The Spark Spectrum of Europium, Eu II

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Structure of the spectrum. The strongest lines of Eu II arise from transitions based on the ground-level of Eu III, $f^7\,{}^8S°$. The lowest terms are $f^7s\,{}^9S°$, ${}^7S°$. Next come $f^7d\,{}^9D°$, ${}^7D°$. Numerous levels, combining with these terms, arise from f^6s^2, f^6sd, and f^8. The number of levels identified is 156; of lines classified, 467. All the stronger lines are included. *Unclassified lines.* About 2000 lines remain unclassified. They probably arise from transitions between levels based upon higher limits in the f^7 configuration of Eu III. *Ionization potential.* Series of three consecutive ${}^9S°$ and ${}^7S°$ terms give the value 11.21 volts. *Zeeman effect.* Patterns for 459 lines, measured at the Massachusetts Institute of Technology, with a field of 87,850 gauss, are tabulated. The g values for 118 levels have been determined. Those for the low levels agree with theory; the higher levels are much perturbed. Patterns for a few lines of Eu I and Eu III are given. The latter confirm that the ground state is ${}^8S°$.

THE second spectrum of europium consists of a simple portion, containing the strongest lines and recognizable series, and a much more extensive complex portion. An analysis of the former by one of us[1] is here somewhat extended and a part of the complex portion interpreted.

I. OBSERVATIONS

(1) The wave-lengths and intensities are taken from King's accurate and comprehensive list[2] which extends from 2109 to 10165A. These measures were made on arc and furnace spectra. After eliminating lines shown to belong to Eu I by the analysis of this spectrum[3] or by temperature class, there remain 2681 lines. Of these 1861 were recorded as enhanced in the spark, and can be definitely assigned to Eu II. We are greatly indebted to Dr. King for re-examining a number of critical cases. For wave-lengths greater than about 4000A most of the lines recorded by King as of temperature class V probably belong to Eu I; short of 3000A almost all should be attributed to Eu II, as the lines of Eu I must here be few and faint.

"Lines of a rich spectrum which is quite absent from the arc, and probably belongs to Eu III" were omitted from King's list. It is probable that some high excitation lines of Eu II are among them. Many of the lines show hyperfine structure, and King's measures are therefore usually given only to 0.01A.

The strongest lines of Eu II are of very great intensity in the arc, and strong in the furnace, so that they are placed in the rather rare temperature class II E. The great bulk of the lines, however, are of class VE.

(2) Observations of the Zeeman effect obtained with the Bitter magnet[4] of the Massachusetts Institute of Technology with a field of 87,850 gauss have been generously placed at our disposal by Professor Harrison. These extend from λ2317 to λ7426 and include all the stronger lines and a great number of faint ones. They were measured upon Harrison's automatic measuring engine.[5] The film-records which it produces are equally notable for the accuracy of the measures and the convenience of their discussion. The permanent record is a great advantage, since any line may be re-examined without replacing a plate in the measuring engine.

The limit of resolution, for lines of favorable intensity (in the usual units) is less than $0.2a$ at λ2500 and less than $0.1a$ in the visible. Some of the patterns in the red are very wide: that for λ7217 extends over 13.3A.

The observed patterns for 460 lines are tabulated in abbreviated form in Table X. Without their aid, the complex part of the spectrum could hardly have been interpreted.

[1] W. Albertson, Phys. Rev. **45**, 499 (1934).
[2] A. S. King, Astrophys. J. **89**, 377 (1939).
[3] H. N. Russell and A. S. King, Astrophys. J. **90**, 155 (1939).
[4] G. R. Harrison and F. Bitter, Phys. Rev. **57**, 15 (1940).
[5] G. R. Harrison, J. Opt. Soc. Am. **25**, 169 (1935).

II. Structure of the Spectrum

(3) The simple part of the spectrum has as limit the ground-level $4f^7\ {}^8S^\circ$ of Eu III, which is undoubtedly very much the lowest. Addition of a $6s$ electron gives the ground-terms of Eu II, a^9S°, a^7S°; of $5d$, a^9D°, a^7D°; of $6p$, z^9P, z^7P; of $7s$, e^9S°, e^7S°; of $6d$, e^9D°, e^7D°; and of $8s$, f^9S°, f^7S°. The last four terms are new. Combinations between these terms account for 72 lines—four percent of the whole number but almost all the strongest ones. Additional series members have not been found. (See Section 9.)

(4) The strongest remaining lines lie between 3100 and 2600A. A few of them show absorption in the furnace at high temperatures. These lines arise from transitions between the ground-levels a^9S°, a^7S° and a host of even levels, which combine also with a^9D° (some strongly) and more weakly with a^7D°. Values of the Zeeman parameter g have been found for most of these levels. All but a few of these exceed 1.5. There are many higher levels, combining with a^7D°, whose combinations with the ground-levels lie beyond the limit of observation. A few high odd levels have been identified by combinations with z^9P, z^7P.

(5) Many fairly strong lines remain unclassified. Most of these are between 4200 and 3000A. There are many resolved Zeeman patterns which indicate that a great many levels with different g values are involved. Most of the latter are less than 1.5. No progress has been made in analyzing this group. Its general nature may however be interpreted, with some confidence, as arising from the transition $4f^76s-4f^76p$ with other limits than ${}^8S^\circ$. The next lowest terms of f^7 should be ${}^6(PDFGHI)^\circ$. By analogy with the d^5 configurations in Cr and Mn we should expect these terms to lie at least 25,000 cm^{-1} higher than $f^7\ {}^8S^\circ$, and to have narrow separations.

TABLE I. *Levels of* Eu II.

Config.	Terms	Electron-Jump to f^7s	Electron-Jump to f^7d
f^8	${}^7F$	$((f-s))$	$f-d$
f^6s^2	${}^7F$	$((s-f))$	$((s-f,\ s-d))$
f^6sd	${}^{9,7,7,5}(PDFGH)$	$d-f$	$(d-f,\ s-d)$
f^6d^2	${}^{9,7,5}(SPDFGHI,\ DFG)$; ${}^7(PDFGHIK,\ PDFGH,\ F)$	$(d-f,\ d-s)$	$d-f$

Addition of an s electron gives ${}^{7,5}(PDFGHI)^\circ$—twelve terms, with 64 component levels—and of a p electron, a triad of terms for each of these—in all 36 terms, and 408 levels. These should be 50,000 cm^{-1} or more above the ground-level. The transition f^7s-f^7p (considering these groups of levels only) should give rise to thousands of lines lying mainly in the near ultraviolet. Most of the mass of unclassified lines in this region probably originate thus. There are two ways of breaking into such a complex of lines—with the aid of frequency differences and g values. The first demands that a large proportion of the faint satellite lines in the multiplets shall be recorded; and there are not enough lines in the present list to make it probable that this is the case. Highly precise g values are available for many lines; but when these were arranged in order of magnitude, there were very few of the concentrations near particular values which would occur if many lines from a single level were involved, and searches with the frequency differences shown by the few encouraging cases proved fruitless. Past experience has shown[6] that attempts at analysis in such a case are very unpromising.

(6) The levels combining with a^9S°, a^7S°, which lie between 30,000 and 45,000, cannot belong to f^7p but may come from configurations with six or eight f electrons. Both f^6 and f^8 give one term much lower than any others. From these we obtain the values given in Table I.

The electron jumps involved in transitions to the low levels are given on the right. The double jumps in parentheses should give fainter lines than the single $d-f$ jump, while those in double parentheses are very improbable. Hence f^6s^2 (though probably the lowest of the configurations) may be excluded here. The very strong combinations with a^9S° are probably nonets from f^6sd.

The relative levels of f^6s^2, f^6sd, and f^6d^2 may be estimated by interpolation between La and Lu. The lowest levels in each configuration are:

La II $6s^2\ {}^1S^\circ$ 7394; $5d6s\ {}^1D_2$ 1394; $5d^2\ {}^3F_2$ 0
Lu II $f^{14}6s^2\ {}^1S_0$ 0; $f^{14}5d6s\ {}^3D_1$ 11796;
$f^{14}5d^2\ {}^5F_2$ 29406.

This indicates that f^6sd should be a few thousand wave numbers lower than f^6d^2 in

[6] W. Albertson, Phys. Rev. **52**, 644 (1937).

TABLE II. *High even levels of* Eu II.

Term	g Obs.	g Theor.	$a^9S^\circ_4$	$a^7S^\circ_3$	$a^9D^\circ_6$	$a^9D^\circ_5$	$a^9D^\circ_4$	$a^9D^\circ_3$	$a^9D^\circ_2$	$a^7D^\circ_5$	$a^7D^\circ_4$	$a^7D^\circ_3$	$a^7D^\circ_2$	$a^7D^\circ_1$
			Combinations											
y^9P_5	1.749	1.800	800		60	8	8			1	*m*			
y^9P_4	1.895	1.950	1200	600		100	60	15		10	—	1		
y^9P_3	2.037	2.250	1000	600			20	30	40		3	6	*m*	
x^9P_5	1.715	1.800	250		400	50	12			*m*	*m*			
x^9P_4	1.889	1.950	200	200		300	100	40		3	—	—		
x^9P_3	2.163	2.250	300	300			100	150	100		3	*m*	1	
y^7P_4	1.746	1.750	4	300		20	—	80		15	6	3		
y^7P_3	1.922	1.917	10	250			10	—	80		8	6	2	
y^7P_2	2.188	2.333		600				—	35			3	6	6
z^9D_6	1.687:	1.667			5	8				—				
z^9D_5	1.710	1.733	300		8	2	8			—	—			
z^9D_4	1.824	1.850	200	—		10	10	5		—	—	—		
z^9D_3	2.002	2.083	100	20			—	3	8		—	—	—	
z^9D_2	2.511	2.667		20				—	*m*			—	—	—
z^7F_6	1.485	1.500			—	—				150				
z^7F_5	1.460	1.500	*v*		—	—	—			50	125			
z^7F_4	1.466	1.500	*v*	*v*		—	—	—		4	80	80		
z^7F_3	1.460	1.500	*v*	*v*			—	—	—		6	30	30	
z^7F_2	1.451	1.500		*v*				—	—			8	40	15
z^7F_1	1.494	1.500							—				10	20
z^7F_0	%	%												12
y^9D_6	1.621	1.667			20	8								
y^9D_5	1.569	1.733	—		8	8	12							
y^9D_4	1.672	1.850	—	12		15	—	15						
y^9D_3	1.974	2.083	—	40			12	—	20					
y^9D_2	....	2.667		40				3	6					

v denotes that a line is in the vacuum region, *m* that it is masked, — that it is absent.

Eu II, and the unobservable f^6s^2 still lower. The relative positions of the f^6sd terms may be estimated from those of f^6d in Sm II[7] of which the lowest is a^8H, followed by a^8D, a^8G, b^8G, and a^8P.

(7) Among the observed levels, the intensities and g values clearly define two ^9P terms and one ^7P. A ^9D term includes the lowest levels, another lies higher, and a ^7F accounts for some very strong lines near λ2500. The g values and multiplet intensities for those terms are given in Table II. The high level of a^7D° tends to reduce the intensities of its combinations in the arc.

The first five terms give good multiplets, and the assignments appear secure; the last is more doubtful. There is evidence of perturbation in the g values. From the intensities and positions (Table II) y^9P and x^9D clearly belong to f^6sd, and x^9P to f^6d^2—likewise probably y^7P. The higher term z^7F may come from f^6d^2 or f^8. The latter seems more probable, on account of the isolation and great strength of the multiplet. Among the high odd levels not belonging to series, part of a $^7F^\circ$ term (e^7F°) is identified by g values, and a term e^7D has been tentatively

TABLE III. *Stronger lines of* Eu II.

Intensity	>1000	1000 to 500	500 to 250	250 to 125	125 to 80
No. of lines	23	11	19	23	54
No. classified	23	11	19	23	46

TABLE IV. *Values of* n^* *in Rydberg formula.*

Electron	Term	n^*	Term	n^*
6s	$a^9S^\circ_4$	2.1997	$a^7S^\circ_3$	2.2202
7s	$e^7S^\circ_4$	3.2488	$e^7S^\circ_3$	3.2692
8s	$f^7S^\circ_4$	4.2662	$f^7S^\circ_3$	4.2873
6p	z^9P_5	2.6099	z^7P_4	2.6214
	z^9P_3	2.5607	z^7P_2	2.6300
5d	$a^9D^\circ_6$	2.3485	$a^7D^\circ_5$	2.4376
	$a^9D^\circ_2$	2.3309	$a^7D^\circ_1$	2.4456
6d	$e^9D^\circ_6$	3.4846	$e^7D^\circ_5$	3.5698
	$e^9D^\circ_2$	3.4706	$e^7D^\circ_1$	3.5719

[7] W. Albertson, Astrophys. J. **84**, 26 (1936).

TABLE V. *Probable error of one determination of g.*

Terms	N	n	r_0
$a^9S°$, $a^7S°$	2	42	±0.0057
$a^9D°$	5	30	±0.0065
High even terms	23	65	±0.0066
z^9P, z^7P	6	47	±0.0060
High odd terms	8	22	±0.0063
$a^7D°$, z^7F	9	20	±0.0057
All	53	226	±0.0062

adopted. These may come from f^6sp, which gives two $^7F°$ terms, or f^6dp, which gives six. The corresponding transitions involve the jumps $f-p$, $p-s$ and $f-d$. Both are possible, but the latter is more probable.

(8) The remaining 70 even and 13 odd levels are indicated by numbers in the tables and tentative term-designations are given for some of them. The g values confirm a few of these definitely, but are indecisive for the rest, owing to "g sharing" due to perturbations.

The higher even levels must come mainly from f^6sd and f^6d^2—which would account for many more than have been observed. Some levels from f^7p with higher limits may however be included. The analysis of the spectrum is still far from complete—only 467 lines out of 2681 having been classified. Almost all the strongest lines are however included, as is shown by Table III.

Considerable progress has also been made in identifying electron-configurations. Levels arising from f^7s, f^7p, f^7d, f^6sd and f^6d^2 have been found with certainty, and f^8 and f^6dp very probably.

III. Series and Ionization Potential

(9) A Rydberg formula, applied to $a^9S°$, $e^9S°$, $a^7S°$, $e^7S°$, gives an ionization potential of 11.4 volts.[8] A better approximation may be obtained by estimating the coefficient β in the Ritz formula

$$T=R/n^{*2}, \quad n^*=n-\alpha+\beta T,$$

where T is the term value. When accurate limits and values of n^* are available, we have from the first two terms of a series

$$\beta=\frac{n^*_1-n^*_2+1}{T_1-T_2}.$$

[8] W. Albertson, Phys. Rev. **45**, 499 (1934).

