716.905	36795.71	15_3-522_3	−04
1*u*	2717.540	36787.12	14_2-517_1	+01
4*M*20*sz*	2718.911	36768.57	S_3-397_4	−06
1*z* } *A* {	2719.333	36762.86	16_4-531_5	−06
2	2719.867	36755.65	S_3-397_2; 17_4-538_5	−10 −07
1	2720.056	36753.09	D_3-415_2	−08
1*Ef*	2721.650	36731.57	19_4-559_5	−07
1	2722.469	36720.52	19_5-562_4	−12
T	2722.683	36717.62	14_2-516_2	−03
1	2723.959	36700.43	$19'_5-565_6$	−13
4*M*10*s* = } *A* {	2724.359	36695.04	S_3-396_3	−04
2	2724.637	36691.29	D_4-429_4	−11
3*y*	2725.054	36685.68	D_2-400_2	−26
E	2726.24	36669.66	D_3-414_3	+28
1*u*	2727.970	36646.46	D_4-428_5	−17
E	2732.79	36581.80	19_2-558_2	+27
2	2733.193	36576.44	09_0-461_1	−10
2	2735.976	36539.24	19_4-557_5	−09
2	2738.008	36512.13	16_4-529_3	+05
3	2743.437	36439.87	13_3-497_4; 18_2-545_3	−20 +14
1	2744.909	36420.33	19_5-559_{34}?	−08
1*u*	2745.328	36414.77	18_3-553_3	−03
1	2745.843	36407.95	13_2-501_3	−02
2	2746.740	36396.05	15_3-518_4	−01
E	2746.98	36392.88	13_1-497_2	−05
2	2747.839	36381.49	D_2-397_2; D_4-426_3	−02 −33
4*rAz*	2748.853	36368.08	D_3-411_4	+02
2	2749.002	36366.11	$19_2-?556_2$	00
1	2750.767	36342.77	16_4-527_5	+03
2	2753.170	36311.05	D_2-396_1	−01
E	2754.44	36294.35	D_2-425_3	−49
3	2754.922	36287.97	13_3-496_4	−08
2	2755.270	36283.37	17_4-533_3	−06
3	2755.947	36274.47	D_3-411_2	00
1	2758.685	36238.48	17_4-533_4	−11
1	2758.880	36235.86	19_4-554_5	00
2	2759.039	36233.82	15_3-516_2	00
2	2760.035	36220.74	15_5-512_5	−03
2	2761.142	36206.22	14_2-511_{32}	−09
4*rZ*	2762.346	36190.44	D_0-361_1	+02
2	2762.705	36185.75	17_6-531_5	−01
2	2764.007	36168.71	13_3-495_2	−02
E	2765.68	36146.76	$15_3-?516'_2$; 19_6-557_5	+36 −31
2	2766.735	36133.04	19_4-553_3	−02
3	2767.147	36127.66	19_3-559_{34}	−08
4*rz*	2768.988	36103.65	D_1-377_1	−02
4*rz*	2769.746	36093.77	D_3-409_3	−01
2	2770.211	36087.70	17_4-531_5	+49
4*rzM*1?	2770.883	36078.95	S_3-390_2	+01
2	2771.624	36069.31	13_3-494_3	−06
2	2772.481	36058.17	18_3-550_2	00
5*rzA*	2774.007	36038.32	D_3-408_2	00
5*rzM*3	2774.483	36032.14	D_4-422_3	−01
2	2776.091	36011.26	17_4-531_4	−02
E	2779.31	35969.54	$19'_5-557_5$	+01
2	2779.729	35964.14	16_4-523_5	−04
2	2780.290	35956.88	19_5-554_5	−20
1*A*	2785.889	35884.62	18_3-548_3	−03
2	2786.520	35876.50	18_1-539_2	−04
2	2787.986	35857.64	D_2-391_1	−03
3	2789.076	35843.63	19_6-554_5	+03
1	2789.376	35839.77	15_5-509_4	+31
3	2789.683	35835.83	D_3-406_3	−02
2*Ef*	2790.569	35824.45	14_2-508_3; 15_5-508_4; 16_4-522_3	+19 +34 00
3	2791.960	35806.61	12_4-479_4	+02
1	2792.216	35803.32	13_3-491_2	+01
2	2792.528	35799.32	13_3-491_4	−05
5*M*3	2792.702	35797.09	S_3-387_4	−07
T	2792.796	35795.88	D_1-374_2	−11
E	2793.50	35786.88	$19_4-550'_5$	−16
2	2796.152	35752.91	D_3-405_4; 19_4-550_5	−07 00
2	2797.202	35739.50	13_2-495_2	−05
2	2797.473	35736.03	15_5-508_5	−09
2	2797.630	35734.03	20_2-567_3	−06
2	2798.454	35723.51	13_3-490_3	−05
4	2799.929	35704.69	D_2-390_2	−04
3*Efz*	2801.175	35688.80	12_4-478_5	00
1	2801.956	35678.86	$18'_2-539_2$	−04
1	2802.959	35666.09	13_2-494_1; $18_1-?537_2$; $19'_5-554_5$	+08 +03 +03
1	2804.021	35652.60	D_4-418_4	−01
3	2804.244	35649.76	16_4-520_5	−06
E	2804.70	35644.02	17_3-533_4	−42
2	2805.633	35632.10	$18_2-?537_2$	+03
2	2807.725	35605.56	19_2-548_3	+02
1	2807.933	35602.92	19_4-548_3	+01
1	2809.228	35586.51	18_1-536_2	−07
1	2809.589	35581.94	18_3-545_3	−14
2	2813.126	35537.20	17_3-532_4	−03
1	2815.419	35508.26	$19_5-550'_5$	00
E	2816.64	35492.84	13_2-492_2	+33
5*rz*	2818.068	35474.89	D_4-416_3	−09
2	2818.126	35474.16	19_5-550_5	+03
E	2820.10	35449.30	15_3-509_4	+10
1	2821.317	35434.05	15_3-508_4	00
E	2821.51	35431.59	12_4-475_3	+18
2	2823.718	35403.91	D_3-402_4	−01
1	2826.093	35374.15	13_2-491_2	+02
1*Eu*	2827.159	35360.82	19_6-550_5	+17
E	2828.79	35340.43	15_3-508_3	00
3*Az*	2829.833	35327.41	13_3-486_4	−24
3*EfH*	2830.296	35321.62	12_4-474_3	−12
5*M*7*sAK*4*z*	2831.387	35308.01	S_3-382_4	−06
1	2832.479	35294.41	13_2-490_3	+03
1	2832.959	35288.43	17_4-523_5	−04
4*M*2*Z*	2833.634	35280.03	D_4-414_3	00
T	2834.146	35273.64	18_2-533_3	+03
3	2835.644	35255.02	S_3-382_3	−03
3	2837.353	35233.78	D_1-369_2	−06
1	2838.681	35217.31	$19'_5-550'_5$	+07
2	2838.897	35214.62	15_5-502_4	−01
3*M*4	2839.343	35209.09	09_0-447_1; 14_2-501_3	−08 −42
1*u*	2840.104	35199.65	12_4-473_3	−08
1*u*	2840.226	35198.14	19_5-547_6	−02
E	2840.74	35191.81	$20_1-?556_2$; 20_2-561_{34}?	−07 +24

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
3z	2841.574	35181.45	D_3-400_2	00
1u	2842.569	35169.13	$16_4-?516_3$	+05
1	2847.359	35109.96	$18'_2-533_3$	00
2M2?	2847.831	35104.15	$D_2-?384_1$	−17
3M3AK2Z	2848.029	35101.71	S_3-380_3	−06
1Ed	2849.474	35083.92	19_3-549_3; 22_4-575_5	+05 −18
1	2850.394	35072.58	17_6-520_5	−06
2	2850.806	35067.51	15_5-501_5	−07
3	2853.501	35034.40	15_3-504_2	−28
2	2855.354	35011.66	13_1-483_2	−05
4K1z	2856.033	35003.35	D_1-366_2	−05
3	2857.144	34989.73	14_2-499_3	−14
3	2858.047	34978.68	D_4-411_4	−07
1	2858.428	34974.22	17_4-520_5	+11
2	2858.747	34970.12	13_3-483_2	−15
1	2860.174	34952.67	17_4-520_4	−04
2	2861.451	34937.07	13_1-482_2	−08
E	2862.43	34925.11	18_2-530_1	−08
?2	2863.893	34907.29	$19'_5-547_6$	+15
2	2865.320	34889.90	D_3-397_4	−01
4M5uK1 −z }A	2866.071	34880.76	D_2-382_3	−06
2 }A	2866.383	34876.97	D_3-397_2	−06
E	2870.54	34826.46	18_2-529_3	−09
E	2870.62	34825.50	09_0-443_1	+09
3	2870.914	34821.92	13_3-481_3	−08
3	2871.376	34816.33	D_3-396_3	−03
1	2872.504	34802.65	17_3-525_2	+38
2	2875.216	34769.83	12_4-469_4	−02
2	2876.936	34749.03	17_4-518_4	−02
1	2878.081	34735.07	17_3-524_4	−17
4M3	2878.721	34727.49	D_2-380_3	+01
5rM10K1 }HA	2879.110	34722.80	S_3-376_3	−03
5rM2?K3z }HA	2879.400	34719.31	D_0-347_1	−01
2	2880.632	34704.45	D_4-409_3	−02
3	2884.181	34661.76	19_6-543_5	+04
1	2885.921	34640.85	16_4-510_{34}	−02
3	2887.660	34620.00	13_3-479_4	−02
1Eu	2888.788	34606.49	19_4-538_5	−02
1	2892.121	34566.60	15_5-496_4	−04
E	2892.44	34562.73	20_2-555_3	+09
2	2893.125	34554.60	17_3-522_3	+01
2	2893.622	34548.66	13_2-483_3	−03
2	2894.255	34541.11	13_2-483_2; 14_2-495_2	+02 +02
E	2894.52	34537.90	14_2-495_3	−27
4rz }A	2896.010	34520.17	D_1-361_1	+02
6rM7HK4Z }A	2896.445	34514.99	S_3-374_2	00
2	2897.197	34506.03	15_3-499_3	−01
2	2898.252	34493.47	$17_4-?516_3$	+10
3	2900.515	34466.56	13_2-482_2	+03
2	2900.809	34463.07	12_4-466_4; 16_4-508_4	00 +32
2	2901.787	34451.45	$17_3-?521_2$	+07
2	2902.041	34448.44	D_2-377_1	00
2	2902.200	34446.56	D_4-406_3	+02
1	2902.606	34441.73	14_2-494_3	00
3	2904.783	34415.94	18_3-533_3; 19_2-536_2	−02 +11
1	2905.598	34406.27	20_2-553_3	+26
2	2906.731	34392.87	13_2-481_3	+05
2	2907.260	34386.60	18_2-525_2	00
2	2908.264	34374.73	16_4-508_5	−03
3A	2909.125	34364.56	09_0-438_1	−03
1	2909.632	34358.59	17_3-520_4	+03
4z	2910.481	34348.56	D_2-376_3	+02
4Z	2911.001	34342.42	D_0-343_1	+05
2	2912.245	34327.75	19_5-538_5	+02
2	2915.112	34293.98	14_2-492_2	−07
2	2916.109	34282.27	17_6-512_5	+02
2	2917.669	34263.94	18_3-532_4	+03
4A?K1z	2918.253	34257.08	D_4-404_5	+01
1u	2919.300	34244.80	13_3-475_3	−04
Eu	2919.69	34240.24	15_3-497_2; 22_4-567_3	+22 −27
2	2921.121	34223.47	12_4-463_3	−01
1	2921.906	34214.26	19_6-538_5	+01
4z }A	2923.100	34200.29	D_3-390_2	+05
4 }A	2923.548	34195.04	S_3-371_4	+02
3z	2925.132	34176.52	15_3-496_4	−06
E	2926.44	34161.29	23_3-580_3	−24
3	2926.984	34154.90	17_3-518_4	00
2	2927.933	34143.82	18_3-531_4	+01
2	2928.196	34140.76	D_2-374_2	00
2	2928.661	34135.34	13_3-474_3	+17
3	2930.155	34117.93	15_5-491_5	00
1	2932.047	34095.93	14_2-490_3	+01
5rK2z	2934.994	34061.71	D_1-357_2	+06
2	2935.632	34054.29	15_3-495_3	−05
4	2936.014	34049.86	D_4-402_3	−13
3	2937.149	34036.70	$19'_5-538_5$	−01
1	2937.673	34030.64	13_1-473_2	−03
3	2939.055	34014.63	D_4-402_4; 20_2-550_2	+02 +28
2	2939.185	34013.14	13_3-473_3	−02
2	2940.954	33992.66	17_3-516_2	00
2	2941.255	33989.19	13_3-473_2	−04
E	2942.14	33978.93	22_5-568_4	+05
2	2942.459	33975.28	$18'_2-522_3$	+01
2	2943.338	33965.13	17_4-510_{34}	−03
2	2943.972	33957.81	15_3-494_3	−09
7rM20HAK10Z	2944.410	33952.77	S_3-369_2	−07
1Ef	2946.527	33928.37	20_2-549_3	−10
8rM20K8Z }HA	2946.992	33923.01	S_3-368_3	−03
6z }HA	2947.393	33918.40	D_3-387_4	−04
1	2949.130	33898.43	18_2-520_3	+03
1	2951.418	33872.06	$18'_2-?521_2$	00
E	2951.79	33867.88	$247_4-?58_5$	+28
E	2956.81	33810.40	15_3-492_2; 19_5-533_4	+18 −20
E	2957.54	33802.06	17_4-509_4	+27
1	2957.931	33797.58	17_6-508_5	00
1	2958.730	33788.45	19_2-530_1	+12
1	2958.846	33787.13	17_4-508_4	+09
3	2960.146	33772.28	13_1-470_2	+01
1	2961.715	33754.39	16_4-501_3	+01
E	2963.44	33734.78	$18'_2-520_3$	+03
1	2963.783	33730.85	13_3-470_2	+02
5AK2Z	2964.520	33722.47	S_3-366_2	+07
E	2965.88	33707.03	12_4-458_4	−01
E	2965.98	33705.89	13_2-474_3; 16_4-501_5	−10 −33
3	2966.578	33699.07	17_4-508_5	+02
2	2967.073	33693.45	17_4-508_3	+03
E	2968.23	33680.35	$18_1-?517_1$	−09
E	2968.78	33674.12	22_5-565_6	+36
E	2971.22	22646.47	$18_2-?517_1$	+02
3	2971.675	33641.28	D_1-353_2	+09
1	2972.497	33631.97	22_4-561_3	+12
3	2972.919	33627.18	12_4-457_5	+03
3	2976.802	33583.33	13_3-469_4; 19_5-531_4	+05 +04
3	2977.104	33578.68	D_2-369_2	+07
E	2977.67	33573.50	20_2-545_3	+01
E	2978.63	33562.68	19_3-533_3	−09
5K3z	2979.860	33548.87	D_2-368_3	+06
E	2981.14	33534.43	16_4-499_3	−31
1	2981.636	33528.89	18_3-525_2	−06
3	2982.620	33517.82	$18_1-?516_{12}$; 19_4-527_5; 19_3-533_4	+28 00 −11
Eu	2982.8	33515.4	12_4-456_3	−3
3	2984.154	33500.60	D_4-397_4	00
1	2985.668	33483.61	$18_2-?516_{12}$	+06
E	2985.86	33481.43	17_3-511_{32}	+11
1	2987.968	33457.83	13_3-468_2	−04
3	2990.512	33429.37	D_3-382_4	+02
3	2990.719	33427.06	D_4-396_3	+01
E	2991.96	33413.19	$18'_2-516_2$	−15