For singly-ionized atoms we have for the s electron:

Element	Be II	Mg II	Ca II	Zn II	Sr II	Cd II	Ba II	Hg II	Ra II
n_1	2	3	4	4	5	5	6	6	7
$\beta\times 10^6$	−0.08	−0.39	−0.63	−0.54	−0.88	−0.88	−1.22	−1.12	−1.46
$0-C$	−0.02	−0.05	−0.01	+0.08	+0.02	+0.02	−0.04	+0.06	0.00

The empirical formula $\beta=10^{-6}$ $(0.50-0.28n_1)$ represents these values surprisingly well.

For Eu II, $n_1=6$. Assuming $\beta=-1.18\times 10^{-6}$ we find that both the $^9S°$ and $^7S°$ terms indicate a limit close to 90,420. The next series member $8s\ ^9S°$ should then be 24,000 below this, or at the level 66,420. A short search revealed the term $f^9S°$ at 66598.00 with three good combinations. When the limit is adjusted until the $6s-7s$, $7s-8s$ intervals give the same value of β, it is found that $\beta=-0.997\times 10^{-6}$ giving a limit 90,716 ($f^7\ ^8S°$ in Eu III) and an ionization potential of *11.21 volts*.

With this limit we find the values of n^* given in Table IV. The large change in n^* for the D terms occurs in the other spectra.

Estimating n^* for the next series members, $8s\ ^7S°$ has been located—provisionally, since its strongest combination is masked by a heavy line. The $6d\ ^9D°$ term should be near 69,000, and $6d\ ^7D°$ about 70,000, but no combinations with z^9P, z^7P have been identified. The same is true for $7p\ ^9P$ (57,000), $7p\ ^7P$ (58,000), $5f\ ^9F$ and ^7F (near 60,000). There are numerous septet levels in this region, but no multiplets have been identified.

IV. Zeeman Effect. Determination of g Values

(10) The number of fully resolved Zeeman patterns is large, for two reasons. The field is high; and the important terms have large multiplicities and small values of L, so that the g values are large and widely spaced. When all the components are recorded, the values of J and g for both levels involved are determined by well-known relations. The range of intensity among the σ-components when $J=\pm 1$, or the π-components when $J=0$, is great, and the fainter ones are often missed; but the π-components in the first case, and the σ's in the second, are more alike, and can be counted, giving the values of J. The strongest lines are over-exposed; but, fortunately, the σ-components came through faintly

along with the π's, and vice versa—just sufficiently to be measurable when the others are burned out. For faint lines the total number of components, and the J values, may be uncertain. The values of g_1 and g_2 given below (Table VII) may in such cases require correction by an integral multiple of g_1-g_2 (which is always accurately determined if any part of the pattern is resolved).

In so rich a spectrum, the patterns of neighboring lines too often overlap. Separating these tangles into their constituents requires patience, and also skill learned by experience, and many insoluble puzzles remain.

For unresolved patterns, the automatic measuring engine is peculiarly valuable. It records the maximum of the profile of a complex blend—while ordinary measures may approximate to the center of gravity of the confused mass. If A is the position of this maximum in the usual units, then, if $J_1=J_2$, $A_\sigma=\frac{1}{2}(g_1+g_2)$, $A_\pi=J(g_1-g_2)$ so that both g values can be found when J is known. This is often contributed by the analysis of the spectrum; and sometimes, though the separate components cannot be measured, their presence and number are indicated by small waves on the recorded profile.

When $J_1=J_2+1$, $A_\sigma=J_1g_1-J_2g_2$, $A_\pi=0$ and the J's and one g must be found from the analysis. The middle of the unresolved σ-blend should correspond to g; but, as the faint edge may not be recorded, this gives only a rough estimate—which, however, is often of value in showing whether a given line may involve a level of known g.

The ground-level $a^9S^\circ_4$ is involved in 19 resolved patterns, which give g values ranging from 1.965 to 2.004 with a mean of 1.984. The probable error r of a single determination comes out ± 0.0063 and of the mean ± 0.0014. For $a^7S^\circ_3$ there are 23 resolved lines, giving $g=1.981$ ± 0.0011, $r=\pm 0.0051$.

The results for other groups of levels are summarized in Table V, where N is the number of levels included, and n the number of resolved lines. The weight of each level is $n-N$. Each resolved line gives two g values so that there are 113 of them. The independent determinations of r are in remarkably good agreement.

(11) Comparing the observed and theoretical values for the low terms, we have Table VI. The observed values are systematically too small. This may arise from an error in the calibration constant, which was determined from the observed patterns of a small number of lines of other elements which appeared on the plates. Multiplication by 1.0086 makes the observed sum equal to the theoretical, and gives the corrected values in column 4. The residuals for the corrected values afford conclusive evidence of the reality of this correction. They are but little greater than their probable errors, except for z^9P_4, z^7P_4, z^9P_3, z^7P_3, which share their g values, preserving the sums.

For the higher terms this g sharing is much greater, and term designations must be correspondingly nebulous.

(12) The observed Zeeman patterns of 459 lines are given in Table VII. Classified lines are marked by an asterisk preceding the wave-length. The third column gives the number of π-components measured on the films, counting the central line (if present) and the components on one side only, and the fourth the positions, of the

TABLE VI. *Observed and theoretical g values.*

Term	Obs.	Theor.	Corr.	Res.	P.E.
$a^9S^\circ_4$	1.984	2.000	2.001	+0.001	±0.0014
$a^7S^\circ_3$	1.981	2.000	1.998	− .002	.0013
$e^9S^\circ_4$	1.985	2.000	2.002	+ .002	.0027
$e^7S^\circ_3$	1.974	2.000	1.991	− .009	.0043
Sum	7.924	8.000	7.992		
$a^9D^\circ_6$	1.659	1.667	1.673	+ .006	± .0035
$a^9D^\circ_5$	1.726	1.733	1.741	+ .008	.0020
$a^9D^\circ_4$	1.842	1.850	1.858	+ .008	.0023
$a^9D^\circ_3$	2.062	2.083	2.080	− .003	.0017
$a^9D^\circ_2$	2.641	2.667	2.664	− .003	.0021
Sum	9.930	10.000	10.016		
$a^7D^\circ_5$	1.592	1.600	1.606	+ .006	± .0062
$a^7D^\circ_4$	1.628	1.650	1.642	− .008	.0044
$a^7D^\circ_3$	1.728	1.750	1.743	− .007	.0044
$a^7D^\circ_2$	1.981	2.000	1.998	− .002	.0036
$a^7D^\circ_1$	2.972	3.000	2.997	− .003	.0036
Sum	9.901	10.000	9.986		
z^9P_5	1.789	1.800	1.804	+ .004	± .0018
z^9P_4	1.877	1.950	1.893	− .057	.0016
z^9P_3	2.195	2.250	2.214	− .036	.0016
z^7P_4	1.801	1.750	1.816	+ .056	.0015
z^7P_3	1.943	1.917	1.960	+ .043	.0021
z^7P_2	2.312	2.333	2.332	− .001	.0025
Sum	11.917	12.000	12.019		

TABLE VII. *Zeeman patterns of* Eu II.

λ	Arc Int.	No. Meas.	π			No. Meas.	σ			J_1	Obs. g_1	J_2	Obs. g_2
*7426.57	1500	4	0	358	725	5	755	1113	1480	4	1836	3	2195
*7370.22	2500	5	0	153	304	8	1119	1271	1423	5	1727	4	1879
*7301.17	2500	3	124	260	390	6	2070	2180	2329	3	2070	3	2200
*7217.55	1500	3	0	452	895	4	1297	1748	2200	3	2197	2	2646
*7194.81	1500	1	136	B		1	1856	C		(4)	1873:	(4)	1839
*7077.10	3000	4	0	193	384	6	1289	1480	1683	4	1872	3	2066
*6645.11	8000	6	0	131	264	9	1003	1131	1393	6	1661	5	1794
*6437.64	4000	1	327	B		6	1732:	1797:	1863:	5	1735	5	1799
*6303.41	2000	3	0	132	241	4	1661::	1786:	1908:	5	1785	4	1846
*6173.05	2000	1	0	D		1	1406	A		(5)	(1726)	(4)	1806
*6049.51	2000	1	232	B		1	2732	C		(4)	1850	(4)	1792
*5966.07	1200	5	0	266	526	5	1014	1276	1539	4	1796	3	2054
*5872.98	500	2	...	254	375	5	1940	2067	2201:	3	2070	3	1946
*5818.74	1000	3	0	704	1407	3	535	1232	1940	3	1940	2	2644
4639.40	4	1	...	213		3	1854:	1951:	2040:	2	1950:	2	2043: ?
4637.74	2	1	0	D		1	1305	A					
4612.43	2	1	0	D		1	1406	B					
4591.06	8?	5	0	220	441	3	1087	1332	1530	5	1750:	4	1970:
*4585.68	8	4	0	298	560	2	m	1057:	1360:	(4)	(1628)	(3)	1908:
4581.62	5	4	0	222	446	5	883	1108	1350	4	1558		1782
4580.23	5	2	...	313:	404	5	1630	1763	1910	3	1767	3	{1630 or 1904
4567.68	1	1	0	D		1	1452	C					
4564.93	2	1	047	B		1	1409	C					
4555.59	6	1	0	D		1	1634	C					
4539.69	3	2	0	1052		2	?	900	1957	2	902	1	152
*4539.24	12	1	0	D		1	2080	B		(4)	1985	(3)	(1943)
*4522.59	2000	3	217	424	634	6	1990	2196	2406	3	1985	3	2197
4516.94	4	1	0	D		1	1365:	A?					
4511.53	3	1	032	B		1	1438	C					
*4508.66	10	1	0	D		1	1995:	C		(4)	(1842)	4	2148:
4505.73	2	1	0	D		1	1530	B?					
4502.10	2	4	466	680	952	1	851	C		4	968:	4	0734:
*4488.28	15	5	019:	157	328	8	1622:	1758:	1920:	(5)	(1580)	(4)	1746
*4485.15	100	4	369:	547:	735	8	1813	1997	2160	4	1987	4	1806
4471.64	4	4	0	290	528:	4	1880	2160	2380	4	1596:	3	1326:
*4464.97	200	3	0	329	654	4	1326	1656	1960	3	1984	2	2311
4463.83	3	1	0	D		1	1434	B?					
4461.546	2	5	0	157	316	4	1559:	1709:	1880:	5	1251:	4	{839: 1095:
4453.08	1	1	0	D		1	1667	C					
4451.63	2	4	0	256	515:								
4444.26	4	1	070	B		1	1463	C					
4442.42	3	1	0	D		1	1361	C					
4441.47	15	3	0	106	219	3	1538:	1603:	1722				
*4435.58	3000	3	0	120	242	too strong!				4	1860	(3)	(1981)
4429.76	15	3	0	096	179	7	1090:	1201:	1282	6	801	5	703
4426.42	5	4	0	234	473	6	850	1097	1330	4	613	3	374
4419.66	8	2	0	142	....	4	1380	1490	1651	3	1651	2	1788
4410.47	1	1	0	D		1	1394	B?					
4407.07	15	1	0	D		1	1423	B					
*4405.27	20	5	0	102	204	4	m	1208	1404:	5	1611:	4	1713:
4403.15	6	1	074	B		1	1004	C					
4397.70	8	1	0	D		1	705	C					
4391.37	10	2	154:	282		4	0	138	278:	2	139	2	−002
4389.07	4	4	287:	377:	460	8	1093:	1204	1297	5	1196	5	1105
*4383.17	200	4	0	169	353	6	1266	1434	1620	4	1789	3	1964
4382.05	4	1	0	D		1	1303	C?					
4379.81	5	1	0	D		1	1808	C					
4372.20	8	4	0	105	204	1	1794	B		4	1491:	3	1390:
4369.47	40	1	0	D		1	1460	A					
4368.42	8	2	0	612		2	1210	1828		2	1827	1	2443
4361.57	8	1	175	B		1	1142:	C					
4357.76	5	1	0	D		1	1242:	S					
*4355.09	300	5	0	198	396	6	999	1190	1379	5	1775	4	1971
4352.94	5	1	0	D		1	1474	A?					
4352.24	6	5	0:	141	283	6	1927	2033	m	4?	1818	3?	1707
4351.261	4	4	0	178	360	3	1603:	1759:	1935:	4	1422:	3	1252
4335.45	4	1	0	D		1	1610	C					
4334.75	12	1	104	B		1	1240:	A and B					
4330.61	40	1	0	D		1	1612	A?					
4317.67	8	1	0	D		1	1281:	S, B?					
4300.84	5	6	0	267	540	7	1941	2246	2499	6	1200:	5	940:
4295.44	15	1	0	D		1	1369:	C					
4288.60	2	5	0	213:	424:	5	856	1059	1259	5	1476	4	1684
4283.873	4	3	0	226	452	3	218	448	690:	3	680	2	910
4281.920	8	3	468	706	938	8	528	752	993	4	523	4	{290 or 756
4260.98	5	1	0	D		1	1341	S					
4253.805	20	2	....	311	456	5	1022	1113	1239:	5	1012	5	1114
4247.06	25	5	0	257	508	5	782	1020	1281	5	276	4	28
4238.689	20	2	0	154		2	2150:	2323:		2	2320:	1	2485:
4234.094	8	4	0	121	229	4	1089	1210	1320	4	0974	3	0858
4232.45	12	6	0	095	181	0				6?		5?	
4211.275	10	4	0	378	731	3	1107	1474	1841	4	0740	3	0373
*4205.05	6000	4	0	211	424	6	2200	2396	2577	4	1983	3	2193
4192.62	12	1	0	D		1	1299	S					
4189.751	5	0?				3	784	896	989				
4183.78	4	1	0	D		1	1951	A?					
4176.62	8	3	220:	461	693	5	1413	1643	1867	3	1640	3	1410
4172.80	30	1	420	B		1	1308	C					
4162.14	8	4	0	463	928	5	1193	1652:	2118	4	727	3	262