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
1	2992.181	33410.73	19_3-532_4	+01
2	2992.932	33402.35	22_5-562_4	−47
4z	2993.616	33394.71	D_4-396_5	+03
3	2995.264	33376.35	D_3-382_3	+02
1	2995.745	33370.98	17_3-510_{34}	−03
2	2995.994	33368.21	19_5-531_5	+01
2	2996.982	33357.21	16_4-497_4	−09
2	2997.612	33350.20	14_2-483_3	+01
5z	2997.794	33348.17	D_2-366_2	00
1	2998.290	33342.66	14_2-483_2	+03
3	3000.243	33320.95	$20_1-?537_2$	−13
E	3000.38	33319.45	$22_4-557_5?$	+55
3	3001.983	33301.64	13_2-470_2	−01
2	3002.827	33292.28	$19'_5-531_4$	+01
Eu	3004.23	33276.76	13_3-466_4	+26
2	3005.012	33268.07	14_2-482_2	00
1	3006.660	33249.84	19_2-525_2	00
1	3007.410	33241.55	20_1-536_2	−05
5	3009.085	33222.76	D_3-380_3	−23
2	3010.426	33208.25	17_3-509_4	+01
Eu	3010.68	33205.44	16_4-496_4	+16
2	3011.682	33194.29	14_2-481_3	−07
2	3013.206	33177.61	17_4-502_4	+05
3z	3013.796	33171.12	D_3-380_4	+01
5z	3016.475	33141.65	D_4-393_5	−03
6rK4z	3017.447	33130.98	S_3-360_4	−02
1	3017.942	33125.55	19_6-527_5	−01
2	3020.220	33100.56	12_4-452_4	+01
2	3021.620	33085.23	18_3-520_4	−01
1	3023.162	33068.36	15_5-481_5	−03
5K4Z }A	3024.931	33049.02	D_1-347_1	−03
3 }A	3025.268	33045.33	09_0-425_1	−02
3	3026.683	33029.89	17_4-501_5	? −55
3z	3026.794	33028.68	13_2-468_2	−01
E	3027.50	33020.96	13_1-463_2	+34
2	3027.804	33017.66	17_3-507_2	00
E	3031.35	32979.03	13_3-463_2	−15
2	3033.585	32954.74	12_4-451_4	00
3	3034.204	32948.02	$19'_5-527_5$	00
E	3038.45	32901.99	$18'_2-511_{32}$; 23_3-568_4	−01; +36
1	3038.720	32899.05	15_5-497_4; $19_2-?521_2$	? +44; +10
?2	3041.749	32866.29	15_3-483_3	−11
5rK2z	3041.876	32864.92	D_2-361_1	00
1	3042.287	32860.48	19_5-523_5	00
E	3042.42	32859.07	15_3-483_2; 17_4-499_3	+27; +04
1	3043.020	32852.57	12_4-450_3	−01
6K1 =	3043.819	32843.95	D_3-376_3	−10
1	3045.585	32824.90	19_4-520_5	00
5rK3z	3046.452	32815.56	D_1-344_2	00
?2	3047.572	32803.50	19_4-520_4	00
1	3048.131	32797.49	13_1-461_1	+03
2	3048.667	32791.72	$18'_2-510_{34}?$	+03
1	3049.360	32784.27	15_3-482_2	+03
6rK5z	3049.694	32780.68	S_3-357_2; 15_5-478_5	+03; −14
Eu	3051.43	32762.07	19_2-520_3	+43
1Ed	3051.935	32756.61	16_4-491_5	+04
1	3052.827	32747.04	19_6-523_5	+04
3A	3054.020	32734.25	09_0-422_1	00
3	3055.401	32719.45	13_3-460_3; 18_3-516_2	+01; +11
2	3056.229	32710.59	15_3-481_3	+06
Eu	3058.53	32685.93	20_2-536_2	−42
Eu	3058.77	32683.37	18_2-508_3	−23
1	3059.825	32672.16	D_1-343_1	+06
1	3062.893	32639.43	22_5-554_5	+17
3	3063.183	32636.34	D_3-374_2; 18_1-507_2	+07; +36
E	3063.59	32631.96	$18_3-?516_{21}$	+04
1	3064.938	32617.66	D_2-359_3	−01
E	3065.65	32610.04	$19'_5-524_4$	−34
E	3065.89	32607.49	13_2-463_3	−24
E	3066.42	32601.86	18_2-507_2	−13
1A	3069.470	32569.50	19_5-523_5	+04
E	3070.94	32553.88	13_3-459_2	−04
E	3071.72	32545.62	$19_5-520_5?$	−50
1K1 −? }A	3073.287	32529.04	D_4-387_4; 17_4-496_4	−09; −53
2 }A	3073.695	32524.73	19_5-520_4	+01
3	3074.094	32520.50	13_3-458_4; $18'_2-508_3$	+03; +55
1	3075.227	32508.53	15_3-479_4	−02
E	3075.34	32507.32	14_2-474_3	−21
2	3081.875	32438.40	$18'_2-507_2$	+06
E	3084.41	32411.76	18_1-504_2	−08
2	3084.834	32407.28	17_4-495_3; 20_2-533_3	−05; −09
2	3084.918	32406.40	D_2-357_2	−02
E	3085.61	32399.16	214_2-53_1	+01
2	3086.981	32384.74	12_4-445_5	+01
1	3087.650	32377.73	18_2-504_2	−12
2	3089.193	32361.56	14_2-473_2	−03
2	3089.321	32360.22	S_3-353_2	+03
E	3090.05	32352.62	$19_2-?516'_2$	−19
2	3090.593	32346.89	$19_2-?516_3$	+10
2	3092.293	32329.12	13_3-456_3	−01
E	3092.52	32326.79	13_2-461_1	−05
5K1z	3093.515	32316.34	D_3-371_4	+04
1	3094.034	32310.92	17_4-494_3	+03
1	3096.013	32290.26	13_2-460_3	00
E	3096.45	32285.66	230_3-55_4	−18
2	3098.449	32264.88	17_3-499_3	00
E	3103.91	32208.09	18_3-511_{32}	+09
1	3104.422	32202.81	13_3-455_3	+02
4	3105.879	32187.70	19_3-520_3	+14
4z	3107.233	32173.68	D_2-354_3	+08
3K1	3108.019	32165.54	S_3-351_4	+08
2Ef	3111.122	32133.46	15_3-475_3	+09
1	3111.961	32124.80	13_2-459_2	+06
E	3112.87	32115.41	13_1-454_2	+26
1	3114.583	32097.76	18_3-510_{34}	+07
1	3116.215	32080.95	17_4-491_5	+09
E	3116.33	32079.76	22_4-545_3	−15
1	3116.869	32074.22	D_3-369_2	+10
1	3117.389	32068.87	18_2-501_3	+02
3z	3117.580	32066.90	13_1-453_1	−08
1	3118.360	32058.89	20_2-530_1	−06
3K2	3119.773	32044.40	D_3-368_3	+08
3K1?z	3120.192	32040.06	D_4-382_4	+02
2	3120.738	32034.45	19_4-512_5	−04
2	3121.170	32030.02	$19'_5-518_4$	−02
Eu	3121.82	32023.36	15_3-474_3	−34
3	3125.363	31987.05	D_4-382_3	+03
Eu	3127.94	31960.73	20_2-539_3	+42
1	3130.465	31934.91	18_3-509_4	−01
1Eu	3133.724	31901.71	15_3-473_3	+02
4z	3133.895	31899.97	13_2-456_3	+02
3	3136.076	31877.78	15_3-473_2	+02
2	3137.641	31861.89	15_5-469_4	+02
1	3137.921	31859.05	12_4-440_3	+03
1	3138.886	31849.25	18_2-449_3	+04
1	3139.430	31843.74	D_3-366_2	+07
2	3140.420	31833.69	D_4-380_3; 22_4-543_5	+01; +14
3	3140.758	31830.27	14_2-468_2	+04
1	3141.183	31825.96	18_3-508_3	+01
3	3141.430	31823.46	12_4-439_4	+06
3	3142.154	31816.13	17_3-495_2; 19_4-510_{34}	+03; +18
E	3145.20	31785.28	15_5-468_5	? +46
3	3145.545	31781.83	D_4-380_4	+03
2	3146.359	31773.60	13_2-455_3	−01
1Ed	3152.000	31716.74	17_3-494_3	00
3	3152.958	31707.11	16_4-481_5	+08
2K1	3155.095	31685.63	$18'_2-499_3$	+07
2	3155.518	31681.38	S_3-346_4	+06
E	3157.02	31666.31	13_3-450_3	+30

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
1	3159.185	31644.62	13_2-454_2	+09
1*Ed*	3159.420	31642.27	19_6-512_5	+04
E	3161.92	31617.25	18_1-497_2	+07
4*z*	3163.419	31602.26	15_5-466_6	+05
E	3163.99	31596.57	13_2-453_1	+21
4*z*	3164.442	31592.04	13_3-449_4	+10
1	3166.744	31569.07	17_4-486_4; 17_3-492_2	−10 +01
1	3168.975	31546.86	19_2-508_3	+02
2	3169.938	31537.28	16_4-479_4; 19_5-510_{34}	+03 ? +11
3	3170.212	31534.54	S_3-344_2	−02
*EK*1?	3171.62	31520.58	18_3-504_2; 20_2-525_2	+38 +22
4*K*1?*z*	3176.602	31471.11	D_1-331_2	−02
2*Ef*	3177.187	31465.31	19_2-507_2	+08
2	3178.254	31454.76	D_4-376_3	+02
3*z*	3179.064	31446.75	17_3-491_4	−04
1	3180.307	31434.45	18_1-495_2	+03
4*Ef*	3180.750	31430.07	13_1-447_1	−02
2*z*	3181.819	31419.52	$18'_2-497_2$	−02
3	3182.860	31409.24	14_2-463_3	−03
3	3183.518	31402.74	S_3-343_3	+02
1	3183.750	31400.46	18_2-495_2	+03
3*z*	3184.051	31397.49	18_2-495_3	−02
3	3184.423	31393.82	D_2-347_1	00
1	3185.210	31386.07	22_4-538_5	−01
2	3186.746	31370.93	17_3-490_3	00
1	3187.769	31360.97	18_1-494_1	−01
3*Ef*	3189.239	31346.42	15_3-468_2	+02
E	3191.22	31326.95	18_2-494_1	+06
1*K*3*Z*	3191.577	31323.45	D_0-313_1	+04
1	3192.392	31315.46	14_2-462_2	+02
E	3192.89	31310.57	18_3-502_4	? +48
2	3195.071	31289.20	13_1-445_2	+02
Ef	3198.24	31258.21	16_4-476_4	+22
5*K*1*z*	3198.843	31252.30	D_3-360_4	+02
1	3199.308	31247.76	13_3-445_2	+02
2	3199.966	31241.34	13_2-450_2; 19_2-504_2	+03 +25
E	3200.40	31237.11	13_2-450_3; $18'_2-495_2$	+38 +33
1	3200.729	31233.89	$18'_2-495_3$	+02
2	3203.054	31211.22	18_3-501_3	+02
2	3205.503	31187.37	18_1-492_2	−01
5*K*2*z*	3207.248	31170.41	S_3-341_4	+08
1	3207.799	31165.06	15_3-466_4	+03
2	3208.098	31162.15	16_4-475_3	+08
4*K*1 =	3208.279	31160.39	D_2-344_2	+06
2	3208.566	31157.61	19_6-508_5	+03
1	3213.142	31113.23	D_4-359_3	+05
2*EfGK*5?*z*	3215.578	31089.66	D_4-373_5	−17
Euf	3216.20	31083.61	$19'_5-509_4$	+23
E	3217.70	31069.12	18_1-491_2	+12
3*z*	3218.612	31060.36	13_1-443_2	00
3	3220.070	31046.29	13_1-443_1	−04
2	3221.625	31031.31	17_4-481_5	−01
3*z*	3221.919	31028.48	D_2-343_3; 19_4-502_4	−01 +13
2	3223.126	31016.86	D_2-343_1	−01
2	3225.636	30992.72	S_3-339_2	+01
E	3225.94	30989.78	$18'_2-492_2$	+04
2	3227.498	30974.85	17_3-486_4	−17
2	3232.135	30930.41	16_4-473_3	+02
1	3232.232	30929.48	19_4-501_3; 17_4-548_3	+02 +42
2	3232.489	30927.03	D_4-371_4	+04
2*z*	3232.654	30925.45	15_3-463_3	+01
2*Edz*	3234.996	30903.06	D_2-342_3	+02
3*Z*	3237.091	30883.05	09_0-404_1	+01
1*Eu*	3238.692	30867.79	15_3-463_2	+08
1	3241.409	30841.91	17_6-478_5	−37
3*K*1*z*	3242.026	30836.05	214_2-52_{23}	00
E	3249.83	30762.04	22_4-532_4	+30
2 =	3251.219	30748.86	12_4-429_4	+12
4*z*	3254.353	30719.25	15_5-457_5	+08
2*z*	3255.959	30704.10	12_4-428_5	+13
3*z*	3256.227	30701.56	14_2-456_3	+07
2	3258.137	30683.57	D_0-306_1	+12
2*z*	3259.659	30669.25	D_3-354_3; 13_2-444_3	+14 +01
3	3261.160	30655.13	D_4-368_3	+12
3*A*	3263.099	30636.92	13_3-439_4	+09
1	3264.337	30625.30	17_3-483_3	+06
2	3265.145	30617.72	17_3-483_2; $20_2-?516_{12}$; 247_4-55_5	+08 +29 +15
E	3266.16	30608.18	15_3-460_3	+21
2*z*	3266.762	30602.56	19_5-501_5	+04
2	3268.128	30589.78	13_2-443_2	+04
1	3268.582	30585.53	13_1-438_1	+02
2	3268.924	30582.33	17_4-476_4	+05
2*z*	3269.626	30575.77	13_2-443_1	+06
2	3270.269	30569.75	247_4-55_4	+02
E	3273.13	30543.02	17_3-482_2; 18_3-495_2	−06 +24
E	3273.47	30539.85	18_3-495_3	−01
Eu	3278.51	30492.92	22_5-553_4	+14
E	3279.16	30486.88	17_4-475_3	? +52
2	3279.588	30482.89	$13_1-?437_0$	−02
1	3283.561	30446.01	14_2-454_2; $(19_2-497_2$	−06 −42)
E	3284.28	30439.36	12_4-426_3	+20
E	3285.99	30423.53	16_4-468_5	+07
E	3288.71	30398.37	14_2-453_1	+47
1	3290.513	30381.68	15_5-454_5	+04
E	3290.63	30380.64	19_4-496_4	+28
E	3291.02	30377.04	17_4-474_3	+35
E	3291.51	30372.52	13_3-437_4	+19
3*z*	3293.711	30352.18	12_4-425_3	00
2*z*	3298.128	30311.54	$19'_5-501_5$	+04
Euf	3299.71	30296.97	22_4-527_5	−42
E	3300.35	30291.10	20_1-507_2	+10
5*K*5*z*	3300.819	30286.82	D_3-351_4	+08
E	3303.31	30263.96	19_2-495_2	+29
E	3303.62	30261.12	19_2-495_3	+37
2	3305.565	30243.34	13_2-440_3	+07
E	3306.33	30236.33	18_1-483_2	+37
2	3309.475	30207.62	13_1-435_2	+04
E	3311.11	30192.69	15_5-452_4	+12
4*K*5*Z*	3311.389	30190.16	S_3-331_2; 19_2-494_1	+03 +03
1	3314.021	30166.18	13_3-435_2	+04
E	3314.52	30161.64	18_1-482_2; 19_4-494_3	+24 −04
3*z*	3316.091	30147.34	D_1-318_2	00
E	3317.07	30138.46	19_3-499_3	+09
2	3317.997	30130.03	13_3-434_3	−03
E	3319.65	30115.04	13_2-438_1	+15
3*Z*	3320.364	30108.55	09_0-396_1	00
E	3321.12	30101.71	19_5-496_4	+13
2*z*	3321.569	30097.63	18_3-490_3	+01
2	3322.253	30091.43	15_3-455_3	+11
E	3324.06	30075.10	16_4-465_5	+05
E	3324.96	30066.96	20_1-504_2	+10
5*K*1?*z*	3326.194	30055.78	D_4-362_5	00
2	3327.629	30042.82	14_2-450_2	−03
2*z*	3328.121	30038.38	14_2-450_3; $18'_2-483_2$	+01 −06
E	3330.56	30016.42	19_2-492_2	−21
5*K*3 =	3331.678	30006.31	S_3-329_3	+02
Ef	3336.55	29962.46	15_3-454_2; $19'_5-497_4$	+22 −12
E	3336.85	29959.76	22_4-524_4	+01
E	3337.49	29954.02	16_4-463_3	−12
3*Ef*	3343.247	29902.47	13_3-432_4	+03
1	3344.446	29891.76	$(17_3-475_3$; 19_4-491_4	−45) +03
3*Efz*	3345.858	29879.14	13_3-432_2	+03
E	3346.10	29876.97	S_3-328_4	+13