TABLE VII.—*Continued.*

λ	Arc Int.	No. Meas.	π			No. Meas.	σ			J_1	Obs. g_1	J_2	Obs. g_2
4160.475	12	1	199	B		1	698	A					
*4151.52	20	3	120	360	571	6	2288	2486	2755	4	(1842)	3	2062
4148.40	8	1	0	D		1	1270	S					
4147.22	12	5	570:	720:	860	7	996:	1150:	1292:	6	1154:	6	1296 or 1012
4145.233	8	6	0	165	339	7	1253	1422	1596	6	748	5	579
4141.72	40	3	330	473	598	7	1418	1573	1723	4	1571	4	1723 or 1419
4141.02	25	1	221	B		1	1940	C					
4136.59	20	2	466	926		4	1820	2286	2768	2	2292	2	1825
*4129.73	5000	1	402	B		5	1767	1882	2004	4	1885	4	2004
4120.77	6	1	244	B		1	1358	C					
4119.30	15	1	0	D		1	1526	B					
*4112.04	30	1	066	B		1	2074	C		3	2062	3	2084
4107.90	10	1	0	D		1	1794	B					
*4096.804	40	5	0	247:	482:	6	755	993	1243	5	1722	4	1964
4092.96	3	1	0	D		1	1560	S					
*4086.423	8	2	m	1519	2300	m				3	(2062)	3	1298
*4085.38	40	3	0	600	1200:	5	897	1472	2065	3	2090	2	2693
4080.77	4	1	0	D		1	1118	A					
4076.95	4	4	1044	1421	1768	8	1230	1578	1935	5	1583	5	1938 or 1228
4071.38	10	3	0	025	m	3	1842	m	2050	5?	1617:	4?	1507:
4067.132	3	1	0	D		1	1393	S					
4066.05	4	2	168:	280		4	1510	1648	1791	2	1791	2	1649
4062.65	15	2	0	151	m?	3	1157	1328	1488	3?	1485	2?	1645
4062.15	15	4	0	200	380	4	1172	1362	1557	4	995	3	809
4061.566	10	6	0	130	262:	7	1420:	1531:	1677	6	1031	5	902
4059.37	15	1	0	D		1	1630	C					
4037.149	5	2	m	913	1376	6	1418	1880:	2330	3	1876	3	1419
4031.35	4	6	0	328	658	7	1587:	1938	2260	6?	625	5?	295
4029.577	4	1	0	D		1	1019	A					
4018.39	6	2	0	816		3	830	1639	2437:	2	1640	1	2452
*4017.58	100	4	0	133	284	5	m	1045	1208	5	1717:	4	1886:
*4011.69	100	1	295	B		6	1874	1986	2095	4	1882	4	1990
3995.98	10	2	890	1790		4	−232	655	1561	2	662	2	−233
3993.931	15	1	0	D		1	1237	B					
3988.24	8	1	0	D		1	967:	A					
3975.566	5	2	0	307		3	1480:	1781	2098	2	1786	1	1476
*3971.98	4000	4	0	177	365	6	1268	1434	1608	4	1796	3	1976
3968.88	3	4	0	176:	340	6	080	236:	444	4	442	3	617
3966.59	8	4	461	685	916	8	995	1241	1463:	4	1234	4	1005
*3964.90	60	1	183	D		1	1820:	C		(4)	(1842)	4	1888
3960.74	3	2	140:	301		4	1637:	1790	1948	2	1792	2	1642
3959.22	3	3	0	378	734:	6	887:	1202	1630	3?	1636:	2?	2005:
3957.916	15	1	157:	B		1	1579	B?					
3953.43	6	2	m	131		1	2033	B					
3947.60	3	3	0	157	312								
3943.97	6	3	0	298	605:	4	m	1188	1500	3	1489:	2	1779:
*3943.08	40	4	0	212:	432:	4	1370	1580	1774	4	1987	3	2196
3939.19	8	1	0	D		1	1152	A					
3938.248	2	1	0	D		1	1437	A					
3930.50	4000	1	105	B		1	1953	C		3	1971	3	1936
*3928.87	15	3	m	158:	328:	0	m	m	m	(4)	(2062)	3	1900:
3927.95	4	3	0	278	559	4	m?	640	910	3?	910:	2?	1184:
3922.526	3	5	735	985	1240	6	651	910	1170:	4	911	4	666 or 1156
*3917.29	60	4	0	98:	196:	3	1228	m	m	6	1654	5	1758
3913.72	10	3	0	363	725	5	698	1055	1430:	3	1427	2	1062
*3907.10	3000	3	0	329	657	5	1324	1658	1985	3	1985	2	2314
3903.62	3	3	485	1010:	1448	5	1152	1638	2101	3	1630	3	2109 or 1151
3900.18	10	3	0	128	m	5	1238	1366:	1504	4	1635	3	1767
3899.49	10	1	0	D		1	2000	A					
3889.52	6	4	525	796:	1020	7	1319	1578	1825	4	1572	4	1315
3876.07	2	3	319:	486	642	6	1008	1178	1357	4	1017	4	857 or 1178
3873.11	4	1	115			1	1607	C?					
3863.66	10	1	0	D		1	1132	B					
3861.18	80	1	0	D		1	1048	A					
3849.62	2	4	m	m	342	5	1972:	2120:	2283:	6	1481:	5	1320:
3849.38	8	3	101:	290:	455	1	1368	m	m	3	1368:	3	1524
3848.40	10	3	0	181	376:	4	265	459	646	3	267	2	077
3848.20	8	1	080	B		1	2433:	A					
3846.40	4	1	0	D		1	1340	S					
*3844.23	8?	1	139	B		1	1737	C		5	1751	5	1723
3842.354	8	1	107	B		1	1009	C					
*3838.239	30	5	0	377	767	9	−413	020:	408	5 4	1175 1548	4 3	1555 or 1928
3831.18	8	3	376	760	1119	5	262	637	996	3	634	3	259
3828.93	30	2	160:	300		4	1633	1790	1939	2	1788	2	1636
*3826.68	50	5	0	282	561	9	382	665:	958	5	1520	4	1800
3825.14	10	1	0	D		1	1238	C					
*3819.67	6000	5	0	200	401	7	m	1186	1390	5	1789	4	1989
3815.495	80	4	0	167	332	7	883	1044	1260	4	1388	3	1554
3813.07	1	1	0	D		1	975	B?					
3805.81	5	3	0	794	1580	5	−094	704	1470:	3?	1492	2?	2280
3804.27	15	6	0	172	345	10?	471	640	798	6?	1293	5?	1457
3801.58	8	6	0	89	172	7	780:	862:	974:	6?	1232	5?	1322
*3799.492	10	2	m	728:	979	7	1267:	1520:	1796:	(4)	(1801)	4	1559
*3799.009	100	4	0	324	642	6	857	1198	1508	4	1835	3	2160
3796.33	8	3	0	171	348	4	1072:	1256	1435	3	1078	2	901

TABLE VII.—*Continued.*

λ	Arc Int.	No. Meas.		π		No. Meas.		σ		J_1	Obs. g_1	J_2	Obs. g_2
3795.04	20	1	**0**	D		1	**1289**	C					
3794.776	5	4	**0**	166	368:	3	**406**	589	754:	5?	1080::	4?	1250::
*3793.06	25	2	m	570	**692**	8	**1624:**	**1780:**	1898:	(5)	(1726)	5	1588:
*3791.50	30	1	**0**	D		1	**1778**	B?		(5)	(1726)	4	1713
*3788.765	30	2	m	825	**1266**	6	1517:	**1935**	2360	3	1941	3	1525
3781.40	50	3	**0**	118	m	3	**802:**	855:	m	5	1017:	4	1072:
3780.54	10	2	**0**	1164:		2	**1825**	634:	m	2	634:	1	−542:
3777.613	15	4	**0**	861	1706	6	**−297**	560	1421	4?	2274:	3?	3131:
3771.147	25	4	**0**	377	756	6	**380**	743	1136	4	1505	3	1882
3769.33	15	1	**0**	D		1	**1367**	A or B					
*3765.93	150	1	**277**	B		2	**2076**	**2161:**	m	(3)	(2062)	3	2152
*3761.12	300	5	**0**	172	340	9	**1035**	1204	1378	5	1719	4	1890
3760.33	50	4?	597	831:	**1029:**	8?	**1502:**	**1706**	1910	4?	1707	4?	1505
3758.54	20	1	**0**	D		1	**1731**	B					
*3757.639	30	3	**0**	761	1510	4	811	**1570**	**2311**	2	2313	2	1563
3756.80	4	1	**0**	D		1	**1731**	B					
3753.77	6	1	**249**	B		1	**1496**	C					
3753.05	30	1	**207**	B		1	**2560**	C					
*3744.54	20	2	m	233:	**532:**	0?	m	m	m	(4)	(1842)	4	1709:
*3743.556	100	3	**0**	486	969	5	**1190**	1670	2153:	3	2154	2	2638
3742.34	15	1	**0**	D		1	**1458**	A?					
*3741.31	400	1	**0**	D		1	**1362**	A		(6)	(1659)	5	1719
3740.25	20	4	366	550:	**743:**	6	1417	1630	**1832**	4	1628	4	1833: or 1423:
3733.65	25	6	478	572	**685**	12	**1472**	1600	1703	6	1595	6	1478
*3724.94	4000	4	384	584:	**751:**	8	**1800**	1988	2171	4	1989	4	1800
3720.72	10	6?	**0**	172	357	2	**1226:**	1389:	m	4?	1902:	3?	2072:
3717.69	80	4	427	660	**869**	7	1280	**1493**	1713	4	1496	4	1283 or 1709
3716.937	60	4	**0**	234:	471:	6	**634**	845	1055	4	1268:	3	1480:
*3714.904	100	1	**208**	B		1	**1853**	C		(4)	(1842)	4	1894
*3713.45	125	1	**0**	D		1	**1911**	A		(3)	(2062)	2	2137
*3710.870	80	1	**0:**	D?		1	**2022**	B		6	1775	(5)	(1726)
3707.42	20	1	**0**	D		1	**1590**	B					
3697.94	12	1	**0**	D		1	**1572**	B					
3696.42	20	3	**0**	234	469	2	2249:	**2444**		3?	1996:	2?	1762:
3695.14	3	1	**0**	D		1	**1403**	A					
3693.80	20	7	**0**	180	362	7	1910	2080	**2273**	7	1203	6	1025
*3688.42	1500	1	**0**	D		1	**2059**	A		(4)	(1984)	3	1959
3685.675	6	3	**0**	470	950	6	1660:	2130:	**2603:**	3	1660:	2	1183:
*3683.267	40	3	**0**	165	323	4	**1369:**	1538	1716:	(5)	(1726)	4	1890
3679.500	80	3	**0**	180	360	4	1644	1798	**1992**	3	1626	2	1447
*3678.259	100	2	**0**	546		3	**1768**	2310	2850	2	2309	1	2852
*3674.634	50	1	**0**	D		1	**1720**	S		(5)	(1726)	5	1714
3668.96	5	1	**0**	D		1	**1280:**	A and B					
3666.77	8	2	**0**	376		3	874	1262	**1630**	2	1255	1	878
3666.27	15	1	**250**	B		1	**1193**	C					
3658.77	10	3	**0**	345	680	0	m	m	m				
3648.26	15	1	**145**	B		?	m						
*3646.75	35	1	458	**m**		4	1729	**2154**	**2610**	2	2169	2	2624
3645.18	30	3	**0**	242	488	5	**1840**	2118	2360:	3	2360:	2	2610:
3636.718	10	4	**0**	201	398	5	1719:	2076	**2457**	4	1345	3	977
*3632.18	80	3	262:	679	**1001**	5	**1725**	2086	2399	3	1730:	3	2066
3631.79	15	3	402	612	**819**	?	m	m	m	4		4	
*3629.80	40	1	**0**	D		1	**1798**	C		4	(1801)	4	1795
3627.41	25	1	**138**	B		1	**1076**	C					
*3622.54	150	1	**0**	D		1	**1080:**	A					
3621.890	50	4	**0**	241	494	5	779:	992	**1236**	4	495	3	742
*3616.152	100	5	**0**	294	591	8	**300**	595	900	5	1502	4	1804
3612.19	20	3	**0**	425	864	3	1541	1972	**2410**	3?	1544	2?	1110
*3611.357	25	3	**0**	940	**1793**	5	**−134**	805:	1780	3	1734	2	2644
*3606.70	80	3	**0**	301	606	4	2046	2366	**2680**	3	2054	2	1744
*3603.20	200	4	812	1197	**1609**	8	**1441**	**1835**	2230	4	1834	4	1434
3596.85	20	1	**0**	m	m	6	**462**	603	755	4?	908	3?	1058
3591.312	20	1	**0**	S		1	**1603**	S					
3590.146	15	5	**0**	155	302	7	1220	1371	**1527**	5	908	4	755
3587.14	4	4	**0**	255	521	5?	**0?**	234	499	4?	755	3?	1013
3573.92	10	2	**0**	133	m?	2	**910**	1047	m	3?	1181:	2?	1316:
3570.10	40	1	**0**	D		1	**1031**	A					
*3562.174	20	4	**0**	309	585	3	**1493**	1770	2068	3	2070	2	2363
*3552.516	100	1	**594**	B		5	**1606**	1727	1853	5	1725	5	1608
3549.71	20	1	**0**	D		1	**1405**	B?					
3549.6	8	0	**m**			1	**1390**	C?					
3543.85	60	1	**0**	D		1	**1160**	A					
3543.11	6	2	184	**353**		5	947:	1140:	1332:	2?	1327:	2?	1444:
*3542.152	80	2	284	**569**		4	**2380:**	**2644**	2901	2	2642	2	2364
*3538.08	40	4	1082:	1483	**1847**	8	1413	**1782**	2160	5	1783	5	1413
3537.74	15	1	**0**	D		1	**1092**	B					
3534.12	20	1	**189**	B		1	**1258**	C		4?	1282	4?	1234
3531.79	15	1	**123**	B		1	**1312**	C		4?	1328	4?	1296
*3531.151	60	5	875	1168	**1450**	10	1213	**1507**	**1787**	5	1791	5	1501
3527.87	30	5	**0**	235	500	6	**250**	497:	724	5	1202	4	1439
3526.648	8	5	**0**	296	617	6	**327**	588	879	5	1482:	4	1779:
*3521.09	100	3	**0**	134	260	3	**1001**	1106:	m	6	1655	5	1786
3520.14	8	1	**0**	D		1	**1390:**	A					
3518.482	25	1	**0**	D		1	**779**	A					
3511.163	10	1	**0**	D		1	**1077**	B					
*3511.03	60	1	**574**	B		6	1551:	**1653**	1762	6	1659	6	1756
*3508.852	20	1	**0**	D		1	**1621**	A		5	1726	4	1746
*3505.30	20	3	**0**	538	1079	5	**907**	1437	1979	3	1973	2	2511
3497.65	5	4	**0**	836	1630:	4	1526	2325	**3177**	3?	1518	2?	690
3495.13	15	6	**0**	231	442	10	**060**	305	534	6	1201	5	1426