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
E	3350.61	29836.76	$13_3-?431_4$	−12
E	3352.00	29824.39	17_4-469_4	−41
E	3352.96	29815.86	D_2-331_2; 19_4-490_3	−04 −01
1	3353.552	29810.60	$19'_5-496_4$	+04
2z	3353.736	29808.96	19_3-496_4	+05
5K1?z	3354.451	29802.61	D_3-346_4; 15_3-452_4	+01 +10
E	3356.71	29782.56	17_3-474_3	+02
E	3357.10	29779.10	22_4-522_3	00
E	3360.76	29746.68	$13_1-?430_0$; $17_6-?467_7$	−05 −10
E	3361.87	29736.86	13_2-435_2	−10
E	3361.97	29735.97	20_2-507_2	+19
2z	3363.341	29723.84	D_4-359_3	−03
Eu	3364.90	29710.09	12_4-418_4	+14
1	3365.941	29700.88	13_2-434_3	00
E	3367.21	29689.71	19_3-495_2	+12
E	3367.56	29686.63	19_3-495_3; $28_5-?579_6$	−04 −07
E	3367.64	29685.92	13_3-430_4	+36
E	3370.17	29663.64	17_6-466_6	−03
1	3370.520	29660.53	17_3-473_3	00
2y =	3371.052	29655.85	D_3-344_2	+01
2 =	3371.358	29653.16	D_1-313_1; 19_5-491_5	+02 +29
E	3373.24	29636.57	16_4-460_3; 17_3-473_2	−10 −03
3K2z	3373.756	29632.08	D_2-329_3	+02
2z	3375.120	29620.11	14_2-445_2	+01
E	3376.90	29604.45	22_4-520_5	−02
E	3378.51	29590.35	19_3-494_3	+12
E	3379.26	29583.79	22_5-524_4	+21
2	3381.735	29562.17	13_3-429_4	00
1y	3382.097	29559.00	15_3-450_2	−02
2z	3382.606	29554.56	15_3-450_3	+02
2z	3384.340	29539.42	19_6-491_5	+03
2A	3386.102	29524.04	D_3-343_3	+04
E	3386.79	29518.03	17_4-466_4	+01
2z	3391.102	29480.52	15_3-449_4	+05
2z	3391.531	29476.79	15_5-445_5; 18_2-475_3	+04 +25
E	3394.62	29449.96	13_2-432_2	+03
E	3395.47	29442.59	19_2-492_2	+04
2z	3395.817	29439.59	13_2-432_1	+03
2AK2z	3398.099	29419.81	19_4-486_4	−15
E	3398.59	29415.57	23_3-533_4	+04
ET	3400.51	29398.97	D_3-342_3	+05
1	3401.396	29391.29	14_2-443_2	+01
E	3402.76	29379.53	22_4-518_4	+12
1	3404.229	29366.84	18_2-474_3	−03
1	3404.802	29361.90	$19'_5-491_5$	+05
1	3405.276	29357.81	16_4-457_5	00
1Ef	3406.834	29344.38	18_3-483_2	+06
1	3407.639	29337.45	12_4-414_3	+04
1	3409.442	29321.94	$19'_5-491_4$	+01
E	3409.61	29320.53	15_5-443_6; 19_3-491_4	+14 +25
E	3410.50	29312.88	$18'_2-475_3$	−01
E	3411.01	29308.50	23_3-532_4	+18
3z	3412.969	29291.64	D_3-341_4	+03
3 =	3413.539	29286.75	S_3-322_3	+02
E	3415.54	29269.55	18_3-482_2	−21
E	3418.24	29246.44	16_4-456_3	+08
E	3418.49	29244.32	19_3-490_3	−10
1	3419.288	29237.52	230_3-52_{23}	00
1	3420.358	29228.37	22_5-520_5	+07
1	3423.302	29203.23	$18'_2-474_3$	+01
Eu	3425.03	29188.47	23_3-531_4	+25
3 =	3427.720	29165.59	13_3-425_3	−02
1	3430.269	29143.91	261_3-55_4	−01
E	3430.38	29142.96	13_1-424_2	+49
E	3433.08	29120.05	16_4-455_3	+03
2z	3433.791	29114.02	D_3-339_2	+03
E	3434.79	29105.56	17_3-468_2	+32
ET	3438.966	29069.95	19_4-483_3	−23
1	3441.975	29044.80	14_2-440_3	−01
3y =	3443.014	29036.03	12_4-411_4	−06
1	3445.411	29015.84	20_1-494_1	−06
2z	3445.726	29013.18	D_1-306_1; 23_3-529_3	00 −13
ET	3446.900	29003.30	22_5-518_4	+06
E	3447.68	28996.77	18_1-470_2	+25
3z	3448.842	28986.97	15_3-444_3	+02
E	3449.28	28983.32	20_2-499_3	+35
2	3451.752	28962.53	18_2-470_2	00
E	3451.91	28961.16	17_4-460_3	+20
1Efz	3452.630	28955.17	13_1-422_1	+01
E	3456.35	28923.97	17_3-466_4	+10
2	3457.372	28915.46	15_5-439_4	+04
3z	3457.726	28912.50	D_2-322_3	00
2	3458.325	28907.49	15_3-443_2	+04
E	3459.00	28901.82	$09_0-?384_1$	+01
2	3459.527	28897.45	D_4-351_4	+02
E	3461.33	28882.37	19_4-481_5	+26
3A?	3463.252	28866.36	S_3-318_2	+02
E	3465.38	28848.62	19_3-486_4	+11
3z	3468.405	28823.48	13_2-426_3	+07
E	3471.34	28799.11	$18'_2-470_2$	+23
3z	3475.836	28761.86	12_4-409_3; 17_4-458_4	+05 −13
E	3477.25	28750.17	12_4-409_5	+21
E	3478.90	28736.54	13_2-425_3	+11
E	3480.48	28723.50	18_1-468_2	−06
3z	3481.828	28712.36	19_4-479_4	+03
E	3482.79	28704.45	266_5-55_5	−01
1	3485.295	28683.80	17_3-463_3	? −48
3z	3485.507	28682.05	17_4-457_5	−05
2z	3489.293	28650.94	15_5-437_4	+02
1	3491.836	28630.07	13_3-419_2	00
E	3492.29	28626.31	17_3-463_2	−24
1	3493.198	28618.90	18_3-475_3	+01
3Az	3500.287	28560.94	15_3-440_3	−04
2z	3503.044	28538.47	14_2-435_2	−03
2Ef	3503.567	28534.21	20_2-495_2	+02
1	3504.658	28525.33	15_3-439_4	−03
2 =	3506.649	28509.13	16_4-449_4; 18_3-474_3	−04 −09
2z	3507.294	28503.89	12_4-406_3	+01
E	3507.89	28499.04	19_3-483_3	+31
3z	3508.746	28492.10	D_2-318_2	−01
2z	3509.025	28489.83	19_6-481_5	−02
1	3509.674	28484.57	13_2-422_1	+02
5z	3510.041	28481.58	S_3-314_4	−02
E	3512.62	28460.68	20_2-494_1	+03
1z	3515.971	28433.55	19_5-479_4	00
E	3516.74	28427.34	13_1-417_2	+36
2	3517.516	28421.06	12_4-405_4	+05
3	3518.485	28413.23	D_4-346_4	−06
2z	3521.717	28387.16	18_3-473_3	−05
3z	3521.916	28385.55	13_3-417_2	+01
1z	3524.243	28366.81	17_3-460_3	00
E	3524.64	28363.64	18_3-473_2	+36
3Efz	3527.004	28344.61	17_4-454_5	+04
E	3527.59	28339.93	19_2-475_3	+18
E	3527.91	28337.36	19_4-475_3	+21
1z	3530.761	28314.45	12_4-404_5	+04
1z	3531.027	28312.31	$19'_5-481_5$	00
E	3531.08	28311.85	D_3-331_2	? +44
1z	3535.551	28276.09	13_1-415_2	+02
4z	3537.455	28260.87	15_5-433_5; 15_3-437_4	00 +01
2z	3538.634	28251.45	14_2-432_2	−02
E	3539.30	28246.11	09_0-377_1	+18
E	3539.90	28241.33	14_2-432_1	+23
2z	3540.741	28234.64	13_3-415_2	+01
2z	3541.648	28227.41	19_4-474_3	−07
ET	3542.655	28219.38	22_5-510_{34}?	+03
1	3543.719	28210.92	18_2-463_2	+04
2	3544.801	28202.31	19_6-478_5	+03

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
2z	3544.981	28200.88	13_2-419_2; (17_3-459_2	−01 −41)
6K2Z	3545.234	28198.86	D_0-281_1	+02
1z	3547.480	28181.01	15_5-432_4	−02
2z	3548.269	28174.74	18_2-462_2	−04
1	3550.694	28155.50	17_4-452_4	00
3z	3550.850	28154.26	19_5-476_4	−03
1	3551.282	28150.84	13_3-414_3	00
E	3552.34	28142.46	$19'_5-479_4$	−07
3z	3554.220	28127.57	D_3-329_3	00
1	3555.760	28115.39	$15_5-?431_4$; 16_4-445_5	−08 00
E	3559.08	28089.18	20_2-490_3	+16
2z	3559.714	28084.16	19_2-473_2	−01
E	3561.26	28071.99	12_4-402_4	+04
2z	3563.457	28054.66	15_3-435_2	−01
E	3565.17	28041.21	22_5-508_4	−02
E	3567.25	28024.86	$19'_5-478_5$	+12
Eu	3567.66	28021.64	18_1-461_1	−07
1z	3568.045	28018.59	15_3-434_3	00
E	3568.40	28015.83	16_4-444_3	+18
3z	3568.993	28011.15	$18'_2-462_2$	+02
2z	3569.233	28009.27	D_4-342_3	+03
E	3569.59	28006.50	19_5-475_6	+01
6	3570.662	27998.05	D_2-313_1; D_3-328_4	+14 −07
2 =	3573.415	27976.48	17_3-456_3	−02
2z	3575.230	27962.28	17_6-499_7	+04
3Edz	3575.979	27956.43	13_2-417_2	+07
2z	3576.384	27953.25	22_5-508_5	+01
?2	3581.233	27915.41	17_6-449_6	+11
1z	3582.242	27907.55	17_4-450_3	+02
E	3582.92	27902.26	D_4-341_4	−04
3 =	3584.109	27893.01	19_6-475_6	−01
1	3589.699	27849.58	13_3-411_4	+06
4K1z	3590.830	27840.81	15_5-429_4	+05
1u	3591.771	27833.51	17_4-449_4	+05
E	3591.98	27831.90	18_3-468_2	−02
E	3592.98	27824.15	$18'_2-461_1$	+08
E	3593.55	27819.74	18_1-459_2	+13
2A?z	3593.979	27816.41	20_1-482_2	−01
T	3595.386	27805.52	13_2-415_2	+07
E	3596.45	27797.31	13_1-411_2	−06
E	3596.63	27795.92	15_5-428_5	−07
3z	3597.271	27790.96	18_3-432_4	+03
1	3597.721	27787.48	$18'_2-460_3$	−01
E	3597.97	27785.57	18_2-459_2	−05
3Z	3598.885	27778.50	D_0-277_1	+04
E	3600.30	27767.60	15_3-432_2; 19_3-475_3	−04 +26
E	3601.84	27755.73	13_3-411_2	−20
3z	3606.074	27723.11	D_1-293_2	00
2Edz	3606.344	27721.03	17_3-454_2	−05
3z	3607.070	27715.46	$19'_5-475_6$	00
EA	3614.24	27660.45	22_4-501_5	? −42
E	3614.80	27656.17	19_3-474_3	+14
E	3615.52	27650.66	18_3-466_4	+08
8rK10Z	3617.522	27635.39	S_3-305_3	+05
E	3619.78	27618.13	262_2-53_1	00
3z	3622.352	27598.54	19_4-468_5	00
3 =	3625.408	27575.28	13_3-409_3	+04
3z	3627.246	27561.30	13_1-408_2; 17_3-452_4	+08 −05
Ef	3628.39	27552.61	19_2-468_2	−20
3z	3630.324	27537.93	14_2-425_3; 17_6-445_5	+02 −28
3z	3630.830	27534.09	19_3-473_3	+07
5z	3631.959	27525.54	D_1-291_2	−03
2	3632.719	27519.78	13_3-408_2	00
1	3636.740	27489.35	22_4-499_3	−04
3z	3637.393	27484.42	12_4-396_3	+03
1	3637.942	27480.27	263_2-53_1	−32
3z	3640.144	27463.65	13_1-407_1	+08
2z	3641.862	27450.70	15_3-429_4	00
E	3642.81	27443.58	278_4-55_4	+11
E	3643.29	27439.96	17_4-445_5	+28
E	3647.13	27411.00	18_3-463_3	+04
3Az	3647.531	27408.03	D_3-322_3	+02
1	3649.023	27396.82	($18'_2-456_3$; 19_5-469_4	−36) +01
3z	3651.008	27381.93	17_6-443_6	+08
E	3652.75	27368.84	19_4-466_4	+03
3z	3654.204	27357.98	D_2-306_1	+03
Eu	3656.15	27343.40	20_2-483_3	+07
1	3656.680	27339.49	18_1-454_2	+06
1	3658.368	27326.85	13_2-411_2	+10
1z	3659.315	27319.78	19_5-468_5	+02
E	3659.53	27318.15	17_3-450_2	+29
1	3660.171	27313.38	17_3-450_3	00
1	3660.369	27311.90	22_4-497_4	−05
2z	3660.609	27310.11	16_4-437_5	+08
E	3661.24	27305.39	18_2-454_2	−02
1	3663.150	27291.17	18_1-453_1	−06
3	3663.360	27289.60	16_4-437_4	+04
1	3663.824	27286.15	14_2-422_1	+06
2z	3665.881	27270.84	$18'_2-455_3$	00
3z	3667.183	27261.16	D_2-305_3; 20_2-482_2	+05 −01
3z	3667.719	27257.17	18_2-453_1	−07
3z	3668.664	27250.15	19_4-465_5	+02
1	3670.771	27234.51	13_3-405_4	+02
ET	3672.95	27218.35	266_0-53_1	+05
3z	3674.584	27206.26	19_6-468_5	−02
3z	3675.559	27199.04	12_4-393_5	+02
E	3680.87	27159.82	22_4-496_4	−11
5z	3682.101	27150.72	D_4-333_5	−04
3 } =	3683.316	27141.76	$18'_2-454_2$; 23_3-510_{34}	00 −34
3 }	3683.399	27141.14	15_3-426_3	+02
3z	3683.945	27137.12	19_5-466_6	−03
2z	3684.663	27131.84	19_2-463_3	−01
2z	3685.023	27129.19	19_4-463_3	−03
5z	3688.069	27106.78	$19_6-?467_7$	00
2	3688.423	27104.18	13_1-404_1; 19_3-469_4	+22 +04
3z } A	3689.877	27093.50	$18'_2-453_1$; 18_3-460_3	−09 +01
3z }	3690.261	27090.68	13_2-408_2	+08
E	3695.21	27054.37	15_3-425_3	+23
E	3697.45	27037.99	19_2-462_2; 22_4-495_3	−03 −30
2z	3698.715	27028.76	$19'_5-468_5$	+02
3 =	3699.411	27023.67	19_6-466_6	00
3z	3702.316	27002.47	14_2-419_2	+04
2z	3703.596	26993.13	13_2-407_1	+10
2z	3705.485	26979.38	23_3-509_4	+05
6K1?Z	3707.929	26961.59	S_3-299_3	+06
1	3711.481	26935.79	(18_1-450_2; 22_5-497_4	−39) +01
2z	3714.238	26915.80	17_6-439_5	+11
2	3715.046	26909.94	20_1-473_2	00
1z	3716.735	26897.71	18_2-450_3	00
2z	3717.099	26895.08	17_3-445_2	−03
3z	3719.412	26878.36	17_4-439_4	+01
2 =	3720.522	26870.34	23_3-508_3	−02
3Az	3722.254	26857.84	19_6-465_5	−03
E	3723.85	26846.29	$19'_5-466_6$	+16
Eu	3727.85	26817.49	17_4-439_5	+33
1	3728.285	26814.39	19_2-460_3	+01
3z	3730.429	26798.97	$19'_5-466_4$	−04
1z	3732.552	26783.74	22_5-496_4	−02
E	3737.85	26745.76	17_3-446_3	−03
E	3738.13	26743.76	17_4-438_3	00
2	3738.899	26738.27	D_4-329_3; $18'_2-450_2$	+01 −27
2z	3739.488	26734.06	$18'_2-450_3$	00
3Efz	3741.714	26718.15	14_2-416_3	+04
2	3742.689	26711.19	22_4-491_5	−03
2 =	3743.820	26703.13	18_3-456_3	−05
Euf	3750.67	26654.37	18_1-447_2	+03

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
2z	3751.432	26648.94	19_2-459_2	+08
1uEf	3753.487	26634.35	17_4-437_5	+03
Eu	3754.15	26629.67	214_2-48_2	00
E	3754.87	26624.56	214_1-48_2	+03
E	3755.49	26620.17	18_2-447_1	−18
E	3756.38	26613.86	17_4-437_4	+01
1	3756.878	26610.31	20_2-475_3	+01
3	3757.093	26608.79	D_4-328_4; 230_3-49_3	−02 +03
1	3757.345	26607.00	14_2-415_2	+01
3Efz	3757.929	26602.87	D_3-314_4; 16_4-430_4	−01 +08
4Efz	3760.133	26587.27	D_2-299_3	−03
2	3760.644	26583.66	287_4-55_5	00
2z	3761.623	26576.75	18_3-455_3	−09
2z	3764.316	26557.74	19_3-463_3	−03
1z	3767.419	26535.86	287_4-55_4	+04
2	3767.846	26532.86	19_4-457_5	−03
5K2Z	3768.448	26528.62	D_1-281_1	+05
3z	3769.213	26523.24	14_2-414_3	+04
3y	3769.869	26518.62	15_3-419_2	+02
1	3770.608	26513.42	18_1-445_2	−01
2z	3772.430	26500.62	20_2-474_2	−01
4Efz	3773.707	26491.65	13_2-402_3	+07
2	3775.447	26479.44	16_4-429_4; 18_2-445_2	+04 00
2z	3778.684	26456.76	$18'_2-447_1$	+08
1	3779.971	26447.75	18_3-454_2	−01
5EfK3z	3780.770	26442.16	S_3-293_2	+05
2	3781.836	26434.70	16_4-428_5	+07
3z	3783.731	26421.47	19_4-456_3	+03
E	3785.05	26412.26	15_3-418_4	+35
2z	3786.375	26403.02	17_6-434_7	+04
E	3790.98	26370.96	13_3-397_4	−41
4z	3792.768	26358.52	13_3-397_2	+03
E	3793.31	26354.77	20_2-473_2; 23_3-502_4	+08 +27
3z	3794.349	26347.53	15_5-414_6	+04
2z	3796.290	26334.06	19_5-458_4	+06
E	3796.92	26329.72	13_1-396_1; 18_2-444_3	+25 −40
2	3798.926	26315.79	$18'_2-445_2$	00
2z	3801.527	26297.78	13_3-396_3; 19_2-455_3	−04 +05
3z	3801.925	26295.03	19_4-455_3; 22_5-491_4	−07 −10
1	3802.938	26288.03	18_3-452_4	00
E	3803.45	26284.46	17_3-439_4; 18_1-443_2	+26 −15
E	3804.98	26273.89	15_3-417_2; 17_3-439_2	−18 −15
E	3805.48	26270.44	18_1-443_1	−14
E	3807.65	26255.47	23_3-501_3	−14
5Z	3809.239	26244.55	S_3-291_2	−02
E	3809.90	26239.97	19_3-460_3	−33
3z	3810.395	26236.58	18_2-443_1	−01
4z	3810.804	26233.77	13_2-400_2	+04
E	3815.76	26199.68	22_4-486_4	+15
1z	3816.393	26195.35	19_4-454_5	−01
6Z	3817.489	26187.83	S_3-291_3	00
2Az	3820.115	26169.82	16_4-426_3	00
1	3824.148	26142.23	18_3-451_4	+01
2uz	3824.392	26140.57	19_6-457_5	−06
2z	3826.198	26128.22	14_2-411_2; 15_5-411_4	−07 +11
E	3826.90	26123.44	15_3-415	+28
E	3827.33	26120.50	19_2-453_1	+02
3 =	3829.133	26108.20	D_1-277_1	+01
2	3830.723	26097.36	12_4-382_4	−02
Eu	3830.98	26095.62	261_3-52_{23}	+02
E	3832.26	26086.91	$18'_2-443_2$	−06
E	3832.85	26082.90	16_4-425_3	+06
1	3834.047	26074.74	19_3-459_2	−04
5EfZ	3835.058	26067.86	D_2-293_2	−02
2	3836.966	26054.90	262_2-52_{23}	−13
4Efz	3838.514	26044.39	12_4-382_3; 18_3-450_2	+03 −15
ET	3839.257	26039.35	15_3-414_3	−02
2Ef	3842.307	26018.68	D_4-322_3	−02
5EfZ	3846.225	25992.17	D_1-276_2	00
3EfK1?Z	3847.501	25983.56	D_0-259_1	−01
1	3852.834	25947.59	14_2-409_3	−01
3z	3855.548	25929.33	13_2-397_2	+02
1	3857.293	25917.60	263_2-52_{23}	+11
3z	3859.298	25904.14	18_2-440_3	−01
2	3861.060	25892.31	14_2-408_2; 18_1-439_2	+17 −05
2	3861.240	25891.11	12_4-380_3	+09
1	3863.475	25876.13	13_1-391_1	+05
3 =	3864.335	25870.37	D_2-291_2	+03
1	3865.324	25863.75	20_1-462_2	−04
2	3866.054	25858.86	13_2-396_1; $(23_3-497_4$	+01 +33)
E	3867.38	25850.01	19_3-456_3; 22_4-483_3	+02 +26
5EfK4?Z	3867.986	25845.95	S_3-287_4	+01
2	3868.579	25841.99	15_5-409_5	+01
E	3869.05	25838.86	12_4-380_4	−28
4z	3872.835	25813.59	D_2-291_3; 17_3-453_2	−01 +08
2z	3874.414	25803.08	19_6-454_5; $328_4-?58_5$	−02 +29
2z	3875.691	25794.57	14_2-407_1	−01
E	3878.51	25775.85	18_2-438_1	+08
1	3880.081	25765.39	19_2-450_2	−04
E	3880.74	25760.98	19_2-450_3	+03
ET	3881.141	25758.34	19_4-450_3	+02
5EfK?z	3881.402	25756.62	D_3-305_3	00
1	3883.837	25740.47	$18'_2-440_3$	−03
2z	3886.451	25723.16	13_1-390_2	+02
E	3888.89	25707.02	$18_1-?437_0$	−14
1z	3890.750	25694.73	$18'_2-439_2$	+01
E	3891.26	25691.35	239_2-49_3	−02
1z	3892.338	25684.25	19_4-449_4	00
3z	3892.729	25681.68	13_3-390_2	−02
1	3893.478	25676.73	20_1-461_1	00
1z	3901.835	25621.74	18_3-445_2	−05
1y	3903.301	25612.12	$18'_2-438_1$	00
1z	3903.987	25607.62	297_5-55_5	+02
2z	3905.980	25594.55	19_3-454_2	−02
Eu	3911.30	25559.76	297_5-55_4	00
1z	3912.824	25549.79	17_3-432_4	−02
E	3916.39	25526.55	17_3-432_2	+07
2z	3918.603	25512.10	12_4-376_3	+02
1A =	3922.339	25487.80	23_3-494_3	−03
2	3924.377	25474.57	20_1-459_2	−06
2 =	3924.699	25472.48	18_3-444_3	+01
2z	3926.040	25463.78	15_3-409_3	+01
Ez	3930.21	25436.75	$19'_5-452_4$	+26
2z	3930.485	25434.98	14_2-404_1; 19_3-452_4	+10 +14
2z	3930.976	25431.80	18_1-435_2	−03
E	3934.59	25408.44	15_3-408_2	+13
3z	3935.048	25405.49	13_2-391_1; 19_5-449_4	+03 +02
2z	3936.239	25397.80	18_2-435_2	−04
3Ef	3936.993	25392.93	18_3-443_2	−04
2z	3937.637	25388.78	19_5-449_6	00
E	3939.93	25374.01	22_4-478_5	−10
2z	3941.837	25361.73	18_2-434_3	−04
1z	3944.803	25342.66	19_2-445_2	−02
E	3945.18	25340.26	23_3-492_2	+11
1	3946.313	25332.96	17_3-430_4	+03
3z	3947.991	25322.20	19_6-449_7	−04
E	3950.10	25308.70	20_2-462_2	+16
3z	3952.529	25293.13	14_2-402_3	+01
2z	3952.909	25290.70	19_4-445_5; $19'_5-451_4$	+23 +02
3z	3953.166	25289.05	19_3-451_4	+02
1	3953.720	25285.51	22_5-481_5	00

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
4 =	3955.317	25275.30	19_6-449_6	00
3z	3958.884	25252.53	13_2-390_2	+01
E	3961.75	25234.24	$18'_2-435_2$	+05
E	3963.70	25221.83	23_3-491_2	+06
2	3965.003	25213.56	D_4-344_4	+01
3*Ef* =	3965.150	25212.62	22_4-476_4	−02
1	3968.173	25193.42	19_2-444_3	+06
2z	3968.594	25190.74	19_4-444_3	+01
E =	3969.18	25187.01	19_3-450_3	+14
E	3972.83	25163.88	15_5-402_4	−09
E	3973.30	25160.90	200_1-45_0	−02
3z	3975.470	25147.17	12_4-373_5	00
1z	3975.897	25144.47	17_4-422_3; (18_1-432_2	+03 −37)
1	3976.289	25141.99	23_3-490_3	−03
2z	3979.293	25123.01	$13_1-?384_1$; 15_3-405_4	+28 +04
E	3980.32	25116.54	22_4-475_3	−18
3z	3980.649	25114.45	$19'_5-449_4$	00
Ez	3981.28	25110.49	18_2-432_2	−32
1	3982.876	25100.41	18_2-432_1	−03
2z	3982.969	25099.83	19_2-443_1	00
3*EfK*1?z	3983.294	25097.77	$19'_5-449_6$	+01
1z	3988.017	25068.05	16_4-414_3	−02
2z	3991.232	25047.86	214_2-46_3	+02
1z	3993.913	25031.05	230_3-48_2	−09
2z	3997.142	25010.83	18_3-439_4	−05
Ez	3997.35	25009.50	214_2-46_1	−04
Ez	3997.77	25006.88	22_4-474_3	−17
2 =	3998.165	25004.43	214_1-46_1	+03
2z	3998.762	25000.70	18_3-439_2	−02
E	3999.19	24998.00	22_5-478_5	+06
3z	4001.379	24984.34	12_4-371_4	+01
3*Z*	4005.408	24959.21	D_1-266_0	−03
8*GK*10*Z*	4008.769	24938.30	S_3-278_4	+01
2z	4010.384	24928.25	230_3-47_4	−01
E	4011.81	24919.38	20_2-459_2	00
Ez	4013.20	24910.75	13_3-382_4	−06
1	4014.943	24899.95	17_3-426_3	−01
4*Efz*	4015.229	24898.17	19_6-445_5	−04
1	4016.114	24892.68	274_4-49_3	+03
E	4017.34	24885.10	22_4-473_3; 28_5-531_4	+06 +22
4*Z*	4019.238	24873.34	D_2-281_1	00
3	4022.123	24855.50	19_5-443_6; 200_1-44_2	+17 +02
ET	4025.19	24836.56	22_5-476_4	+09
3*Z*	4028.798	24814.32	09_0-343_1	−04
1 =	4029.030	24812.88	17_3-425_3	−10
1	4029.615	24809.28	15_3-402_3	−01
E	4031.66	24796.67	274_3-52_{23}	+01
2z	4035.368	24773.91	15_3-402_4	00
3z	4036.870	24764.70	19_4-440_3; 17_4-418_4	−06 −20
2z	4039.869	24746.32	18_3-437_4; 23_3-486_4; 305_3-55_4	−06 +21 −10
2 =	4040.600	24741.84	19_6-443_6	−01
1z	4042.402	24730.81	14_2-397_2	−04
1z	4043.909	24721.60	19_2-439_2	−01
5*K*1?*Z*	4045.615	24711.16	S_3-276_2	−01
2 =	4046.716	24704.44	13_3-380_3	−01
2	4047.948	24696.93	D_1-263_2	−02
1	4048.266	24694.98	20_2-456_3	+39
E	4052.35	24670.10	14_2-396_3	−08
3z	4053.948	24660.37	14_2-396_1	−02
1z	4055.243	24652.50	13_3-380_4; $13_2-?384_1$	−07 +39
E	4055.64	24650.09	15_5-397_4	+15
Ez	4057.45	24639.10	19_2-438_1	+09
2 =	4060.716	24619.27	19_3-444_3	−01
3z	4064.799	24594.55	19_4-438_3	00
E	4065.35	24591.23	20_1-450_2; 247_4-49_5	+03 −05
1z	4066.005	24587.25	17_4-416_3	−02
E	4069.17	24568.15	20_2-455_3	−10
2z	4069.804	24564.30	$19'_5-443_6$	−01
4	4070.618	24559.38	D_1-262_2	−03
2	4071.939	24551.42	15_3-400_2	−02
2z	4073.161	24544.05	15_5-396_5	+01
E	4073.88	24539.70	19_3-443_2	−08
6*Eρ′K*5 =	4074.374	24536.75	S_3-274_3	−03
1	4079.794	24504.16	18_3-434_3	+05
E	4082.07	24490.48	18_1-425_1	−04
4z	4082.972	24485.09	19_4-437_5	−02
1z	4083.722	24480.58	16_4-409_5	−04
4z	4088.340	24452.94	D_2-277_1	−02
2z	4088.778	24450.32	19_5-439_4	−04
2z	4089.392	24446.64	266_5-51_4	−03
2	4090.646	24439.14	20_2-454_2	−03
2	4092.398	24428.68	13_2-382_3	+07
3z	4095.710	24408.93	17_6-414_6	−02
2z	4097.673	24397.07	18_2-425_3	−24
E	4098.52	24392.21	17_4-414_3	−15
2z	4099.029	24389.22	19_5-439_5	+05
1	4101.855	24378.30	22_4-468_5	+19
5*Eρ′fK*1?z	4102.713	24367.27	D_4-305_3	−04
E	4107.83	24336.94	D_2-276_2	00
2z	4108.538	24332.73	18_2-424_2	00
4 =	4109.758	24325.50	13_3-376_3	−01
2z	4110.573	24320.67	$18'_2-426_3$	+03
4*Z*	4111.819	24313.31	D_1-259_1	+01
1*u*	4112.487	24309.36	D_3-291_3; 20_1-447_1	+25 00
2z	4115.588	24291.04	15_5-393_5	00
3z	4118.060	24276.46	18_3-432_4	−03
2z	4118.189	24275.69	(13_2-380_3; 19_6-439_5	+42) 00
2z	4120.863	24259.94	15_3-397_4	+04
1z	4122.025	24253.11	18_3-432_2	−05
1z	4123.064	24247.00	15_3-397_2	−02
3z	4126.808	24225.00	19_2-434_3	00
Ez	4130.05	24205.98	19_5-437_5	? −35
1*y* =	4132.216	24193.29	19_3-440_3	−02
1*Ldy* =	4133.492	24185.82	19_5-437_4	−04
Ez	4136.38	24168.95	$18'_2-424_2$	−13
5*Efz*	4137.475	24162.55	D_2-274_3	00
2z	4138.030	24159.31	13_1-374_2; 19_5-439_4	+14 −03
2	4138.308	24157.68	19_3-439_4	−01
1 =	4139.325	24151.75	16_4-405_4	+07
1z	4140.044	24147.55	19_3-439_2	+02
1*uz*	4140.410	24145.41	18_2-422_1	−02
2z	4142.261	24134.63	18_2-422_3	+01
2z	4145.168	24117.71	13_3-374_2	−02
2z	4145.953	24113.14	12_4-362_5	+02
1z	4149.445	24092.84	19_6-437_5	−01
1*y*	4149.749	24091.08	17_4-411_4	+04
E	4152.60	24074.51	19_4-433_5	−08
2*Z*	4154.678	24062.51	193_0-43_1	00
1	4159.793	24032.91	17_3-417_2	00
1z	4160.039	24031.49	20_2-450_3	+02
1z	4160.353	24029.67	22_4-465_5	−03
E	4161.52	24022.99	19_3-438_3	−11
E	4165.18	24001.82	22_5-468_5	−12
2	4166.151	23996.23	13_2-377_1	00
2*Ef*	4168.664	23981.78	$18'_2-422_1$	00
E	4170.04	23973.86	19_2-432_2	−19
3z	4170.538	23970.99	$18'_2-422_3$	+02
5z	4171.189	23967.25	D_3-287_4	+03
E	4171.83	23963.58	19_2-432_1	−10
E	4176.03	23939.48	20_1-443_2	−15
E	4176.64	23935.98	18_3-429_4	−24
1	4177.835	23929.13	$19_4-?431_4$	−16
1 =	4180.245	23915.33	$19'_5-437_5$	+02
E	4181.39	23908.80	22_4-463_3	+01
E	4182.34	23903.37	17_6-409_5	−07
E	4182.88	23900.29	314_4-55_4	+13
1z	4183.674	23895.72	18_1-419_2	−04
2z	4183.834	23894.81	19_5-437_4	−03