TABLE VII.—*Continued.*

λ	Arc Int.	No. Meas.		π		No. Meas.		σ		J_1	Obs. g_1	J_2	Obs. g_2
3491.11	12	4?	**0**	322	641	5	**748**	1079	1390	4?	1715	3?	2037
3489.25	25	5	**0**	222	444	9	**729**	953	1182	5	1596:	4	1810:
*3488.301	30	2	**0**	262		3	**2130**	2624	3150	2	2635	1	3155
3485.16	15	3	**0**	212	437	6	**751**	965	1189	4	1393	3	1176
3481.62	30	4	**0**	399	799	6	**424**	815	1213	4	1614	3	2014
*3476.604	30	5	**0**	384	709	6	**117**	471	833	5	1532	4	1884
3474.50	15	5	**0**	403	806	7	**−197:**	197:	621	5	1422	4	1824
3469.28	30	1	**0**	*D*		1	**828**	*B*					
3466.86	20	4	**0**	642	1270	6	**−539**	105	725	4	1374	3	2010
*3461.38	80	3	**0**	715	1440	5	**491**	1200	1922	3	1920	2	2637
*3457.56	30	3?	**0**	432	810	?	*m*	*m*	*m*	?		?	
3453.474	50	4	**0**	210	437	5	1299	1510	**1730**	4	1084	3	868
3446.37	20	1	**0**	*D*		1	**1458**	*A*					
*3445.176	30	1	**0**	*D*		1	**2155**	*B*		(3)	(2062)	2	2016
*3440.999	80	4	**0**	312	592	7	**850**	1129	1450	4	1753	3	2053
*3440.820	30	2	**0**	652		3	**1740**	2375	3002	(2)	(2312)	1	2962
3435.72	30	1	**0**	*D*		1	**1430**	*B*					
3435.05	40	1	**0**	*D*		1	**1165**	*A*					
*3427.757	15	1	**943**	*B*		4	**1860**	**2318**	2762	2	2310	2	1844
*3425.022	80	1	**156**	*B*		1	**1639**	*C*		6	1652	6	1626
3423.09	60	1	**0**	*D*		1	**1273**	*C*?					
*3421.68	25	4	**0**	154	324	0	*m*	*m*	*m*	(3)	(1943)	2	2094
3421.231	12	1	**0**	*D*		1	**1091?**	*B*					
3419.845	25	5	**0**	208	412	5	**597:**	805	990	5	1427	4	1635
T3418.809	(8)	3	259	521	**805**	5	573	702	836:	3	1734	3	1472
3417.42	10	1	**273**	*B*		1	**1374**	*C*		4?	1340	4?	1408
3416.73	60	1	**0**	*S*		1	**1413:**	*A*					
3412.72	60	5	**0**	192	391	7	**585?**	777:	974:	5	1168:	4	1350:
3406.14	25	6	**0**	453	860	?	*m*	*m*	*m*				
3405.43	15	1	**605**	*S*		2	344	964		1	347	1	961
*3396.58	200	5	**0**	156	320	9	**1034**	1189	1349	5	1662	4	1819
*3391.989	100	4	**0**	368	738	4	**595**	980	1338	4	1704	3	2074
3390.783	80	1	**0**	*D*		1	**939**	*A*					
3373.22	25	1	**150**	*B*		1	**1286:**	*C*?					
3370.52	8	1	**296**	*B*		1	**1277:**	*C*					
*3369.055	200	5	**0**	124	284	4	**1203**	*A*		6	1639	(5)	(1726)
*3367.635	40	3	291	623	**946**	6	1717:	2041:	2343	(3)	(2062)	3	2374 or 1750
3355.42	20	1	**0**	*D*		1	**1328**	*A*					
*3338.75	80	5	**0**	321:	672	6	**0**	375	722	5	1447	4	1805
3338.49	30	1	**142**	*B*		1	**1217**	*C*?					
3336.51	15	1	**0**	*D*		1	**1368**	*S*					
3333.66	10	1	**0**	*D*		1	**967**	*S*					
3331.21	15	3	**0**	459	887	5	**197**	644	1122	3	1088	2	1538
3328.05	15	1	**418**	*B*		5	905	**1062**	1206	3?	1209:	3?	1059:
3325.97	30	1	**0**	*D*		1	**1327**	*B*					
*3321.857	100	1	**0**	*D*		1	**1647**	*C*?		(6)	(1659)	5	1661:
*3313.33	400	1	**182**	*B*		1	**1840**	*C*		4	1862:	4	1818:
*3308.02	200	6	**0**	463	915	8	**−529**	−109	456	5	1414	4	1875
3304.497	50	3	373	598	**735:**	6	1546	1735	1924	4	1732	4	1540 or 1924
*3301.95	150	5	**0**	373	730	mess				5	1517	(4)	(1877)
3298.30	25	1	**0**	*D*		1	**1447**	*A* and *B*					
*3277.78	600	3	**0**	429	875	4	**1453**	1815	2205	(3)	(2195)	2	2631:
3269.39	5	1	**0**	*D*		1	**1282**	*A*					
*3266.39	200	4	**0**	374	735	5	**764:**	1093:	1442	4	1815	3	2176
3265.69	10	1	**0**	*D*		1	**1335**	*A*					
3263.48	6	5	**0**	340	655:	8	1650	1992	2300	5	1075:	4	755: or 1395:
3262.59	10	1	**0**	*D*		1	**1042**	*A*					
3259.38	3	1	**199**	*B*		1	**1390:**	*C*?		6?	1406:	6?	1374:
3258.68	20	1	**640**	*B*		1	**1525**	*C*		9?	1561	9?	1489
3251.44	20	1	**0:**	*D*		1	**1094**	*A*					
3235.81	4	1	**0**	*D*		1	**1269**	*A*					
3232.315	20	6	**0**	186	366	6	**550**	738:	940	6?	1544	5?	1743
*3221.694	30	3	**0**	282	567	4	**1172**	1452	1740	3	1738	2	1455
3207.31	20	4	**0**	291	604	6	**326**	667	1000	4	1288	3	1598
3187.03	6	4?	**0**	190	368	?	*m*	*m*	*m*	?		?	
3179.23	4	1	**101**	*B*		1	**1553**	*C*?					
*3173.607	100	1	**0**	*D*		1	**1929**	*S*		(4)	(1984)	3	2002
3172.89	4	1	**0**	*D*		1	**1412**	*B*					
*3171.942	50	4	482	614:	**802:**	7	1424	**1590**	1755	5	1588	5	1428 or 1748
3170.964	10	1	**0**	*D*		1	**1390**	*A*?					
*3170.409	50	1	**0**	*D*		1	**1784**	*B*		(4)	(1628)	3	1576
3166.49	25	1	**0**	*D*		1	**1680**	*B*					
3149.88	60	5	**0**	194	397	5	**1112?**	1312	1523	5	1914:	4	2113:
3149.41	5	1	**0**	*D*		1	**1037**	*S*					
*3144.207	15	2	567:	**1301**		4	650	**1327**	**1975?**	2	1974	2	1319
3140.356	15	3	319	657	**974**	6	1548	**1881**	2200	3	1877	3	1553
3130.73	80	4	**0**	139	*m*	8	**713**	820	966	5	1238	4	1373
3117.99	15	1	**0**	*D*		1	**1860**	*B*					
*3113.02	30	1	**0**	*D*		1	**2069**	*B*		(3)	(1728)	2	1558
*3097.45	100	3	**0**	286	*m*	4	1978	2270	**2595:**	3	1979	2	1690
*3077.358	200	4	342	504	**652**	8	**1828**	**1982**	2140	4	1824	4	1987
3076.069	30	1	**478**	*B*		5	1447:	**1580:**	**1691:**	4	1683:	4	1564:
3070.46	6	3	**0**	155	300	4	**1152**	1328:	1472:	4	1624	3	1777
*3069.110	50	5	**0**	416	843	6	**222**	602	1048	5	1461	4	1881
*3054.94	600	1	**162**	*B*		1	**2018**	*C*		(3)	2045	3	1991
*3042.53	4	3	**0**	374	774	3	**0?**	487:	860	?		?	
3035.38	10	3	**0**	388	814	4	2011:	2429	**2840:**	3	2031	2	1627
3025.503	12	3	**0**	679	1354	4	**261**	936	**1611**	3	1617	2	2294

TABLE VII.—*Continued.*

λ	Arc Int.	No. Meas.		π		No. Meas.		σ		J_1	Obs. g_1	J_2	Obs. g_2
3017.974	12	3	0	188	358	3	765	943	1108:	3?	1132	2?	1317
3012.385	40	1	0	D		1	1596	B					
*3010.496	4	3	0	253	502	4	1029	1285	1537	3	1536	2	1788
3009.54	12	4	0	145	296	4	785	871	1021	4?	1317	3?	1465
*3006.26	80	3	315	635	959	6	1665	1988	2291	3	1982	3	1665
*3004.80	20	3	0	665	1322	2	647	1291:		3	1981	(2)	(2641)
2998.14	10	1	041	B		1	1260:	C					
*2995.221	50	1	0	S		1	1930	S		4	1968	(3)	(1981)
*2991.33	300	5	0	272	545	9	630	896	1162	5	1710	4	1982
2990.68	3	1	0	S		1	1948:	C					
2986.92	12	4	0	243	495	5	355	m	827	5?	1340	4?	1594
2978.950	20	1	0	D		1	1810	B					
2973.42	5	6?	0	m	572:	6	2508	2750	3026:	5?	2025:	4?	1784:
*2966.52	10	2	0	884		3	1104	1990	2848	2	1990	1	2874
2963.76	4	1	0	D		1	1297	B?					
*2960.21	300	1	0	D		1	1991	A		(3)	(1981)	3	2001
*2959.47	80	4	820	1254	1690:	7	1588	1998	2438	4	2004	4	1585
2956.15	6	3	0	181	373	4	880	m	1251	5?	1613	4?	1796
*2952.68	600	1	0	D		1	1734	C?		4	1909:	(3)	(1981)
*2949.12	25	3	510:	1110:	1658:	6?	932	1480	2008:	(3)	(1981)	3	1434
2948.68	6	3	0	207	395	4	668	867	1069	3	1069	2	1270
*2947.29	100	4	0	314	622	5	2309	2616	2933	4	1993	3	1681
*2940.82	15	4	0	399	801	7	470	847:	1271	4	1672	3	2071
2939.50	6	4	450	684	890	5	1253:	1487:	m	4	1710	4	1483
2932.53	12	1	0	D		1	1316	A or B					
*2925.04	600	1	0	D		1	2080	B		4	2006	(3)	(1981)
2922.56	4	1	0	D		1	1067	A					
*2917.439	30	4	0	398	786	5	412	812	1136	4	1591	3	1984
*2906.68	1000	1	0	D		1	1819	A		(4)	(1984)	3	2026
2904.96	3	2	624	1243		?	m	m	m	2		2	
*2893.83	300	4	0	680	1380	6	2671	3347	4030	4	1992	3	1315
*2887.85	60	4	772	1160	1539	8	1600	1989	2375	4	1990	4	1603
2878.25	4	1	117	B		1	1657:	C					
*2876.06	60	4	0	506	999	7	−024:	459	952	4	1474	3	1983
2874.86	4	3	m	182	383	7	1714:	1908:	2079:	5?	1360:	4?	1179:
*2871.57	12	5	0	236:	454	6	685	909	1132:	5	1589	4	1815
2869.05	3	3	248	465	683	0				3		3	
2867.18	2	2	m	515	734	0				3		3	
*2864.42	20	1	124	B		1	1642	C		6	1663	6	1621
*2862.57	500	4	0	321	640	7	2312	2640	2940	4	1991	3	1673
*2859.67	300	3	193:	363	518	6	1993	2160	2340	3	2166	3	1993
2852.05	15	1	288	B		1	1587	C					
2850.40	3	1	0	S		1	1334	S					
*2843.96	60	3	553	1110	1668	6	1423	1982	2537	3	1983	3	1428
2841.36	2	1	0	D		1	1641	B					
2840.14	4	1	0	D		1	1058	A					
*2833.26	125	4	0	515	1037	7	−055	430	948	4	1461	3	1975
*2829.30	125	3	0	170	365	5	1646	1810	1980	3	1985	2	2165
*2828.72	500	4	0	283	565	6	842:	1124	1408	4	1692	3	1975
2827.26	30	5	0	421	847	3	−134	271	713	5	1543	4	1963
*2820.78	800	1	0	D		1	1918	A		(4)	(1984)	3	2028
*2816.18	500	3	261	509	749	6	1738	1982	2232	3	1987	3	1733
*2813.94	1200	1	357	B		1	1900:	C		(4)	(1984)	4	1895
2813.083	40	1	0	S		1	1985	S					
*2811.75	200	1	0	D		1	1712	A		4	1904	(3)	(1981)
*2802.84	600	3	0	230	459	5	1530	1753	1978	3	1979	2	2206
*2781.93 }	400	3	756:	1179	1601	5	1214:	m	m	4	1986	4	1591
*2781.89 }		3	264	514	762	6	1733	1986	2239	3	1987	3	1734
*2752.17	150	4	0	658	1300	6	−700	−051	597	4	1322	3	1972
*2747.286	100	4	0	555	1077	6	m	355:	870	4	1437	3	1982
*2744.26	200	4	1012	1514	2039:	8	965	1463	1979	4	1979	4	1470
*2740.62	200	3	0	382	765	5	1228	1603	1990	3	1984	2	2364
2730.93	5	1	117	B		1	1572	C					
*2729.44	300	3	245:	563	844	6	1425	1705	1979	3	1703	3	1983
*2729.33	300	3	(0)	150	334		m	m	m	(4)	(1984)	3	2176:
*2727.78	800	3	0	242	m	7	m	m	1261	5	1739	4	1969
*2716.98	400	3	254	508	751	6	1244	1479	1731	3	1725	3	1975
*2705.28	150	4	1031	1560	2073	8	1468	1984	2500	4	1982	4	1465
*2701.90	400	5	0	393	790	7	067:	m	746	5	1567	4	1971
*2701.14	250	4	587	874	1147	8	1697:	1988	2273:	4	1990	4	1702
2695.60	5	1	0	S		1	1820	S					
*2692.03	250	1	147	B		1	1957	C		(3)	1972	3	1923
*2685.66	200	1	324	B		1	1929	C		(4)	(1984)	4	1904
*2678.29	200	4	0	414	824	6	319	736	1146	4	1566	3	1980
*2668.34	300	4	0	219	438	6	1059:	1290	1518	4	1739	3	1960
*2658.41	20	3	0	248	476:	0				(4)	(1984)	3	1742
2653.613	40	4	0	1038	2060	4	1130	2172	3095	4	950	3	1990
*2641.27	250	4	0	262	524	8	680	925	1189	5	1712	4	1973
*2638.77	400	4	0	279	562	7	845	1117	1400	4	1685	3	1965
*2635.50	60	5	0	528	1062	6	−650	−133	402	5	1460	4	1990
*2626.776	25	2	..	1670	2185		m	m	m	(4)	(1984)	4	1436
2604.608	40	3	0	194	338	4	1993	2266	2380	3	2008	2	1831
*2600.26	10	2	863	1787		4	237	1110	2018	2	1997	2	1115
*2592.61	10	2	915	1770		2	1083	2000	m	2	1994	2	1090
*2585.76	12	1	0	S		1	2965	S		1	2965	0	0/0
*2581.86	30	3	0	547	1043	5	413	930	1460	3	1464	2	1984
*2577.56	20	3	0	403	791	0	m			5	1586:	(4)	(1984)
*2577.14	150	1	0	D		1	1010	A		6	1485	(5)	(1580)
*2574.76	30	3	300	564	827	6	1185	1457	1737	3	1731	3	1455
*2568.53	20	1	1463			2	1497	2978		1	1502	1	2974
*2568.17	80	4	0	258	524	6	681	936	1203	4	1464	3	1724
*2564.17	125	4	0	166	340	6	807	947	1117	5	1455	4	1623

TABLE VII.—*Continued.*

λ	Arc Int.	No. Meas.	π			No. Meas.	σ			J_1	Obs. g_1	J_2	Obs. g_2
*2563.48	10	*2*	**0**	500		*3*	1498:	1962:	**2420:**	2	1966:	1	1486:
*2559.18	80	*3*	263:	448:	**660**	*8*	1304	1467	**1631**	4	1469	4	1633
*2557.54	25	*3*	360	721	**1080**	*6*	1025	**1374**	**1730**	3	1738	3	1381
*2554.781	50	*1*	**571**	*B*		*1*	**1580**	*C*		5	1580	5	1466
*2547.243	15	*2*	**0**	1522		*3*	**0**	1449	2980	2	1451	1	2977
*2542.262	40	*2*	560	**1077**		*4*	**910**	1448	2003	2	1993	2	1451
2538.52	4	*1*	**0**	*D*		*1*	**1907**	*B*?					
2531.79	8	*4*	**0**	425	842	*3*	**493**	940	1406	4	1774	3	2197
*2513.76	5	*1*	**0**	*D*		*1*	**1884**	*S*		4	1957	(3)	(1981)
*2499.391	50	*2*	*m*	993	**1448**	*4*	1028	**1498**	2005	3	1505	3	1988
*2490.46	10	*3*	**0**	264:	496:	*1*	**1260**	*A*		3	1736	(2)	(1981)
*2454.944	60	*1*	**0**	*S*		*1*	**1990:**	*S*		(3)	(1981)	2	1976
*2407.492	40	*1*	**0**	*S*		*1*	**1984**	*S*		(3)	(1981)	3	1987
*2398.916	10	*2*	473	**964**		*4*	1012	**1499**	1991	2	1994	2	1503
*2390.43	8	*1*	**1479**			*1*	1437	2962		*1*	1486	1	2965

three strongest of them (others being omitted for economy's sake) in units of $0.001a$. The strongest component is in heavy type. The letters *B* and *D* denote unresolved patterns strongest at the outer edges or at the center.[9] Components too faint to be recorded are indicated by dots $\cdots$, those masked by other lines by *m*. The fifth and sixth columns give similar data for the σ-components—giving the number of components observed on one side of the center, i.e., in the $\sigma+$ or $\sigma-$ group, whichever is the better observed. Unresolved patterns strongest on the inner edge, the outer edge, or at the center are denoted[9] by *A*, *B* and *C*, sharp components by *S*.

The last four columns give the values of J and g for the two terms involved in each line. For completely resolved patterns, these are derived from the data for the individual line: otherwise, the values of J and g, or both, found for one term in other ways are used to find g for the other. Such assumed values are given in parentheses. Doubtful values are marked by colons. In some cases where the g values are ambiguous by a multiple of Δg, two values are given. These g values have not been corrected for the scale-factor discussed in Section 11. "*T*" precedes lines taken from Albertson's list.

V. Tables

(13) *Energy levels.* The levels finally accepted as real are found in Table VIII, which gives the designation, the adopted value, and the mean value of g, with the number of lines on which this is based. The whole number of energy levels is 156; of g values, 118.

It may be noted that, though $e^9D^\circ_3$ is well defined by four good combinations, all four lines are so blended on the Zeeman plates that no g value could be found; and that two of the three combinations of $f^7D^\circ_3$ fall on strong lines shown by Zeeman effect and term analysis to belong elsewhere. The position of the level in the middle of a narrow multiplet is the reason for its inclusion. The level 125_7 depends on a single strong line λ3622.54. The combination $a^9D^\circ_6 - f^6d^2\ {}^9F_7$ should give a strong line in this vicinity checked by no other combinations. The observed g value is 1.576 and the theoretical 1.571,—strongly supporting this identification.

(14) *Unclassified lines.* Table IX gives particulars regarding those lines of Eu II of intensity 50 or more which have not been classified. The Zeeman patterns and g values show that most of these must belong to the undecipherable part of the spectrum described in Section 5.

(15) *Lines of* Eu I. The arc in a magnetic field (as is well known) shows only the strongest lines of neutral atoms of low ionization potential. A few of the strongest lines of Eu I are measured upon the films, with the results given in Table X. The theoretical g values are 2.000 for ${}^8S$ and 1.778, 1.937, 2.286 for the components of ${}^8P$. The correction found in Section 11 will produce an almost exact agreement.

(16) *Lines of* Eu III. Dr. King has kindly communicated by letter a list of the strongest lines of the high excitation spectrum, in the region covered by our Zeeman data. Patterns have been observed for seven of these. Two are completely resolved, and show that both lines

[9] W. F. Meggers and H. N. Russell, J. Research Nat. Bur. Stand. **17**, 131 (1936).

TABLE VIII. *Levels in* Eu II.

Designation		Level	g	No.
	$a^9S^\circ_4$	*0.00*	1.984	19
	$a^7S^\circ_3$	*1669.21*	1.981	23
	$a^9D^\circ_2$	*9923.00*	2.641	7
	$_{3}$	*10081.65*	2.062	8
	$_{4}$	*10312.82*	1.842	5
	$_{5}$	*10643.48*	1.726	7
	$_{6}$	*11128.22*	1.659	2
	$a^7D^\circ_5$	*16860.72*	1.592	4
	$_{4}$	*17004.06*	1.628	2
	$_{3}$	*17140.87*	1.728	2
	$_{2}$	*17247.67*	1.981	3
	$_{1}$	*17324.66*	2.972	3
	z^9P_3	23774.28	2.195	7
	$_{4}$	24207.86	1.877	10
	$_{5}$	26172.83	1.789	8
	z^7P_4	26838.50	1.801	13
	$_{3}$	27104.07	1.943	5
	$_{2}$	27256.35	2.312	4
	z^9D_2	30189.31	2.511	1
	$_{3}$	31500.82	2.002	1
	$_{4}$	32486.10	1.824	1
	$_{5}$	33420.20	1.710	1
	$_{6}$	34764.97	1.687:	1
101_4		33779.95	1.565	1
102_3		33919.70	1.681	1
103_2		33944.49	1.690	1
	y^9P_3	34393.57	2.037	5
	$_{4}$	35527.02	1.898	5
	$_{5}$	36648.95	1.749	2
104_3	z^9H_3?	34546.10	1.307	2
105_4		34617.73	1.603	1
106_3	z^9G_3?	34923.43	1.669	2
107_4		35045.98	1.966	2
108_3	z^9F_3?	35440.88	2.004	2
109_3		35567.74	1.434	1
	z^7D_2	35846.96	1.931	1
	$_{3}$	37167.90	1.733	1
	$_{4}$	37010.70	1.702	4
110_4	z^9F_4?	35935.81	1.591	2
111_4	z^9H_4?	36428.89	1.472	2
	x^9P_3	36628.00	2.163	5
	$_{4}$	37223.78	1.892	6
	$_{5}$	37849.34	1.715	3
112_3		36821.20	1.428	1
113_4	z^9G_4?	36954.00	1.463	2
114_5	z^9F_5?	37000.00	1.578	2
115_2		37003.23	2.151	2
	y^7P_2	37336.83	2.196	2
	$_{3}$	38804.98	1.916	2
	$_{4}$	39134.72	1.746	4
116_6		37583.63	1.775	1
117_3		37605.51	1.735	4
$118_{3,4}$		37622.87		
119_2		37799.89	1.744	1
120_5	z^9G_5?	37932.19	1.460	1
121_4		37993.64	1.322	3
122_4		38058.03	1.436	3
	x^7P_2	38146.44	2.364	3
	$_{3}$	38463.66	1.716	1
	$_{4}$	39554.43	1.694	3
123_3		38295.89	1.703	1
124_1	$^9F_1$	38582.08	3.155	1
125_7	$^9F_7$	38725.32	1.576:	1
126_5		38784.47	1.601	2
127_4		38995.52	1.566	3
128_2		39099.43	2.016	1
129_6		39601.80	1.756	1
130_3		39767.55	1.750 or 2.374	2
131_6		40316.92	1.632	2
132_4		40870.72	1.892	1
133_6		41099.11		
134_5		41223.24	1.661	1
135_4		41438.13	1.694:	1
136_4		41666.81	1.505	1
137_4		41714.84		
138_2		42391.03	1.935	1
	y^9D_2	42438.56		
	$_{3}$	43193.46	1.987	1
	$_{4}$	44075.84	1.672	1
	$_{5}$	45126.78	1.602	2
	$_{6}$	46029.14	1.621	1
139_4		42710.14		
$140_{3,4}$		42939.45		
$141_{4,5}$		43461.07		
142_5		43643.12	1.645:	1
143_5		44947.15		
144_4		46032.03	1.418: :	1
145_4		46584.45		
146_2		48171.51	1.455	1
$147_{1,2}$		48180.68		
148_5		48378.03	1.748 or 1.428	1
149_2		48522.28		
150_3		48536.61	1.576	1
151_4		48872.85		
152_3		48910.95		
$153_{4,5}$		49003.10		
154_2		49043.00	1.319	2
	$e^9S^\circ_4$	*49128.03*	1.985	5
155_2		49254.68	1.558	1
156_3		49480.46		
	$e^7S^\circ_3$	*49646.62*	1.974	2
157_2		49720.89		
158_1	$^7D_1$	50947.46	2.874	1
	$e^7F^\circ_5$	*52963.40*	1.526	2
	$_{4}$	*53150.34*	1.552	2
	$_{3}$	*53490.44*	1.525	1
	$_{2}$	*53861.26*	1.563	1
1^0_4		*53783.01*	1.875:	1
	$e^9D^\circ_2$	*54273.98*	2.620:	1
	$_{3}$	*54320.69*	1.912	1
	$_{4}$	*54380.30*	1.807	4
	$_{5}$	*54484.27*	1.507	3
	$_{6}$	*54565.04*	1.655	1
	$e^7D^\circ_5$	*54428.76*	1.414	1
	$_{4}$	*54295.02*		
	$_{3}$	*54589.10*		
	$_{2}$	*54490.63*		1
	$_{1}$	*54435.41*	2.852	1
$2^0_{3,4}$		*54600.07*		
3^0_3		*55156.18*		
4^0_3		*55193.08*		
5^0_3		*55559.02*		
	x^7F_6	55651.82	1.490	1
	$_{5}$	55991.33	1.460	2
	$_{4}$	56067.39	1.466	2
	$_{3}$	55967.88	1.460	2
	$_{2}$	56571.04	1.451	2
	$_{1}$	56245.61	1.494	2
	$_{0}$	55986.45	0/0	1
159_2		55693.94	1.115	1
160_2		55807.25	1.090	1
$6^0_{3,4}$		*56158.66*		
161_3		56229.17	1.381	1
	$f^7D^\circ_5$	*56271.40*	1.662	1
	$_{4}$	*56293.33*	1.649:	1
	$_{3}$	*56309.21*		
	$_{2}$	*56321.27*	1.792:	1
	$_{1}$	*56310.89*	2.962	1
$7^0_{2,3}$		*56421.62*	1.844	1
8^0_5	$^7D^\circ_5$?	*56781.20*	1.454	2
$9^0_{3,4}$		*57127.26*		
10^0_4		*57270.14*		
$11^0_{3,4}$		*57360.05*		
$162_{1,2}$		57363.68		
163_3		57388.87	1.736:	2
$164_{2,3}$		57415.06		
$165_{3,4}$		57634.02		
166_2		58920.64	1.502	1
12^0_3		*59045.49*	2.061	2
167_1		59145.26	1.486	1
168_2		59334.70		
$169_{4,5}$		59343.45		
13^0_3		*59765.77*		
$170_{3,4}$		59995.34		
	$f^9S^\circ_4$	*66598.00*		
	$f^7S^\circ_3$	*66836.16*		

TABLE IX. *Strongest unclassified lines of* Eu II.

λ	Arc Int.	Temp. Class	Wave No. cm^{-1}	J_1	g_1	J_2	g_2
4644.23	50	V	21526.09	–	—	–	—
3861.18	80	V E	25891.50	–	—	–	—
3843.15	50	V E	26012.97	7?	1.439:	7?	1.367:
3815.495	80	V E	26201.51	4	1.388	3	1.554
3781.40	50	V E	26437.75	5	1.229:	4	1.343:
3760.33	50	V E	26585.88	5?	1.707	5?	1.505
3738.08	80	V E	26744.12	–	—	–	—
3717.69	80	V E	26890.80	4	1.496	4	1.709 or 1.283
3716.937	60	V E	26896.25	4	1.268:	3	1.480:
3687.78	80	V E	27108.90	–	—	–	—
3679.500	80	V E	27169.90	3	1.626	2	1.447
3621.890	50	V E	27602.05	4	.495	3	.742
3543.85	60	V E	28209.87	–	—	–	—
3453.474	50	V E	28948.09	4	1.084	3	.868
3423.09	60	V E	29205.03	–	—	–	—
3416.73	60	V E	29259.39	–	—	–	—
3412.72	60	V E	29293.77	5?	1.100::	4?	1.290::
3390.783	80	V E	29483.28	–	—	–	—
3149.88	60	V E	31738.08	5	1.914?	4	2.113?
3130.73	80	V E	31932.21	5	1.238	4	1.373
3022.148	60	V	33079.44	not on films			
2673.424	60	V E	37394.12	" " "			
2347.05	50	V	42593.61	" " "			

involve a term with $J=3\frac{1}{2}$ and $g=1.985$, which is evidently the ground term $f^7\ a^8S^\circ_{3\frac{1}{2}}$ of Eu III. The other four patterns are consistent with origin from the same level, as shown in Table XI.