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
1*uz*	4186.016	23882.36	17_3-415_2	? +36
E	4193.82	23837.90	16_4-402_3	−09
E	4197.56	23816.67	17_4-409_3	−09
2*y* =	4199.631	23804.94	17_4-409_5	+03
2	4200.031	23802.66	16_4-402_4	+05
E	4200.90	23797.73	13_3-371_4	−03
2*z*	4203.825	23781.19	12_4-359_3	−02
3*z*	4204.415	23777.85	19_4-430_4	−02
1*u*	4205.560	23771.38	214_1-45_0	00
3*z*	4207.056	23762.93	19_6-434_7	−05
2*Ef*	4215.387	23715.96	19_5-432_4	−01
2	4218.561	23698.13	$18'_2-419_2$	+01
5*z*	4219.383	23693.51	D_4-299_3	+01
E	4220.29	23688.43	13_2-374_2	−12
E	4220.55	23686.97	19_3-435_2	−03
3*z*	4222.061	23678.48	15_5-387_4	−01
2	4224.768	23663.30	23_3-475_3	00
1	4226.348	23654.45	19_4-429_4	−03
1	4226.922	23651.24	18_1-417_2; $(19_3-434_3$	−02 +32)
E	4231.34	23626.53	18_3-426_3	−11
E	4231.97	23623.01	28_5-518_4	+36
1*z*	4233.006	23617.24	18_2-417_2	00
2*z*	4234.358	23609.71	19_4-428_5	00
E	4236.60	23597.21	13_1-369_2	+19
2*z*	4240.150	23577.46	18_2-416_3	+01
3*z*	4241.451	23570.22	15_3-390_2	−01
4*K*1?*z*	4244.374	23554.00	D_4-297_5; $(23_3-474_3$	+03 +37)
E	4245.54	23547.53	20_1-439_2	+15
2	4249.464	23525.78	13_3-368_3	00
E	4250.85	23518.12	21_0-453_1	+35
E	4253.24	23504.91	$19'_5-433_5$	+12
2*z*	4254.066	23500.33	18_1-415_2	+01
1*uz*	4254.29	23499.11	19_5-430_4	+02
E	4254.64	23497.17	17_3-411_4	+28
1*z*	4258.532	23475.69	17_4-405_4	−27
5 =	4259.362	23471.11	214_2-44_2	−03
1	4259.942	23467.92	17_6-404_5	+03
3*z*	4260.299	23465.95	$(18_2-415_2$; 214_1-44_2	−38) +01
5 =	4263.318	23449.33	230_3-46_3	+02
3	4266.547	23431.59	23_3-473_3	−03
E	4267.77	23424.86	$19'_5-432_4$	−09
1*u*	4268.054	23423.31	19_3-432_4	+01
5*Ef*K2*Z*	4269.399	23415.94	S_3-263_2	−01
3	4269.784	23413.83	$18'_2-416_3$	+03
1*u*	4270.910	23407.65	23_3-473_2	−04
1	4272.314	23399.95	19_3-432_2	−02
2 =	4273.694	23392.40	22_4-458_4	+05
3*EfZ*	4274.554	23387.69	200_1-43_1	+06
1*u*	4275.153	23384.41	20_2-443_2	+03
3*z*	4275.497	23382.54	18_2-414_3	00
2*z*	4276.752	23375.67	19_5-429_4	−03
E	4277.89	23369.46	17_4-404_5	+10
1*z*	4278.416	23366.58	13_1-366_2	00
Ez	4282.41	23344.80	19_4-426_3	−10
2*z*	4283.813	23337.15	12_4-354_3	+01
3*z*	4286.021	23325.13	13_3-366_2	−01
E	4287.00	23319.81	19_2-425_1	+04
1*y*?	4290.152	23302.66	$18'_2-415_2$	−02
1	4292.743	23288.60	15_3-387_4; 16_4-397_4; 263_2-49_3	−17 00 −13
6*rGK*15*z*	4294.623	23278.41	S_3-262_2	00
1	4298.420	23257.85	19_4-425_3	−07
6*GK*4*Z*	4302.123	23237.83	S_3-261_3	−01
E	4303.49	23230.42	14_2-382_3	+27
Eu	4304.92	23222.71	17_3-409_3	+10
1	4305.634	23218.88	$18'_2-414_3$	−01
E	4306.36	23214.94	16_4-396_3	−11
1 =	4306.886	23212.13	247_4-47_4	−02
4*z*	4307.645	23208.01	$19'_5-430_4$	−06
2*z*	4308.963	23200.94	22_4-456_3	−07
E	4309.89	23195.94	19_2-424_2	−03
T	4311.10	23189.44	15_5-382_4	+04
2	4312.354	23182.70	16_4-396_5	+02
1	4318.587	23149.24	23_3-470_2	−05
1	4322.754	23126.92	17_4-402_4	+02
E	4328.44	23096.55	13_2-368_3	−05
E	4330.34	23086.41	20_1-435_2	? −44
3*z*	4330.670	23084.65	$19'_5-429_4$	−03
3*z*	4330.979	23083.00	19_3-429_4	−03
3*z*	4332.140	23076.81	14_2-380_3	00
T	4335.357	23059.69	D_3-278_4	+12
L	4338.230	23044.42	$18_1-?411_0$	−02
1	4339.080	23039.91	$19'_5-428_3$	00
2*z*	4339.463	23037.88	20_2-440_3	? +47
E	4343.53	23016.29	22_5-458_4	+11
1	4344.977	23008.64	19_2-422_1	−03
3*z*	4345.846	23004.03	18_3-419_2	−09
1	4346.294	23001.67	23_3-469_4	−07
3*z*	4347.014	22997.85	19_2-422_3	−01
2*z*	4347.517	22995.19	19_4-422_3	−04
2*Efz*	4348.129	22991.96	20_2-439_2	−17
E	4348.95	22987.61	18_2-411_2	−02
2	4353.304	22964.62	17_3-406_3	−06
3 =	4355.179	22954.74	12_4-351_4	−03
3*z*	4361.822	22919.78	D_4-291_3	−02
4*z*	4364.795	22904.17	D_2-262_2	−01
3*z*	4366.080	22897.43	18_3-418_4	00
1*Eu*	4366.359	22895.96	13_2-366_3	00
1	4368.773	22883.33	13_1-361_1	00
1	4371.738	22867.74	20_2-438_3	+04
3*z*	4372.539	22863.60	D_2-261_3	−01
3	4378.501	22832.42	D_3-276_2	−03
1	4380.130	22823.98	$18'_2-411_2$	00
3*z*	4384.868	22799.33	15_3-382_4	−01
2	4386.780	22789.39	20_1-432_1	−06
E	4387.47	22785.79	18_1-408_2; 22_4-452_4	+32 −07
3	4389.851	22773.45	19_3-426_3	00
2*z*	4394.092	22751.47	18_2-408_2	−01
2	4395.089	22746.30	15_3-382_3	−02
E	4397.55	22733.57	13_3-360_4	−13
E	4399.28	22724.64	19_2-419_2	? −37
1*Ef*	4400.222	22719.76	18_3-416_3	−04
E	4404.48	22697.82	14_2-376_3	−05
E	4405.06	22694.83	23_3-466_4	−13
1	4406.404	22687.89	18_1-407_1	−01
E	4406.72	22686.29	19_3-425_3	−18
3 =	4408.285	22678.22	266_5-49_5	+05
1	4408.720	22675.97	28_5-509_4	−02
E	4411.73	22660.53	28_5-508_4	−11
4*Ef*	4412.206	22658.06	D_2-259_1; D_3-274_3	−01 00
1	4413.020	22653.88	18_2-407_1	−03
Ez	4415.10	22643.19	$18'_2-409_3$	−10
2	4415.719	22640.03	22_4-451_4	−02
2*Z*	4418.458	22626.00	$20_1-?430_0$	00
1	4419.264	22621.88	19_3-424_2	−01
3 =	4420.474	22615.68	19_4-418_4	−01
2*z*	4421.015	22612.91	17_4-397_4	+02
2*z*	4421.852	22608.63	18_3-415_2	−05
E	4422.51	22605.26	17_6-396_5	−24
2*z*	4423.785	22598.76	22_5-454_5	00
1	4424.914	22592.98	15_3-380_3	00
Eu	4433.63	22548.57	18_2-406_3	? −44
E	4435.43	22539.42	17_4-396_3	+08
1	4435.745	22537.83	22_4-450_3	−06
3*z*	4436.912	22531.89	20_2-435_2; 239_2-46_3	+29 −03
2*z*	4438.300	22524.85	18_3-414_3; $(313_1-53_1$	−04 +46)
2*z*	4441.820	22507.00	17_4-396_5	+03
E	4444.05	22495.72	20_2-434_3	+20
E	4444.45	22493.70	239_2-46_1	+08
2 =	4445.161	22490.08	14_2-374_2; $18'_2-407_1$	−01 −18
3*z*	4449.018	22470.59	12_4-346_4	−04

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
2	4450.361	22463.80	22_4-449_4	−02
E	4452.06	22455.21	23_3-463_3	−16
2*z*	4455.471	22438.04	19_4-416_3	−02
2	4458.100	22424.81	13_1-357_2	−02
2*z*	4458.304	22423.79	19_3-422_3	+01
3*Z*	4460.507	22412.71	13_2-361_1	00
2*z*	4463.507	22397.64	23_3-463_2	00
3	4466.357	22383.35	13_3-357_2	−04
Eu	4470.79	22361.16	23_3-462_2	−38
Eu	4471.85	22355.86	$362_5-?58_5$	+04
1	4472.528	22352.47	17_6-393_5	−03
E	4475.60	22337.13	19_5-418_4	+22
Eu	4477.13	22329.50	19_2-415_2	−07
Eu	4477.36	22328.36	18_1-404_1	+15
Ef	4477.83	22326.01	287_4-51_4	+14
E	4479.58	22317.29	16_4-387_4	+16
E	4480.99	22310.27	17_3-400_2	−01
6*LdK*2*Z*	4484.197	22294.31	D_1-239_2; 18_2-404_1	00 +09
Eu	4490.33	22263.88	22_5-451_4	00
1*z*	4492.334	22253.93	17_4-393_5	−04
2*z*	4493.978	22245.78	19_2-414_3	00
2*z*	4494.518	22243.11	19_4-414_3	−04
3	4495.315	22239.17	15_5-373_5	−02
E	4496.27	22233.93	20_2-432_1	−27
E	4497.69	22227.41	$15_5-?372_6$	−2
2	4498.474	22223.54	18_3-411_4	−03
3*z*	4504.865	22192.02	12_4-343_3	−01
Eu	4510.33	22165.14	13_2-359_3	−32
3*z*	4512.913	22152.45	18_2-402_3	−01
2 =	4513.305	22150.53	13_3-354_3	−04
1	4514.320	22145.54	20_1-425_1	00
1	4515.890	22137.84	23_3-460_3	−06
2	4517.375	22130.57	$18'_2-404_1$	00
2	4529.777	22069.98	22_4-445_5	−06
2	4530.479	22066.56	12_4-342_3	−02
2*z*	4534.726	22045.90	$19'_5-418_4$	+01
3*z*	4535.065	22044.24	19_3-418_4	00
2*Z*	4536.668	22036.46	21_0-438_1	+2
E	4539.68	22021.83	20_1-424_2	+09
E	4540.29	22018.87	17_3-397_4	+13
2	4542.900	22006.23	15_3-374_2; $(17_3-397_2$	−03 +37
1	4543.290	22004.34	13_1-353_2	−03
3	4543.524	22003.20	214_2-43_1	−03
1	4544.585	21998.06	214_1-43_1	−03
3*z*	4546.498	21988.81	$18'_2-402_3$	00
1	4550.332	21970.28	22_4-444_3	−02
3*z*	4551.860	21962.91	13_3-353_2; 333_5-55_4	−02 −06
1	4552.540	21959.62	12_4-341_4	−02
1	4553.661	21954.23	13_2-357_2	+02
E	4554.68	21949.32	18_3-409_3	+03
Eu	4556.20	21942.00	19_4-411_4	+17
3*r*	4556.859	21938.81	23_3-458_4	−12
2	4558.984	21928.59	18_1-400_2	−01
2	4559.121	21927.93	14_2-369_2	−01
3*z*	4563.602	21906.39	19_3-417_2	−01
1*u*	4564.084	21904.09	28_5-501_5	−02
2	4565.325	21898.14	14_2-368_3	00
1	4566.229	21893.79	18_3-408_2	−04
E	4568.55	21882.66	19_5-414_6	+23
4*K*?*Z*	4570.665	21872.54	230_3-44_2	−01
1	4571.910	21866.59	19_3-416_3	−02
Eu	4579.95	21828.20	16_4-382_4	+16
3*Z*	4586.856	21795.34	09_0-313_1	−06
4*z*	4588.766	21786.27	261_3-47_4	−07
Eu	4591.22	21774.63	16_4-382_3	−39
2 =	4592.429	21768.89	19_6-414_6	−06
2	4592.584	21768.17	13_3-351_4	−03
4*z*	4599.972	21733.20	247_4-46_3	00
E	4608.83	21691.41	18_3-406_3	+05
3*z*	4609.928	21686.26	15_3-371_4	−03
4 =	4613.328	21670.27	D_4-278_4; 19_2-409_3	+01 +09
1	4614.869	21663.04	19_5-411_4	−01
E	4623.18	21624.10	18_1-397_2	−08
2	4623.696	21621.68	16_4-380_3	00
E	4624.47	21618.07	20_2-426_3	+02
E	4625.17	21614.80	19_2-408_2	+08
Eu	4630.17	21591.46	$19'_5-414_6$	+05
E	4630.42	21590.29	18_2-397_2; 20_2-425_1	+10 00
3*z*	4634.830	21569.75	16_4-380_4	−05
E	4637.92	21555.39	28_5-497_4	+20
1*u*	4640.318	21544.24	22_4-440_3	−09
1	4641.812	21537.30	D_3-263_2; 22_5-443_6	+07 −21
3 =	4642.579	21533.75	13_2-353_2	00
2	4643.169	21531.01	20_2-425_3	−06
2	4646.159	21517.15	19_2-407_1	00
Eu	4657.04	21466.88	20_2-424_2	+39
3	4657.450	21464.99	278_4-49_5	−03
6*Z*	4659.886	21453.77	D_0-214_1	−03
2	4661.248	21447.50	22_4-439_5	−02
3	4661.990	21444.09	15_3-369_2	−02
Ef	4665.80	21426.58	$18'_2-397_2$	+04
3	4668.480	21414.27	15_3-368_3	−04
E	4668.90	21412.36	13_1-347_1; 19_2-406_3	+13 +13
2	4671.663	21399.68	D_3-262_2	−01
3	4676.647	21376.87	19_5-409_5	−05
3*z*	4677.710	21372.02	$19'_5-411_4$	−01
2	4679.058	21365.87	$18'_2-396_3$	00
6*K*?*Z*	4680.539	21359.11	D_3-261_3	−01
1	4681.203	21356.07	$18'_2-396_1$	−01
E	4682.57	21349.82	297_5-51_4	+01
E	4686.37	21332.51	23_3-452_4	+07
E	4687.11	21329.15	17_3-390_2	+08
1	4687.654	21326.68	19_4-405_4	−09
Eu	4692.14	21306.29	20_1-417_2	+04
5*K*?*z*	4693.748	21298.99	266_5-47_4	−05
1	4694.677	21294.77	18_3-402_3	−04
2	4698.120	21279.17	20_2-422_1	−02
2	4698.647	21276.79	19_3-411_2	00
3*z*	4700.422	21268.75	D_4-274_3; 20_2-422_3	00 +37
E	4701.61	21263.39	19_6-409_5	−05
3	4702.486	21259.42	18_3-402_4; 341_4-55_5	−01 +15
2	4706.184	21242.72	16_4-376_3	−02
2	4711.199	21220.10	19_4-404_5	−05
3	4712.504	21214.23	14_2-361_1	−02
Eu	4713.43	21210.08	299_3-51_4	−20
E	4713.88	21208.06	12_4-333_5	−04
1	4714.528	21205.12	15_5-362_5	−02
2	4716.878	21194.55	17_6-382_6	00
2	4718.643	21186.62	23_3-451_4	−01
2	4720.409	21178.70	13_1-344_2	−04
3	4725.148	21157.46	19_2-404_1	00
E	4725.61	21155.38	09_0-306_1 20_1-415_2	−06 +04
1	4726.293	21152.33	17_4-382_4	00
4*y*	4729.664	21137.26	13_3-344_2	−04
Eu	4730.68	21132.71	22_5-439_4	+17
2	4738.173	21099.30	17_4-382_3	−01
E	4741.53	21084.37	23_3-450_3	−10
E	4745.58	21066.34	18_2-391_1	00
E	4749.88	21047.31	17_3-387_4	+04
1	4751.378	21040.66	19_3-408_2	+02
2	4752.222	21036.92	18_3-400_2	−04
2	4752.598	21035.26	13_1-343_1	−02
E	4757.02	21015.69	19_2-402_3	−01
4*K*1*z*	4757.565	21013.30	S_3-239_2; 19_4-402_3	−01 +23
3	4757.790	21012.30	15_5-360_4	−03
2	4758.225	21010.39	23_3-449_4	−01
Eu	4759.37	21005.31	13_3-343_6	−15
E	4760.21	21001.61	22_4-434_3	−33
Eu	4761.62	20995.39	20_2-419_2	−14