The wave-lengths are taken from the M.I.T. list,[10] the intensities estimated by King on his spark spectra. The wave number of each line evidently determines an even level of Eu III. These must arise from the configuration f^6d. Further analysis of the spectrum must await measures, which have been made only on the few lines which occur on the M.I.T. spectra, taken with lower excitation.

[10] G. R. Harrison, Massachusetts Institute of Technology *Wavelength Tables* (J. Wiley and Son, New York, 1939).

(17) *Classified lines of* Eu II. The final results of this investigation are found in Table XII, which lists 467 classified lines. Though only 25 percent of the known spark lines are included, they comprise much the greater part of the total intensity of emission.

A very great many additional terms and lines are to be anticipated theoretically, and might be observed, if europium were not one of the rarest of the elements. Thanks to the generosity of Dr. McCoy, Dr. King had an unusually large amount of material available. It is probable,

TABLE XI. *Lines of* Eu III.

λ	Int.	Patterns	J_1	g_1	J_2	g_2
2522.17	20	(**199**, **589**, **990**) ··· 1790, 2180, 2580, **2962**	$3\frac{1}{2}$	1.980	$2\frac{1}{2}$	1.592
2513.79	400	(0) **1.884**	($3\frac{1}{2}$)	(1.985)	$4\frac{1}{2}$ $2\frac{1}{2}$	1.963 2.025
2446.04	500	(**367**) **1938**	($3\frac{1}{2}$)	1.990	$3\frac{1}{2}$	1.895
2444.39	200	(0) **1.880**	($3\frac{1}{2}$)	(1.985)	$4\frac{1}{2}$ $2\frac{1}{2}$	1.961 2.027
2435.19	15	(**160**, **418**, **732**) too faint	($3\frac{1}{2}$)	(1.985)	$2\frac{1}{2}$ $2\frac{1}{2}$	1.965 2.275
2375.46	500	(**108**, **337**, **561**, **785**) **974**, 1187, 1410, ···	($3\frac{1}{2}$)	(1.986)	$4\frac{1}{2}$	1.762
2350.53	20	(···, 625, **866**) too faint	($3\frac{1}{2}$)	(1.985)	$3\frac{1}{2}$ $3\frac{1}{2}$	1.860 2.110

TABLE X. *Lines of* Eu I.

λ	Int.	Pattern	J_1	g_1	J_2	g_2	Designation
6018.15	2500	(**98**, 297, 480) **1105**: 1390: ···	$4\frac{1}{2}$	1.783:	$3\frac{1}{2}$	1.977:	$a^8S^\circ_{3\frac{1}{2}}-z^8P_{4\frac{1}{2}}$
4661.88	7000	(**139**, 417, 700) **1154**, 1404, 1650, 1898+···	$3\frac{1}{2}$	1.988	$2\frac{1}{2}$	2.266	$a^8S^\circ_{3\frac{1}{2}}-y^8P_{2\frac{1}{2}}$
4627.22	8000	(···, **218**) **1.934**:	($3\frac{1}{2}$)	(1.985)	$3\frac{1}{2}$	1.924	$a^8S^\circ_{3\frac{1}{2}}-y^8P_{3\frac{1}{2}}$
4594.03	10000	(**106**, 332, 554, 767) **999**, 1217, 1437, 1656+	$4\frac{1}{2}$	1.760	$3\frac{1}{2}$	1.982	$a^8S^\circ_{3\frac{1}{2}}-y^8P_{4\frac{1}{2}}$
3334.33	600	(0) **1.837**	$4\frac{1}{2}$	1.952	($3\frac{1}{2}$)	(1.985)	$a^8S^\circ_{3\frac{1}{2}}-106_{4\frac{1}{2}}$
3213.75	200	(0) **1.443**	($3\frac{1}{2}$)	(1.985)	$2\frac{1}{2}$	2.202	$a^8S^\circ_{3\frac{1}{2}}-112_{2\frac{1}{2}}$
3111.43	500	(**124**, 365, 624) **886**, 1130, 1367, 1629+	$4\frac{1}{2}$	1.750	$3\frac{1}{2}$	1.997	$a^8S^\circ_{3\frac{1}{2}}-115_{4\frac{1}{2}}$

TABLE XII. *Classified lines of* Eu II.

λ	Arc Int.	Temp. Class	Wave No. Vac.	Multiplet Designation
10165.61	5	V E	9834.40	$a^7D^\circ_4-z^7P_4$
10142.99	2	V E	9856.33	$a^7D^\circ_2-z^7P_3$
10066.03	8	V E	9931.68	$a^7D^\circ_1-z^7P_2$
10034.22	12	V E	9963.17	$a^7D^\circ_3-z^7P_3$
10019.58	30	V E	9977.72	$a^7D^\circ_5-z^7P_4$
9988.65	15	V E	10008.62	$a^7D^\circ_2-z^7P_2$
9898.30	40	V E	10099.98	$a^7D^\circ_4-z^7P_3$
9883.16	10	V E	10115.45	$a^7D^\circ_3-z^7P_2$
7455.52	2	V E	13409.19	$x^7P_4-e^7F^\circ_5$
7426.57	1500	IV E	13461.45	$a^9D^\circ_4-z^9P_3$
7370.22	2500	IV E	13564.38	$a^9D^\circ_5-z^9P_4$
7301.17	2500	IV E	13692.67	$a^9D^\circ_3-z^9P_3$
7217.55	1500	IV E	13851.30	$a^9D^\circ_2-z^9P_3$
7194.81	1500	IV E	13895.08	$a^9D^\circ_4-z^9P_4$
7077.10	3000	IV E	14126.19	$a^9D^\circ_3-z^9P_4$
6645.11	8000	III E	15044.51	$a^9D^\circ_6-z^9P_5$
6437.64	4000	III E	15529.36	$a^9D^\circ_5-z^9P_5$
6303.41	2000	IV E	15860.05	$a^9D^\circ_4-z^9P_5$
6173.05	2000	IV E	16194.98	$a^9D^\circ_5-z^7P_4$
6049.51	2000	IV E	16525.70	$a^9D^\circ_4-z^7P_4$
5987.5	1 −	V	16696.8	$a^7D^\circ_2-103_2$
5966.07	1200	IV E	16756.82	$a^9D^\circ_3-z^7P_4$
5953.84	80*	V E	16791.24	$a^9D^\circ_4-z^7P_3$
5872.98	500	IV E	17022.42	$a^9D^\circ_3-z^7P_3$
5820.91	25*	V E	17174.69	$a^9D^\circ_3-z^7P_2$
5818.74	1000	IV E	17181.10	$a^9D^\circ_2-z^7P_3$
5794.61	6	V E	17252.64	$a^7D^\circ_3-y^9P_3$
5767.61	10	V E	17333.41	$a^9D^\circ_2-z^7P_2$
5749.02	3	V E	17389.46	$a^7D^\circ_4-y^9P_3$
5675.9	1 −	V	17613.5	$a^7D^\circ_4-105_4$
5437.36	1	V E	18386.18	$a^7D^\circ_3-y^9P_4$
5397.35	3	V E	18522.48	$a^7D^\circ_1-z^7D_2$
5375.04	8	V E	18599.35	$a^7D^\circ_2-z^7D_2$
5355.73	10	V E	18666.41	$a^7D^\circ_5-y^9P_4$
5344.39	1	V E	18706.02	$a^7D^\circ_3-z^7D_2$
5183.2	1	V E	19287.7	$a^7D^\circ_3-111_4$
5158.48	1	V E	19380.17	$a^7D^\circ_2-x^9P_3$
5094.44	3	V	19623.79	$a^7D^\circ_4-x^9P_3$
5060.45	1	V	19755.60	$a^7D^\circ_2-115_2$
5052.11	1	V E	19788.21	$a^7D^\circ_5-y^9P_5$
5018.59	2	V	19920.38	$a^7D^\circ_2-z^7D_3$
4996.91	1	V E	20006.80	$a^7D^\circ_4-z^7D_4$
4995.61	6	V E	20012.01	$a^7D^\circ_1-y^7P_2$
4991.89	5	V E	20026.92	$a^7D^\circ_3-z^7D_3$
4976.44	6	V E	20089.10	$a^7D^\circ_2-y^7P_2$
4964.06	1 −	V E	20139.20	$a^7D^\circ_5-114_5$
4961.40	3	V E	20149.99	$a^7D^\circ_5-z^7D_4$
4958.00	2	V E	20163.81	$a^7D^\circ_4-z^7D_3$
4950.12	3	V E	20195.91	$a^7D^\circ_3-y^7P_2$
4909.49	3	V E	20363.04	$a^7D^\circ_5-x^9P_4$
4885.10	3	V E	20464.71	$a^7D^\circ_3-117_3$
4852.65	1	V E	20601.56	$a^7D^\circ_4-117_3$
4824.26	4	V E	20722.80	$a^7D^\circ_5-116_6$
4783.64	1	V E	20898.76	$a^7D^\circ_2-x^7P_2$
4749.64	4	V	21048.36	$a^7D^\circ_2-123_3$
4725.69	6	V E	21155.03	$a^7D^\circ_3-123_3$
4716.29	2	V E	21197.20	$a^7D^\circ_5-122_4$
4712.12	3	V E	21215.95	$a^7D^\circ_2-x^7P_3$
4695.35	4	V E	21291.73	$a^7D^\circ_4-123_3$
4688.51	3	V E	21322.79	$a^7D^\circ_3-x^7P_3$
4667.41	3	V E?	21419.18	$a^9D^\circ_3-z^9D_3$
4658.63	15	V E	21459.55	$a^7D^\circ_4-x^7P_3$
4633.07	8	V	21577.94	$a^9D^\circ_2-z^9D_3$
4614.63	6	V E	21664.16	$a^7D^\circ_3-y^7P_3$
4585.68	8	V E	21800.93	$a^7D^\circ_4-y^7P_3$
4576.93	10	V	21842.60	$a^9D^\circ_5-z^9D_4$
4575.0	2	V E	21851.8	$a^7D^\circ_2-128_2$
4545.45	3	V	21993.88	$a^7D^\circ_3-y^7P_4$
4539.24	12	V E	22023.97	$z^7P_3-e^9S^\circ_4$
4522.59	2000	II E	22105.05	$a^7S^\circ_3-z^9P_3$
4517.36	6	V E	22130.64	$a^7D^\circ_4-y^7P_4$
4508.66	10	V	22173.34	$a^9D^\circ_4-z^9D_4$
4488.28	15	V E	22274.02	$a^7D^\circ_5-y^7P_4$
4485.15	100	V E	22289.57	$z^7P_4-e^9S^\circ_4$
4484.67	8	V	22291.95	$a^9D^\circ_6-z^9D_5$
4464.97	200	V E	22390.30	$z^7P_2-e^7S^\circ_3$
4462.14	5	V E	22404.50	$a^9D^\circ_3-z^9D_4$
4435.58	3000	II E	22538.66	$a^7S^\circ_3-z^9P_4$
4434.81	20	V E	22542.57	$z^7P_3-e^7S^\circ_3$
4433.28	8	V	22550.35	$a^7D^\circ_4-x^7P_4$
4405.27	20	V E	22693.73	$a^7D^\circ_5-x^7P_4$
4389.2	2	V	22776.8	$a^9D^\circ_5-z^9D_5$
4383.17	200	IV? E	22808.15	$z^7P_4-e^7S^\circ_3$
4355.09	300	V E	22955.21	$z^9P_5-e^9S^\circ_4$
4320.98	2	V E	23136.42	$a^9D^\circ_4-101_4$
4229.520	5	V E	23636.71	$a^9D^\circ_5-z^9D_6$
4205.05	6000	II E	23774.26	$a^9S^\circ_4-z^9P_3$
4170.0	2	V E	23974.1	$a^9D^\circ_5-105_4$
4166.05	2	V	23996.81	$a^9D^\circ_2-102_3$
4151.52	20	V E	24080.80	$a^9D^\circ_4-y^9P_3$
4144.51	8	V E	24121.53	$a^9D^\circ_6-z^9D_6$
4129.73	5000	II E	24207.85	$a^9S^\circ_4-z^9P_4$
4124.54	10	V E	24238.31	$a^7D^\circ_5-133_6$
4112.04	30	V E	24311.99	$a^9D^\circ_3-y^9P_3$
4096.804	40	V E	24402.41	$a^9D^\circ_5-107_4$
4086.423	8	V E?	24464.40	$a^9D^\circ_3-104_3$
4085.38	40	V E	24470.64	$a^9D^\circ_2-y^9P_3$
4074.48	3	V	24536.10	$a^9D^\circ_3-105_4$
4042.018	15	V E	24733.15	$a^9D^\circ_4-107_4$
4024.24	4	V E	24841.80	$a^9D^\circ_3-106_3$
4017.58	100	IV E	24883.60	$a^9D^\circ_5-y^9P_4$
4011.69	100	V E	24920.13	$z^9P_4-e^9S^\circ_4$
4004.59	6	V E	24964.31	$a^9D^\circ_3-107_4$
3998.81	4	V E	25000.40	$a^9D^\circ_2-106_3$
3971.98	4000	II E	25169.27	$a^7S^\circ_3-z^7P_4$
3964.90	60*	V E	25214.21	$a^9D^\circ_4-y^9P_4$
3943.08	40	V E	25353.74	$z^9P_3-e^9S^\circ_4$
3942.21	30	V E, IV?	25359.33	$a^9D^\circ_3-108_3$
3930.50	4000	II E	25434.88	$a^7S^\circ_3-z^7P_3$
3929.91	6	V E	25438.70	$z^9P_4-e^7S^\circ_3$
3928.87	15	V E	25445.43	$a^9D^\circ_3-y^9P_4$
3917.70	10	V E	25517.98	$a^9D^\circ_2-108_3$
3917.29	60	II, V E	25520.65	$a^9D^\circ_6-y^9D_5$
3907.10	3000	II E	25587.21	$a^7S^\circ_3-z^7P_2$
3901.63	3	V	25623.08	$a^9D^\circ_4-110_4$
3875.10	8	V?	25798.50	$a^7D^\circ_3-140_{3,4}$
T3864.04	2		25872.34	$z^9P_3-e^7S^\circ_3$
3854.64	20	V E	25935.43	$a^7D^\circ_4-140_{3,4}$
3844.23	8?	V E	26005.66	$a^9D^\circ_5-y^9P_5$
3838.239	30	V E	26046.25	$z^7P_3-e^7F^\circ_4$
3826.68	50	V E	26124.93	$z^7P_4-e^7F^\circ_5$
3819.67	6000	II E	26172.87	$a^9S^\circ_4-z^9P_5$
3810.76	3?	V E	26234.07	$z^7P_2-e^7F^\circ_3$
3799.66	3	V E	26310.70	$a^9D^\circ_5-113_4$
3799.492	10	V E	26311.87	$z^7P_4-e^7F^\circ_4$
3799.009	100	V E	26315.21	$a^9D^\circ_4-x^9P_3$
3796.01	8	V E	26336.00	$a^9D^\circ_4-y^9P_5$
3794.39	4	V E.	26347.24	$a^9D^\circ_3-111_4$
3793.06	25	V E	26356.48	$a^9D^\circ_5-114_5$
3791.50	30	V E	26367.32	$a^9D^\circ_5-z^7D_4$
3788.765	30	V E	26386.36	$z^7P_3-e^7F^\circ_3$
3778.87	6	V E	26455.45	$a^9D^\circ_6-116_6$
3778.65	4	V?	26456.99	$a^7D^\circ_4-141_{4,5}$
3765.93	150	V E	26546.35	$a^9D^\circ_3-x^9P_3$
3761.12	300	V E	26580.30	$a^9D^\circ_5-x^9P_4$
3758.29	30	V	26600.31	$a^7D^\circ_4-141_{4,5}$
3757.639	30	V E	26604.92	$z^7P_2-e^7F^\circ_2$
3752.83	15	V E	26639.01	$a^7D^\circ_4-142_5$
3752.51	5	V E	26641.29	$a^9D^\circ_4-113_4$
3747.21	3	V E	26678.97	$z^7P_3-1^\circ_4$
3744.54	20	V E	26697.99	$a^9D^\circ_4-z^7D_4$
3743.556	100	IV E	26705.00	$a^9D^\circ_2-x^9P_3$
3741.31	400	IV E	26721.04	$a^9D^\circ_6-x^9P_5$
3736.26	2	V E	26757.15	$z^7P_3-e^7F^\circ_2$
3732.73	8	V E	26782.45	$a^9D^\circ_5-142_5$
3729.740	20	V E	26803.92	$a^9D^\circ_6-120_5$
3724.94	4000	II E	26838.67	$a^9S^\circ_4-z^7P_4$
3714.904	100	V E	26910.97	$a^9D^\circ_4-x^9P_4$
3713.45	125	V E	26921.51	$a^9D^\circ_3-115_2$
3712.40	8	V E	26929.12	$a^9D^\circ_3-z^7D_4$
3710.870	80	V E	26940.22	$a^9D^\circ_5-116_6$
3710.282	10	V E	26944.49	$z^7P_4-1^\circ_4$
3688.42	1500	II E	27104.19	$a^9S^\circ_4-z^7P_3$
3683.267	40	V E	27142.12	$a^9D^\circ_3-x^9P_4$
3678.259	100	V E	27179.06	$z^7P_2-e^7D^\circ_1$
3676.64	20	V E	27191.03	$z^7P_3-e^7D^\circ_4$
3674.634	50	V E	27205.88	$a^9D^\circ_5-x^9P_5$
3673.19	80	V E	27216.57	$z^7P_3-e^9D^\circ_3$
3670.81	12	V E	27234.22	$z^7P_2-e^7D^\circ_2$
3664.29	3	V E	27282.67	$z^7P_2-e^7D^\circ_3$
3663.47	12	V?	27288.78	$a^9D^\circ_5-120_5$
3662.94	30	V E	27292.73	$a^9D^\circ_4-117_3$
3660.629	12	V	27309.96	$a^9D^\circ_4-118_{3,4}$
3655.25	8	V	27350.14	$a^9D^\circ_5-121_4$
3650.38	3	V E	27386.63	$z^7P_3-e^7D^\circ_2$
3646.75	35	V	27413.89	$a^9D^\circ_2-y^7P_2$
3646.65	30	V E	27414.64	$a^9D^\circ_5-122_4$
3641.19	20	V E	27456.51	$z^7P_4-e^7D^\circ_4$
3637.68	50	V E	27482.24	$z^7P_4-e^9D^\circ_3$
3635.85	20	V E	27496.07	$z^7P_3-2^\circ_{3,4}$
3632.18	80	V E	27523.86	$a^9D^\circ_3-117_3$
3630.50	12	V E	27536.59	$a^9D^\circ_4-x^9P_5$
3629.80	40	V E	27541.90	$z^7P_4-e^9D^\circ_4$
3623.430	12	V E	27590.32	$z^7P_4-e^7D^\circ_5$
3622.54	150	V E	27597.10	$a^9D^\circ_6-125_7$
3616.152	100	V E	27645.85	$z^7P_4-e^9D^\circ_5$
3614.80	8	V E	27656.19	$a^9D^\circ_6-126_5$
3611.57	100	V E	27680.92	$a^9D^\circ_4-121_4$
3611.357	25	V E	27682.56	$a^9D^\circ_2-117_3$
3606.70	80	V E	27718.30	$a^9D^\circ_3-119_2$
3603.20	200	V E	27745.22	$a^9D^\circ_4-122_4$
3602.49	12	V E	27750.69	$z^7P_4-e^7D^\circ_3$