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
Eu	4765.65	20977.64	19_4-402_3	−05
E	4768.06	20967.04	14_2-359_3	+04
E	4770.76	20955.18	239_2-44_2	+02
E	4772.51	20947.49	18_1-390_2	+10
3	4773.911	20941.35	13_2-347_1; 19_5-404_5	+26; −02
Eu	4780.34	20913.19	18_2-390_2	−21
Eu	4785.99	20888.51	22_5-437_5	00
2	4787.943	20879.98	13_3-342_3	−03
2	4788.442	20877.80	16_4-373_5	−03
E	4792.82	20858.71	287_4-49_3	−03
Eu	4793.88	20854.10	22_4-433_5	−06
2	4797.548	20838.17	19_3-406_3	00
2	4807.369	20795.61	12_4-329_3	+01
E	4812.62	20772.92	13_3-341_4	−15
1	4816.108	20757.87	19_2-400_2	+02
E	4816.82	20754.81	$?285_6-49_5$	+04
E	4817.69	20751.06	20_2-417_2	+06
E	4818.34	20748.27	346_4-55_5	−01
Eu	4818.92	20745.77	18_3-397_4	+35
E	4826.99	20711.09	20_2-416_3	−12
T	4828.084	20706.38	331_2-53_1	−03
1	4835.031	20676.64	20_1-411_2	00
E	4837.52	20665.98	12_4-328_4; 23_3-445_2	−17; −22
6*K*8*Z*	4843.829	20639.08	D_2-239_2	00
E	4844.32	20636.98	13_1-339_2	+09
3	4854.095	20595.43	13_3-339_2	−02
E	4858.61	20576.30	13_2-343_3	+02
Eu	4863.01	20557.69	22_4-430_4; 287_4-49_5	+25; −24
E	4867.98	20536.66	305_3-51_4	+19
Eu	4872.81	20516.32	20_2-414_3; $(291_3-49_3$	+02; −53)
Eu	4875.40	20505.42	17_3-382_3	+26
E	4880.72	20483.07	15_3-359_3	−10
6*K*5?*z*	4886.922	20457.08	D_4-266_5	−03
2*u*	4888.386	20450.95	13_2-342_3	+12
1	4890.295	20442.97	16_4-368_3; 28_5-486_4	−04; +20
1	4890.892	20440.48	20_1-408_2	−01
2*Ef*	4892.442	20434.01	22_4-429_4	−04
T	4896.784	20415.88	276_2-48_2	−01
2*Ef*	4902.332	20392.78	19_2-396_3	+02
Ef	4902.97	20390.14	19_4-396_3	+01
1	4910.763	20357.77	19_4-396_5	+01
Eu	4912.18	20351.89	17_3-380_3	+07
E	4914.32	20343.02	20_1-407_1	+10
2	4916.193	20335.29	14_2-353_2	00
Eu	4922.92	20307.49	261_3-46_3	+10
EuT	4924.565	20300.71	17_6-373_5	+06
2	4931.561	20271.92	15_3-357_2	00
Eu	4932.77	20266.96	262_2-46_3	+14
Eu	4933.77	20262.85	293_2-49_3	+28
E	4948.57	20202.27	17_4-373_5	+15
Ef	4953.07	20183.92	19_3-400_2	+15
E	4961.55	20149.39	$18'_2-?384_1$	−13
T	4967.670	20124.56	22_4-426_3	+09
T	4968.424	20121.51	20_2-411_2	+12
Ef	4972.57	20104.75	19_4-393_5	−01
Eu	4976.33	20089.56	18_2-382_3	+07
E	4977.22	20085.97	278_4-47_4	+08
5*K*3*Z*	4982.613	20064.22	D_0-200_1	−04
E	4984.11	20058.17	22_5-429_4	+30
E	4984.72	20055.71	18_3-390_2	00
2*z*	4986.943	20046.79	15_5-351_4; 322_3-52_{23}	00; +08
E	4995.37	20012.97	22_5-428_5	−14
E	5002.82	19983.17	20_1-404_1	−06
6*K*?*z*	5006.169	19969.81	D_4-261_3	00
E	5007.22	19965.62	19_6-396_5	+12
E	5013.48	19940.70	20_2-409_3	00
E	5014.63	19936.12	18_2-380_3	−03
6*K*?*z*	5015.334	19933.31	D_3-247_4	00
E	5017.21	19925.84	$18'_2-382_3$	00
T	5019.511	19920.72	23_3-438_3	+02
T	5022.484	19904.93	28_5-481_5	+01
Eu	5025.32	19893.69	$19'_5-397_4$	−19
Eu	5025.67	19892.30	19_3-397_4	+07
T	5027.435	19885.33	20_2-408_2	+09
Eu	5028.97	19879.25	19_3-397_2; 281_1-48_2	−10; −24
2	5040.369	19834.31	13_1-331_2	00
Eu	5041.82	19828.60	266_0-46_1	−09
E	5044.32	19818.78	19_3-396_3	+10
E	5052.27	19787.60	20_2-407_1	−07
8*K*3*Z*	5053.300	19783.55	D_1-214_1	+02
5*K*?*z*	5054.615	19778.40	D_1-214_2	+01
1*Ef*	5055.528	19774.83	22_4-422_3	+03
T	5056.103	19772.58	$18'_2-380_3$	+08
E	5058.05	19764.96	17_3-374_2	−04
Eu	5063.65	19743.11	14_2-347_1; 299_3-49_3	−04; +01
T	5065.677	19735.21	28_5-479_4	+07
6*K*1?*z*	5069.148	19721.70	D_2-230_3	+01
Eu	5071.59	19712.20	19_6-393_5	−30
E	5077.02	19691.12	18_1-377_1	+02
T	5085.900	19656.74	15_3-351_4	+01
2	5105.489	19581.32	297_5-49_5	+01
E	5110.36	19562.66	15_5-346_4	+01
E	5111.77	19557.26	18_2-376_3	+05
E	5117.59	19535.03	$19'_5-393_5$	+07
2	5124.240	19509.67	14_2-344_2	+01
E	5128.53	19493.37	$18'_2-377_1$	−09
2	5130.123	19487.30	239_2-43_1	−01
1	5138.403	19455.90	28_5-476_4	+02
E	5141.28	19445.00	17_3-371_4	−13
2	5145.774	19428.40	20_2-404_1	? +42
E	5154.43	19395.41	22_4-418_4	+16
Eu	5154.88	19393.71	$18'_2-376_3$	+15
Eu	5162.1	19366.5	14_2-343_1	+3
Eu	5162.7	19364.2	13_2-331_2	+5
Eu	5177.78	19307.92	28_5-475_6	−16
3	5183.974	19284.87	18_3-382_4	+01
Eu	5188.89	19266.59	17_6-362_5	−01
3*z*	5192.725	19252.37	14_2-342_3	00
1*u*	5195.63	19241.61	259_1-45_0	00
3	5203.258	19213.39	19_5-387_4	−04
3	5204.516	19208.75	20_1-396_1	+01
3	5206.189	19202.58	19_3-390_2	+02
Eu	5212.35	19179.87	13_2-329_3	+02
2*Ef*	5212.804	19178.22	287_4-47_4	−02
E	5214.18	19173.14	17_3-368_3	−01
6*K*3*Z*	5224.680	19134.62	D_3-239_2	+03
3*z*	5242.989	19067.79	16_4-354_3	−01
Eu	5247.38	19051.83	15_5-341_4	+17
2	5255.409	19022.73	22_4-414_3	+01
2*z*	5259.356	19008.46	274_3-46_3	+01
E	5268.52	18975.40	17_4-360_4	+14
E	5269.28	18972.67	17_3-366_2	+16
E	5274.78	18952.89	19_2-382_3	+16
2	5275.555	18950.09	19_4-382_3	−03
E	5278.55	18939.35	291_3-48_2	+12
E	5283.29	18922.33	$19'_5-387_4$	−08
E	5285.51	18914.39	21_0-407_1	0
Eu	5317.8	18799.5	19_2-380_3	+1
2	5318.880	18795.73	276_2-46_1	−03
Eu	5329.8	18757.2	18_2-368_3	+3
1*u*	5337.360	18730.66	261_3-44_2	+03
Eu	5339.2	18724.2	19_5-382_4; 20_2-397_2	−1; +25
Eu	5339.9	18721.2	22_4-411_4	−2
2	5348.947	18690.08	262_2-44_2	+02
2	5350.440	18684.87	293_2-48_2	−08
1	5351.903	18679.76	277_1-46_1	+02
1*Z*	5354.463	18670.83	09_0-281_1; 23_3-426_3	00; −22
E	5355.24	18668.14	19_5-382_6	+09
E	5356.69	18663.40	20_2-396_3	+12
2*u*	5357.120	18661.57	15_3-341_4	−03

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
E	5368.60	18621.66	28_5-468_5	+31
E	5372.85	18606.93	278_4-46_3	−01
3	5374.163	18602.39	20_1-390_2	−02
Eu	5379.40	18584.29	23_3-425_3	+22
2*z*	5388.023	18554.54	19_6-382_6	−01
E	5388.60	18552.57	263_2-44_2	+05
1	5391.088	18543.99	D_4-247_4	−01
1	5397.970	18520.35	19_2-377_1	00
E	5398.27	18519.30	23_3-424_2	−19
E	5400.96	18510.09	13_1-318_2	? −43
E	5406.35	18491.64	18_3-374_2	−18
E	5408.59	18483.98	15_3-339_2	00
Eu	5413.04	18468.79	13_3-318_2	−29
E	5413.89	18465.89	19_5-380_4	−21
E	5415.59	18460.09	13_2-322_3	−20
2	5419.400	18447.12	22_4-409_3	00
1*u*	5422.88	18435.29	22_4-409_5	+02
E	5423.48	18433.25	$19'_5-382_4$	−07
1	5423.935	18431.69	19_3-382_4	+02
E	5427.25	18420.45	19_2-376_3	00
Eu	5428.04	18417.76	19_4-376_3	−06
3*z*	5435.063	18393.96	D_1-200_1	−03
Eu	5435.64	18391.99	{ 17_4-354_3; (28_5-466_4	−10; +37)
E	5438.89	18381.00	17_3-360_4	−11
E	5439.59	18378.64	19_3-382_3	−01
Eu	5451.82	18337.42	$19'_5-382_6$	00
2	5456.593	18321.37	23_3-422_3	−01
Eu	5464.5	18294.9	328_4-51_4	−1
E	5475.09	18259.47	281_1-46_1	+11
5*Z*	5477.802	18250.45	09_0-277_1	00
1	5486.018	18223.10	314_4-49_3	+02
2*z*	5487.786	18217.24	D_3-230_3	+04
T	5489.134	18212.76	19_2-374_2	+09
6*K*?*z*	5492.331	18202.16	297_5-47_4	−02
Euf	5492.54	18201.47	16_4-346_4	+18
1	5496.245	18189.19	22_4-406_3	00
2	5500.62	18174.75 +.31	$19'_5-380_4$	−33
2	5503.53	18165.13 +.27	{ 14_2-331_2; (299_3-48_2; (329_3-51_4	−10; −40); −39)
7*K*?	5514.77	18128.09 +.20	D_2-214_1	−21
T	5521.008	18107.62 +.04	18_1-361_1	+04
Eu	5528.05	18084.56	13_3-314_4	+23
Ou	5528.5	18083.1	372_6-55_5	−3
1	5531.54	18073.15 +.43	18_2-361_1	−44
1	5537.80	18052.72 +.20	19_4-373_5	−19
Eu	5546.5	18024.4	373_5-55_4	+5
Eu	5548.9	18016.6	13_1-313_1	+3
Eu	5551.0	18009.8	17_4-351_4	+1
Eu	5553.2	18002.6	$20_1-?384_1$	+6
E	5554.08	17999.80	22_4-404_5	+08
E	5559.78	17981.34	14_2-329_3	−05
E	5571.98	17941.97	23_3-418_4	+13
Eu	5575.85	17929.52	18_3-369_2	−11
Eu	5578.28	17921.71	314_4-49_5	00
Eu	5588.13	17890.12	19_4-371_4	+05
Eu	5601.8	17846.5	19_3-376_3	+1
1*z*	5604.32	17838.45	318_2-49_3	+11
1	5608.07	17826.52	18_2-359_3	+18
Eu	5615.16	17804.00	23_3-417_2	00
Ez	5617.03	17798.07	17_3-354_3	+13
2*Bu*	5617.33	17797.11	16_4-342_3	−13
E	5618.69	17792.81	22_4-402_3	+17
1−*T*	5629.647	17758.19	15_5-328_4	+02
Eu	5629.93	17757.37	22_4-402_4	+11
1*Bu*	5631.30	17752.97 +.03	333_5-51_4	−05
2*K*?	5631.94	17750.95 −.09	12_4-299_3	+11
2	5642.12	17718.93 +.25	D_1-193_0	−18
4*z*	5648.42	17699.18 +.09	{ 18_3-366_2; 287_4-46_3	−01; −11
Eu	5651.25	17690.30	16_4-341_4	00
E	5654.12	17681.32	15_3-331_2	−08
E	5660.110	17662.70	$18'_2-359_3$	+01
2	5660.67	17660.86 −.25	19_6-373_5	+21
E	5663.30	17652.66	23_3-415_2	−43
Eu	5664.0	17650.5	19_2-369_2	0
2*Bu*	5664.40	17649.23 +.19	{ 18_1-357_2; $19_6-?372_6$	+11; +2
1	5673.41	17621.21 −.47	19_2-368_3	+49
2	5674.45	17617.98 +.10	19_4-368_3	−11
1	5675.38	17615.09 +.01	18_2-357_2	00
*B*2	5676.608	17611.28	{ 12_4-297_5; 19_5-371_4	−03; −01
*B*2	5676.924	17610.30	17_2-353_2	00
Eu	5690.13	17569.43	23_3-414_3	+13
Eu	5694.55	17555.79	28_5-457_5	+09
2	5697.86	17545.59 .14	13_2-313_1	−11
E	5704.38	17525.54	17_4-346_4	−04
1*Eu*	5715.35	17491.91	305_3-48_2	+19
Eu	5722.0	17471.6	$19'_5-?372_6$	+1
2*Bu*	5723.19	17467.95 +.37	259_1+43_1	−37
1	5728.60	17451.46	$18'_2-357_2$	+02
4*z*	5735.11	17431.62 +.05	274_3-44_2	−07
2*Eu*	5739.59	17418.02	322_3-49_3	+07
2*Bu*	5747.26	17394.78 −.03	306_1-48_2	−10
2	5749.22	17388.86 −.05	305_3-47_4	+02
1*Eu*	5753.41	17376.19	13_1-306_1	−17
2*Bu*	5756.16	17367.89 +.24	15_3-328_4	−22
2*Bu*	5759.66	17357.34 +.03	291_3-46_3	−06
1−*T*	5771.988	17320.26	$19'_5-371_4$	−01
1*Eu*	5791.36	17262.33	291_2-46_1	−03
2	5793.02	17257.39 −.07	276_2-44_2	+09
2	5796.54	17246.91 +.12	17_4-343_3	−07
1	5799.53	17238.02	13_3-305_3	−06
4	5804.86	17222.17 +.05	262_2-43_1	00
Eu	5806.10	17218.50	$18'_2-354_3$	−12
2*Eu*	5806.25	17218.05	28_5-454_5	−12
Eu	5814.2	17194.5	18_2-353_2	−13
E	5821.03	17174.34	{ 23_3-411_2; 366_2-53_1	−05; +22
2	5822.60	17169.71 +.04	22_4-396_3	+01
1	5832.32	17141.10	277_1-44_2	−18
2	5833.62	17137.28 +.13	22_4-396_5	−05
2	5838.99	17121.53 +.09	{ 17_4-342_3; 382_4-55_5	00; 00
2	5845.28	17103.08 +.08	293_2-46_3	−04
2	5851.59	17084.64 +.08	263_2-43_1	−03
1	5854.45	17076.30	19_3-369_2	−14
1	5856.64	17069.92 +.09	20_2-380_3	+01
2	5864.64	17046.64 +.05	19_3-368_3	00
1*Eu*	5869.91	17031.33	$18'_2-353_2$	+35
1*Eu*	5871.58	17026.49	281_1-45_0	+15
1*Eu*?	5874.24	17018.79	19_4-362_5	−07
1*Eu*	5875.68	17014.62	17_4-341_4	+03
2	5880.21	17001.48 −.02	341_4-51_4	00
2*Bu*	5891.59	16968.65 −.10	18_3-359_3	−04
E	5901.99	16938.76	16_4-333_5	00
2	5902.66	16936.84 −.03	19_2-361_1	+01
1−*Eu*	5904.5	16931.6	17_3-346_4	+2
1	5913.51	16905.74	13_2-306_1	00
Eu	5917.33	16894.84	342_3-51_4	+30
Eu	5921.03	16884.28	22_4-393_5	−05
Eu	5921.28	16883.58	28_5-451_4	+29
Eu	5927.03	16867.20	22_5-397_4	+12
1	5934.49	16846.00	19_3-366_2	00
1*Eu*	5940.90	16827.82	{ D_4-230_3; 328_4-49_3	−07; −02
Eu	5942.7	16822.7	266_0-43_1	+3
4	5947.56	16808.98 −.07	13_2-305_3	+08
1	5953.97	16790.86	20_2-377_1	−01
2	5956.18	16784.64 .00	17_3-344_2	−03
Eu	5958.6	16777.8	15_3-322_3	−2
1*Ef*	5964.53	16761.15	22_5-396_5	−01
4	5965.88	16757.36 +.06	18_3-357_2	−08
2	5972.46	16738.89 −.15	D_2-200_1	+13
Eu	5973.5	16736.0	23_3-406_3	+2
2	5978.91	16720.84 +.08	281_1-44_2	−06
2*Bu*	5983.84	16707.07 +.03	28_5-449_4	+01
2*ud*-*Eu*	5986.98	16698.30	329_3-49_3	−09

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
2*dBu*	5989.59	16691.04	20_2-376_3	+07
Eu	5990.11	16689.57	19_2-359_3	−01
Eu	5991.05	16686.95	19_4-359_3	00
1*Eu*	6003.30	16652.90	17_3-343_3; 23_3-405_4	+07 −02
1	6009.68	16635.23	12_4-287_4	−02
4	6012.79	16626.62 −.08	19_6-362_5	+02
Eu	6015.7	16618.6	D_3-214_2	−1
4	6021.52	16602.53 −.06	18_2-347_1	+04
2	6028.32	16583.78 −.08	299_3-46_3	+08
1*Eu*	6035.52	16564.00	13_3-299_3	−27
2*Bu*	6041.62	16547.28 −.05	19_5-360_4	+01
3	6043.33	16542.60 −.04	314_4-47_4	+02
Eu	6049.0	16527.1	17_3-342_3	−3
2	6049.90	16524.64 −.07	18_3-354_3	+02
1*Eu*	6055.90	16508.27	22_5-393_5	+11
2*Bu*	6065.05	16483.36 −.14	20_2-374_2	+17
1	6066.82	16478.54	19_2-357_2	+21
1	6067.64	16476.31	20_1-369_2	+02
Eu	6077.7	16449.0	$19'_5-362_5$	−0
3	6081.46	16438.88 −.07	$18'_2-347_1$	+04
1	6094.76	16403.01	18_1-344_2	+02
1	6107.41	16369.02	18_2-344_2	+03
2	6111.67	16357.62 −.07	15_3-318_2	+01
2	6115.55	16347.24 −.05	14_2-313_1	00
1	6119.35	16337.09	18_3-353_2	+11
4	6128.28	16313.29 −.04	28_5-445_5	+01
2	6143.91	16271.77 −.15	22_4-387_4	−01
1	6147.18	16263.12	17_4-333_5	+07
1*Eu*	6148.22	16260.38	318_2-48_2	−34
2	6153.75	16245.76 +.03	19_2-354_3; 20_1-366_2	+25 −09
2	6154.88	16242.78 .00	17_3-339_2; 19_4-354_3	−04 −10
2	6161.45	16225.47 +.05	18_2-343_1	−07
2	6169.11	16205.32 +.02	$18'_2-344_2$	−03
1*Eu*	6187.54	16157.05	28_5-443_6	+13
1	6193.23	16142.21	18_3-351_4	−04
2*u*-*B*	6195.986	16135.03	13_2-299_3	−06
4	6203.54	16115.39 +.05	19_3-359_3	−11
1*u*	6219.50	16074.02	377_1-53_1	+17
1*Eu*	6224.41	16061.85	$18'_2-343_1$	−04
1	6225.80	16057.76	19_2-353_2	−11
Eu	6240.59	16019.73	393_5-55_5	−16
1	6245.74	16006.50	351_4-51_4	+15
3	6254.33	15984.50 +.05	333_5-49_5	−02
2*u*	6258.93	15972.75	15_3-314_4	−12
Eu	6259.19	15972.12	393_5-55_4	+07
4	6285.89	15904.24 −.04	19_3-357_2	−01
3	6291.04	15891.23	20_2-369_2	−01
4	6292.02	15888.75 −.07	13_1-291_2	00
2	6303.18	15860.63 −.17	19_4-351_4	+12
1	6308.47	15847.33	13_3-291_2	+02
Eu	6324.7	15806.7	16_4-322_3	0
1*Eu*	6331.38	15789.98	23_3-397_4	+15
Eu	6335.2	15780.5	291_3-44_2	−1
1*Eu*	6342.31	15762.78	20_1-361_1	+18
Eu	6346.8	15751.6	28_5-439_4	−4
Eu	6352.49	15737.54	322_3-47_4	+09
1*Eu*	6359.15	15721.05	17_4-328_4	−05
1	6361.07	15716.28	23_3-396_3	00
1	6364.77	15707.14	14_2-306_1	−14
2	6371.43	15690.73 −.11	20_2-366_2; 28_5-439_5	+13 −03
Eu	6378.5	15673.3	277_1-43_1	−1
Eu	6379.3	15671.4	19_3-354_3	−03
1	6382.51	15663.49	$18'_2-339_2$	−01
2*Eu*	6384.68	15658.17	18_3-346_4	+06
2	6402.07	15615.63 −.02	13_2-293_2	−04
4	6404.22	15610.39 −.02	14_2-305_3	−05
2	6416.02	15581.68	19_5-351_4	−05
2*u*-*Eu*	6435.52	15534.57	341_4-49_3	+22
1	6439.72	15524.33	22_4-380_4	−12
2	6445.13	15511.31 −.02	18_3-344_2	−04
Eu	6456.49	15484.05	19_3-353_2	+26
3	6464.16	15465.65	19_2-347_1	−08
1*Eu*	6474.78	15440.27	17_3-331_2	+03
2	6484.09	15418.11 −.03	13_2-291_2; $?384_1-53_1$	−02 +12
2*u*	6500.29	15379.70	18_3-343_3; $432_4-?58_5$	+19 −23
2	6508.01	15361.46 −.09	13_2-291_3	+07
3	6532.40	15304.09 −.05	20_1-357_2	−01
1*Eu*	6534.05	15300.23	$433_5-?58_5$	+14
4	6538.16	15290.61 +.04	$19'_5-351_4$	−10
2	6552.84	15256.34	17_3-329_3	−04
1*Eu*	6553.81	15254.08	18_3-342_3	+02
2	6554.24	15253.08	281_1-43_1	+03
1*Eu*	6562.88	15233.01	341_4-49_5	+03
3	6563.16	15232.36 −.16	19_2-344_2	+12
3	6573.96	15207.35 .00	20_2-361_1	00
2*Eu*	6600.06	15147.20	18_3-341_4; 328_4-47_4; 402_4-55_5	+08 −14 +24
2	6607.17	15130.90 +.03	17_4-322_3	−09
2*Eu*	6609.06	15126.58 −.01	15_3-305_3	−03
3*Eu*	6611.63	15120.70	329_3-48_2	−07
1*Eu*	6620.60	15100.20	19_2-343_3; 23_3-390_2	−20 +04
3*Eu*	6621.69	15097.71	19_4-343_3; 19_5-346_4; $(28_5-433_5$	−07 +12 +31)
1*u*	6636.60	15063.80	314_4-46_3; 402_3-55_4	+17 +06
1*u*	6654.45	15023.41	346_4-49_3	+05
1	6657.02	15017.61	28_5-432_4	+05
1*u*	6664.16	15001.50	16_4-314_4	−07
1	6675.99	14974.92	19_2-342_3	−03
2	6677.19	14972.23	19_4-342_3	−09
4	6678.41	14969.50 −.04	18_3-339_2	00
1	6682.65	14960.00	20_2-359_3	−10
5*Eu*	6693.11	14936.63 −.07	14_2-299_3; 331_2-48_2	00 −30
2	6713.30	14891.70 −.04	13_1-281_1	−05
2*Eu*	6725.19	14865.48	19_4-341_4	+10
2*Eu*	6733.06	14847.99	362_5-51_4	−01
2*Eu*	6740.03	14832.63	22_4-373_5	+15
2*Eu*	6746.58	14818.24	23_3-387_4; 374_2-52_{23}	−12 −21
2	6754.56	14800.74	28_5-430_4	+06
1	6755.75	14798.13	405_4-55_5	+25
2	6778.34	14748.81	20_2-357_2	−04
2	6799.35	14703.25	15_5-297_5	−08
3*Eu*	6805.31	14690.37 .00	19_2-339_2	−02
2	6811.38	14677.26	$18'_2-329_3$; 28_5-429_4	+18 −03
3	6814.93	14669.62	22_4-371_4	−02
4	6820.25	14658.18 −.11	19_3-344_2	+02
2	6828.43	14640.63	318_2-46_1	+04
1	6832.23	14632.48	28_5-428_5	−04
1	6844.88	14605.43	333_5-47_4	+04
2	6853.73	14586.58	19_5-341_4	−02
2	6874.93	14541.61	306_1-45_0	−12
2	6876.05	14539.24	351_4-49_3	+02
2	6877.60	14535.96	19_3-343_3	? −40
3	6908.31	14471.34 −.04	13_1-277_1	−03
1	6915.49	14456.32	22_5-373_5	+01
1	6917.21	14452.73	15_3-299_3	−07
2	6920.98	14444.83	$22_5-?372_6$	+2
4	6934.29	14417.12 +.04	14_2-293_2	−08
1	6943.72	14397.54	22_4-368_3	−12
3	6964.14	14355.34 +.01	13_1-276_2	−01
4	6984.28	14313.93 −.04	13_3-276_2	+02
2*d*	6993.15	14295.76	$19'_5-341_4$	+18
2	6994.06	14293.90	19_3-341_4	−03
1	7002.73	14276.21	23_3-382_3	−04
1*d*	7016.01	14249.20	368_3-51_4	? +43
1*u*	7020.23	14240.63	$443_6-?58_5$	+06
1	7058.79	14162.84	14_2-291_3	−05
2	7098.23	14084.15	$445_5-?58_5$	−06