TABLE XII.—*Continued.*

λ	Arc Int.	Temp. Class	Wave No. Vac.	Multiplet Designation
3601.08	8	V E	27761.56	$z^7P_4 - 2^\circ_{3,4}$
3583.22	3	V E	27899.92	$z^7P_2 - 3^\circ_3$
3578.49	8	V E	27936.80	$z^7P_2 - 4^\circ_3$
3572.58	20	V E	27983.02	$a^9D^\circ_4 - 123_3$
3563.79	3	V	28052.03	$z^7P_4 - 3^\circ_3$
3562.174	20	V E	28064.76	$a^9D^\circ_3 - x^7P_2$
3559.42	3	V E	28086.47	$a^7D^\circ_5 - 143_5$
3559.09	6	V?	28089.08	$z^7P_3 - 4^\circ_3$
3552.516	100	V E	28141.05	$a^9D^\circ_5 - 126_5$
3551.27	8	V E	28150.93	$a^9D^\circ_4 - x^7P_3$
3544.17	20	V E	28207.32	$z^9P_5 - e^9D^\circ_4$
3542.152	80	V E	28223.39	$a^9D^\circ_2 - x^7P_2$
3538.08	40	V E	28255.87	$z^9P_5 - e^7D^\circ_5$
3532.23	25	V E	28302.67	$z^7P_2 - 5^\circ_3$
3531.151	60	V E	28311.31	$z^9P_5 - e^9D^\circ_5$
3530.36	8	V E	28317.66	$z^7P_4 - 3^\circ_3$
3526.06	8	V	28352.19	$a^9D^\circ_5 - 127_4$
3525.78	6	V E	28354.44	$z^7P_4 - 4^\circ_3$
3523.49	30	V E	28372.87	$a^9D^\circ_2 - 123_3$
3522.37	15	V E	28381.89	$a^9D^\circ_3 - x^7P_3$
3521.09	100	V E	28392.21	$z^9P_5 - e^9D^\circ_6$
3513.326	10	V E	28454.95	$z^7P_3 - 5^\circ_3$
3511.03	60	V E	28473.56	$a^9D^\circ_6 - 129_6$
3508.852	20	V E	28491.23	$a^9D^\circ_5 - y^7P_4$
3508.731	10	V E?	28492.21	$a^9D^\circ_4 - y^7P_3$
3505.30	20	V E	28520.10	$a^7S^\circ_3 - z^9D_2$
3502.79	20	V E	28540.53	$a^9D^\circ_2 - x^7P_3$
3488.301	30	V E	28659.08	$a^9D^\circ_2 - 124_1$
3485.43	25	V E	28682.69	$a^9D^\circ_4 - 127_4$
3480.837	6	V E	28720.53	$z^7P_4 - 5^\circ_3$
3476.604	30	V E	28755.50	$z^9P_4 - e^7F^\circ_5$
3461.38	80	V E	28881.97	$a^9D^\circ_2 - y^7P_3$
3460.281	15	V E	28891.14	$a^7D^\circ_3 - 144_4$
3457.56	30	V E	28913.88	$a^9D^\circ_3 - 127_4$
3454.146	15	V E	28942.45	$z^9P_4 - e^7F^\circ_4$
3452.25	15	V E?	28958.35	$a^9D^\circ_5 - 129_6$
3445.176	30	V E	29017.81	$a^9D^\circ_3 - 128_2$
3443.97	4	V	29027.97	$a^7D^\circ_4 - 144_4$
3440.999	80	V E	29053.03	$a^9D^\circ_3 - y^7P_4$
3440.820	30	V E	29054.54	{ $z^7P_2 - f^7D^\circ_1$ { $z^7P_3 - 6^\circ_{3,4}$
3439.59	10	V E?	29064.93	$z^7P_2 - f^7D^\circ_3$
3427.757	15	V E	29165.26	$z^7P_2 - f^7D^\circ_2$
3427.045	6	V E	29171.32	$a^7D^\circ_5 - 144_4$
3426.442	20	V E	29176.46	$a^9D^\circ_2 - 128_2$
3425.022	80	V E	29188.72	$a^9D^\circ_6 - 131_6$
3421.68	25	V E	29217.06	$z^7P_3 - f^7D^\circ_3$
3414.02	5	V E	29282.61	$z^9P_4 - e^7F^\circ_3$
3409.95	5	V E	29317.56	$z^7P_3 - f^7D^\circ_2$
3409.645	15	V E	29320.18	$z^7P_4 - 6^\circ_{3,4}$
3403.16	12	V E	29376.05	$z^7P_4 - e^7F^\circ_4$
3396.58	200	V E	29432.96	$z^7P_4 - f^7D^\circ_5$
3394.064	20	V E	29454.78	$z^7P_4 - f^7D^\circ_4$
3391.989	100	V E	29472.80	$a^9D^\circ_3 - x^7P_4$
3380.25	100	V E	29575.15	$z^9P_4 - 1^\circ_4$
3379.65	6	V E	29580.40	$a^7D^\circ_4 - 145_4$
3369.055	200	V E	29673.42	$a^9D^\circ_5 - 131_6$
3367.635	40	V E	29685.93	$a^9D^\circ_3 - 130_3$
3364.21	15	V E	29716.15	$z^9P_3 - e^7F^\circ_3$
3363.35	8	V E	29723.75	$a^7D^\circ_5 - 145_4$
3351.20	20	V	29831.51	$a^7S^\circ_3 - z^9D_3$
3349.7	3	V	29844.9	$a^9D^\circ_2 - 130_3$
3338.75	80	V E	29942.75	$z^7P_4 - 8^\circ_5$
3335.62	12	V E	29970.85	$a^9D^\circ_6 - 133_6$
3329.805	12	V E	30023.18	$z^7P_3 - 9^\circ_{3,4}$
3322.74	8	V E	30087.02	$z^9P_4 - e^7D^\circ_4$
3321.857	100	V E	30095.02	$a^9D^\circ_6 - 134_5$
3321.47	8	V E	30098.52	$z^9P_5 - f^7D^\circ_5$
3319.89	80	V E	30112.85	$z^9P_4 - e^9D^\circ_3$
3314.03	2	V E	30166.09	$z^7P_3 - 10^\circ_4$
3313.33	400	V E	30172.46	$z^9P_4 - e^9D^\circ_4$
3308.02	200	V E	30220.89	$z^9P_4 - e^7D^\circ_5$
3307.34	6	V E	30227.11	$a^9D^\circ_5 - 132_4$
3304.19	40	V E	30255.92	$z^7P_3 - 11^\circ_{3,4}$
3301.95	150	V E	30276.45	$z^9P_4 - e^9D^\circ_5$
3300.61	4	V E	30288.74	$z^7P_4 - 9^\circ_{3,4}$
T3289.38	(5)	—	30392.14	$z^9P_4 - 2^\circ_{3,4}$
3285.11	5	V E	30431.64	$z^7P_4 - 10^\circ_4$
3282.51	20	V E	30455.75	$a^9D^\circ_5 - 133_6$
3277.78	600	V E	30499.70	$z^9P_3 - e^9D^\circ_2$
3275.51	4	V E	30520.83	$z^9P_3 - e^7D^\circ_4$
3275.43	5	V E	30521.58	$z^7P_4 - 11^\circ_{3,4}$
3272.77	400	V E	30546.38	$z^9P_3 - e^9D^\circ_3$
3266.39	200	V E	30606.04	$z^9P_3 - e^9D^\circ_4$
3246.393	20	V E	30794.56	$a^9D^\circ_5 - 135_4$
3240.89	4	V E	30846.85	$a^7D^\circ_1 - 146_2$
3239.92	6	V E	30856.09	$a^7D^\circ_1 - 147_{1,2}$
3232.82	5	V E	30923.85	$a^7D^\circ_2 - 146_2$
3231.87	10	V E	30932.94	$a^7D^\circ_2 - 147_{1,2}$
3221.694	30	V E	31030.64	$a^7D^\circ_3 - 146_2$
3217.467	6	V E	31071.41	$a^9D^\circ_5 - 137_4$
3214.79	2	V E	31097.28	$z^9P_5 - 10^\circ_4$
3211.90	4	V E	31125.26	$a^9D^\circ_4 - 135_4$
3204.45	5	V E	31197.62	$a^7D^\circ_1 - 149_2$
3196.560	10	V E	31274.62	$a^7D^\circ_2 - 149_2$
3195.100	10	V E	31288.91	$a^9D^\circ_2 - 150_3$
3186.44	4	V E	31373.94	$a^7D^\circ_4 - 148_5$
3184.229	8	V E	31395.73	$a^7D^\circ_5 - 150_3$
3173.607	100	V E	31500.80	$a^9S^\circ_4 - z^9D_4$
3171.942	50	V E	31517.34	$a^7D^\circ_5 - 148_5$
3170.409	50	V E	31532.58	$a^7D^\circ_4 - 150_3$
3165.14	3	V	31585.07	$a^9D^\circ_3 - 136_4$
3160.33	10	V E	31633.14	$a^9D^\circ_3 - 137_4$
3157.313	15	V E	31663.36	$a^7D^\circ_2 - 152_3$
3151.84	6	V E	31718.34	$a^7D^\circ_1 - 154_2$
3150.484	15	V E	31732.00	$a^9D^\circ_3 - 151_4$
3146.699	6	V E	31770.16	$a^7D^\circ_3 - 152_3$
3144.82	6	V E	31789.14	$z^7P_2 - 12^\circ_3$
3144.207	15	V E	31795.34	$a^7D^\circ_2 - 154_2$
3136.964	15	V E	31868.75	$a^7D^\circ_4 - 151_4$
3133.23	8	V E	31906.73	$a^7D^\circ_4 - 152_3$
3129.83	3	V E?	31941.39	$z^7P_3 - 12^\circ_3$
3128.90	8	V E?	31950.88	$z^9P_4 - 6^\circ_{3,4}$
3124.19	12	V E	31999.05	$a^7D^\circ_4 - 153_{4,5}$
3123.42	2	V E	32006.94	$a^7D^\circ_2 - 155_2$
3122.91	6	V E	32012.16	$a^7D^\circ_5 - 151_4$
3117.603	15	V E	32066.66	$a^9D^\circ_5 - 139_4$
3115.77	5	V E?	32085.52	$z^9P_4 - f^7D^\circ_4$
3113.02	30	V E	32113.86	$a^7D^\circ_3 - 155_2$
3110.26	6	V E	32142.36	$a^7D^\circ_5 - 153_{4,5}$
3101.53	3	V	32232.83	$a^7D^\circ_2 - 156_3$
3097.45	100	V E	32275.28	$a^7S^\circ_3 - 103_2$
3094.183	6	V E	32309.36	$a^9D^\circ_3 - 138_2$
3091.292	10	V E	32339.57	$a^7D^\circ_3 - 156_3$
3089.64	3	V E	32356.86	$a^9D^\circ_3 - y^9D_2$
3087.02	2	V	32384.33	$z^9P_3 - 6^\circ_{3,4}$
3085.89	2	V E	32396.18	$a^7D^\circ_1 - 157_2$
3079.058	8	V E?	32468.06	$a^9D^\circ_2 - 138_2$
3078.57	5	V E	32473.21	$a^7D^\circ_2 - 157_2$
3078.27	1	V	32476.38	$a^7D^\circ_4 - 156_3$
3077.358	200	V E	32486.00	$a^9S^\circ_4 - z^9D_4$
3075.14	3	V E	32509.43	$z^7P_2 - 13^\circ_3$
3074.556	6	V E?	32515.60	$a^9D^\circ_2 - y^9D_2$
3071.58	5	V E	32547.11	$z^9P_3 - f^7D^\circ_3$
3069.110	50	V E	32573.30	$z^9P_4 - 8^\circ_5$
3068.47	1	V E	32580.09	$a^7D^\circ_3 - 157_2$
3060.81	4	V E	32661.62	$z^7P_3 - 13^\circ_3$
3054.94	600	V E	32724.38	$a^7S^\circ_3 - y^9P_3$
3042.53	4	V E	32857.85	$a^9D^\circ_3 - 140_{3,4}$
3040.77	40	V E	32876.87	$a^7S^\circ_3 - 104_3$
3040.429	12	V E	32880.56	$a^9D^\circ_4 - y^9D_3$
3036.84	5	V	32919.42	$z^9P_4 - 9^\circ_{3,4}$
3036.11	4	V	32927.33	$z^7P_4 - 13^\circ_3$
3015.869	6	V	33148.31	$a^9D^\circ_4 - 141_{4,5}$
3015.52	2	V	33152.15	$z^7P_4 - 11^\circ_{3,4}$
3006.26	80	V E	33254.26	$a^7S^\circ_3 - 106_3$
3004.80	20	V E	33270.42	$a^9D^\circ_2 - y^9D_3$
2999.4	1	V E	33330.3	$a^9D^\circ_4 - 142_5$
2997.36	2	V E	33353.00	$z^9P_3 - 9^\circ_{3,4}$
2995.221	50	V E	33376.81	$a^7S^\circ_3 - 107_4$
2991.33	300	V E	33420.23	$a^9S^\circ_4 - z^9D_5$
2990.26	15	V E	33432.18	$a^9D^\circ_5 - y^9D_4$
2976.58	2	V E?	33585.83	$z^9P_3 - 11^\circ_{3,4}$
2973.30	2	V	33622.88	$a^7D^\circ_1 - 158_1$
2966.52	10	V E	33699.72	$a^7D^\circ_2 - 158_1$
2960.21	300	V E	33771.55	$a^7S^\circ_3 - 108_3$
2959.47	80	V E	33779.99	$a^9S^\circ_4 - 101_4$
2956.07	2	V	33818.84	$a^9D^\circ_6 - 143_5$
2952.68	600	V E	33857.67	$a^7S^\circ_3 - y^9P_4$
2949.12	25	V E	33898.54	$a^7S^\circ_3 - 109_3$
2947.29	100	V E	33919.59	$a^9S^\circ_4 - 102_3$
2940.82	15	V E	33994.21	$a^9D^\circ_3 - y^9D_4$
2940.45	8	V E	33998.48	$a^9D^\circ_6 - y^9D_5$
2925.04	600	IV E	34177.59	$a^7S^\circ_3 - y^7D_2$
2917.439	30	V E	34266.63	$a^7S^\circ_3 - z^9F_4$
2914.29	4	V E	34303.66	$a^9D^\circ_5 - 143_5$
2906.68	1000	IV E	34393.46	$a^9S^\circ_4 - y^9P_3$
2899.10	8	V	34483.38	$a^9D^\circ_5 - y^9D_5$
2893.83	300	I, V E	34546.18	$a^9S^\circ_4 - 104_3$
2887.85	60	V E	34617.71	$a^9S^\circ_4 - 105_4$
2886.46	3	V	34634.38	$a^9D^\circ_4 - 143_5$
2876.06	60	V E	34759.62	$a^7S^\circ_3 - 111_4$
2871.57	12	V E	34813.96	$a^9D^\circ_4 - y^9D_5$
2864.42	20	V	34900.86	$a^9D^\circ_6 - y^9D_6$
2862.57	500	V E	34923.41	$a^9S^\circ_4 - 106_3$
2859.67	300	V E	34958.83	$a^7S^\circ_3 - x^9P_3$
2852.55	8	V	35046.08	$a^9S^\circ_4 - 107_4$
2843.96	60	V E	35151.93	$a^7S^\circ_3 - 112_3$
2834.34	2	V E	35271.23	$z^9P_3 - 12^\circ_3$
2833.26	125	V E	35284.67	$a^7S^\circ_3 - 113_4$
2829.30	125	V E	35334.06	$a^7S^\circ_3 - 115_2$
2828.72	500	V E	35341.30	$a^7S^\circ_3 - z^7D_4$