TABLE II—*Continued.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
1	7111.20	14058.45	(20_1-344_2; 293_2-43_1	+44); −06
1	7127.07	14027.15	12_4-261_3	00
3	7140.51	14000.74	13_2-277_1	−01
2	7162.64	13957.49	$18'_2-322_3$	−03
1	7179.88	13923.99	357_2-49_3	−04
1*u*	7184.71	13914.63	20_1-343_1	+08
1	7191.33	13901.81	313_1-45_0	+04
1	7198.62	13887.73	19_2-331_2	−08
2	7200.16	13884.76	13_2-276_2	+03
2	7216.32	13853.66	18_3-328_4; 341_4-47_4	+03; −19
1	7218.16	13850.12	342_3-48_2	? +33
2	7226.02	13835.07	19_5-333_5	+01
2	7237.08	13813.93	373_5-51_4	−02
1	7245.23	13798.39	22_4-362_5	−04
2	7278.21	13735.87	15_3-291_2; (20_2-347_1; 343_1-48_2	+03; −38); −09
3	7285.82	13721.52	19_6-333_5	−06
1*u*	7291.83	13710.20	13_2-274_3	−14
1	7295.15	13703.96	19_2-329_3	−01
3	7296.57	13701.30	19_4-329_3	−04
1	7347.88	13605.63	22_4-360_4	+01
1	7355.00	13592.46	344_2-48_2	−04
1	7365.15	13573.73	360_4-49_3	+05
2	7381.27	13544.08	$19'_5-333_5$	+04
1	7384.04	13539.00	329_3-46_3	+06
3	7385.08	13537.09	$18'_2-318_2$	−04
1	7389.00	13529.92	$15_5-?285_6$	+05
1	7448.26	13422.26	22_5-362_5	00
3	7483.34	13359.34	20_2-343_1; 347_1-48_2	+04; +33
2	7504.07	13322.45	13_1-266_0	+03
3	7508.98	13313.74	19_3-331_2	+01
3	7537.42	13263.50	18_3-322_3	−02
2	7550.46	13240.58	18_1-313_1	+01
3	7569.87	13206.63	18_2-313_1	+05
2	7582.85	13184.04	28_5-414_6	+02
3	7614.07	13129.98	19_3-329_3	+09
1	7630.24	13102.14	318_2-44_2	+01
1	7643.40	13079.59	362_5-49_5	+10
2	7654.78	13060.15	13_1-263_2	+02
?3	7664.86	13042.96	$18'_2-313_1$	+03
1	7679.15	13018.70	13_3-263_2	+01
3	7688.93	13002.14	$19'_5-328_4$	+05
1	7689.96	13000.40	19_3-328_4	−04
1	7699.42	12984.41	19_2-322_3	00
2	7700.96	12981.82	19_4-322_3	+04
1	7736.16	12922.75	13_1-262_2	+16
1	7758.58	12885.42	17_3-305_3	−03
2	7761.13	12881.19	13_3-262_2	+04
3	7784.11	12843.15	18_3-318_2	+02
2	7808.95	12802.29	14_2-277_1	00
2	7863.45	12713.57	20_1-331_2	−01
2	7867.01	12707.82	16_4-291_3	+02
2	7880.34	12686.33	14_2-276_2	+06
1	7883.17	12681.76	322_3-44_2	+02
2	7886.45	12676.49	13_1-259_1	+01
2	7909.19	12640.05	22_4-351_4	−03
3	7940.92	12589.54	13_2-263_2	+03
1	7955.43	12566.57	18_2-306_1	−05
2	7957.05	12564.02	19_2-318_2	00
1	7991.67	12509.59	371_4-49_3	−07
4	8017.17	12469.81	18_2-305_3	+03
1	8043.11	12429.51	15_3-278_4	−05
1	8054.87	12411.44	13_2-261_3	+04
3	8055.61	12410.31	19_3-322_3	−02
2	8060.35	12403.01	$18'_2-306_1$	+04
3	8123.78	12306.16	$18'_2-305_3$	+03
1	8165.71	12242.98	28_5-404_5	+02
?2	8210.20	12176.64	19_4-314_4	−01
1*u*	8222.52	12158.38	20_2-331_2	+05
1	8311.60	12028.08	15_3-274_3	+03
1	8321.98	12013.08	23_3-359_3	−02
2	8338.02	11989.96	19_3-318_2	+02
1	8348.77	11974.53	20_2-329_3	+04
1	8350.25	11972.40	344_2-46_1	+03
1	8359.81	11958.72	$466_6-?58_5$	−03
2	8382.88	11925.80	09_0-214_1	+01
2	8402.53	11897.90	19_5-314_4	+03
1	8409.50	11888.05	361_1-48_2	+14
2	8417.08	11877.34	22_4-343_3	00
2	8470.92	11801.86	23_3-357_2	+01
3	8475.15	11795.96	18_2-299_3	−01
1	8486.81	11779.75	22_5-346_4	−02
1	8499.60	11762.04	393_5-51_4	−06
2	8506.95	11751.88	22_4-342_3	−01
2	8516.37	11738.87	347_1-46_1	−01
1	8577.75	11654.88	380_4-49_3	+03
3	8585.07	11644.93	22_4-341_4	−02
3	8594.38	11632.31	$18'_2-299_3$; $43_1-?550'_2$	−01; +11
3	8613.22	11606.88	$19'_5-314_4$	+03
2	8614.49	11605.17	19_3-314_4	−03
2	8641.56	11568.81	23_3-354_3	−22
1	8710.56	11477.17	396_3-51_4	? +44
2	8740.44	11437.93	17_3-291_3	−01
2	8746.59	11429.89	19_2-306_1	+03
1	8776.45	11391.00	14_2-263_2	−05
1	8777.45	11389.70	20_1-318_2	−09
1	8821.12	11333.32 −.39	19_2-305_3	+30
2	8823.27	11330.56 −.15	19_4-305_3	+17
15	8865.43	11276.67 −.08	18_2-293_2	+12
4	8871.50	11268.96 −.18	22_5-341_4	+18
4	8883.71	11253.47 +.06	14_2-262_2	−04
7	8915.70	11213.10 −.16	14_2-261_3	+16
3	8922.93	11204.01	368_3-48_2	−01
2	8936.67	11186.78	23_3-351_4	+12
3	8984.13	11127.69 −.09	28_5-393_5	+12
4	8996.04	11112.95	18_1-291_2; $18'_2-293_2$	−05; +05
1	9023.80	11078.77	18_2-291_2	−24
0	9041.53	11057.04	16_4-274_3	+29
5	9069.98	11022.36	18_2-291_3	+09
5	9082.15	11007.59	14_2-259_1	+19
4	9139.69	10938.29	18_3-299_3	−03
20	9158.86	10915.40 −.02	$18'_2-291_2$; 44_2-558_2	+04; +02
2	9165.49	10907.50	15_3-263_2; 387_4-49_3	+28; −02
1	9175.47	10895.64	20_1-313_1	+05
4	9177.37	10893.38	22_4-333_5	−03
2	9206.67	10858.71	$18'_2-291_3$	+09
2	9227.14	10834.62	20_2-318_2	+08
4	9282.67	10769.81	15_3-262_2	+13
3*u*	9291.96	10759.04	19_3-305_3	+10
3	9317.78	10729.23	15_3-261_3	+12
4	9320.37	10726.25	357_2-46_1	−03
3	9378.88	10659.33	19_2-299_3	+12
25	9381.29	10656.59	19_4-299_3	+01
2	9389.87	10646.86	404_5-51_4	+15
1	9485.21	10539.84	405_4-51_4	−25
1	9505.37	10517.49	(19_4-297_5; 22_5-333_5	+44); +25
1	9507.51	10515.12	28_5-387_4	+10
5	9515.89	10505.86	347_1-45_0	00
25	9538.45	10481.01	22_4-329_3	+10
1	9590.68	10423.93	23_3-343_3	+01
4	9595.25	10418.97	18_3-293_2	+07
2	9667.99	10340.58	20_2-313_1	+24
1	9707.53	10298.46	23_3-342_3	−01
1	9736.31	10268.02	361_1-46_1	+24
4	9747.98	10255.73	20_1-306_1	+10
8	9764.48	10238.40	19_5-297_5	+13
7	9780.72	10221.40	18_3-291_2	+04
20	9809.30	10191.61	23_3-241_4	+08
10	9813.74	10187.00	13_2-239_2	+13
10	9835.20	10164.73	18_3-291_3	+16
4	9859.30	10139.93	19_2-293_2	+14

TABLE II—*Concluded.*

Intensity (See text)	λ_{air}	ν_{vac}	Assignment	$\nu_{obs}-\nu_{calc}$
12	9873.87	10124.97	19_6-297_5	+18
3	9912.76	10085.24	19_3-299_3	+11
18	9915.78	10082.17	18_2-281_1	+16
0	9963.75	10033.63	422_3-52_{23}	? +37
2	9983.22	10014.06	23_3-339_2	+15
2*un*	10021.50	9975.81	22_5-328_4	? +52
4*n*	10050.31	9947.21	$19'_5-297_5$	−04
1	10079.52	9918.39	$18'_2-281_1$	+03
3	10115.52	9883.08	19_4-291_3	+20
2	10126.93	9871.95	382_3-48_2	−06
0	10217.38	9784.56	366_2-46_1	+03
4	10241.63	9761.40	22_4-322_3	+05
0	10306.04	9700.39	20_2-306_1	+01
3	10347.27	9661.75	18_2-277_1	+12
2	10409.77	9603.71	20_2-305	+17
1*ud*	10450.97	9565.85	19_3-293_2	+14
0	10477.97	9541.20	19_4-287_4	+21

but instead of each level having its own column, each column after the heavy line represents all the odd levels in an interval of 1000 cm^{-1}, and the numbers in the body of the array show the number of underwater spark lines belonging to the levels in that interval. The symbols in the first column represent the initial states of all the lines, and the numbers in the first row represent energy values in thousands of wave number units. In the face of the general tendency of the numbers to cluster on the diagonal from upper left to lower right on account of the spectrum selectivity of the apparatus, the preponderance of low levels among the $^7S_3$ combinations is striking.

(B)

Level *21_0*. The reality of this level tends to be confirmed by the following Zeeman-effect patterns:

$$21_0-404_1 \quad (0) \quad 1.66$$
$$21_0-438_1 \quad (0) \quad 1.05.$$

266_0. The reality of this level tends to be confirmed by the following Zeeman-effect pattern:

$$D_1-266_0 \quad (0) \quad 1.55.$$

359_3 and 360_3. Here is a remarkable example of two neighboring levels with the same J, mutually almost exclusive in their combinations.

371_4. The J value of this level is verified by the following conclusions from Zeeman-effect blends:

D_3-371 implies g_3 (impossible) or $g_4=0.9$
15_3-371 implies $g_3=0.29$ or $g_4=0.99$.

387_4. The J value of this level is evident from its combinations. Catalan and Poggio's conclusion that $J=3$ was a necessary consequence of accepting Beining's pattern for S_3-387, but

TABLE III. Observed (tentative) g values of the $5d^46s(^6D)ns$ levels of W I.

	$^7D_1$	$^7D_2$	$^7D_3$	$^7D_4$	$^7D_5$	$^5D_1$	$^5D_2$	$^5D_3$	$^5D_4$
IDEAL *LS*	3.00	2.00	1.75	1.65	1.60	1.50	1.50	1.50	1.50
$5d^46s^2$		(excluded)				1.51	1.48	1.50	1.49
$5d^46s7s$	2.83	1.9	1.74	1.68	1.7		1.55	1.66	1.4

TABLE IV. Upper state statistics of Meggers' underwater spark lines (doubtful and ambiguous cases omitted).

	36				40					45					50					55	57 ·10^3 cm^{-1}
D_0				1	1			1													
D_1				1	2	3	2	2			1										
S_3	2	2	3	2	3	1	1														
D_2			2		3	1	2	3	1	2	1		1								
D_3							3	3	1	6	1			2							
D_4						1	1	2	1	1	3		3	5							
09_0									1												
12_4														1							
15_5																			1		
16_4																					1
17_6																				1	

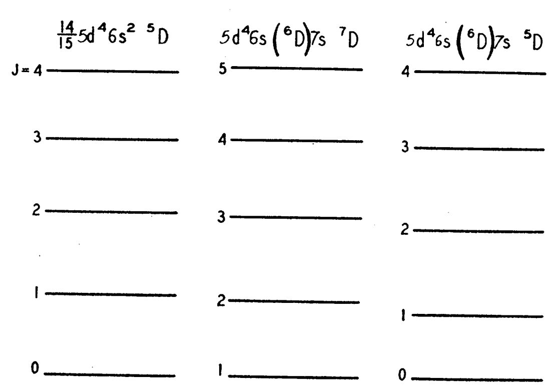

FIG. 3. Relative separations arising from W III $5d^4\,^5D$ plus s electrons. The relative separations within the $5d^46s7s\,^7D$ (center column) are, within one part in a thousand, equal to those of W II $5d^46s\,^6D$, although the absolute separations of the latter are greater by 4.1 percent.

Beining has evidently misread a difficult and unusual pattern.

404$_5$. The J value of this level is verified by the following conclusions from Zeeman-effect blends:

D_4-404 implies g_4 (impossible) or $g_5=1.00$
12_4-404 implies $g_4=1.61$ or $g_5=1.09$.

430$_4$. The J value of this level was determined by independent Zeeman-effect studies. The numerical coicidence with 19_6 is evidently fortuitous.

?430$_0$. The reality of this level tends to be confirmed by the apparently simple nature of the Zeeman-effect pattern of $20_1-?430_0$.

434$_3$. The J value of this level had to be determined from the consistency of Zeeman-effect blends:

15_3-434 implies $g_2=1.02$ or $g_3=1.47$
18_2-434 implies $g_2=1.70$ or $g_3=1.24$
19_2-434 implies $g_2=1.24$ or $g_3=1.20$.

?467$_7$. The reality of this level tends to be confirmed by the Zeeman-effect pattern of $19_6-?467_7$ on Harrison's plates, which is a wide blend showing large J values with g(smaller J) > g(larger J).

497$_2$. There is a possibility that this level has an energy about 0.4 cm^{-1} lower than shown and $J=3$, or that the level listed and the lower one constitute a real pair.

55$_5$. The J value of this level may be 4. Though it shows no $J=3$ combinations, its only $J=6$ combination, 372_6-55_5, is weak and in bad wave number disagreement.

?58$_5$. The J value of this level may be 6. Though it shows no $J=7$ combinations, its only unambiguous $J=4$ combination, $247_4-?58_5$, is weak and in bad wave number disagreement.

(C) νν23044.52, 23043.96

Belke's λ4338.278 intensity 1*r*, was the only line listed as reversed in the arc which we were unable to classify. A careful re-examination shows it to be a pair, with the vacuum wave numbers given here.

Poggio[25] uses, probably in some cases correctly, several lines that we have omitted on the grounds that a comparison of the arc and spark intensities shows them to be probably not attributable to the neutral atom: e.g., "13_2-504_2."

(D)

Table V is a list of all the unclassified lines that appear, on account of their intensity or their occurrence under special conditions, to give evidence of important undiscovered structural properties of the atom. Since all the solar lines, arc reversals, and raies ultimes are classified, we have selected for inclusion in the table only those unclassified lines that have been reported in the underwater spark or furnace spectrum, or have

TABLE V. Important-appearing unclassified lines of the tungsten arc spectrum.

Intensity						Wave-length				
	arc									Zeeman effect
B	*K*	*T*	spark *T*	under-water spark	fur-nace	this paper	*T*	Wave number	Assignment	*J* values (tentative)
2		10	5	M20		2533.641	0.633	39457.04	$D_1-?411_0$	1, 0
2		15	8	M1		2560.139	.119	39048.69		1, 0
3		10	—	M1		2606.406	.386	38355.57	$D_3-?431_4$	
2		9	12	M2?		2847.831	.823	35104.15	$D_2-?384_1$	
1		8 1d	9 18n	H		2852.37	.909 .10	35048.25	Ta ?0.355	
5		12d	10d			3221.220	.212	31035.21		1, 0
3		12	10		1−	3281.944	.939	30461.00		2, 1
5		12	201			3495.250	.246	28602.11		7, 6
5		12	7			3688.069	.069	27106.78	$19_6-?467_7$	large
4		12	10			4000.702	.694	24998.00		
4		40	3			5071.739	.733	19711.62		5, 4
	5					9161.43	—	10912.33		
	7					9531.13	—	10489.06		
	5					9757.39	—	10245.83		
	15					10002.65	—	9994.60		

a Belke or Kiess intensity greater than 3. The list consists of 15 lines. There are 29 unclassified lines with intensity 3, not counting the region $\nu > 40,000$ cm^{-1}.

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The Small Angle Scattering of Electrons by Aluminum

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The angular distribution of scattering of 46.4-kev electrons scattered by an aluminum foil 1.3×10^{-5} cm thick has been studied in the angular range between 0° and 10°. The values obtained for the mean projected angle of scattering have been compared with the values predicted by the theoretical treatment of Goudsmit and Saunderson, and agreement between experiment and theory has been found. The type of scattering has been investigated and it has been found that the scattering observed in this experiment was mainly plural.

INTRODUCTION

MOST of the previous experiments on multiple electron scattering have been concerned with electrons of several Mev energy.[1–4] There has been very little work done on electrons having energies of less than 100 kev.[5] With this in mind, a study of the scattering of 46.4-kev electrons in thin aluminum foils was undertaken.

For the values of the energy, thickness, atomic number, and angular range used, various criteria for single scattering show that the scattering should be non-single.[6,7]

The problem of incoherent multiple scattering has been treated theoretically by E. J. Williams,[8] and by Goudsmit and Saunderson.[9] Both treatments refer to and give values for the mean of the projected angle which is usually dealt with in non-stereoscopic cloud-chamber work. A given projected angle α corresponds to an infinite slit, perpendicular to the plane of projection, placed so that the line perpendicular to it drawn from the scattering center makes an angle α with the direction of the incident beam. If a collecting chamber provided with such a slit could be set at such a given angle, the intensity of the scattered current at that angle could be measured; this intensity will be called the slit intensity.

The mean projected angle of scattering $\langle\alpha\rangle_{\text{Av}}$ is defined by

$$\langle\alpha\rangle_{\text{Av}} = \frac{\int_0^\infty \alpha F(\alpha)d\alpha}{\int_0^\infty F(\alpha)d\alpha},$$

where $F(\alpha)$ is the relative slit intensity.

Goudsmit and Saunderson treat the problem of non-single scattering by using a special property of the Legendre polynomials which makes possible the determination of the angular

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