TABLE XII.—*Continued.*

λ	Arc Int.	Temp. Class	Wave No. Vac.	Multiplet Designation
2825.17	8	V	35385.71	$a^9D^\circ_5-y^9D_6$
2820.78	800	IV E	35440.78	$a^9S^\circ_4-108_3$
2816.18	500	IV E	35498.66	$a^7S^\circ_3-z^7D_3$
2813.94	1200	IV E	35526.92	$a^9S^\circ_4-y^9P_4$
2811.75	200	V E	35554.59	$a^7S^\circ_3-x^9P_4$
2810.71	15	V E?	35567.74	$a^9S^\circ_4-109_3$
2802.84	600	IV E	35667.61	$a^7S^\circ_3-y^7P_2$
2781.93	400	IV E	35935.68	$a^9S^\circ_4-110_4$
2781.89			35936.20	$a^7S^\circ_3-117_3$
2780.53	20	V	35953.78	$a^7S^\circ_3-118_{3,4}$
2766.92	10	V E	36130.62	$a^7S^\circ_3-119_2$
2752.17	150	V E	36324.25	$a^7S^\circ_3-121_4$
2747.286	100	V E	36388.82	$a^7S^\circ_3-122_4$
2744.26	200	V E	36428.94	$a^9S^\circ_4-111_4$
2740.62	200	V E	36477.32	$a^7S^\circ_3-x^7P_2$
2729.44	300	V E	36626.73	$a^7S^\circ_3-123_3$
2729.33	300	IV E	36628.20	$a^9S^\circ_4-x^9P_3$
2727.78	800	IV E	36649.01	$a^9S^\circ_4-y^9P_5$
2716.98	400	IV E	36794.69	$a^7S^\circ_3-y^7P_3$
2715.02	3	V	36821.25	$a^9S^\circ_4-112_3$
2705.28	150	V E	36953.81	$a^9S^\circ_4-113_4$
2701.90	400	V E	37000.03	$a^9S^\circ_4-114_5$
2701.14	250	V E	37010.44	$a^9S^\circ_4-z^7D_4$
2692.03	250	V E	37135.68	$a^7S^\circ_3-y^7P_3$
2685.66	200	V E	37223.76	$a^9S^\circ_4-x^9P_4$
2678.29	200	V E	37326.18	$a^7S^\circ_3-127_4$
2670.85	15	V	37430.15	$a^7S^\circ_3-128_2$
2668.34	300	V E	37465.36	$a^7S^\circ_3-y^7P_4$
2658.41	20	V E	37605.30	$a^9S^\circ_4-117_3$
2657.17	10	V	37622.83	$a^9S^\circ_4-118_{3,4}$
2641.27	250	V E	37849.31	$a^9S^\circ_4-x^9P_5$
2638.77	400	V E	37885.17	$a^7S^\circ_3-y^7P_4$
2635.50	60	V	37932.17	$a^9S^\circ_4-120_5$
2631.23	15	V E	37993.72	$a^9S^\circ_4-121_4$
2626.776	25	V E	38058.14	$a^9S^\circ_4-122_4$
2624.01	6	V	38098.26	$a^7S^\circ_3-130_3$
2610.5	2	V	38295.4	$a^9S^\circ_4-123_3$
2605.47	4	V	38369.34	$a^7D^\circ_1-159_2$
2600.26	10	V	38446.21	$a^7D^\circ_2-159_2$
2597.81	4	V	38482.47	$a^7D^\circ_1-160_2$
2592.61	10	V	38559.65	$a^7D^\circ_2-160_2$
2585.76	12	V E?	38661.79	$a^7D^\circ_1-x^7F_0$
2585.45	2	V	38666.42	$a^7D^\circ_3-160_2$
2581.86	30	V E	38720.19	$a^7D^\circ_2-x^7F_3$
2581.2	1	V	38730.1	$a^9D^\circ_3-152_3$
2577.56	20	V	38784.78	$a^9S^\circ_4-126_5$
2577.14	150	V E	38791.10	$a^7D^\circ_5-x^7F_6$
2576.22	10	V	38804.95	$a^9S^\circ_4-y^7P_3$
2574.76	30	V E	38826.95	$a^7D^\circ_3-x^7F_3$
2568.53	20	V, V E	38921.12	$a^7D^\circ_1-x^7F_1$
2568.17	80	V E	38926.58	$a^7D^\circ_3-x^7F_4$
2565.71	6	V E	38963.90	$a^7D^\circ_4-x^7F_3$
2564.55	10	V E	38981.52	$a^7D^\circ_2-161_3$
2564.17	125	V E	38987.30	$a^7D^\circ_4-x^7F_5$
2563.6	1	V	38996.0	$a^9S^\circ_4-127_4$
2563.48	10	V E	38997.78	$a^7D^\circ_2-x^7F_1$
2559.18	80	V E	39063.31	$a^7D^\circ_4-x^7F_4$
2557.54	25	V E	39088.36	$a^7D^\circ_3-161_3$
2554.781	50	V E	39130.57	$a^7D^\circ_5-x^7F_5$
2554.50	4	V E	39134.87	$a^9S^\circ_4-z^7P_4$
2552.01	15	V E?	39173.05	$a^9D^\circ_4-155_2$
2549.82	4	V	39206.69	$a^7D^\circ_5-x^7F_4$
2548.63	4	V E?	39225.00	$a^7D^\circ_4-161_3$
2547.243	15	V E	39246.36	$a^7D^\circ_1-x^7F_2$
2542.262	40	V E	39323.25	$a^7D^\circ_2-x^7F_2$
2535.36	8	V E?	39430.29	$a^7D^\circ_3-x^7F_2$
2527.40	5	V	39554.5	$a^9S^\circ_4-x^7P_4$
2516.10	4	V	39732.09	$z^7P_3\ -f^7S^\circ_3$
2514.36	3	V	39759.58	$z^7P_4\ -f^9S^\circ_4$
2513.76	5	V	39769.07	$a^7S^\circ_3-135_4$
2499.391	50	V	39997.69	$a^7S^\circ_3-136_4$
2496.81	10	V E	40039.03	$a^7D^\circ_1-162_{1,2}$
2496.4	1	V	40045.6	$a^7S^\circ_3-137_4$
2492.02	15	V	40115.99	$a^7D^\circ_2-162_{1,2}$
2490.46	10	V E	40141.11	$a^7D^\circ_2-163_3$
2488.83	3	V E?	40167.40	$a^7D^\circ_2-164_{2,3}$
2483.84	8	V	40248.09	$a^7D^\circ_3-163_3$
2483.23	3	V	40274.19	$a^7D^\circ_3-164_{2,3}$
2472.96	8	V	40425.15	$z^9P_5\ -f^9S^\circ_4$
2468.8	1	V	40493.26	$a^7D^\circ_3-165_{3,4}$
2460.50	12	V	40629.85	$a^7D^\circ_4-165_{3,4}$
2454.944	60	V	40721.80	$a^7S^\circ_3-138_2$
2452.08	40	V	40769.35	$a^7S^\circ_3-y^9D_2$
2445.99	5	V	40870.85	$a^9S^\circ_4-132_4$
2435.86	2	V	41040.81	$a^7S^\circ_3-139_4$
2425.05	8	V	41223.23	$a^9S^\circ_4-134_5$
2407.492	40	V	41524.36	$a^7S^\circ_3-y^9D_3$
2403.34	5	V	41596.09	$a^7D^\circ_1-166_2$
2398.916	10	V	41672.80	$a^7D^\circ_2-166_2$
2396.5	2	V E	41714.8	$a^9D^\circ_4-137_4$
2392.77	3	V	41779.83	$a^7D^\circ_3-166_2$
2390.43	8	V E	41820.72	$a^7D^\circ_1-167_1$
2386.05	40	V	41897.48	$a^7D^\circ_2-167_1$
2379.65	50	V	42010.16	$a^7D^\circ_1-168_2$
2375.31	60	V	42086.91	$a^7D^\circ_2-168_2$
2369.3	1	V	42193.7	$a^7D^\circ_3-168_2$
2361.14	30	V	42339.46	$a^7D^\circ_4-169_{4,5}$
2358.32	3	V E?	42390.08	$z^9P_4\ -f^9S^\circ_4$
2357.39	12	V	42406.81	$a^7S^\circ_3-y^9D_4$
2353.18	2	V	42482.67	$a^7D^\circ_5-169_{4,5}$
2340.64	20	V	42710.25	$a^9S^\circ_4-139_4$
2332.76	8	V E	42854.51	$a^7D^\circ_3-170_{3,4}$
2325.34	6	V	42991.24	$a^7D^\circ_4-170_{3,4}$

* Intensity refers to blend of arc and spark line.

therefore, that a complete analysis of this extremely complex spectrum will be long deferred.

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